Food insecurity among the elderly in developed countries:

Insights from a multi-national analysis

Jae Yeon Park

School of Human Nutrition

McGill University, Montreal

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Abstract

Background: Food insecurity is an intricate phenomenon, which makes it difficult to fully understand it along with its causes and consequences. While the effects of food insecurity in elderly populations show their own distinct characteristics in demographic and physiological features, including functional impairments, social isolation, and higher demand for healthcare services, there are fewer independent studies conducted on food insecurity in the elderly.

Objective: This study aims to estimate the prevalence of food insecurity and its association with demographic and socioeconomic factors that characterized elderly survey respondents in 51 developed countries and to discuss similarities and differences across regions.

Methods: Cross-sectional data are taken from the Gallup World Poll (4-year file for 2014-2017) based on respondents aged ≥ 65 (n = 33,692). Food insecurity, the main outcome variable, was assessed using the Food Insecurity Experience Scale, a direct measure of experience-based food insecurity. Descriptive statistics of target populations and the prevalence of food insecurity are produced. Demographic variables include age, gender, marital status, household size, education level, social support, subjective health status, and affective well-being. For socioeconomic variables, income, employment status, urbanicity, and community environments are evaluated. Adjusted logistic regression is used to compute odds ratios for elderly food insecurity and the level of statistical significance is set at 5%.

Results: Globally, young seniors had higher odds of being food insecure than older seniors, and great heterogeneity of the prevalence of food insecurity among seniors was found between regions, ranging from OR 0.25 (Australia and New Zealand) to OR 3.25 (Middle East). At the individual level, food insecure seniors were more likely to live alone (OR 1.65, 95%CI: 1.42, 1.88), not have a partner (OR 1.42, 95%CI:1.27, 1.60), and tended to

have poorer scores on social support (OR 2.05, 95%CI:1.81, 2.31) and well-being. Also, poor community infrastructure (OR 1.70, 95%CI: 1.54, 1.87) was associated with food insecurity of elderly people, and there were more food insecure elderly people in urban areas.

Conclusions: This study concludes that not only personal factors but also social conditions could prevent the elderly from achieving full food security status. These findings emphasize the need for various approaches to address food insecurity issues among seniors through both the community level and the individual level.

Résumé

Contexte: L'insécurité alimentaire est un phénomène complexe étroitement lié aux enjeux de société et de santé publique, rendant ainsi difficile aussi bien la compréhension de ses causes que de ses conséquences. Alors que les effets de l'insécurité alimentaire chez les populations vieillissantes touchent aussi bien la démographie que les caractéristiques physiologiques entre autres troubles fonctionnels, isolation sociale ou encore une forte demande des services de santé, il y a toutefois de moins en moins d'études indépendantes réalisées à ce sujet.

Objectifs: Basée sur un sondage réalisé dans 51 pays développés auprès de personnes âgées, cette étude vise à mesurer la prédominance de l'insécurité alimentaire et son rapport aux facteurs démographique et socio-économique auprès de ces populations tout en discutant des similitudes et des differences entre ces pays.

Méthodologie: En se basant sur l'échelle de mesure de l'insécurité alimentaire, le sondage international Gallup (Gallup World Poll) a réalisé entre 2014 et 2017 un sondage auprès de 33,692 personnes âgées de 65 ans et plus. Les résultats de ce sondage, utilisés pour cette étude croisée, ont permis d'obtenir des statistiques descriptifs de la population ciblée et la predominance de l'insécurité alimentaire. En ce qui concerne les données démographiques, ont été pris en compte l'âge, le sexe, le statut marital, la taille du foyer, le niveau d'éducation, l'aide sociale, l'état de santé et le bien-être. Quant aux données socio-économiques, le revenu, l'employabilité ainsi que le voisinnage avaient été pris en compte. Ainsi, le rapport de cotes (RC) avait été calculé utilisant le modèle de régressions logistiques avec un niveau de signification statistique à 5%.

Résultats: D'une manière générale, pour un groupe de personnes ayant entre 65 et 75ans, il y avait un plus grand risque de souffrir d'insécurité alimentaire qu'un groupe de personnes dont l'âge variait entre 75 et 85ans; de plus on remarquait une grande hétérogénéité de la

prédominance de l'insécurité alimentaire parmi ces groups de personnes avec un RC allant de 0.245 (Australie et Nouvelle-Zélande) à 3.249 (Moyen-Orient). Au niveau plus individuel, les personnes âgées souffrant d'insécurité alimentaire avaient plus tendance à vivre seule, à ne pas être couple et à recevoir le moins d'aide sociale et de bien-être. De même, le manque d'infrastructures communautaires avait un impact sur l'insécurité alimentaire chez ces personnes; de plus celles vivant en milieu urbain étaient plus sujettes à l'insécurité alimentaire.

Conclusion: Cette étude a permis de montrer que tout comme les facteurs personnels, les conditions sociales aussi peuvent empêcher les personnes âgées d'atteindre le seuil de sécurité alimentaire. Ces recherches ont aussi permis de voir la nécessité de la mise en place de politiques spécifiques en matière d'insécurité alimentaire chez les personnes âgées aussi bien sur le plan communautaire qu'individuel.

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<div align="right">Jae Yeon Park</div>

Contribution of Authors

This thesis manuscript is contributed by listed authors that devote the majority of their efforts to various stages of designing, research and writing. As the lead author, Jae Yeon Park conceptualized the research framework, reviewed the literature, carried out the analytic calculations, interpreted the findings, and wrote all chapter of this dissertation. Dr. Hugo Melgar-Quiñonez supervised the project, critically reviewed and revised the manuscript. Dr. Patrick Cortbaoui provided assistance throughout the study and contributed to the final version of the manuscript. Dr. Timothy Schwinghamer aided in verifying the analytical methods and numerical results of the logistic regression. All authors provided critical feedback and declared no conflict of interest in regard to this manuscript.

Table of contents

List of Tables

List of Figures

Abbreviation

CAI	Community Attachment Index
CBI	Community Basics Index
CI	Confidence Intervals
FAO	Food and Agriculture Organization
FIA	Food Intake Assessment
FIES	Food Insecurity Experience Scale
FIES SM-I	Food Insecurity Experience Scale Survey Module for Individuals
GNI	Gross National Income
GWP	Gallup World Poll
HDI	Human Development Index
MO	Middle-old group
NAI	Negative Affectivity Index
OO	Oldest-old group
OR	Odds Ratio
PAI	Positive Affectivity Index
UNDP	United Nations Development Programme
UNID	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VoH	Voices of the Hungry
WHO	World Health Organization
YO	Young-old group

CHAPTER 1. Introduction

1.1 Background

The world is experiencing a situation without precedent, which is becoming a growing challenge to the stainability of public system, and population ageing became one of the most consequential social alterations with implications for all sectors of society. Globally, the population of aged 80 years or over is growing faster than any other age groups, given the interesting fact that adult diapers have become a globally booming market due to an expected surge in demand (United Nations, 2015).

As living longer does not necessarily connote living healthier, the quality of life during the extra years has emerged as one of the most daunting and costly challenges facing public health policies (Crimmins & Beltran-Sanchez, 2011; Ziliak & Gundersen, 2018). Varieties of international agendas underline the importance of well-being in older age, both in its own right and for the instrumental benefits of inducing the social participation of elderly people which would act as a broad range of contributions to the whole society (Development Initiatives, 2017; Sidorenko & Walker, 2004). Human beings have devoted their full attention to quantitative aspect of lifespan, but now it is time to set new goals in public health, improving 'health-span' with the functional and illness-free period of life (Olshansky, 2018).

Even though several countries have implemented policies and assistance services to protect health and food security of senior citizens, projected trends in population ageing and a lack of research in this area give rise to concerns about the fiscal sustainability of existing health care and pension systems to manage the growing number of older adults (Canadian Institute for Health Information, 2017; World Health Organization, 2015). Preparing for the social and political shifts in time associated with an ageing population is thus necessary to ensure achieving the fairer society where "no one is left behind" (Development Initiatives, 2017).

1.2 Study Rationale

As food insecurity is inextricably connected with socio-economic weaknesses, there has been a common perception that elderly citizens in affluent nations are safe with multiple protections. Such unwarranted notions might provide conditions that allow for an unethical acceptability of the presence of food insecurity among the elderly, especially in developed areas. As such, questions on the food insecurity status of the elderly calls for greater efforts to understand the extent and if needed, the introduction of policies to reduce and prevent this problem (Campbell, 1991; FRAC, 2015; Hamelin, Mercier, & Bédard, 2008). While chronic nutritional deficiencies are more prevalent in developing countries, food insecurity has come to be recognized as a rising social issue among the elderly in many high-income countries (Food and Agriculture Organization, 2017). As the need to provide food security in old age continues to grow, many countries may confront these crises unless reforms are made and system targeting improves (Mitchell, 1993; Oliveira & Watanabe, 2010).

1.3 Study Objectives

This study aims 1) to examine the food insecurity status of different chronological age groups of seniors in developed countries, 2) to detect and generate empirical data on the demographic and socio-economic factors influencing food insecurity of the elderly in developed countries, and 3) to compare the prevalence of food insecurity in senior population at a global level.

CHAPTER 2. Literature Review

2.1 Food Security

 2.1.1 Concepts of Food Security

Food security is elusive to define and ways of thinking about it have evolved over decades to reflect the society of the time period. The initial concept can be traced back to the 1974 World Food Summit:

"Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuation in production and prices" (United Nations, 1975).

This understanding of the concept can be appreciated based on the world food situation. It was right after the era of an abundance of crops made possible by the green revolution. In the 1970s, the unfolding global food crisis broke out followed by shocks faced by the global food supply on a grand scale (Jachertz, 2015; Marion, 2011). The importance of the issue of food security rose to prominence on the international agenda and the United Nations embarked on several major actions to secure better use of the world's resources (Food and Agriculture Organization, 1974).

Since the 1974 World Food Conference, the concept has "evolved, developed, multiplied and diversified" (Marion, 2011). Also in parallel, the development of food security measures has expanded from a focus on the national level to individual level, from temporal inadequacy to chronic insecure status, and from basic foodstuffs to nutritious and sufficient food, emphasizing both food quantity and quality (variety of diet) (Bickel & Nord, 2000; United Nations, 1975). In 1996, the definition was further widened and specified to describe the multidimensional nature of food security in terms of the so called four pillars: accessibility, availability, utilization and stability (Marion, 2011). This understanding has also been called the four dimensions of food security and can be found in the most widely accepted definition as announced at the World Food Summit 1996, Rome Declaration on World Food Security. It states that,

"*Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (Food and Agriculture Organization, 2002).

Since this summit, the analysis of food security as the Human Right to adequate food has emerged and currently over 40 countries have the right to food or some of its aspects enshrined in their constitution (Knuth & Vidar, 2011).

The definition recognizes that food insecurity occurs when people are not able to get adequate social, national, cultural, physical or economic access to enough food as defined above. The Food and Agriculture Organization (FAO) defined food insecurity as:

"*A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life*" (Marion, 2011).

2.1.2 Determinants of Food Security

Food security is a multifaceted situation that is affected by the interaction of a range of agro-physical, socioeconomic, and nutritional factors and can vary in significance across regions, communities, individuals as well as over time (Riely, Mock, Cogill, Bailey, & Kenefick, 1999). From the FAO definition, the factors affecting food security can be clustered into four key groups: availability, access, utilization, and stability (Marion, 2011).

Food availability

Food availability can be described as "sufficient quantities of food of appropriate quality, supplied through all forms of domestic production, imports, food stocks and food aid" (World Food Programme, 2009). The fact that the world is already producing enough food to feed its entire population implies that the concept of food availability should extend beyond the number of calories in food intake and also focus on the availability of culturally

acceptable, nutritious for all the macro and micro nutrients, and safe food (Pangaribowo, Gerber, & Torero, 2013).

Accessibility to food

        The World Food Program defines food access "as having physical, economic, and social ability to acquire adequate amounts of food regularly through a combination of purchases, barter, borrowings, food assistance or gifts" (World Food Programme, 2009). Barriers to physical access could result from not only personal health problems but also systemic causes, such as poor infrastructure or inefficient food distribution (Food and Agriculture Organization & Programme, 2014). The economic dimension can be simply illustrated by a situation when people cannot afford to buy sufficient food. And the third element, social-cultural access, arises when a member of a particular social group is hampered to obtain the food, even though he/she is physically and economically available to buy and get the food (Marion, 2011).

Food utilization

        Food utilization addresses how much food the people eat, what they eat, and how they prepare and store food (World Food Programme, 2009). It also includes the intra-household food distribution, health care and sanitation practices as they relate to nutrition (USAID, 1992).

Stability of supply and access

        Stability refers to the stability of the three dimensions, described above: availability, accessibility, and utilization for food security at all times without risks (World Food Programme, 2009). The main risks of stability are unexpected natural disasters, economic and social disruption, unstable political climate, and energy scarcity (Marion, 2011).

2.1.3 Measuring Food Security

The more complex the underlying reality to be reflected, the greater the need for multilayered indicators; for example, there is no best single indicator of health status. As this notion also applies to food security, a range of indicators has been being proposed for decades to capture this complex nature of food security across the world (Marion, 2011).

Food Insecurity Experience-based Measurement

Food insecurity experience-based measurement is the only fundamental method that measures direct experience of food accessibility, perceived by the affected individuals (Food and Agriculture Organization, 2016a). Not only does it imply compromised food diversity and reduced food quantity, but the scale also captures psychosocial elements including latent anxiety and worries over obtaining sufficient food (Nord, Cafiero, & Viviani, 2016). As the unit of analysis is quite straightforward and inexpensive, this scale is well fitted for international-level studies comparing the severity of food insecurity in different parts of the world (Food and Agriculture Organization, 2016b).

Food Intake Assessment

Food intake assessment (FIA) addresses the actual amount of food consumed by the individual members of a household (Livingstone, Robson, & Wallace, 2004). There are three commonly used methods to measure the dietary intake including: 24-hour dietary recalls, food frequency questionnaires, and food records (Prentice, Mossavar-Rahmani, Huang, & Van Horn, 2011). Using FIA is possible to measure both caloric intakes and nutrient content of food items eaten. It also allows for understanding dietary patterns of food consumption at the individual/household level. As FIA heavily relies upon the memory of participants, it can have substantial measurement error (Pérez-Escamilla & Segall-Corrêa, 2008).

Anthropometric indicators

Anthropometric indicator is quite a unique indicator that approaches the hunger from the composition of the human body. It measures the health status such as size, weight, or body proportions and ultimately assess the impact of the interactions between food insecurity and body transformation (Marion, 2011). As anthropometry allows for understanding consequences of chronic malnutrition at the individual level, it is a popular method in national surveys (Pérez-Escamilla & Segall-Corrêa, 2008).

2.2 Seniors

2.2.1 Defining the Seniors

Globally, there is no official set age that determines when one is considered a senior citizen. The criteria commonly chosen are chronological, clinical, and socio-demographical which vary with cultures, eras and the purposes of the research. According to the World Health Organization, the chronological age of 65 years may be generally used to denote as old age, because people at that age tend to start perceiving significant life changes with increased major burdens of health care and non-communicable diseases (Christine & Joaquim, 2013; United Nations, 2017; World Health Organization, 2015). More specific breakdowns into subgroups, such as 'young-old' and 'middle-old', may help improve the accuracy of analysis and make more meticulous understanding of the elderly.

2.2.1 Demographic profile of Seniors

The demographic transition has been an ongoing part of population changes occurring across the world. Population aging, an inevitable consequence of falling fertility rates and declining mortality rates, is one of the most notable global demographic trends of the 21st century. Regardless of countries' developmental stages or geographic location, the number of persons aged 80 years and over continues to grow faster than any other age group across the world (United Nations, 2015). This global aging process is most advanced in developed countries. For example, Japan is suffering from what has been called a "super-

aging" process with 33% of the population aged 60 years and over in 2017, followed by Italy (29%), Germany (28%), and Portugal and Finland (27%) (United Nations, 2017). Also, the pace of population ageing is projected to accelerate even more in the coming decades, particularly in high-income countries. In these countries, life expectancy of older age persons has been rising dramatically in recent years (World Health Organization, 2015). This means that the adaptation to rapid demographic changes will have to be undertaken much more quickly now than during any other era. This growing portion of the elderly within national populations brings with it specific concerns because of their unique vulnerabilities.

2.2.2 Vulnerabilities of Seniors in public health

The vulnerabilities of seniors are characterized in public health policy as: frailty, chronic diseases, mental impairment, and social challenges.

Frailty

Frailty, in the field of gerontology and geriatrics, can be defined as the condition of being weak and delicate which often accompanies a number of chronic diseases (Fried et al., 2001). In practice, it is seen as a syndrome/precursor which progresses as the pathophysiology of the metabolic level declines with aging (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013). Some scientists describe ageing as, "a slow-motion car crash – everything just gets wrecked simultaneously" (Kirkwood, 2008). When this cumulative decline reaches an aggregate threshold, it can be an indicator of the severity of the aging process, physiologic alteration, chronic diseases, immune deficiency, or comorbidity over a life span (Clegg et al., 2013).

Chronic diseases

It has been noted that chronic diseases increase sharply with age. While there is no evidence to determine inevitable causality between aging process and onset of disease, yet age is obviously the biggest risk factor for a broad variety of clinical conditions that often

prohibits the elderly from living normal lives (Kirkwood, 2008). In 2013, WHO estimated the average number of years to be lived in good health as 62 years, with the corresponding value of total life expectancy at birth as 71 years. This implies that there is a nine year difference (as of 2013) between good health and life expectancy where the elderly cannot enjoy a satisfactory life due to disability, frailty, and/or chronic diseases (World Health Organization, 2015). A decline in vision and hearing ability is one of the most common symptoms in the ageing process as is decline in muscular function (Jaul & Barron, 2017). For example, one in three elderly persons between the ages of 65 to 74 in the United States suffers from hearing loss, and nearly half of those older than 75 years of age have trouble with their hearing (National Institute on Deafness and Other Communication Disorders, 2018). Cardiovascular disease, osteoporosis, dementia, and diabetes are representative types of chronic conditions, commonly found in the elderly (Jaul & Barron, 2017). The prevalence of multimorbidity is increasing significantly with age and the impact of multimorbidity on quality of life seems to be much greater than the sum of each effect (Salive, 2013; World Health Organization, 2015).

Mental impairments

       The elderly not only suffer from physical decline but also face mental health issues. Poorer psychological health in older populations, particularly in older men, has been identified as a significant problem in terms of prospective negative outcomes regarding increased utilization of medical care resources, high rates of suicide risk and the severity of the caregiver burden (Butcher, Holkup, & Buckwalter, 2001; Byers & Yaffe, 2011; Enache, Winblad, & Aarsland, 2011). All these issues are interconnected, since for a person to be diagnosed with dementia, he or she can have comorbid depression (Byers & Yaffe, 2011). This suggests that mental instability can have a negative influence on physical activity and diet quality, and vice versa (Jacka & Berk, 2013).

Social challenges

Beyond these functional impairments, elderly also face social difficulties. Elderly people frequently experience additional threats to their wellbeing, such as changes in social positions, losing their sense of self-worth, as they lose control of independent function, or the loss of close relationships due to death or decline (World Health Organization, 2015). These social difficulties may increase their isolation and disrupt their social network during this critical time.

2.3 Criteria for Developed country

The term 'developed country', also known as industrialized country or affluent country, is based on multiple concept classifications. It is often used to designate a nation that is more economically advanced with a relatively high level of general standard of living and technological infrastructures (UNDP, 2016; UNID, 2017; World Bank, 2017). The most commonly used criteria by sector for evaluating a country's level of development is described below.

Economic criteria

The primary factor used to determine if an economy is considered either developed or developing is 'gross national income (GNI) per capita'. Using this classification, the World Bank assigns the world's economies into four income groups – high, upper-middle, lower-middle, and low (**Table 1**).

Table 1. Country Economies Classification

Threshold	GNI/Capita (current US$)
High-income	>12,235
Upper-middle income	3,956-12,235
Lower-middle income	1,006-3,955
Low-income	<1,005

Source: World Bank

Sociological criteria

Human Development Index (HDI) is a summary measure developed by the United Nations to gauge a country's level of human development. The higher the HDI the more prosperous the country is (UNDP, 2016). The HDI emphasizes that people and their capabilities should be the criteria for assessing the development of society and it is taken into account under three dimensions: a long and healthy life, education opportunity, and a decent standard of living. Countries are grouped into low-, medium-, high-, and very high-HDI and countries that have achieved very high HDI are designated as developed.

2.4 Food Security of Seniors

Given the key components of food security: availability, accessibility, utilization and stability, older adults are one of more vulnerable population groups because their uniquely vulnerable position across the four dimensions of food security may limit the ability to use food (Hall & Brown, 2005). Their specific vulnerabilities implies a whole series of challenges that they face from difficulties with food available to meet their needs, to their gaining access to food, to their ability to be involved in preparing, eating and maintaining an adequate diet (Quandt, Arcury, & Bell, 1998; Quandt & Vitolins, 1997). Clearly, food insecurity in older adults is a potential risk factor for poor nutritional status, unhealthy eating patterns, chronic disease and mental distress (Fernandes et al., 2018).

2.4.1 Food Insecurity of Seniors in Developed Countries

Food insecurity was commonly perceived as a social problem of developing countries and was associated with poverty, absence of social protection programs and limited access to resources. It was widely assumed that because these social conditions did not take place in developed countries, food insecurity was not a major concern in these countries. However, the related situation grew to threaten the political and social stability of developed nations recently for different reasons from their peers in developing countries (Campbell, 1991; Ishiguro, 2014; Strickhouser, Wright, & Donley, 2014). For example, 38 % of the elderly population in Japan have been struggling to purchase foodstuffs and

daily necessities (Ishiguro, 2014), and racial and ethnic disparities in health conditions among U.S. older adults has emerged as a serious social disintegration issue resulting in wide ranges in food insecurity (Institute of Medicine, 2011; Neff, Palmer, McKenzie, & Lawrence, 2009). While these studies highlight food insecurity issues of concern among the elderly, less is known about food insecurity of the elderly in other affluent nations, because previous studies on food insecurity in developed countries have focused heavily on children and women.

2.4.2 Factors associated with Food Insecurity of Seniors

The elderly population presents unique demographic and physiological features including functional impairments, economic insecurity and sensory impairments which are not normally seen in other generations. Therefore, this suggests that the risk factors of food insecurity among the elderly and their implications should be studied separately (Lee & Frongillo Jr, 2001a) (**Figure 1**).

Economic factors

Although many combined factors affect food insecurity, financial resources are the most significant risk factor at both individual and community levels. The economic environment such as inflation, unemployment rates, housing price, and tax rates has considerable impacts on food insecurity (Bickel & Nord, 2000; Coleman-Jensen, Matthew, Christian, & Anita, 2016; Cook & Frank, 2008; Shobe, Narcisse, & Christy, 2018). Food insecurity is most widespread in the lowest-income groups and practically decreases as income rises (Strickhouser et al., 2014).

Functional impairments

Health problems contribute to food insecurity in five distinct ways: limiting access to sufficient food; limiting the practical use of food; increasing the need for special nutrients and meal patterns, leading to anxiety about being able to maintain a constant

balance; increasing medical expenses; and the loss of appetite, resulting in anorexia of aging (Hall & Brown, 2005; Wolfe, Olson, Kendall, & Frongillo, 1996).

Sociodemographic factors

Sociodemographic factors of food security in elderly may be broken down roughly into community and individual levels. In community-based research, high social capital is thought of as an indicator of community development and both allow residents to obtain higher quality of food services and resources (Carter, Dubois, Tremblay, & aljaard, 2012; Cummins et al., 2009; Kay, 2005). At the micro-level, having a higher education, smaller family size, living with partners, and being retired are all positively associated with food security (Coleman-Jensen et al., 2016; Donald, Craig, & Victor, 1998; Hanson, Sobal, & Frongillo, 2007; Olayemi, 2012).

2.4.3 Consequences of Food Insecurity in Seniors

Unmet needs for adequate calories and nutritional balance can affect shaping senior's health in many ways, with potentially negative consequences for mental and physical, in addition to social wellbeing (Alley et al., 2009; Olson, 1999). This is particularly true for minority populations who unequally experience a lack in access opportunities to food compared to the rest of society (Strickhouser et al., 2014). Previous studies have shown that food insecurity is an important determinant of non-communicable diseases such as heart diseases, some types of cancer, hypertension, stroke, pulmonary diseases or type 2 diabetes (Bhattacharya, Currie, & Haider, 2004; Vozoris & Tarasuk, 2003). Feeding America (2018) reports in its latest summary of charitable food distribution in the U.S. that the households with older adults are at an increased risk of having a chronic health condition, including diabetes (41%) and high blood pressure (70%) which could be mitigated by balanced diet. Food insecure elderly are also more likely to report poorer mental health, particularly in terms of depression, distress, and anxiety (Vozoris & Tarasuk, 2003).

Associations between food insecurity and health problems are likely to be bidirectional (Lee & Frongillo Jr, 2001b; Stuff et al., 2004). While insufficient food intake influences physical and mental health, poor health conditions do also affect negatively in achieving food security. At the end, the whole situation could be a vicious circle with no end in sight, until the appropriate action is taken immediately.

CHAPTER 3. General Methodology

3.1 Research design

This study was conducted through a collaboration between the McGill University's Institute for Global Food Security and the Food and Agriculture Organization of the United Nations (FAO) under the Voices of the Hungry Project. The study used a cross-sectional design to analyze qualitative data collected from 2014 to 2017.

3.2 Context

3.2.1 Voices of the Hungry Project

The Voices of the Hungry Project (VoH) was launched in 2013 by FAO to provide up-to-date information about food insecurity at the global level. A key objective of the project is to undertake international cross-sectional and national comparisons of prevalence rates of food insecurity and ultimately, to step closer to hearing the voices of the people who suffer from a lack of safe and nutritious food (Food and Agriculture Organization, 2016a).

One of the greatest achievements of VoH is the methodological innovation of the 'Food Insecurity Experience Scale (FIES)' which is a timely, reliable and cost-effective tool for providing comparable information on food insecurity experience across countries. The FIES has been adopted as an indicator for monitoring the international development agenda, the 2030 Agenda for Sustainable Development - target 2.1 'End Hunger" - providing meaningful performance or setback for international and national level policy making. For worldwide application of the FIES, FAO has been leveraging on the Gallup® World Poll (GWP) since 2014 (Food and Agriculture Organization, 2016a).

3.2.2 Food Insecurity Experience Scale

The Food Insecurity Experience Scale (FIES) is the first survey-based experiential measure of food security developed by the United Nations Food and Agriculture

Organization (FAO) as a part of the Voices of the Hungry (VoH) project. Of the four dimensions of food security - Accessibility, Availability, Utilization and Stability - the FIES is the only measure to evaluate the 'access' component of food security directly. It relies on people's direct responses to a series of well-designed questions about food-related conditions, behaviors and experiences (Food and Agriculture Organization, 2016a) (**Table 2**).

Table 2. Items in the Food Insecurity Experience Scale

	Questions in the Food Insecurity Experience Scale Survey Module as fielded in the GWP	
	During the last 12 months, was there a time when…:	
Q1	… you were worried you would not have enough good to eat because of a lack of money or other resources?	Worried
Q2	… you were unable to eat healthy and nutritious food because of a lack of money or other resources?	Healthy
Q3	… you ate only a few kinds of foods because of a lack of money or other resources?	Fewfoods
Q4	… you had to skip a meal because there was not enough money or other resources?	Skipped
Q5	… you ate less than you thought you should because of a lack of money or other resources?	Ateless
Q6	… your household ran out of food because of a lack of money or other resources?	Ranout
Q7	… you were hungry but did not eat because there was not enough money or other resources?	Hungry
Q8	… you went without eating for a whole day because of a lack of money or other resources?	Whlday

Source: Food and Agriculture Organization, 2016a

The scales are based on the single-parameter logistic item response theory (Rasch model), in which the probability of being food insecure is estimated depending on the raw score (the number of affirmative answers) on the questionnaire. Then, the response scores are classified into four different levels of severity: food security, mild food insecurity, moderate food insecurity, severe food insecurity. In addition to contemplating aspects related to deprivations in diet quality and quantity, they also capture psychological aspects of the experience of food insecurity that others do not (**Figure 2**). Due to the ease of FIES data collection and a straight-forward interpretation, FIES is considered as an ideal

indicator for being applied as a national-level survey (Food and Agriculture Organization, 2016b).

3.2.3 Gallup World Poll

In 2005, Gallup, Inc. began Gallup® World Poll (GWP), which is a public opinion poll gathered from nationally representative samples of the adult individuals in 160 different countries or territories, representing 99% of the world's adult population. Gallup asks residents from Afghanistan to Zimbabwe the same questions in the same way, which makes it possible to make direct cross-cultural and national comparisons and to track the global trends annually (Gallup & Newport, 2010).

GWP are being conducted based on nationally representative samples of 1,000 adult citizens aged 15 years and older, using a standard set of core questions, optionally followed by supplemental questions in some regions, that has been translated into national languages and dialects of the country. Gallup uses either face-to-face interviews for 1 hour or telephone surveys for 30 minutes conducted by qualified trainers. Each sample is weighted to adjust for non-response and unequal selection probability. Post-stratification weights are adjusted so that weighted totals agree with the national totals for age, gender, area, and socioeconomic status (Food and Agriculture Organization, 2016b; Gallup & Newport, 2010).

3.3 Sample Size and Selection criteria

This study used a national-level dataset: 2014-17 Gallup World Poll (GWP). The study samples are nationally representative of the adult population aged 15 years or more, based on the probability sampling method. Surveys were conducted with approximately 1,000 respondents once per year over the telephone by the trained interviewers. As a consequence of the inclusion criteria, a total number of 33,692 individuals, in 50 different developed countries, were included in the final statistical analysis. Countries and sample size by region are presented in **Table 3**.

Inclusion criteria

For the purposes of the study, only individuals who aged 65 years or more and who lived in developed countries were included. The inclusion criteria for defining developed countries in this study was based on the World Bank classification and the Human Development Index by the United Nations Development Program. Using two country classification, the combined criteria, that the study used, differentiated at a finer level. The specific content of each classification is explained in the following.

1) high-income economies with a GNI per capita of $12,476 or more
2) graded as 'very high Human Development Index' in the HDI report

Exclusion criteria

The analytic sample excluded all individuals who had incomplete information on food insecurity, subjective health status, sociodemographic and economic variables that were used for variables of interest. Respondents who answered 'do not know' or 'refused' to any of questions were also excluded.

Table 3. Sample size of individuals surveyed by country

Country	n	Country	n	Country	n
European Union		Ireland	472	Hong Kong	304
United Kingdom	530	Latvia	941	Japan	1214
France	617	Lithuania	767	Taiwan	384
Germany	666	Luxembourg	517	Northern America	
Netherlands	714	Malta	691	United States	444
Belgium	565	Portugal	531	Canada	428
Spain	268	Slovakia	760	Latin America and the Caribbean	
Italy	667	Slovenia	812	Argentina	789
Poland	773	EU others		Chile	768
Hungary	1146	Russia	1276	Puerto Rico	152
Czech Republic	826	Iceland	291	Trinidad & Tobago	90
Romania	1297	Montenegro	652	Uruguay	1037
Sweden	973	Norway	575	Middle East	
Greece	1073	Switzerland	623	Saudi Arabia	30
Denmark	760	Oceania		Israel	491
Austria	534	Australia	1274	Bahrain	54
Croatia	656	New Zealand	970	Kuwait	37
Cyprus	565	Asia		United Arab Emirates	65
Estonia	1121	South Korea	720	Total	
Finland	1267	Singapore	515	51 Countries	33692

3.4 Measures

3.4.1 Food insecurity status

Food insecurity status was the main outcome variable for the study and it was assessed using the Food Insecurity Experience Scale Survey Module for Individuals (FIES SM-I). The FIES SM-I is a psychometric metric composed of eight questions with simple dichotomous responses 'yes or no' regarding their access to nutritious and adequate food. The severity of an individual's food insecurity could be calculated by noting how many items have been affirmed - affirmative responses are summed up and then classified into 4 different food insecurity levels (row score range): food secure (0), mildly food insecure (1-3), moderately food insecure (4-6), or severely food insecure (7-8) (**Figure 2**) (Food and Agriculture Organization, 2016a).

3.4.2 Predictor variables

Socio-demographic variables

        Sociodemographic variables included: age groups, gender, the place of birth, highest level of education attained, marital status, number of people living in the household, job status, urbanicity, and social support index. The social support index was used to measure perceptions of respondents on the adequacy of the social support. It is designed to capture a feeling of belonging and an opportunity for making friends.

Economic variables

        Economic variables included: per capita income quintiles. Household income per capita was estimated based on monthly income including wages, salaries, remittances from family members, farming, and all other sources. Respondents were categorized (five categories) based on per capita income (Gallup Inc., 2018).

Community Environmental variables

        Two community environmental domains were assessed: community basics index (CBI) and community attachment index (CAI). The CBI was used to measure overall satisfaction with life regarding environment, housing, and community infrastructure. The CAI assessed respondents' community satisfaction regarding social belongingness. Both indices are regarded as a practical way to evaluate abstract constructs such as the likelihood that one will recommend the neighborhood as a place to live, or the desirability of infrastructure services.

Variables on Subjective Health Status

        Health variables included self-reported health and the positive/negative affectivity index (PAI/NAI). The self-reported physical health item asked about any health problems that negatively affected everyday activity. The PAI and NAI were assessed as an indicator of subjective emotional well-being on daily conditions, which estimated individual experience of affective reactions against psychosocial health, defined by Kahneman and

Diener, 1999. It includes a series of questions related to feelings of pleasure and pain, of joy and sorrow, and of satisfaction and dissatisfaction within the whole range of circumstances, from the biological to the societal (Kubovy, Kahneman, Diener, & Schwarz, 1999).

3.5 Statistical analysis

The statistical analysis was performed using IBM's Statistical Package for the Social Sciences (SPSS) software version 21. Associations were considered statistically significant at $p < 0.05$ in all teats.

3.5.1 Descriptive Statistics

Descriptive statistics were performed to establish baseline information of the data in the study. Frequency distributions were constructed to organize the number of individuals in each variable: age groups, gender, the place of birth, highest level of education attained, marital status, number of people living in the household, job status, urbanicity, social support, community environment and health status.

3.5.2 Binary Logistic regression

The magnitude of the associations between food insecurity and independent variables were estimated using binary logistic regression. This statistical technique is popularly used in epidemiological studies because it is well fitted to examine how a set of predictor variables is related to a dichotomous outcome (Osborne, 2008). For the data analysis, 'yes' and 'no' responses to the FIES items were converted to arbitrary codes, one and zero, and the raw FIES score was calculated for each respondent. The output of logistic regression is probability values ranging from 0 to 1 which refers to the probability of an event occurring (Kleinbaum & Klein, 2010). The regression coefficients are estimated based on maximum likelihood estimation. An interpretation of the logit coefficient which make the interpretation more straightforward and intuitive is the 'odds ratio' (Kleinbaum &

Klein, 2010). Odds ratios were used to quantify the effect of the covariates which had significant associations with the outcome, prevalence of food insecurity. To do that, the logistic regression provides a model of observing the probability of an individual becoming food insecure, given a particular exposure. In this study, the model was adjusted for the covariate variables listed above.

The logistic model equation is specified explicitly as:

$$Logit(p) = a + b_1x_1 + b_2x_2 + b_3x_3 + \cdots$$

Where

p = the probability that an individual will be food insecure (food insecure = 1, food secure = 0)

a = the constant of the equation

$b_{1,2,3,}$ = the coefficient of the independent variables

$x_{1,2,3,}$ = the independent variables of interest (for this study are: age range, gender, marital status, immigration status, jab status, education level, household size, income quintiles, social support, urbanicity, CBI, CAI, self-reported health, PAI, and NAI.)

The statistical analysis was performed using the IBM SPSS® Complex Samples (version 21). Associations were considered statistically significant at $p < 0.05$.

3.6 Ethical Consideration

All data used on this study was collected by the Gallup Worldwide Research division of Gallup, Inc., as part of the Gallup World Poll®. Gallup gained governmental approvals for the survey in each country and the identities of survey respondents remain strictly confidential. Gallup states that it is "not affiliated with any political or advocacy groups". The content of the survey applies rigorous research standards and scientifically proven methodologies to analyze data.

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Figures

Figure 1. Conceptual Framework: Food Insecurity in the Elderly
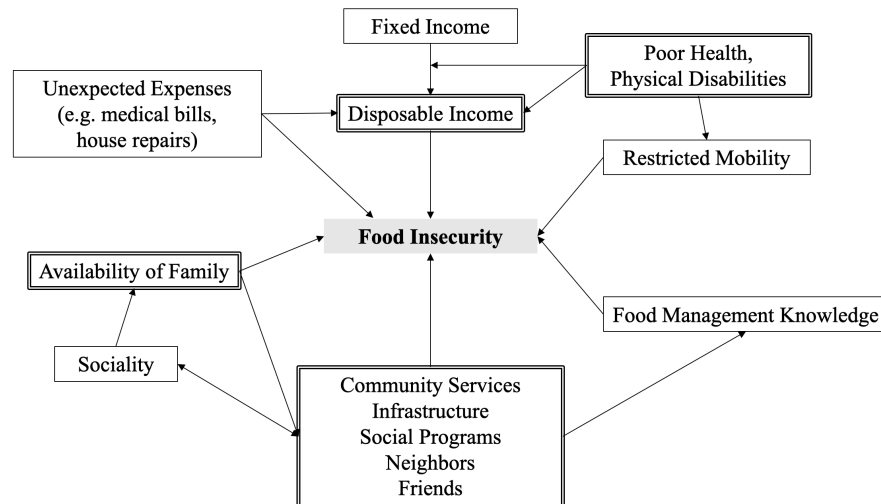
Source: Wolfe, 1996 & Hall, 2005

Figure 2. Definition of Food Insecurity levels

Source: FAO. 2016

CHAPTER 4. Manuscript

Heterogeneous factors predict food insecurity among the elderly in developed countries: Insights from a multi-national analysis of 51 countries

Jae Yeon Park[1], Arlette Saint Ville[1], Timothy Schwinghamer[2], Dr. Patrick Cortbaoui[1], Hugo Melgar-Quiñonez[1]

[1] McGill University, Sainte-Anne de Bellevue, QC, Canada; School of Dietetics and Human Nutrition; Institute for Global Food Security
[2] McGill University, Sainte-Anne de Bellevue, QC, Canada; Department of Plant Science

4.1 Abstract

Background: Food insecurity is an intricate phenomenon, which makes it difficult to fully understand it along with its causes and consequences. While the effects of food insecurity in elderly populations show their own distinct characteristics in demographic and physiological features, including debilitating sickness, social isolation, and higher demand for healthcare services, there are fewer independent studies conducted on food insecurity in the elderly.

Objective: This study aims to estimate the prevalence of food insecurity and its association with demographic and socioeconomic factors that characterized elderly survey respondents in 51 developed countries and to discuss similarities and differences across regions.

Methods: Cross-sectional data are taken from the Gallup World Poll (4-year file for 2014-2017) based on respondents aged ≥ 65 (n = 33,692). Food insecurity, the main outcome variable, was assessed using the Food Insecurity Experience Scale, a direct measure of experience-based food insecurity. Descriptive statistics of target populations and the prevalence of food insecurity are produced. Demographic variables include age, gender, marital status, household size, education level, social support, subjective health status, and affective well-being. For socioeconomic variables, income, employment status, urbanicity, and community environments are evaluated. Adjusted logistic regression model is used to compute odds ratios for elderly food insecurity and the level of statistical significance is set at 5%.

Results: Globally, young seniors had higher odds of being food insecure than older seniors, and great heterogeneity of the prevalence of food insecurity among seniors was found between regions, ranging from OR 0.25 (Australia and New Zealand) to OR 3.25 (Middle East). At the individual level, food insecure seniors were more likely to live alone (OR 1.65, 95%CI: 1.42, 1.88), not have a partner (OR 1.42, 95%CI:1.27, 1.60), and tended to have poorer scores on social support (OR 2.05, 95%CI:1.81, 2.31) and well-being. Also,

poor community infrastructure (OR 1.70, 95%CI: 1.54, 1.87) was associated with food insecurity of elderly people, and there were more food insecure elderly people in urban areas.

Conclusions: This study concludes that not only personal factors but also social conditions could prevent the elderly from achieving full food security status. These findings emphasize the need for various approaches to address food insecurity issues among seniors at both the community level and the individual level.

4.2 Introduction

Food security is an elusive concept, as is reflected in the continuing evolution of definitions to reflect the society of the time period. The latest definition of food security has been officially designated as "a state that exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization, 2002).

Given the fact that food insecurity is a multifaceted situation that is affected by the interaction of a range of physical, social, and financial factors, older adults are one of the most vulnerable population groups because their uniquely susceptible condition may limit the ability to maintain reliable sources of well-balanced diet (Hall & Brown, 2005; Quandt & Vitolins, 1997; Souter & Keller, 2000). Their specific vulnerabilities imply a whole series of challenges that they might face from difficulties with food access to impaired abilities which would disturb them in preparing, eating or maintaining healthy eating habits (Fernandes et al., 2018; Ishikawa et al., 2016). Previous studies have found that chronic food insecurity in older adults could be a potential risk factor for poor health and diet-sensitive disease, which can result in significant morbidity or even death if left untreated (Salive, 2013; Salti & Ghattas, 2016).

As food insecurity is inextricably connected with socioeconomic weaknesses, there has been a common perception that senior citizens in affluent nations are safe owing to multiple social protections (Middleton, Mehta, McNaughton, & Booth, 2017; OECD, 2015). Such unwarranted assumptions might provide conditions that allow for an unethical acceptability of the presence of food insecurity among the elderly in developed areas. In reality, the extent of food insecurity in the elderly population is often overlooked and this misconception holds back a timely introduction of policies to reduce and prevent the problem appropriately (Loopstra & Tarasuk, 2012; National Research Council, 2013; Russell, Flood, Yeatman, & Mitchell, 2014).

The lack of population-based health research on food insecurity at old age is critical. There is a dearth of information to figure out whether the current social welfare

system is protecting, or can continue to protect, the underprivileged elderly group against undernourishment. The paper intense to contribute a more detailed understanding of the current state of food insecurity among the elderly in the developed countries and to generate empirical data on the risk factors influencing food insecurity in later life.

4.3 Methodology

4.3.1 Research design

This study employs a quantitative cross-sectional research design, including a multinational-scale measurement, quantification, and comparison of the prevalence of food insecurity. The research was provided as part of a collaboration between the Margaret A Gilliam Institute for Global Food Security at McGill University and the Food and Agriculture Organization of the Voices of the Hungry Project of the United Nations.

4.3.2 Sources of data

Data used for the study were collected by the Gallup® World Poll (GWP) from 2014 to 2017, a series of nationally representative cross-sectional surveys in more than 150 countries. For criteria of country selection, the 2017 World Bank and the 2016 United Nations Development Program database were used.

Gallup® World Poll

GWP has been conducted annually on nationally representative samples of 1000 adult non-institutionalized people (aged 15 years and older) in over 150 countries. Interviews were administered via telephone in all countries with at least 80% telephone coverage, or otherwise face-to-face. Respondents were selected on the basis of probability-based sampling and the dataset went through a quality assurance process, including post-stratification weights so that projection of results is as close as possible to the national population (Gallup Inc., 2018). All percentages presented in the tables and the text of this paper are estimates derived from population weighted data.

4.3.3 Study sample

Sample Inclusion and Exclusion

This study consisted of individuals aged 65 years or more who lived in developed countries. The inclusion criteria for defining developed countries were based on the World Bank classification and the Human Development Index of the United Nations Development Program: 1) high-income economies with a GNI per capita of $12,476 or more, and 2) graded as 'very high Human Development Index' in the HDI report (UNDP, 2016; World Bank, 2017).

The analytic sample excluded all individuals who had incomplete information on food insecurity, subjective health status, sociodemographic, and economic data that were used for variables of interest. Respondents who answered 'don't know' or 'refused' to any of questions were also excluded.

Sample Size

A total of 33,692 individuals from 51 developed countries in the 2014-17 GWP surveys corresponded to the selection criteria of this study; the data from these respondents were included in the analyses.

4.3.4 Measurements

4.3.4.1 The Food Insecurity Experience Scale

The prevalence of food insecurity was measured using the Food Insecurity Experience Scale Module for Individuals (FIES), a global standard scale that directly measures the access dimension of food insecurity, developed by the Food and Agriculture Organization (FAO). The FAO carried out linguistic and cultural adaptations of the FIES before surveying nationally representative samples; thus this tool allows for the identification of public trends and comparison of outcomes across regions (Food and Agriculture Organization, 2016). The FIES is an experience-based metric of severity of food insecurity estimated directly from responses to a series of questions regarding food

access in respondents' daily lives during the previous 12 months (Ballard, Kepple, & Cafiero, 2013). It consists of 8 questions which ask people about anxiety and concerns regarding the obtainment of food and compromise in the quantity and the diversity of food intake (Ballard et al., 2013) (**Table 2**). The responses are recorded as simple dichotomous variables ('yes' or 'no') to minimize differences in response styles and to improve the precision of comparability across countries. Respondents' food insecurity status was calculated by summing up the affirmative responses and then classifying them into different severity levels (**Figure 2**) (Food and Agriculture Organization, 2016).

4.3.4.2 Variables

Dependent Variable

Food insecurity status measured using the FIES is the main dependent variable for this study. An elderly person would be classified as 'food insecure' if he or she answered at least one of the eight items in the affirmative.

Independent Variables

Economic variables included per capita income quintiles. Household income per capita was estimated on the basis of monthly income, including wages, salaries, remittances from family members, farming, and all other sources. Respondents were divided into fifths based on per capita income (Gallup Inc., 2018).

Sociodemographic variables included age group, gender, marital status, immigration status, job status, highest level of education attained, number of people living in the household, and perceived social support. Chronological age was used to subcategorize the elderly into three groups: young-old (YO, 65 to 74), middle-old (MO, 75 to 84), and oldest-old (OO, 85 or more).

Community environment variables included urbanicity, community basics index (CBI), and community attachment index (CAI). The CBI measured overall satisfaction with living environment, housing, and community infrastructure. The CAI assessed respondents' community satisfaction regarding social belongingness.

Health variables included self-reported health and the positive/negative affectivity index (PAI/NAI). The self-reported physical health item asked about any health problems that negatively affected everyday activity, and the PAI and NAI were used to measure the general picture of emotional wellbeing as perceived by the respondent.

Every index (social support, CBI, CAI, PAI, and NAI) was organized into several questions with a simple dichotomous response (**Table 4**). Each item was scored either 1 for affirmative answers or 0 for other negative answers. The record's final score is the mean value of items. GWP tested Cronbach's alpha for the reliability of the indices at the country level (Gallup Inc., 2017).

Table 4. Description of Indices

Indices	Index Questions
Perceived social support Index	· If you were in trouble, do you have relatives or friends you can count on to help you whenever you need them, or not? · In the city or area where you live, are you satisfied or dissatisfied with the opportunities to meet people and make friends? (Cronbach's alpha 0.65)
Community basics index	· In the city or area where you live, are you satisfied or dissatisfied with the public transportation systems / the roads and highways / the quality of air / the quality of water / the availability of good affordable housing / the educational system or the schools / the availability of quality healthcare? (Cronbach's alpha 0.90)
Community attachment index	· Are you satisfied or dissatisfied with the city or are where you live? · In the next 12 mths, are you likely or unlikely to move away from the city or area where you live? · Would you recommend the city or area where you live to a friend or associate as a place to live, or not? (Cronbach's alpha 0.76)
Positive affectivity index	· Did you feel well-rested yesterday? · Were you treated with respect all day yesterday? · Did you smile or laugh a lot yesterday? · Did you learn or do something interesting yesterday? · Did you experience enjoyment during a lot of the day yesterday? (Cronbach's alpha 0.91)
Negative affectivity index	· Did you experience the following feelings during a lot of the day yesterday? How about physical pain / worry / sadness / stress / anger? (Cronbach's alpha 0.80)

Cronbach's alpha is aggregated at the country level.
Source: Gallup, Inc. 2017

4.3.5 Statistical analysis

Descriptive statistics of study population by age and each of the variables were analyzed. Adjusted binary logistic regression was used to examine the association of food insecurity with the each of the independent variables and is adjusted for all predictor variables (age range, region, gender, marital status, immigration status, job status, household size, income quintiles, education level, social support, urbanicity, CBI, CAI, self-reported health, PAI, and NAI). The statistical analysis was performed using the IBM SPSS® Complex Samples (version 21). Associations were considered statistically significant at $p < 0.05$.

The identities of survey respondents remain strictly confidential and are approved by the government authorities in each country. The content of the survey applies rigorous research standards and scientifically proven methodologies to analyze data.

4.4 Results

Descriptive analysis

The prevalence of food insecurity was not evenly distributed throughout the population. Micro levels of food insecurity status by three age groups are presented in **Table 5**. Overall, 17.9% of seniors reported being food insecure. Of this food-insecure category, 12.2% were in the mild food insecurity, 3.8% were in the moderate food insecurity, and 1.9% were in the severe food insecurity status. There were differences among age groups: the oldest-old had a relatively lower rate of food insecurity than the other age groups.

Table 5. Food insecurity status at different levels of severity by age group (n = 33,692)

Age	n	Food insecurity status (%)			
		Food secure	Mild food insecure	Moderate food insecure	Severe food insecure
85 or more (Oldest-old)	1996	1680	223	60	33
		84.2%	11.2%	3.0%	1.7%
75 to 84 (Middle-old)	10078	8199	1283	404	192
		81.4%	12.7%	4.0%	1.9%
65 to 74 (Young-old)	21618	17775	2609	827	407
		82.2%	12.1%	3.8%	1.9%
Total	33692	27654	4115	1291	632
		82.1%	12.2%	3.8%	1.9%
		Linear-by-Linear Association: <0.001			

Source: Gallup, Inc. 2014-2017

The results for descriptive characteristics of the study population by age groups are presented in **Table 6**. Most of the survey respondents were female (YO=55.9%, MO=60.7%, OO=60.6%), were born inside their country of current residence (YO=90.4%, MO=90.2%, OO=88.7%), and had completed secondary school or higher (YO=74.3%, MO=61.8%, OO=57.5%). In the young-old group, almost 60% of respondents lived with a partner, whereas the majority of the oldest-old (63.4%) were widowed. As people get older, more of them tend to live alone: 62.4% of the oldest-old were a single household, which is nearly double the percentage of those in the young-old group (33.2). 71.1% of the young-old responded that they had good social support they can count on, followed by the middle-old (69.6%) and the oldest-old (66.7%). The scores for community environment increased with age; whereby 76.2% of the oldest-old were satisfied with the city where they lived. Regarding the health-related variables, the oldest-old had the higher proportions of respondents who had a negative opinion about their own health condition for age, including perceived physical health problem, PAI and NAI.

Table 6. Descriptive characteristics for the sample of the elderly in developed countries. (n = 33,692)

Variables	n (%)		
	Young-old (YO)	**Middle-old (MO)**	**Oldest-old (OO)**
Gender			
Male	9533 (44.1%)	3965 (39.3%)	786 (39.4%)
Female	12085 (55.9%)	6113 (60.7%)	1210 (60.6%)
Born in Country			
Yes	19548 (90.4%)	9092 (90.2%)	1770 (88.7%)
No	2070 (9.6%)	986 (9.8%)	226 (11.3%)
Education			
College/university	4628 (21.4%)	1699 (16.9%)	322 (16.1%)
Secondary/high school	11425 (52.8%)	4533 (45.0%)	826 (41.4%)
Elementary	5565 (25.7%)	3846 (38.2%)	848 (42.5%)
Marital status			
Married	12822 (59.3%)	4334 (43.0%)	536 (26.9%)
Single/never married	3740 (17.3%)	1200 (11.9%)	195 (9.8%)
Widowed	5056 (23.4%)	4544 (45.1%)	1265 (63.4%)
Household size			
1	7185 (33.2%)	4867 (48.3%)	1245 (62.4%)
2	10624 (49.1%)	4042 (40.1%)	548 (27.5%)
3-4	2908 (13.5%)	889 (8.8%)	152 (7.6%)
5 or more	901 (4.2%)	280 (2.8%)	51 (2.6%)
Employment status			
Employed	4647 (21.5%)	995 (9.9%)	151 (7.6%)
Unemployed	195 (0.9%)	38 (0.4%)	7 (0.4%)
Out of workforce	16776 (77.6%)	9045 (89.7%)	1838 (92.1%)
Per capita Income quintiles			
Richest 20%	5231 (24.2%)	1284 (12.7%)	246 (12.3%)
Fourth 20%	5105 (23.6%)	2023 (20.1%)	281 (19.1%)
Middle 20%	4916 (22.7%)	2484 (24.6%)	468 (23.4%)
Second 20%	3850 (17.8%)	2291 (22.7%)	436 (21.8%)
Poorest 20%	2516 (11.6%)	1996 (19.8%)	465 (23.3%)
Social support			
High	15364 (71.1%)	7012 (69.6%)	1332 (66.7%)
Moderate	5218 (24.1%)	2544 (25.2%)	557 (27.9%)
Low	1036 (4.8%)	522 (5.2%)	107 (5.4%)
< Community Environment >			
Urbanicity			
Urban	18423 (85.2%)	8551 (84.8%)	1747 (87.5%)
Rural	3195 (14.8%)	1527 (15.2%)	249 (12.5%)
Community Basics Index			
High	12996 (60.1%)	6284 (62.4%)	1261 (63.2%)
Moderate	6087 (28.2%)	2706 (26.9%)	530 (26.6%)
Low	2535 (11.7%)	1088 (10.8%)	205 (10.3%)
Community Attachment Index			
High	16001 (74.0%)	7600 (75.4%)	1521 (76.2%)
Moderate	2820 (13.0%)	1380 (13.7%)	264 (13.2%)
Low	2797 (12.9%)	1098 (10.9%)	211 (10.6%)

< Subjective Health status >

Health problem			
No	13023 (60.2%)	4769 (47.3%)	884 (44.3%)
Yes	8595 (39.8%)	5309 (52.7%)	1112 (55.7%)
Positive Affectivity Index			
High	6400 (29.6%)	2460 (24.4%)	447 (22.4%)
Moderate	9974 (46.1%)	4715 (46.8%)	953 (47.7%)
Low	5244 (24.3%)	2903 (28.8%)	596 (29.9%)
Negative Affectivity Index			
Low	8486 (39.3%)	3494 (34.7%)	705 (35.3%)
Moderate	5390 (24.9%)	2586 (25.7%)	534 (26.8%)
High	7742 (35.8%)	3998 (39.7%)	757 (37.9%)
Total	21618	10078	1996

Young-old (YO): 65-74/ Middle-old (MO): 75-84/Oldest old (OO): 85 or over
Source: Gallup, Inc. 2014-2017

Logistic Regression

The result of binary logistic regression allowed us to observe which contextual variables remained significantly associated with the prevalence of food insecurity among the elderly in developed countries (**Table 7**). Compared to the food-secure elderly, the food-insecure elderly was more likely to be poor, live alone, and had a lower level of education. Also, the elderly who were food insecure tended to perceive their social support as weak, were less satisfied with their community environment, and had lower self-rating of health status.

As age increased, food insecurity rates went down. For example, the young-old were statistically more likely to be food insecure (OR=1.65) than those in the oldest-old. There was no significant difference in food insecurity between men and women. In terms of marital status, single elderly—including never married, separated, and divorced—were more probably experiencing food insecurity (OR=1.42), as were widowed elderly adults (OR=1.34). The coefficient of household size was estimated positive, which indicated that in large households the elderly were less likely to be food insecure (OR=0.60). There were a gradual increased odds of food insecurity on the lower education and income levels. Regarding employment status, there was no significant difference in food insecurity between the elderly who were "out of the workforce" and the employed; nevertheless, "unemployed" seniors were 2.81 times more likely to be food-insecure (OR=2.81). The community environment indicators, including CBI (OR=1.70) and CAI (OR=1.42), had a

positive effect on food security status among the elderly. When compared to those who lived in urban zones, the elderly who lived in rural areas (OR=0.84) were less likely to be food insecure. To address the relationship between health condition and food insecurity status, perceived physical health problem, PAI, and NAI were measured. As indicated in **Table 7**, all health-related variables were significantly related to the prevalence of food insecurity, such that individuals with perceived health problem (OR=1.55), low levels of PAI (OR=2.00), and high levels of NAI (OR=2.57) were more likely to be food insecure.

Table 7. Logistic regression analysis of food-secure verses food-insecure ($n = 33,692$)

Variables	95% CI	
	Odds ratio	*p* value
Age*	1.000	
85 or more (Oldest-old) (Ref.)	1.000	
75 to 84 (Middle-old)	1.313 (1.137, 1.517)	<0.001
65 to 74 years (Young-old)	1.653 (1.420, 1.884)	<0.001
Gender		
Male (Ref.)	1.000	
Female	1.041 (0.972, 1.115)	0.247
Born in Country*		
Yes (Ref.)	1.000	
No	1.139 (1.020, 1.271)	0.020
Education*		
College/university (Ref.)	1.000	
Secondary/high school	1.308 (1.180, 1.451)	<0.001
Elementary	1.831 (1.642, 2.042)	<0.001
Marital status*		
Married/domestic partner (Ref.)	1.000	
Single/never married/separated/divorced	1.424 (1.271, 1.595)	<0.001
Widowed	1.335 (1.206, 1.479)	<0.001
Household size*		
1 (Ref.)	1.000	
2	0.783 (0.708, 0.886)	<0.001
3 - 4	0.666 (0.589, 0.752)	<0.001
5 or more	0.596 (0.500, 0.711)	<0.001
Employment status		
Employed (Ref.)	1.000	
Unemployed	2.809 (2.065, 3.820)	<0.001
Out of the workforce	0.956 (0.870, 1.050)	0.347
Per capita Income quintiles*		
Richest 20% (Ref.)	1.000	
Fourth 20%	1.962 (1.748, 2.202)	<0.001
Middle 20%	2.953 (2.639, 3.304)	<0.001
Second 20%	3.882 (3.456, 4.360)	<0.001
Poorest 20%	5.102 (4.481, 5.809)	<0.001

Social support*		
High (Ref.)	1.000	
Moderate	1.318 (1.228, 1.414)	<0.001
Low	2.047 (1.814, 2.311)	<0.001
< Community Environment>		
Urbanicity*		
Urban (Ref.)	1.000	
Rural	0.843 (0.772, 0.922)	<0.001
Community Basics Index*		
High (Ref.)	1.000	
Moderate	1.366 (1.271, 1.468)	<0.001
Low	1.697 (1.544, 1.865)	<0.001
Community Attachment Index*		
High (Ref.)	1.000	
Moderate	1.259 (1.155, 1.373)	<0.001
Low	1.416 (1.294, 1.468)	<0.001
< Subjective Health status >		
Health problem*		
No (Ref.)	1.000	
Yes	1.545 (1.443, 1.654)	<0.001
Positive Affectivity Index *		
High (Ref.)	1.000	
Moderate	1.273 (1.162, 1.395)	<0.001
Low	1.992 (1.804, 2.201)	<0.001
Negative Affectivity Index *		
Low (Ref.)	1.000	
Moderate	1.417 (1.288, 1.558)	<0.001
High	2.536 (2.329, 2.761)	<0.001

The asterisks denote statistical significance at the following levels: $*p < 0.05$; $** p < 0.01$; $***p < 0.001$.

All presented values were odds ratios with 95% confidence intervals (CI); Odds ratios were adjusted each of the variables shown.

Source: Gallup, Inc. 2014-2017

Globally Aggregated Analysis

Across the 7 global regions, encompassing 51 developed countries, the prevalence of food insecurity among the elderly ranged from 6.4% in Oceania to 26.4% in East Asia (**Table 8**). Oceania (OR=0.31), North America (OR=0.41), and Asia (OR=0.88) were characterized by statistically significantly less prevalent food insecurity among the elderly than where the European Union members, while food insecurity was more prevalent in Latin America/the Caribbean (OR=1.58), and the Middle East (OR=1.62). When adjusted for confounders, the odds of food insecurity increased in all global regions: Oceania (OR=0.46), Latin America/the Caribbean (OR=1.75) and Middle East (OR=2.05).

Table 8. Food insecurity prevalence by global region

Variables	Food insecure	Unadjusted			Adjusted		
	% (n)	OR	95% CI	*p*	OR	95% CI	*p*
EU (Ref.)	18.2% (3730)	1.000			1.000		
EU others	19.5% (665)	1.087	0.992 1.192	0.075	1.068	0.962 1.185	0.217
Oceania	6.4% (143)	**0.306**	0.258 0.364	<0.001	**0.462**	0.384 0.557	<0.001
Asia	16.3% (512)	**0.877**	0.793 0.971	0.011	0.954	0.847 1.075	0.443
North America	8.3% (72)	**0.405**	0.317 0.517	<0.001	0.774	0.595 1.008	0.057
Latin America and the Caribbean	26.0% (737)	**1.579**	1.442 1.730	<0.001	**1.747**	1.569 1.964	<0.001
Middle East	26.4% (179)	**1.617**	1.358 1.925	<0.001	**2.050**	1.664 2.526	<0.001

The number of countries included in each region is as follows (Table 3): European union (EU): 27;
EU others: 5; Oceania: 2; Asia: 5; North America: 2; Latin America and the Caribbean: 5; Middle east: 5.
Adjusted odds ratios were adjusted for confounders; age range, region, gender, marital status, immigration
status, job status, household size, income quintiles, education level, social support, urbanicity, CBI, CAI,
self-reported health, PAI, and NAI.
Bolded values have a *p*<0.05

4.5 Discussion and conclusion

The time to prepare for an aging society is not when it has reached a peak or is about to reach it, but before nations have encountered challenges of population aging. Preparation for old age is a necessary plan for individuals as well as an extremely important requirement for sustainable national development. While food insecurity and malnutrition among the elderly are a primary issue in developing countries, they undoubtedly do occur/recur *de novo* in developed nations as well (Bocquier et al., 2015; Russell et al., 2014; Tarasuk, Mitchell, & Dachner, 2016). Much has warned the growing social challenges of an aging world we will face, yet the implications of this demographic transition especially in an underprivileged older adult population has not been much considered or discussed spatially. To narrow these disparities, our study provides insight into the more complex dimensions of factors for risk in food security in later life, particularly in terms of elderly people's ability to access appropriate foods for maintaining a nutritious diet, alongside the result thoroughly eliciting evidence of the necessity for implementing both individual- and community-level protection policies.

Consistent with previous studies, we found that respondents who were food insecure were more likely to be in the lower income bracket, although there was no clear evidence that employment status was associated with the prevalence of food insecurity among the elderly (Fernandes et al., 2018; Lee & Frongillo Jr, 2001; Russell et al., 2014; Strickhouser, Wright, & Donley, 2014). The strong relationship between financial stability and food security was confirmed once again.

Our study found that food insecure elderly respondents tended to have lower levels of education. In a similar context, some studies have found that education level was linked to expenditure for healthy diet (Enza, A., Margaret, & E., 2009; Finger, Tylleskär, Lampert, & Mensink, 2013). These findings suggest that education influences how elderly people manage their diet and change their attitudes to food and nutritional habits. Therefore, policies and social programs in conjunction with food and nutrition education may reduce the food insecurity rate amongst the elderly.

Overall, elderly persons who lived with a spouse were food secure, a finding significantly higher than that in any other marital status groups. In addition, the study found that those who lived alone were at greater risk for falling into being food insecure. These aspects can be explained in more detail by previous studies. Obtaining food is an active behavior which might be difficult to undertake easily by elderly people living alone who suffer from a lack of physical functioning and social communication (Ishikawa et al., 2016; Thompson et al., 2011). Thus, living alone has a negative impact on food accessibility and consumption in multiple ways. In the same vein, social support has been found to be a key determinant of acquiring appropriate foods for a nutritious diet (Ishikawa et al., 2016). In contrast to this fact, there has been a conspicuous and an unfortunate increase in the number of elderly people living alone (United Nations, 2017). This suggests that this phenomenon should be an issue of concern for welfare policy makers, and that additional community programs are needed to support elderly citizens living alone. Delivery services by supermarkets, NGOs that provide assistance to go grocery shopping, and policies that facilitate the trips for the elderly to grocery stores would play an important role in reducing

this specific risk factor for the elderly who live alone, have physical difficulties, and suffer from food insufficiency.

One contribution of this study is the inclusion of health measures that moves beyond simply estimating physical impairments and also includes emotional status. The study shows that older adults are likely to be affected in the prevalence of food insecurity by affective well-being status, which aligns with previous research. This study was not able to determine whether the relationship between food insecurity and emotional well-being is causal, yet there is the potential for reverse causality between these two variables because negative emotions and depressive feeling can affect food insecurity through lethargy, low motivation to eat heathy, or high financial burden, e.g. medical costs (Lee & Frongillo Jr, 2001; Tugade, Fredrickson, & Barrett, 2004). The interactions between food insecurity and mental health deserve further investigation to help broaden the influence of social assistance programs on the affective well-being of senior citizens; doing this would build resilience for mental health and stability and, in turn, will positively impact food security.

Another important finding of this study is that not only personal factors, but also community environments shape the food security status of the elderly. This emphasis on the responsibility of individuals could be seen as blaming people for their historical or habitual behaviors, neglecting the reality that the prevalence of food insecurity is strongly associated with and can be constrained by social milieus. This implies that additional supports and intervention at the community level may be beneficial; they would include age-friendly programs that encourage the isolated elderly to mingle and eat together and supports public farmers' markets to help ensure that people outside an urban area have access to healthy and affordable foods.

Australia and New Zealand are, apparently, in the midst of a population crisis just like the other developed nations however the odds of food insecurity rate among the elderly in this area are significantly much lower (World Health Organization, 2015). This consequence demonstrates that Australia and New Zealand respond quite well to this profound shift in population demographics regarding to food insecurity issues compared to

other regions. Additional research needs to go deep into these two countries' response to this specific demographic crisis, as it will be a good lesson for other countries to obtain valuable information on their reformation of public health and welfare policies in order to obtain a sustainable social development.

Food insecurity in what we consider developed countries could seem to be somehow contradictory; however food poverty has not always been caused only by scarcity or lack of food, but it is more often triggered by resource inequality which has been constantly worsening everywhere regardless of societal development (Holt-Giménez, Shattuck, Altieri, Herren, & Gliessman, 2012; OECD, 2013). Experiences of food insecurity, including changes in meal quality and worrying about acquiring food, are common among elderly populations in countries around the world (De Castro, 1993; Mudge, Ross, Young, Isenring, & Banks, 2011; Wellman, Weddle, Kranz, & Brain, 1997). The significant risk factors of the problem are likely to occur simultaneously, pushing the elderly into being much more vulnerable to food insecurity. To assure food security and well-being for the elderly, food security assistance systems should be responsive to the heterogeneity and the upward trend of the number of elderly adults.

In 2002, the Madrid International Plan of Action on Ageing, adopted at the Second World Assembly on Ageing, drew up a comprehensive action plan for "building a society for all ages". The Plan highlighted the importance of collaboration between governments, nonprofit organizations, and other actors for success in ensuring the security and dignity of older persons (United Nations, 2002). In line with the signs of times, this study has produced several important findings to confront to the global concerns about the elderly. In our view, this study has the potential to encourage policy makers and service providers to think carefully about diversity in food security status and potential risk factors among the elderly.

4.6 Study strengths and limitations

One of the greatest strengths of this study is the large number of rich datasets with a high response rate from participants in a populations-based research and a wide range of

data collection techniques enabling the divulgence of respondents' status, insights, intentions, and actions regarding the prevalence and potential risk factors for food insecurity. The measurement tool has been demonstrated for reliability and validity for implementations in different populations allowing a number of global comparisons to be made. To our knowledge, this is the first global scale study to address a broad range of potential determinants of food insecurity among the elderly in affluent nations.

Although the study has achieved its aims, there were some unavoidable limitations. Because of the nature of cross-sectional research, I cannot support results on the risk factors for the food insecurity among the elderly or on causal relationships can not be determined. It might be considered that another limitation of this study is that the sample population did not include the institutionalized people nor the minority groups.

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Chapter 5. Conclusions

As food is now not only plentiful but overabundant enough to cause serious waste problems around the world, a lack of food accessibility could be as easy to be overlooked as pressing issue especially in affluent nations. However, in the reality food insecurity among the elderly is still a critical social and public health problem that requires immediate attention for implementing appropriate policies and government initiatives. Although other underprivileged conditions in developed areas are being closely observed and dealt with variety of projects and studies, disadvantaged elderly group has not been widely recognized despite the projection that whose number and share in a society will continually increase. Here we presented the status of food security among the older adults in developed countries and how various social, demographic, and economic factors could influence the possibility of food insecurity, one of human basic rights, on a global scale.

While overall status of food security in elderly population was quite good, approximately 20% of the elderly in developed countries still suffer from accessibility to adequate nutritious food in their daily lives and there were a broad range of risk factors threatening sociodemographic disparities in food security status. Economic instability is already well-known and most frequently listed risk factors for food insecurity, however this study provides additional evidence for disadvantageous effect of other sociodemographic characteristics of elderly population on the prevalence of food insecurity which may become more important element to be studied in the future for adjusting welfare system and policies more effectively.

Appropriate public assistance, which can result in increasing food availability and accessibility of the elderly, would build resilience for food and nutrition security which in turn will positively impact general health condition. Ultimately, the improvement of elderly health will make a great contribution to individuals' well-being as well as social sustainability; if the elderly lived in good health, this unprecedented demographic increase in the proportion of seniors will be regarded not

as a public burden, but as growing human resource with accumulated experience and judgment that might be the valuable to social/national development.