

**Investigating Older Adults' Functional Capacity and Clinical Profiles in an Emergency
Department in Tehran, Iran**

by
Aein Zarrin

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

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Dedication

I dedicate this thesis to my beloved uncle whose memory has inspired many of my career and life choices.

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Introduction

While population aging has been investigated mostly in developed countries, developing nations are also experiencing a demographic shift (World Health Organization, 2012). Iran is no exception; in 2012, World Health Organization [WHO] indicated that population aging is happening at its fastest rate in Iran, alongside Cuba and Mongolia (Kiani, Bayanzadeh, Tavallae, & Hogg, 2010; World Health Organization, 2012). In fact, by 2050, Iran's population will have a higher a proportion of older adults than the U.S., as 21.7% of their population will be above 60 years of age (Kiani et al., 2010; World Health Organization, 2012).

Such demographic change has significant implications for the Iranian healthcare system. Population aging is highly associated with a growing prevalence of chronic diseases (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002; Dexter et al., 2010; Nolte & Knai, 2015; Zwar et al., 2006). As a result, countries that are experiencing population aging could expect higher morbidity, mortality, and healthcare costs due to the growing prevalence of chronic diseases (Barlow et al., 2002; Dexter et al., 2010; Nolte & Knai, 2015; World Health Organization, 2018; Zwar et al., 2006).

One of the sectors of healthcare that is affected substantially by population aging is acute care, particularly emergency departments [ED]. EDs play an integral role in provision of care to the elderly (Aminzadeh & Dalziel, 2002; Gideon A Caplan, Williams, Daly, & Abraham, 2004; Veillette, Demers, Dutil, & McCusker, 2009; Wofford, Schwartz, & Byrum, 1993). Consequently, it is important that EDs address older adults' physical and social needs to minimize the burden of chronic conditions and the subsequent symptoms that are associated with aging.

Similar to many developed countries, Iran is facing a discrepancy between its current demographic changes and its healthcare infrastructure (Goharinezhad et al., 2016; Jeddian et al., 2016; Kiani et al., 2010; Pines et al., 2011; Smith, Shokoohi, & Holliman, 2007; World Health Organization, 2009). In the meantime, due to the novelty of geriatrics in Iran, there are no guidelines to reconcile this disparity (Goharinezhad et al., 2016; Jeddian et al., 2016; Kiani et al., 2010; Pines et al., 2011; Smith et al., 2007; World Health Organization, 2009). As a response, some government policies and NGOs have requested the development of comprehensive action plans to fill this gap (Goharinezhad et al., 2016; Jeddian et al., 2016; Peykari et al., 2017; Sepanlou, Kamangar, Poustchi, & Malekzadeh, 2010). Development of such guidelines requires

a strong body of evidence; however, considering the paucity of information on the clinical profiles of older Iranians in acute care (Sepanlou et al., 2010), investigating Iranian older ED patients' health status is a priority. Researchers, such as Gray et al. (Leonard C Gray et al., 2013), McCabe & Kennelly (McCabe & Kennelly, 2015) and Latham & Ackroyd-Stolars (Latham & Ackroyd-stolarz, 2014) have investigated the clinical or the functional status of older ED patients in developed nations. However, none of these studies had a pre-dominant focus on developing countries; although the findings of these investigations could be informative, they cannot necessarily be applied to developing nations, with different socio-demographic structures and health systems. Additionally, none of these investigations evaluated the functional profiles of older adults.

Therefore, this research project is aiming to investigate older adults' functional capacity and clinical profiles in an emergency department in Iran. This project is an initial step in "investigating older adults' functional capacity and clinical profiles in Iran. It will focus on one ED in a large, public-funded, national center of excellence in Tehran. It is anticipated that the results of this investigation will represent the first step in developing a deeper understanding of emergency geriatric medicine in urban areas of this country.

Literature Review

Population Aging in Iran

The world's population is aging globally (Kiani et al., 2010; World Health Organization, 2012). Advancements in public health and medical technologies, urbanization, and lower fertility rates have all attributed to this demographic phenomenon (World Health Organization, 2012). However, the underlying processes that lead to population aging have been relatively different in specific regions of the world (UNICEF, 2013; World Health Organization, 2012).

Iran is experiencing population aging due to a combination of political and societal factors that took place after the 1979 revolution (UNICEF, 2013; World Health Organization, 2012). As population growth was encouraged during the revolution, Iran underwent a population explosion in late 70's and early 80's (Hoodfar & Assadpour, 2000; Karamouzian, Sharifi, & Haghdoost, 2014; Mohammad, Khalaj, Farahani, Rahgozar, & Farahani, 2002). However, the government re-introduced family planning policies in 1989 to control the growth and to facilitate a sustainable recovery from the diminished post-war economy (Hoodfar & Assadpour, 2000;

Karamouzian et al., 2014; Mohammad et al., 2002). Such policies resulted in a substantial reduction of fertility rates from 6.5 per woman in 1967 to 1.6 in 2012 (Erfani, 2013).

In the meantime, to ensure adequate maternal/child health, the Ministry of Health and Medical Education of Iran diverted a significant portion of its political efforts and resources to public health interventions that targeted infant and youth health (Hoodfar & Assadpour, 2000; Karamouzian et al., 2014; Mohammad et al., 2002). These interventions resulted in a considerable decrease in infant mortality rates. From 1975 to 2000, the infant mortality rate in Iran dropped from 104.6 infant deaths per 1000 births to 28.2 (The World Bank, 2018). Such improvement in child and infant health has resulted in a larger number of Iranians surviving to older ages, leading to a higher population of middle-aged adults, predicting further imminent population aging.

Overall, the combination of lower fertility rates, effective policy-making for infant and youth health, and enhancements in public health interventions led to population aging among Iranians that were born throughout the population explosion in Iran (Erfani, 2013; Hoodfar & Assadpour, 2000; Karamouzian et al., 2014; Mohammad et al., 2002; The World Bank, 2018). Despite the population explosion, with adequate public health initiatives, newborns received better care and had a much higher survival rate to adulthood in comparison with previous generations; in the meantime, birthrates in the following generations fell dramatically, resulting in a decline in the proportion of younger generations. While those who were born during the population explosion are middle-aged now, their proportion in the Iranian population still remains the highest as birth rates have fallen significantly, suggesting an aging population in Iran.

Implications of Population Aging on the Iranian Healthcare System

In healthcare, population aging is usually associated with a higher prevalence of chronic conditions, geriatric syndromes, frailty, and disability (Denton & Spencer, 2010; Lysenkov & Yakhno, 2018; Marengoni et al., 2011; Tabue-Teguo et al., 2017). Geriatric syndromes involve a series of conditions and symptoms that are highly associated with frailty and disability. Examples of geriatric syndromes are depression, functional decline, poly-pharmacy, incontinence, and caregiver stress (Denton & Spencer, 2010; Flacker, 2003; Inouye, Studenski, Tinetti, & Kuchel, 2007; Lysenkov & Yakhno, 2018; Marengoni et al., 2011; Tabue-Teguo et al.,

2017). Frailty is the accumulation of multiple physical and mental impairments that increases an individual's vulnerability to stressors, such as trauma, sub-optimal care, co-morbidities, and inadequate support (Bergman et al., 2007; Bortz, 1993; Fried et al., 2001).

Such growth in the number of individuals with chronic conditions and geriatric syndromes has severe economic and clinical consequences, such as higher mortality, morbidity and healthcare consumption, particularly in developing nations (Bloom et al., 2011; Abegunde, Mathers, Adam, Ortegón, & Strong, 2007; World Health Organization, 2017). Iran is experiencing similar issues. In 2013, Iranian adults above 65 years of age experienced about seven million years lost to disability (Vos et al., 2015). Throughout the same year, 236,000 deaths occurred due to chronic conditions, which marks a 14.5% increase since the 1990's (Vos et al., 2015). This substantial increase has been mainly attributed to population aging in Iran (Namazi Shabestari et al., 2015; Vos et al., 2015). Moreover, it is predicted that the burden of chronic diseases and geriatric syndromes is going to increase from 14.3 million in 2003 to 19.4 in 2025 (Khajehkazemi et al., 2013).

The increased prevalence of chronic conditions, geriatric syndromes, and disabilities indicate a higher usage of health services (R. M. Anderson, 2018; R. Anderson & Newman, 1973; Babitsch, Gohl, & von Lengerke, 2012; Denton & Spencer, 2010; Lysenkov & Yakhno, 2018; Marengoni et al., 2011; Tabue-Teguo et al., 2017). However, service usage among older adults is not distributed homogeneously; in fact, older adults tend to utilize certain sectors of healthcare more than the others. For instance, emergency departments [ED] play an integral role in care provision to older adults (Bazargan, Bazargan, & Baker, 1998; Mitchell & Krout, 1998; Parboosingh & Larsen, 1987; Pines, Mullins, Cooper, Feng, & Roth, 2013; Schumacher, 2005; Shah, Rathouz, & Chin, 2008; Wolinsky, 1994; Wolinsky & Johnson, 1991; Zeinalhajlou, Ghafouri, & Matlabi, 2017).

Emergency Department and Older Adults

A review by Samaras et al. indicated that on average, older adults constitute about a quarter of ED visits internationally (Samaras, Chevalley, Samaras, & Gold, 2010) and this number is expected to rise due to population aging (Burkett, Martin-Khan, Scott, Samanta, & Gray, 2017; European Commission, 2012; Roberts, McKay, & Shaffer, 2008).

Acute care is one of the most accessible health sectors to older adults (Aminzadeh &

Dalziel, 2002; Jane McCusker & Verdon, 2006; Veillette et al., 2009; Wofford et al., 1993). EDs are considered major entry points for older people in healthcare (Aminzadeh & Dalziel, 2002; Jane McCusker & Verdon, 2006; Veillette et al., 2009; Wofford et al., 1993). Services offered in ED create the potential to address both outpatient and inpatient needs of older patients, and in most cases EDs could bridge the gap between the two (Carpenter & Platts-Mills, 2013; Hwang & Morrison, 2007). In health systems with less focus on community-based health, EDs could also act as a safety net by accommodating patients with varying needs (Gideon A Caplan et al., 2004; A. Costa, 2013; Xu, Nelson, & Berk, 2009). Further, EDs are a common entry point to acute inpatient care, psychiatric care, social services, and community care services (Aminzadeh & Dalziel, 2002; A. Costa, 2013; Jane McCusker & Verdon, 2006; Veillette et al., 2009; Wofford et al., 1993).

On an individual level, older adults usually struggle with more acute issues and tend to visit EDs with a higher level of complexity because of their co-morbidities, atypical presentation of symptoms, and higher chances of trauma due to geriatric syndromes, such as falls and poly-pharmacy (Albert, McCaig, & Ashman, 2013; Leonard C Gray et al., 2013; Ng et al., 2002; Olivier et al., 2009; Peters, 2010; Pines et al., 2013). These patients are usually more concerned with their health and seek medical attention more regularly; additionally, they tend to perceive their health issues as more urgent in comparison with the rest of the population (Kamali, Jain, Jain, & Schneider, 2011; Lowthian, Curtis, Stoelwinder, McNeil, & Cameron, 2013). Meanwhile, many older patients live alone; the absence of caregivers in their lives forces them to visit EDs as their first line of help, which leads to higher ED visits (Bazargan et al., 1998; Parboosingh & Larsen, 1987; Shah et al., 2008).

Older ED patients are exposed to a variety of stressors, which in cases of frailty could complicate their care even further. When admitted to ED, older adults are subjected to longer and more extensive investigations, which leads to lengthier hospital and ED stays (Denman, Ettinger, Zarkin, Coon, & Casani, 1989; Hedges et al., 1992; Watson, Marshall, & Fosbinder, 1999). In the meantime, lengthier ED stays are shown to be correlated with a higher probability of adverse health outcomes (Ellis, Marshall, & Ritchie, 2014; Graf, Zekry, Giannelli, Michel, & Chevalley, 2011; Wright, Tan, Iliffe, & Lee, 2014). Older ED patients also suffer from a higher rate of misdiagnosis and medication errors in acute care (Burkett et al., 2017; Chin et al., 1999; Lewis, Miller, Morley, Nork, & Lasater, 1995; Meldon et al., 2003b) and admission to ED could in fact

be a predictor of functional decline and poor care transitions (Caplan, Brown, Croker, & Doolan, 1998).

It could be concluded that ED are a significant sector of any healthcare system for addressing older adults' complex needs, particularly in countries that lack community-based health, such as Iran. Meanwhile, as the above literature indicates, acute care-provision to older adults is a complex task and there is a need for improvement in current clinical ED guidelines.

Emergency Care in Iran

Iran has a two-tier health system. The public health sector is governed by the Ministry of Health and Medical Education (Mehrdad, 2009). Following the ministry's guidelines, health provision is overseen by directors of medical schools and teaching hospitals in various provinces (Mehrdad, 2009). Although these institutions are mandated to provide both preventive and tertiary care, the majority of their resources are usually allocated to the latter. The private health system in Iran also focuses mainly on secondary and tertiary care-provision, suggesting an overall hospital-based health system (Mehrdad, 2009; Noroozian, 2012).

As part of this hospital-focused system, the Iranian emergency healthcare was first established to treat traumas from an airport collapse in Tehran in 1974 (Smith et al., 2007; The Iranian Ministry of Health and Medical Education, 2000). Since this incident, Iran has made significant improvements in managing acute traumas and infectious diseases (Smith et al., 2007; The Iranian Ministry of Health and Medical Education, 2000). Throughout the past four decades most initiatives have focused primarily on developing a national triage system and trauma care to reduce wait-times (Smith et al., 2007; The Iranian Ministry of Health and Medical Education, 2000). To do so, Emergency Medicine was established as a specialty about two decades ago, and nowadays most urban hospitals employ a combination of emergency medicine specialists (Smith et al., 2007).

Despite such improvements in reducing the burden of traumas and infectious diseases, the Iranian acute care has not been adapted to manage the growing number of older adults and their chronic conditions in ED (Smith et al., 2007). Similar to many developed countries, Iran is struggling with a mismatch between its current demographic changes and the infrastructure of its emergency healthcare (Goharinezhad et al., 2016; Jeddian et al., 2016; Kiani et al., 2010; Pines et al., 2011; The Iranian Ministry of Health and Medical Education, 2000; World Health

Organization, 2009). Currently, Iran lacks a comprehensive model that facilitates an effective collaboration between allied health professionals to tackle the complexities of older ED patients (Goharinezhad et al., 2016; Jeddian et al., 2016; Smith et al., 2007). Absence of such a system has led to high rates of misdiagnosis and overcrowding of general and Intensive Care Unit wards (Jeddian et al., 2016).

Optimal Care-Provision to Older Iranian Acute Care Patients

To fill this gap, Iranian policy-makers have issued numerous action plans in the past decade, encouraging a comprehensive strategy to provide optimal acute care to the aging population. For instance, Iran's 2016 Five-Year National Development Plan emphasized the need for chronic disease management strategies to lower the burdens of chronic conditions among the aging population (Office of Program, Budget, Statistics, 2017). Within this paradigm, implementation of chronic disease management protocols within emergency care has been prioritized (Office of Program, Budget, Statistics, 2017). In addition, risk management of older patients in EDs was highlighted as a priority in previous development plans (Babitsch et al., 2012; World Health Organization, 2009). However, risk management and practicing comprehensive care requires a thorough understanding of the nature and the needs of older people in Iranian EDs.

Considering the novelty of geriatric medicine in Iran, there is a lack of data on the older populations, resources available to them, and their health status (Parboosingh & Larsen, 1987; Sheykhi, 2006). Currently, there are no standardized assessments or a database with a primary focus on geriatric medicine in Iran (Goharinezhad et al., 2016). A qualitative assessment conducted by Goharinezhad et al., identified that this lack of a comprehensive information system for the elderly is one of the challenges in planning and policymaking for this population (Goharinezhad et al., 2016). To fill this gap, investigating the clinical and functional profiles of older Iranians in ED would be highly informative.

Clinical and Functional Status of Older ED Patients

In a 2014 cross-sectional retrospective study, Latham & Ackroyd-Stolarz reviewed 34,454 older adults' (65+) ED visits at four different sites in Nova Scotia, Canada (Latham &

Ackroyd-stolarz, 2014). This study showed that most older adults visited EDs throughout weekdays for injury or symptom related complaints, the majority of which were shortness of breath (9.3%), chest pain (8.1%), and lower extremity pain (7.9%) (Latham & Ackroyd-stolarz, 2014). While about 70% of the study's population were discharged after their visit, 20.8% were admitted to the hospital following their admission to the ED. Last, this article indicated that there was a positive relationship between age and length of hospital stay (Latham & Ackroyd-stolarz, 2014).

In a more recent study, McCabe and Kennelly conducted a literature review to investigate the prevalence of geriatric syndromes among older ED patients above 70 years of age. In this review, it was shown that about 10% of older ED patients experience delirium and 26% present to ED with a degree of cognitive impairment (McCabe & Kennelly, 2015). This article also highlighted risks of poly-pharmacy among ED patients who were admitted from residential care, as well as the poor prognosis for older adults who visit ED due to frequent falls (McCabe & Kennelly, 2015).

While the majority of such studies focus on the clinical characteristics of older adults, Gray et al. conducted a more comprehensive study in 2013, where the functional capacity of older patients above the age of 75 was investigated in seven countries, including India, Australia, Germany, Canada, Belgium, Sweden, and Iceland (Gray et al., 2013). They focused on functional, psycho-social, and symptomatic characteristics of older adults in acute care using a multi-disciplinary tool, called interRAI Emergency Department Contact Assessment (ED-CA) (Gray et al., 2013). This multi-national study (referred to as "interRAI ED study" throughout this thesis) compared the functional capability of older adults at pre-morbid (three days prior to admission) and admission stages. Overall, interRAI ED study indicated the need to address older patients' functional characteristics as part of their treatment. Additionally, Gray et al., investigated the health outcomes of older ED patients 28 days following their discharge. The findings indicated that the prevalence estimates of functional deficits increased by 50-100% in areas such as bathing, personal hygiene, dressing lower body, and locomotion (Gray et al., 2013). Additionally, the high prevalence of caregiver stress (24% in six countries and 76% of informal caregivers in India), cognitive impairment (26%), frequent recent falls (37%), daily pain (39%), and dyspnea (37%) were highlighted in this study (Gray et al., 2013). Additionally, Costa et al. utilized the findings of interRAI ED study to investigate the most significant predictors of

adverse health outcomes 28 days post-discharge. This study highlighted the importance of evaluating geriatric syndromes, caregiver stress, trauma, and older patients' self-report mood to predict ED patients' length of stay, re-admission to ED or hospital, and discharge to higher levels of care, such as long-term care facilities (Costa et al., 2014)

Although the above information could be highly informative to estimate the Iranian ED patients' characteristics, it is important to note that these studies did not target any low- to middle-income countries except India. Similarly, the majority of the participants were recruited from health systems in which community-based and primary care are highly practiced, such as Canada, Australia, and Belgium (Government of Canada, 2012; The Commonwealth Fund, n.d.; World Health Organization, 2016). Further, India, with a much larger population, higher number of rural patients, more severe poverty, and larger health expenditure per capita, is an inadequate representation of Iran (Balarajan, Selvaraj, & Subramanian, 2011).

Consequently, while these studies could build a general understanding of older patients' needs, they are insufficient to develop comprehensive geriatric guidelines to specifically address Iranian older ED patients' needs. To do so, there is a need for a more comprehensive investigation of older adults' characteristics at ED in Iran. Currently, there is no existing data on the functional status of older ED patients in this country. Thus, this research project represents a first step in investigating the functional profiles of older adults in an Iranian ED setting, specifically in the ED of the Shariati Hospital in Teheran. To do so, a similar protocol as Gray et al. will be adopted. While following the same methodology and research instruments as this multi-national project, this thesis also investigates the ED patients' diagnostic and medication information to reach a broader understanding of their health. This comprehensive dataset will allow for a thorough investigation of the current health status of older adults in this ED setting.

Study Rationale

This master's thesis aims to describe the needs of older Iranian adults presenting to a major ED in Teheran and compare their clinical and functional profiles to the those that participated in the interRAI ED study. Overall, this project has three main objectives:

1. To understand functional and diagnostic status of older adults presenting to an urban ED in Iran.
2. To compare these clinical and functional characteristics with other seven countries that participated in interRAI ED multinational study.
3. To identify variables that estimate the probability of ED re-admissions and death among older adults.

Understanding Functional and Diagnostic Status of Older Adults Presenting to ED

Considering the dearth of knowledge in Iranian geriatrics, this research project could be informative for evidence-based decision-making among stakeholders. By describing older adults' health status in an Iranian ED, researchers will be able to identify areas of research that require further investigation. Clinicians could also gain a deeper understanding of the needs of their older patients in ED. Using this project's results, they could speculate what areas of chronic disease management must be prioritized and what aspects of older adults' health must be addressed in their practice. Last, policy-makers are enabled to identify older adults' needs in healthcare. Having knowledge of the functional and clinical characteristics of older adults will assist policy-makers to devise specific strategies that could help reconcile the mismatch between current ED care models and older adults' complexity.

Comparison of Shariati Hospital's Older ED Patients Health Status with the Rest of the World

Gray et al., investigated functional profiles of older adults in ED across seven nations. As explained in the Methods section, this research project is pursuing a similar methodology to enable a thorough comparison of findings between Iran and the aforementioned seven countries.

Such comparisons will enable the audience to evaluate the characteristics of older ED patients in an Iranian setting with other countries and also highlight the potential benefits of

adopting a standardized approach to assessment. Researchers could compare and contrast the Iranian geriatric acute care with global benchmarks. Iranian academics who are interested in investigating older Iranians' health could also utilize these results to identify characteristics that are exclusive to their elderly population. Global health researchers, on the other hand, could identify which issues are shared globally and which characteristics are specific to the populations with a similar socio-demographic structure as Iran. Similarly, clinicians could benefit from these results by identifying Iranian older patients' unique needs. This information is also beneficial to those practicing medicine outside of Iran, considering the growing population of older Iranians across the world and the complications of healthcare delivery to older immigrants. Policy-makers in Iran will gain a deep understanding of the status of Iranian geriatric acute care. The results of this research project will contribute to understanding Iran's potential to provide chronic disease management and optimal care in ED to older adults; through this evaluation, policy-makers could identify which areas of acute care require more attention. Moreover, a deeper understanding of the nature of older patients in ED will enable policy-makers to tailor future policies to the Iranian culture and Iranian older adults' needs.

Identifying Variables that Predict the Probability of Post-Discharge Outcomes

This thesis aims to develop statistical models that highlight the correlation between older patients' health status upon admission to ED and their health outcomes 28 days following discharge from ED. Learning the common predictors of adverse post-discharge outcomes will help researchers design future research and identify key risk factors for higher service use and sub-optimal outcomes. Clinicians could also utilize these results to determine which Iranian older adults' characteristics predict adverse outcomes. It is hypothesized that geriatric syndromes and frailty would be highly correlated with adverse post-discharge outcomes (Costa et al., 2014); retaining this hypothesis will emphasize the importance of inter-disciplinary care-provision by addressing older adults functional and mental health. Meanwhile, policy-makers will benefit from these models to estimate older people's potential service use based on their characteristics at admission to the ED; and thus, minimize healthcare costs by designing policies that allocate health resources according to patients' risk for adverse outcomes.

Methods

Study Design

Similar to the multi-national study conducted by Gray et al., this master's thesis is an observational cohort study. The data collection for this project took place between June-October 2018 in Tehran, Iran.

Study Sample

This study targeted Shariati Hospital's older ED patients. The inclusion criterion for age was 65 and over, contrary to Gray et al., who only included older adults above 75, aiming to target those at the highest risk of poor outcomes (Gray et al., 2013). The main justification for including a wider age range of patients was to investigate the overall health status of older adults, despite their level of frailty. At the same time, life expectancy is about five to six years lower in Iran (Shah et al., 2008; The United Nations, 2017); Noroozian adds that while most developed countries consider 65 as the beginning of older adulthood, this number is often reduced to 60 among developing countries, mainly due to their lower life expectancy (Noroozian, 2012). Consequently, it was speculated that including older adults between the ages of 65 and 75 must be informative.

Exclusion criteria were older adults who could not communicate in English or Farsi and did not have a surrogate who could communicate in any of those two languages. Unaccompanied older adults with cognitive impairments and older adults who were in severe acute medical crisis (highest level of triage acuity; resuscitation) were also excluded.

Considering that this project is an observational/exploratory study, no specific outcomes were identified to calculate the sample size. It was assumed that variables of clinical importance would emerge within a sample size of at least 100, regardless of their statistical significance. Also, to enable a statistical comparison with the Multi-National study results, it was ensured that at least 100 older adults above the age of 75 were recruited.

Study Setting

Data collection for this research project took place at Shariati Hospital, in Tehran, Iran. Shariati Hospital, which is affiliated with the Tehran University of Medical Sciences, is one of Iran's largest teaching hospitals (Tehran University of Medical Sciences, n.d.). This public facility was established in 1973 and currently accommodates more than 500 beds, serving 190,000 outpatients annually (Tehran University of Medical Sciences, n.d.). Further, hosting one of Iran's largest EDs, Shariati Hospital receives about 19,800 ED patients per year (Tehran University of Medical Sciences, n.d.).

As Shariati Hospital is designed to provide affordable healthcare, patients from all socio-economic statuses visit this facility (Tehran University of Medical Sciences, n.d.). However, the majority of patients come from low- to middle-income families. Meanwhile, Shariati hospital offers many rare specialized therapies, such as foot angiography and stem-cell interventions (Tehran University of Medical Sciences, n.d.), which attracts patients with more complex needs from around Iran. As a result, recruitment of patients at Shariati Hospital exposed the research investigators to a diverse range of patients with varying degrees of complexity. In addition, since this academic facility is renowned for accommodating high volumes of research projects, it was anticipated that collaborating with Shariati Hospital would ease the data collection process logistically and enhance the final dataset's quality.

Data Collection

Followed by arranging the data collection period with the ED's director, two research students, AZ and KM, visited Shariati Hospital ED for 30 consecutive weekdays. Considering that older patients are most likely to visit the ED in the morning or early afternoon, data collection took place during morning shifts (8 A.M. to 4 P.M.) (Downing & Wilson, 2005; Gray et al., 2013). At the beginning of each data collection day, with the help of the triage nurse and EMR systems, research students screened all new patients who met the inclusion criteria by inquiring about their age, cognitive health, and level of acuity. Students then approached the selected patients and explained the study design, purpose, risks, and benefits, followed by obtaining a consent form. Older adults with cognitive impairments or communication barriers were only approached in the presence of their caregivers. In such cases, although the surrogate was the main point of contact, older adults were involved in the discussion as well. After obtaining participants' consent, research students utilized interRAI ED-CA (CA) Version 9.3 on a tablet to investigate patients' functional, mental, and social health. The interRAI ED-CA is one of interRAI's shorter instruments that was originally designed to support "home-care assessment intake and emergency department referral processes" (Canadian Institute for Health Information, 2012; A. P. Costa et al., 2017). Currently, the primary use of this short-standardized assessment tool is to support clinical decision-making for older adults by primary care and acute care health providers (Canadian Institute for Health Information, 2012; Costa et al., 2017). The interRAI ED-CA captures a variety of patient's performance and functional capacity measures to reach a multi-disciplinary understanding of older adults' health status (Costa, 2013; Costa et al., 2017). This instrument identifies older adults who might benefit from a lengthier, more comprehensive assessment (conducted with the interRAI Acute Care Comprehensive Geriatric Assessment tool) by investigating their physical, cognitive, social, and mental health (Canadian Institute for Health Information, 2012; Costa et al., 2017). More details on specific variables measured by this instrument are provided below (please refer to Table 1).

At the end of the assessment, older adults and their caregivers were also asked to list their medications and diagnoses at admission. Following the interview, research students reviewed participants' medical charts to verify the accuracy of diagnoses and medication data alongside recording patients' serum creatinine level, height, and weight. The main reason for re-collecting

the diagnostic and medication data was that Shariati ED's medical charts were incomplete and the investigators preferred not to rely solely on participants' memory, due to the risk of recall bias. In cases of discrepancies, participants were approached again for clarification. Twenty eight days following their discharge, participants' length of ED-stay, length of hospital stay (if applicable), number of hospital re-admissions, and number of ED readmissions were recorded using medical charts and phone-calls. When the data collector was informed that a participant was deceased, the date of death was recorded. interRAI ED-CA data alongside participants' medication and diagnostic information were all automatically stored in an encrypted online database.

Measurements and Variables

Three clusters of data were collected. First, the interRAI Emergency Department Contact Assessment [ED-CA] instrument was utilized to assess older adults' functional, cognitive, and mental health status. Second, research students reviewed patients' medical charts and "medication boxes" to collect participants' medication and diagnostic data. Finally, 28 days after ED discharge, participants' length of ED and hospital stay, ED and hospital re-admissions, and mortality was documented.

Choosing the interRAI ED-CA: Considering the objectives of this project, a comprehensive understanding of older ED patients was preferred. Therefore, when choosing among measurement instruments, the comprehensiveness of the assessment tool was a priority. Further, since data collection was taking place in addition to the ED's regular clinical assessments, it was important that the chosen tool was concise to avoid distressing patients and/or disrupting hospital's routines. It was deemed that using interRAI ED-CA would satisfy both the brevity and the comprehensiveness of this study's data collection requirements.

Validity and Reliability of the Instrument: The interRAI ED-CA consists of a series of validated questions derived from other interRAI instruments, pre-dominantly the interRAI Acute Care Comprehensive Geriatric Assessment (AC-CGA), a more comprehensive and lengthier assessment tool (Costa et al., 2017; Gray et al., 2008; Gray et al., 2013; Hirdes et al., 2008; Wellens et al., 2011). In a study conducted by Gray et al., the overall AC-CGA instrument had a moderate to almost perfect inter-rater reliability for about 81% of the questions (Gray et al.,

2008). Another study by Hirdes et al., indicated significant reliability among five interRAI instruments, including interRAI post-acute care, interRAI Long Term Care Facilities, interRAI mental health, and interRAI Home-Care. It is important to note that these instruments share a high number of overlapping items with interRAI ED-CA (Hirdes et al., 2008). Considering the proven reliability of ED-CA items, this project did not involve any reliability testing. It was speculated that testing the reliability would thus needlessly complicate the data collection process and potentially overwhelm participants. The validity of interRAI ED-CA items has also been tested extensively in a variety of contexts, including other cultures and languages; the overlapping items with interRAI ED-CA were shown to be a useful tool to measure the intended variables (Costa et al., 2017; Gray et al., 2008; Gray et al., 2013; Hirdes et al., 2008; Wellens et al., 2011).

Independent Variables Measured by the interRAI ED-CA: As mentioned earlier, this study utilized the interRAI ED-CA version 9.3 which consists of 34 items that are divided into three categories: 1. Demographic information, 2. Intake and initial history, and 3. Clinical evaluation. Table 1 provides a brief summary of the components of each category and the data sources that the research students utilized to measure each item. Within the clinical evaluation category, investigators recorded participants' cognitive status, activities of daily living (ADL) and dyspnea during pre-morbid and admission phases. The interRAI ED-CA defines the pre-morbid stage as three days prior to admission to the ED (Canadian Institute for Health Information, 2012; Costa et al., 2017). ADLs included bathing, personal hygiene, dressing lower body, and locomotion (Costa et al., 2017). It is important to note that all questions were measured as a categorical variable except the demographic data, assessment date, reason for referral, and hospital use, which were recorded either as a text or a ratio variable.

Table1: Components of the interRAI ED-CA’s Categories and Data Sources to Measure Items

Category	Components	Data Sources	Variable Type (Scale)
Demographic Information	Name, Age, gender, chart number	Medical chart; Double-checked with patients	Text, Categorical (0 and 1)
Intake and Initial History	Assessment date, reason for referral, where patient was admitted from, living status, caregiver burden, reception of community services, and time since last hospital stay	Medical chart and communication with patient and their family	Text, Categorical (0 and 1)

Clinical evaluation	Cognitive status, behavioral issues, self-report mental health, Activities of Daily Living (ADLs), Instrumental activities of daily living (IADLs), Falls, Dyspnea, Pain symptoms, Patients' stability, and nutritional status	The data was primarily collected through communicating with the patient and the caregivers. This data was complimented by data collector's further observation of patients and communication with nurses	Categorical (0 and 1; 0-2; 0-4)
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Other Independent Variables: To assess the interRAI ED-CA's feasibility, the overall length of the assessment for each patient was recorded. Following, the interRAI ED-CA data was collected, and the medication and diagnostic history of patients at admission were documented.

28 days after discharge, research students followed up to measure participants' mortality, length of ED-stay, length of hospital stay (if applicable), number of hospital re-admissions, and number of ED readmissions.

Dependent Variables: The first two parts of this project investigate the prevalence of older ED patients' health status. Therefore, there are no particular dependent variables for this phase. For the third objective, the dependent variables were post discharge outcomes including re-admission to ED and mortality. It is important to note that initially, investigators attempted to include both ED and hospital re-admissions; however, since some patients are occasionally admitted to hospitals for regular appointments with physicians, this variable was removed.

Training Data Collectors

The interRAI ED-CA is designed to be utilized by any health professional, such as nurses, physicians, care-coordinators, and social workers (Costa et al., 2017). Throughout this study, data collectors communicated with patients and their caregivers, reviewed medical charts, and collaborated with allied ED health professionals to document the most accurate answer for each of the assessment tool items. Such inter-disciplinary assessment requires extensive training. Consequently, AZ was trained by the interRAI team at the University of Waterloo two months prior to data collection. Using the notes that were taken during his training sessions, alongside the interRAI ED-CA's manual, AZ trained the other data collector, KM, at Tehran University in Iran. It is worth noting that KM is a clinical pharmacist. Thus, he was familiar with the regular assessment protocols in an Iranian clinical setting.

Ethics

An ethics clearance has been issued by The University of Waterloo Office of Research Ethics (ORE# 32443). A sample copy of the English version of the consent form and information letter that was provided to all potential participants is presented in Appendix A. Further, to use the multinational dataset, an ethics clearance has been obtained by interRAI Canada from Waterloo Office of Research Ethics.

Data Analysis

A combination of descriptive and inferential analysis took place. The de-identified data was stored in an encrypted excel file as well as interRAI's highly secured database. All analyses were conducted on SAS Version 9.4. ATC/DDD 2018 (WHO Collaborating Centre for Drug Statistics Methodology, 2018) and ICD-10 codes (The Centers for Medicare and Medicaid Services (CMS) & the National Center for Health Statistics (NCHS), 2018) were also utilized to document medication and diagnosis data respectively.

Descriptive Analysis: Frequency distribution was the main format of describing participant's health status. The majority of variables in this project were categorical, so frequency distributions were thought to be informative by providing a general understanding of the magnitude of each measure. From the interRAI ED-CA items, the following variables were presented using frequency distributions: gender, age-groups, living status prior to and after

admission to ED, social support, hospital use prior to ED admission, cognitive capacity, mental health, self-report health, functional capacity at pre-morbid and admission stages, clinical symptoms, and nutritional status. In addition to ED-CA items, post-discharge outcomes were presented in the same manner. The mean of continuous variables, such as age, were also calculated to add more depth to descriptive analysis.

Using Brousseau et al.'s methodology, participants' frailty level and the mean frailty index were determined (2018). In 2018, Brousseau et al., utilized the same database as the multi-national study by Gray et al., to derive a frailty index [FI-ED] from 24 interRAI ED-CA items (2018). Accordingly, this methodology is a suitable approach to identify deficit accumulation and frailty among older ED patients (Brousseau et al., 2018). Determining participants' frailty index enabled the investigators to stratify participants based on their frailty level, thus providing the frequency of each independent variable in different frailty groups. The details of this methodology alongside the list of included variables are provided in this thesis appendices (Brousseau et al., 2018).

Inferential Statistics: Previously, Gray et al., used a 95% CI to present prevalence estimates of functional deficits and geriatric syndromes. Therefore, to allow for a meaningful comparison with Gray et al.'s results, 95% CIs were calculated.

To determine the relationship between independent variables and post-discharge outcomes (dependent variables), logistic regression was used. Logistic regression is a well-established statistical method to investigate the correlation between different types of variables and categorical outcomes (Everitt & Dunn, 2001; Hosmer & Lemeshow, 2000; King, 2003). Considering that the dependent variables of this project were primarily binary or categorical, logistic regression was chosen as the main method of inferential analysis. Regression model results were presented as odds ratios to compare and contrast independent variables' ability to predict certain outcomes. It is important to note that investigating the predictors of sub-optimal medication profiles would have been informative; however, this objective is out of the scope of this thesis. Additionally, diagnostic data was not included in logistic regression for two main reasons. First, diagnostic information was speculated to be highly correlated with functional characteristics of older ED patients at Shariati, and thus interfere with the validity of the final

model. Second, considering the large number of diagnoses, investigators thought inclusion of diagnostic information might complicate model selection process.

Two types of logistic regression were used in this study. First, using univariate logistic regressions, the correlation between single independent variables and health outcomes was determined. Following this step, multi-variate logistic regression was conducted to model the correlation of multiple variables with post-discharge outcomes. Using best subset selection, the best multivariate model was determined. Best subset regression calculates the predictive power of every possible combination of variables. Using this data mining technique, a summary of chi-square values for every possible combination of independent variables was outlined, where the higher the value, the stronger the model's predictive capability was. As expected, chi-square values grew by increasing the quantity of variables. However, the most optimal number of co-variables for a model was chosen where such growth became negligible. Following this step, the student investigator evaluated each model based on its parsimony, clinical validity, and cultural relevance. For instance, variables such as living alone and caregiver stress could be of higher priority within the Iranian context, considering the collectivist values. Such consideration would be informative as they could further emphasize differences or similarities between the Iranian cohort and the global literature.

It is important that, best subset selection was chosen as opposed to stepwise regression, where a sequential series of additions and subtractions of predictors lead to choosing "the best" model (King, 2003). Because of the limited capability of SAS 9.4 in conducting stepwise regression (King, 2003) and to decrease the order of entry and deletion effects (Costa et al., 2014; King, 2003), best subset regression was chosen in this study.

Testing the Final Model: The Hosmer-Lemeshow test was used to evaluate the final model's goodness of fit. This test evaluates whether any considerations of non-linearity or interactions are required to build the model (Hosmer & Lemeshow, 2000; King, 2003). While the Hosmer-Lemeshow test is informative to evaluate the calibration of the model, it does not comment on the specificity and sensitivity of the regression. Consequently, the area under the curve test [AUC Test] was used to evaluate the combination of sensitivity and specificity of the final model. To ensure that the assumptions of logistic regression are not violated, the residuals were analyzed. It is important that the residuals vary randomly around zero and are dispersed with no specific patterns. Such characteristics indicate that any errors associated with the model

are due to random errors. To rule out the influence of co-variates on the model, a test of collinearity was also conducted. Throughout this test, individual covariates were eliminated and the model's tolerance was evaluated (Costa et al., 2014; Hosmer & Lemeshow, 2000). This test ensured that the included variables were not significantly correlated with each other, as such circumstances interfere with the internal validity of the regression model.

Missing Data: Older adults with more functional deficits are more likely to experience adverse health outcomes (Costa et al., 2014). Consequently, there is a higher chance that a high attrition rate during data collection may be confounded by missing participants' higher frailty level. Such a high attrition rate highlights the tentative presence of non-ignorable missing data.

To account for this attrition, the student investigator analyzed the demographic, functional, and clinical profiles of participants that were missing at follow-up to ensure that no apparent patterns exist between the attrition group and the remaining participants. Following this step, list-wise deletion was utilized through which the missing data was simply eliminated from the regression analysis (Diggle, Heagerty, LiangKung-Yee, & Zeger, 2002; Little, 1995).

Results

Figure 1: Flow Diagram of Data Collection

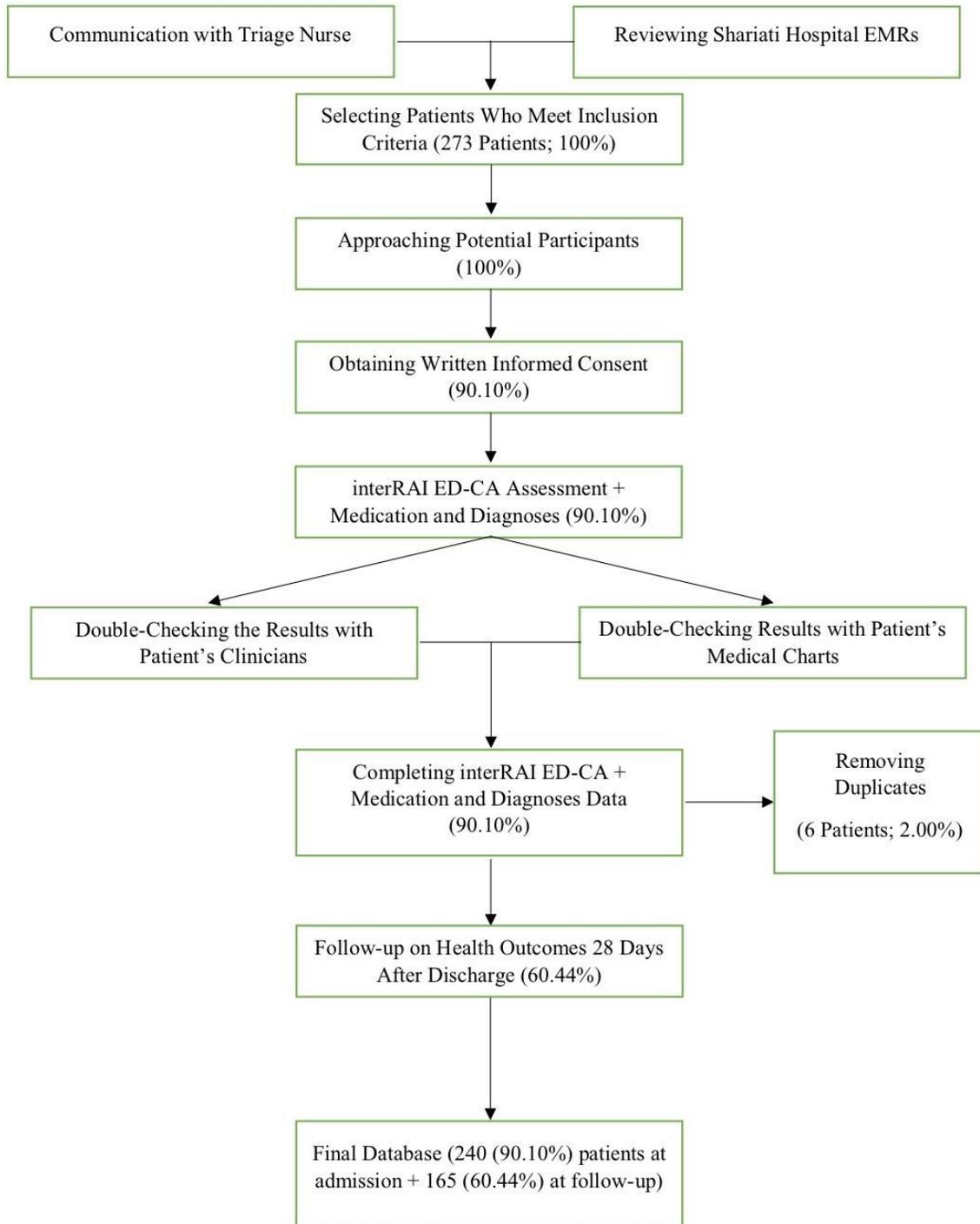


Figure 1 summarizes the recruitment process. Two hundred and forty older ED patients at Shariati Hospital were recruited, which constitutes 90.10 % of all eligible candidates. All data

was collected between 8:30 AM-5:00 PM at Shariati Hospital on Iranian working days (Saturday-Wednesday). The average time to complete the interRAI ED-CA assessment was 6.04 ± 3.17 minutes. Throughout the follow-up period, 75 participants had missing chart data and were also unavailable through phone calls, which marks a 31.3% attrition rate. Since the magnitude of the attrition rate could be large enough to influence the results of this analysis, characteristics of participants with missing follow-up data are included as a separate group in the following section.

Objective 1: Understanding Clinical and Functional Status of Older Acute Care Patients in Iran

Table 2 presents participants' demographic characteristics across age-groups. It is important to note that the missing group is not exclusive of other age-groups and consists of patients from all ages above 65 with missing follow-up data. About 52% (N=124) of patients were above 75 years of age. The mean age of participants was 75.9 ± 7.3 . This increased to 81.6 ± 5.1 among patients who were 75 years or older. The majority of participants were male (57.1%) and lived with someone (72.5%). Caregiver stress was high among all groups ranging from 29.0% in the younger cohort to 46.7% among older adults above 75. About 82% (N=197) of participants were admitted to the ED from a private home, and 16.3% of older adults were hospitalized at another acute care setting prior to their ED visit to await for a vacant bed at Shariati Hospital. Interestingly, less than 2% were admitted to ED from a long-term care facility. More than half of older adults visited the ED and 112 (46.9%) had a history of inpatient hospitalization in the last three months prior to their ED admission. Overall, considering the overlap between 95% confidence intervals, there was no significant difference between the demographic characteristics of the three groups.

Table 2: Demographic Information

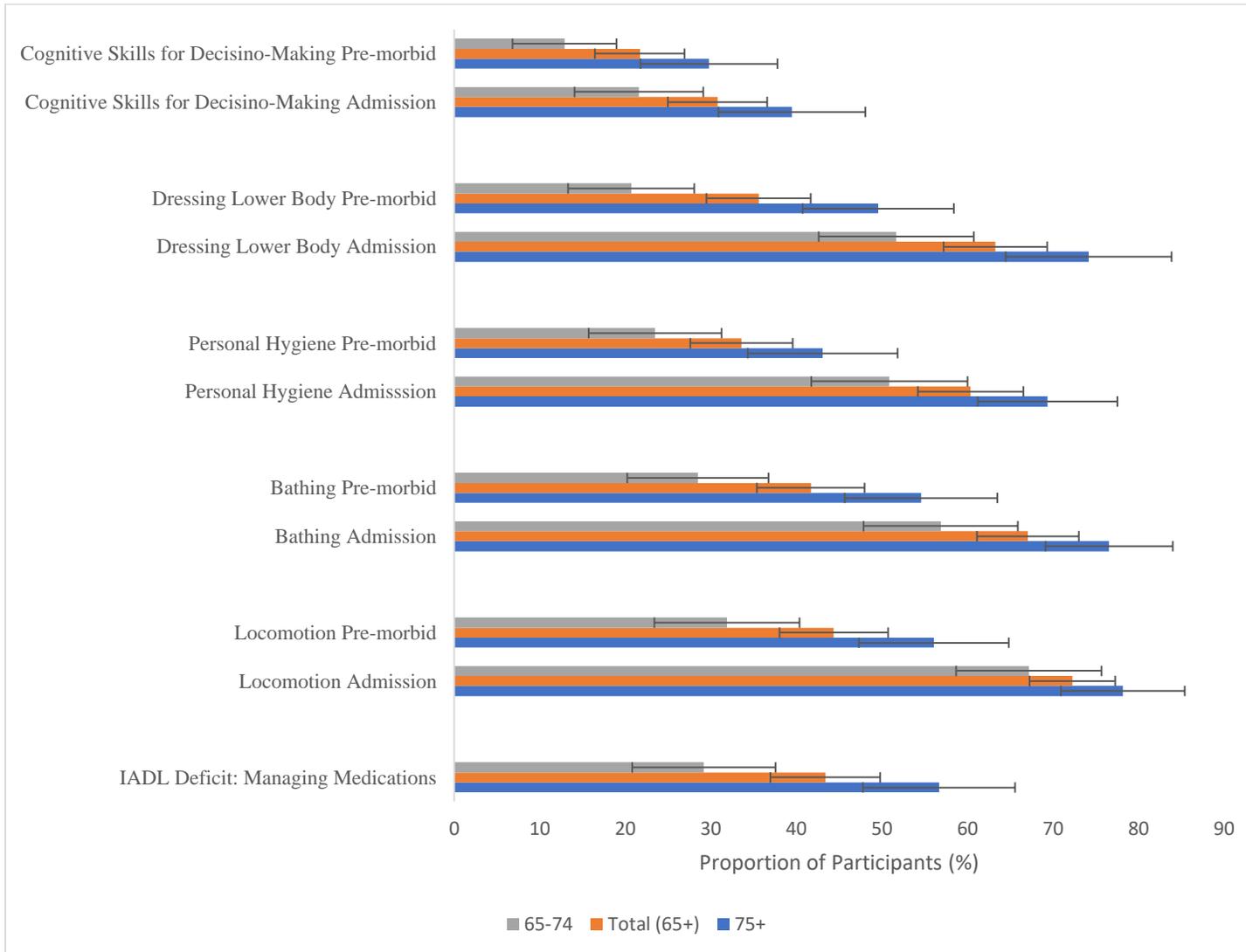
Characteristic (95% CI)		65-74 Years of Age	75 and Above	Participants with Missing Follow-up Information	Total (65+)
Sample Size (%)		116 (48.3%)	124 (51.7%)	75 (31.3%)	240
Mean Age		69.8±2.9 (69.2-70.3)	81.6±5.1 (80.7-82.5)	76.5±7.3 (74.8-78.2)	75.9 ±7.3 (75.9-76.)
Females		45.7% (36.6-54.8)	40.32% (31.7-49.0)	49.3% (38.0-60.7)	42.9% (36.7-49.2)
Living Alone		19.8% (12.6-27.1)	15.3% (9.0-21.7)	13.3% (5.6-21.0)	17.5% (12.7-22.3)
Caregiver Stress (95% CI)		29.0% (20.1-37.9)	46.7% (37.7-55.6)	40.3% (28.6-52.0)	38.6% (32.2-45.1)
Admitted from	Community	84.5% (77.9-91.1)	79.8% (72.8-86.9)	85.3% (77.3-93.3)	82.1% (77.2-86.9)
	Acute	13.8 (7.5-20.1)	18.6% (11.7-25.4)	14.7% (6.7-22.7)	16.3% (11.6-20.9)
	Long-Term Care	1.7 (0.0-4.1%)	1.61% (0.0-4.0)	0.0	1.7% (0.0-3.3)
Visited ED in the Past 3 Months		50.0% (40.9-59.1)	52.0% (43.2-60.9)	48.7% (37.3-60.0)	51.1% (44.7-57.4)
Hospital Admission in the Past 3 Months		48.3% (39.2-57.4)	45.5% (36.7-54.3)	42.7% (35.9-58.7)	46.9% (50.5-53.2)

Figure 2 compares the prevalence estimates of functional and cognitive deficits across different age-groups in pre-morbid and admission periods. Please note that the error bars in this graph represent 95% confidence interval for each variable. More than one third of participants required assistance with daily decision-making at admission. Further, more than half of all participants required some degree of supervision in each of the activities of daily living categories. and 43.4% (95% CI 37.0-49.7) of the whole sample size required supervision with managing their medications.

As Figure 2 indicates, the proportion of older adults who needed help with ADLs increased significantly from the pre-morbid period. Of all participants, 51.7% (95% CI 45.3-58.0) had at least one ADL deficit in the pre-morbid stage; this number increased to 77.9% (95% CI 72.7-83.2) at admission. Such decline was observed most in bathing where the proportion of participants requiring help or supervision with it increased from 41.7% (95% CI 35.4-48.0) to 67.1% (95% CI 61.1-72.0%). Moreover, locomotion was the most common functional deficit, with more than 70% (95% CI 67.3-78.5) of patients requiring assistance or supervision at admission.

Functional dependency increased with age. Older adults above 75 years of age had the highest proportion of functional and cognitive deficits. In fact, ADL and cognitive dependencies were significantly higher in this cohort across all domains and time-frames.

Figure 2: Prevalence Estimates (95% CI) of Functional and Cognitive Deficits across Age-Groups



About two-thirds of patients (95% CI 59.2%-71.3%) had signs of acute change in their mental status, which suggests high rates of delirium. Additionally, 36.3% of participants (95% CI 30.2-42.3%) had a history of falls in the last 3 months, from which 54 of them (62.1%) were above 75 years of age. Similarly, at admission, 44.1% (95% CI 36.2%-48.7%) reported significant weight loss and 36.4% (95% CI 30.3%-42.5%) had shortness of breath at rest or while doing normal activities. About 43% (95% CI 36.7%-49.2%) of all participants reported experiencing pain on a daily basis during the last 3 days prior to their admission.

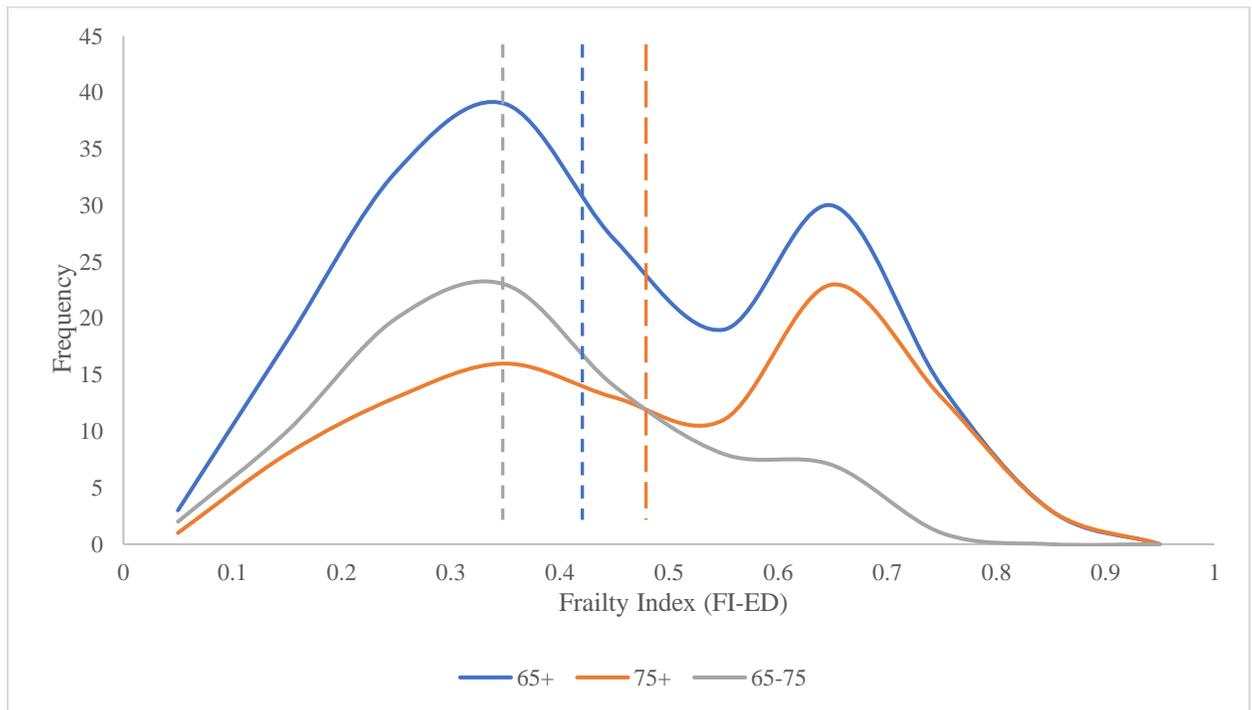
Table 3 highlights the proportion of patients with at least an ADL deficit, cognitive impairment and/or history of falls in the past 90 days. As this table indicates, there was no significant difference in the proportion of older adults with such deficits between the two time-frames or across various age-groups.

Table 3: Prevalence Estimates of Functional Deficits or Cognitive impairment

		65-74 (N=116)	75 and Above (N=124)	Missing at Follow-up (N=75)	Total (65+) (N=240)
ADL Deficit or Cognitive Impairment	Premorbid (95% CI)	67.2% (58.7-75.8)	82.3% (75.5-89.0)	74.7% (64.8-84.5)	75.0% (69.5-80.5)
	Admission (95% CI)	74.1% (66.2-82.1)	83.1% (76.5-89.7)	78.7% (69.4-87.9)	78.8% (73.6-83.9)
ADL Deficit or Cognitive Impairment or History of Falls	Admission (95% CI)	82.8% (75.9-89.6)	85.5% (79.3-91.7)	83.3% (72.5-90.2)	84.2% (79.6-88.8)

Figure 3 highlights the distribution of FI-ED across various age-groups. In this figure, mean FI-ED values for each age-group is represented by colored vertical lines. Further, the 99th percentile among older adults between 65 and 75, above 75, and the total sample were 0.76, 0.82, and 0.82 respectively, representing the most frail individuals in each sub-set. As indicated by Figure 3, the distribution of FI-ED among older participants and all patients was bi-modal, suggesting the large proportion of both highly functional and frail patients at Shariati ED.

Figure 3: Distribution of Frailty Index Across Age-Groups



Figures 4 and 5 illustrate the proportion of most common chronic conditions and medications among participants respectively. On average, older adults were diagnosed with 3.84 (± 1.92) chronic conditions at time of admission to Shariati ED. More than half of older adults were already diagnosed with hypertension and seven of the most common diagnoses were cardiovascular. Similarly, the most common medications were prescribed to manage cardiovascular symptoms of older adults. On average, participants were prescribed 5.76 (± 4.22) medications at time of admission, indicating poly-pharmacy.

Figure 4: Frequency of Most Common Diagnoses among Participants (65+)

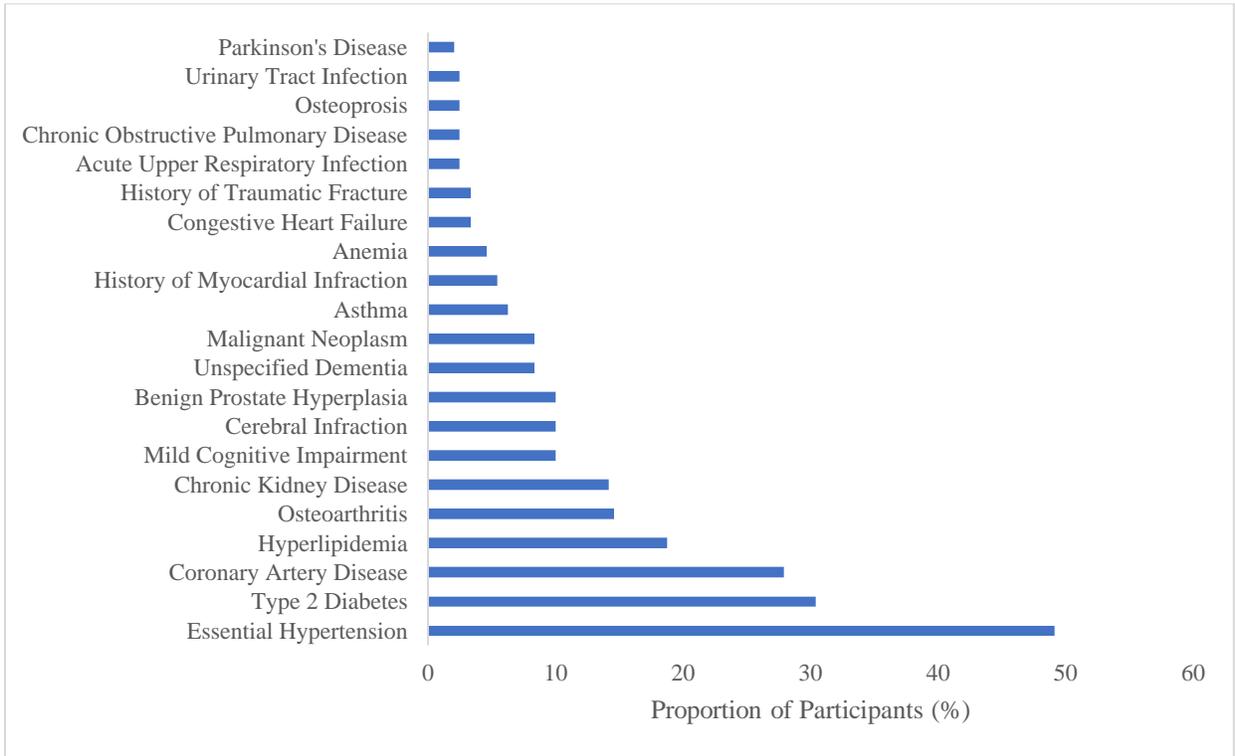


Figure 5: Frequency of Seven Most Common Medications among Participants

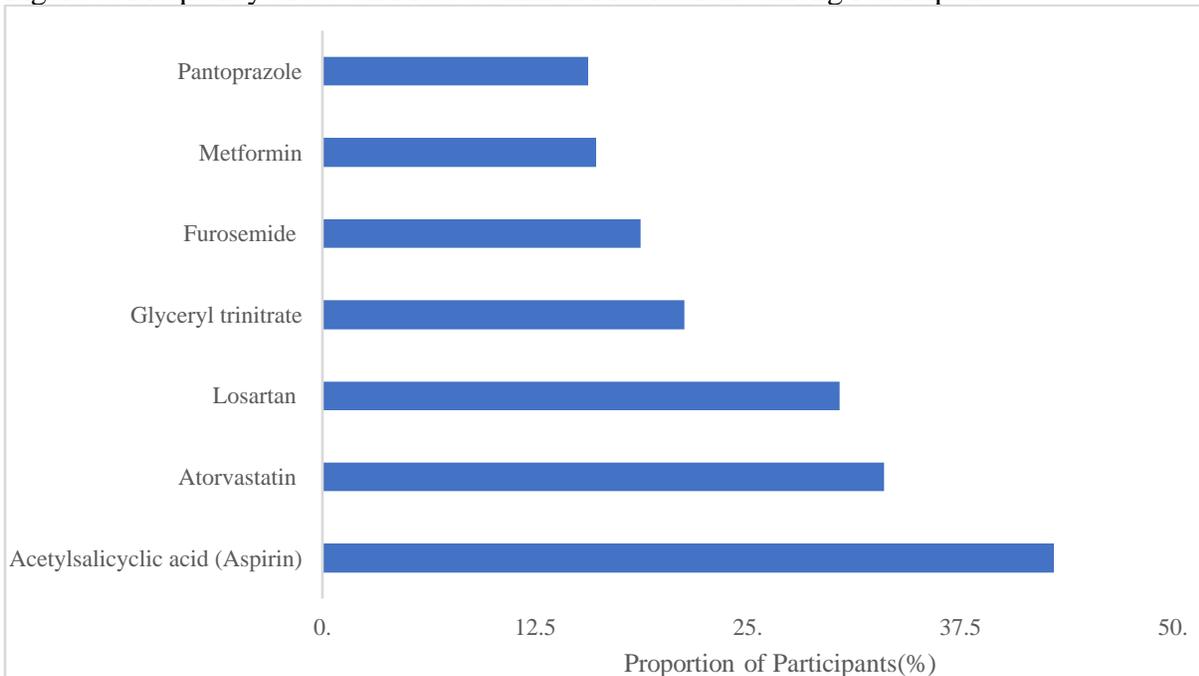


Table 5 summarizes participants' discharge destination. About 83% of patients were hospitalized in an acute-care inpatient unit following their discharge from ED. 79.4% of these older adults were admitted to ED from a private home, 1.9% came from a nursing home, and 18.7% were already hospitalized in an acute care setting prior to their admission. It is important to note that no patients were admitted to a nursing home/long-term facility. Overall, there were no discharge destinations other than hospitals or private homes. About 10% of patients (N=11) died in ED from which the majority were above 75 years of age (N=7).

Table 5: Discharge Destinations

Discharge Destination	65-74 Years of Age	75 and Above	Total (65+)
Private Home/Community	7 (10.1%)	5 (7.5%)	11 (8.5%)
Acute Care Hospital	55 (83.3%)	55 (82.1%)	107 (82.9%)
Long-Term Care Facility/Assisted Living	0 (0.00%)	0 (0.0%)	0 (0.0%)
Deceased in ED	4 (6.1%)	7 (10.4%)	11 (8.5%)

Lastly, Table 6 is a comparison of functional deficits, cognitive impairment, dyspnea, and frailty between participants who were present at the 28-day follow-up and those whose post-discharge information was missing. There were no significant differences between the functional and clinical profiles of older adults.

Table 6: Comparison between Functional Capacity and Frailty of Participants Missing to Follow-up and the Rest of the Dataset

Activities of Daily Living		Present at Follow-Up	Missing	P-value
Bathing*	Premorbid	64 (39.02%)	34 (47.89%)	0.2058
	Admission	111 (67.27%)	50 (66.67%)	0.9262
Personal Hygiene*	Premorbid	53 (32.12%)	27 (36.99%)	0.4638
	Admission	99 (60%)	46 (61.33%)	0.8448
Dressing Lower Body*	Premorbid	57 (34.55%)	28 (37.84%)	0.6230
	Admission	105 (63.64%)	47 (62.67%)	0.8851
Locomotion*	Premorbid	70 (42.42%)	36 (48.65%)	0.3705
	Admission	121 (73.33%)	54 (72.00%)	0.8294
Cognitive Skills*	Premorbid	36 (21.82%)	16 (21.33%)	0.9327
	Admission	51 (30.91%)	23 (30.67%)	0.9699
Dyspnea*	Premorbid	80 (48.48%)	35 (47.30%)	0.8651
	Admission	90 (54.55%)	37 (50.00%)	0.5150
Managing Medications*		74 (45.96%)	27 (37.50%)	0.2284
Stairs*		104 (63.03%)	49 (62.22%)	0.6352
Mean FI-ED**		0.4151	0.4428	0.3563

Objective 2. Comparing Clinical and Functional Characteristics of Shariati Hospital Older ED Patients with Other Countries: An Extension to the Multi-National Study

In this section, functional capacity and clinical characteristics of older Iranian adults over 75 years of age are compared with those in seven other countries that participated in interRAI's multinational project. It was speculated that limiting this section's analysis to this age-group would facilitate a more standardized comparison. The proportion of older adults with functional decline, ADL deficits, and frailty was the highest amongst those above the age of 75. In addition, interRAI's multinational ED-CA database only included older adults above the age of 75, targeting a more frail group of patients.

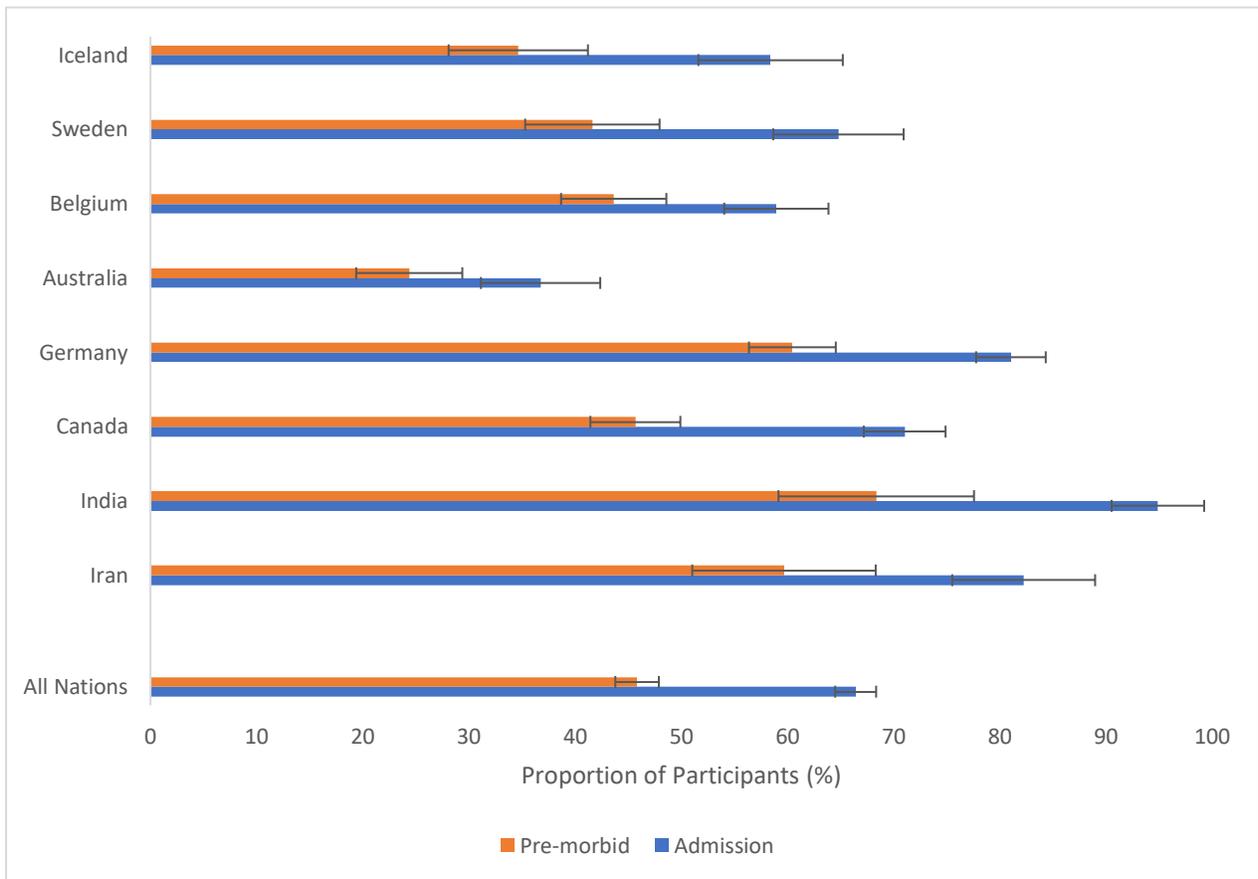
As mentioned in the Methods section, seven countries participated in interRAI's multinational study, including Canada (N=532), Australia (N=283), Belgium (385), Germany (549), Sweden (N=233), Iceland (N=202), and India (N=98), resulting in a total of 2,282 patients from 13 different facilities. Similar to the Iranian cohort, consent rate was about 90% and data collection took place during working days. Table 6 compares the demographic information of participating nations with the Iranian cohort. While some characteristics of Iranian participants were most similar to those of India, there were considerable differences. The mean age ranged from 79.7 (India) to 85.2 (Sweden). Similar to India, and contrary to the other countries, male participants constituted the majority of the Iranian sample. About 18% of Iranian older adults lived on their own. While this number is significantly lower than most of the participating settings, it was higher than the proportion of older adults living on their own in India (about 3%). Caregiver stress was about 20% higher than the overall sample size and 50% lower than the Indian sample size. Similar to all seven nations, the majority of participants were admitted from the community. Meanwhile, the proportion of patients admitted from acute care settings was noticeably higher than in the multinational dataset. Since the Iranian ED patients were predominantly admitted from the community or acute care settings (99.2%), the rest of the categories, including residential facilities, were collapsed into the "other" section. Last, similar to the multi-national data, high number of patients had visited ED (51%) and/or were hospitalized (47%) in the last 90 days prior to their ED admission.

Table 6: Demographic Information across countries

	Iran (75+) (N=124)	India (N=98)	Canada (N=532)	Germany (N=549)	Australia (N=283)	Belgium (N=385)	Sweden (N=233)	Iceland (N=202)	All Nations (N=2282)
Mean Age \pms.d.	81.58 \pm 5.1	71.9 \pm 5.6	84.9 \pm 6.0	83.0 \pm 4.0	81.9 \pm 4.9	82.0 \pm 4.8	85.2 \pm 5.9	82.7 \pm 4.5	83.20 \pm 5.5
Sex (Female) (%)	40.3	44.9	65.0	60.7	54.8	54.3	61.4	55.5	58.8
Living Alone (%)	15.3	3.1	42.7	34.2	42.8	37.2	59.7	52.5	40.6
Caregiver Stress (%)	46.67	75.51	22.31	13.84	10.47	29.3	30.5	11.5	23.8
Admitted from (%)									
Community	82.1	99.0	79.4	58.7	64.9	96.9	87.1	84.7	77.8
Other acute care	16.3	0.0	0.8	1.3	0.0	0.0	0.4	0.0	0.5
Other	1.7	1.0	20.3	44.0	19.9	3.1	12.5	15.4	22.0
Visited ED in the Past 3 Months (%)	52.0	65.3	57.9	19.2	0.0	17.1	34.9	34.3	34.8
Hospital Admission in the Past 3 Months (%)	45.5	63.3	19.2	32.9	22.3	22.1	30.9	30.4	27.5

Figure 6 compares prevalence estimates of older adults requiring help in performing at least one of the four domains of personal activities of daily living. Overall, the prevalence of ADL deficits was high across all nations, particularly at admission. However, participants in Iran, Germany, and Canada had a higher proportion of older adults with such functional deficits at admission. Similar to the Iranian cohort, there was a significant increase in the proportion of older adults with ADL deficit from pre-morbid to admission periods.

Figure 6: Prevalence Estimate of Older Adults with at Least One ADL Deficit across Participating Countries



Locomotion (95% CI 47.08-51.20) and bathing (95% CI 58.89-62.91) were the most common ADL deficits in both Iran and other nations. Further, the largest decline was observed in both domains. The frequency of recent falls was high among all countries, with no significant difference between Iran and other nations. On average 39.1% (95% CI 37.07-41.08) of older

adults in all countries, except Iran, required supervision to manage their medications. This proportion was about 17% higher in Iran (95% CI 47.80-65.53). Followed by India (95% CI 73.97-89.30) and Sweden (95% CI 36.98-49.71), Iran had the third highest rate of cognitive impairment at admission (95% CI 30.91-48.12). Excluding India, the proportion of older adults experiencing significant weight loss was at least 20% (95% CI 34.3-51.8) higher than the remaining countries. Weight loss in India was about 30% more common than in Iran (95% CI 65.5-82.9). Acute change in mental status of patients was similar in Iran and India and about 45-65% higher than other participating countries. Such high rate of change in mental status suggests the high rate of delirium in Shariati's ED.

Overall there has been a relatively consistent pattern of functional deficits and morbidity when comparing the countries. This pattern is reflected in Figure 7, a graphical comparison of the mean frailty score (FI-ED). Following India, mean FI-ED was the highest in Iran. While the mean FI-ED in Iran (0.49) was 15-25% higher than other countries., the 99th percentile (0.82) was the same as all nations combined. In the meantime, mean FI-ED was about 10% higher in India, with a 99th percentile of 0.86.

Figure 7: Mean Frailty Index (FI-ED) and 95% Confidence Interval across Countries

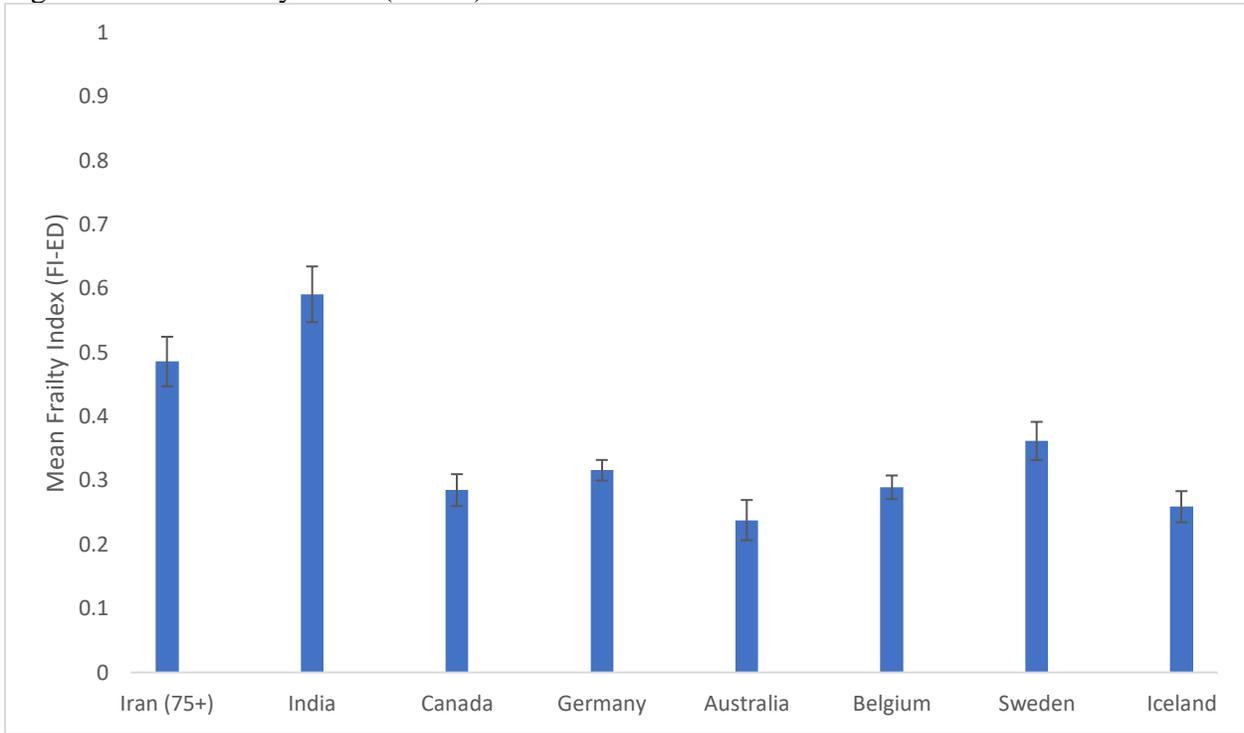


Table 7 also compares 28-day post-discharge outcomes between countries. No discharges were made to a higher level of care in Iran. Median length of stay was the highest in Canada and lowest in Iran. Further, Iran (11.6%) and Sweden (25.8%) had the lowest and highest re-admission rates respectively. Despite such low length of stay and re-admission rates, the death rate in Iran was about two to four times higher than the remaining countries, excluding India.

Table 7: Outcomes Across the Participating Countries

	Iran (75+)	India	Canada	Germany	Australia	Belgium	Sweden	Iceland	All Nations
Median Length of Stay (Days)	3	6	12	7	4	3	6	6	7
Re-admission to ED or Hospital (%)	11.6	13.3	19.2	20.2	7.8	16.1	25.8	16.3	17.7
Discharge to Higher Level (%)	0.00	0.0	11.5	20.0	0.0	3.8	6.9	1.2	10.6
Deceased (%)	21.0	31.6	6.0	9.8	1.1	4.7	0.0	1.0	6.6

Objective 3. Identification of Variables that Estimate the Probability of ED Re-Admission and Death among Older Adults.

While about 90.10% (N=240) of all eligible patients participated in this study, 31.25% (N=75) had missing follow-up data and did not answer the investigators' phone calls. This high attrition rate was mainly due to lack of communication between hospitals' Health Information Systems, as patients' electronic medical records were not updated in cases of referral to other hospitals. As a result, those patients who were discharged to another hospital had missing data, and investigators had to rely on calling them/their families for follow-up. As mentioned earlier, there were no significant differences between the functional and clinical characteristics of these individuals and the rest of the sample; therefore, the missing data is simply not considered (list-wise deletion) in this section.

Overall, discharge destinations were limited, since every patient was discharged to either the community or an acute care setting. Table 8 presents the unadjusted odds ratio of each clinical and demographic variable by post-discharge outcomes.

Table 8: Un-Adjusted Odds Ratio for Study Variables Post-Discharge Outcomes

Variable		Any ED or Hospital Re-Admission Within 28 Days Post-Discharge (N=19)	Deceased (N=28)
Sex, female		1.44 (0.70-2.95)	1.14 (0.50-2.60)
Lives Alone		1.02 (0.42-2.51)	0.46 (0.13-1.65)
Caregiver Stress		1.01 (0.48-2.13)	1.60 (0.69-3.72)
Cognitive Impairment	Pre-Morbid	0.71 (0.28-1.78)	1.70 (0.67-4.29)
	Admission	0.79 (0.36-1.75)	1.64 (0.70-3.84)
	Potential Delirium	1.73 (0.77-3.87)	2.91 (0.95-8.93)
ADL Impairment			
Bathing	Pre-Morbid	0.92 (0.44-1.91)	2.92 (1.26-6.77)
	Admission	0.63 (0.30-1.31)	2.41 (0.86-6.76)
	Acute Decline	0.62 (0.27-1.44)	0.59 (0.22-1.57)
Personal Hygiene	Pre-Morbid	1.21 (0.57-2.57)	3.05 (1.32-7.02)
	Admission	0.85 (0.42-1.74)	3.54 (1.27-9.89)
	Acute Decline	0.66 (0.28-1.51)	0.98 (0.40-2.41)
Dressing Lower Body	Pre-Morbid	1.99 (0.57-2.52)	4.41 (1.86-10.41)
	Admission	1.04 (0.50-2.17)	2.93 (1.05-8.20)
	Acute Decline	0.81 (0.37-1.80)	0.44 (0.16-1.24)
Locomotion	Pre-Morbid	0.99 (0.48-2.04)	3.01 (1.29-7.05)
	Admission	1.77 (0.74-4.20)	2.36 (0.77-7.27)
	Acute Decline	1.54 (0.73-3.22)	0.50 (0.89-1.32)
Any Pre-Morbid Impairment		1.28 (0.63-2.61)	3.05 (1.25-7.42)

Any Impairment at Admission		1.31 (0.55-3.16)	2.58 (0.73-9.14)
Any Acute ADL Decline		0.93 (0.42-2.06)	0.48 (0.17-1.34)
IADL Status			
Difficulty with Medications		1.13 (0.55-2.32)	4.47 (1.77-11.28)
Difficulty with Stairs		1.24 (0.59-2.61)	4.08 (1.34-12.43)
Impaired Comprehension		0.15 (0.02-1.16)	2.97 (1.06-8.33)
Conditions and Symptoms			
Poor Self-Reported Health	Pre-Morbid	2.49 (0.63-9.75)	3.15 (1.36-7.3)
	Admission	1.41 (0.50-3.99)	2.11 (0.87-5.14)
Depressive Symptoms		1.39 (0.65-2.94)	2.10 (0.84-5.30)
Self-Report Anxiety		1.87 (0.89-3.91)	0.31 (0.10-0.94)
Self-Report Anhedonia		0.92 (0.41-2.06)	2.48 (0.81-7.63)
Any Behaviors		0.55 (0.24-1.23)	0.94 (0.38-2.32)
Hallucinations and Delusions		0.93 (0.41-2.11)	4.11 (1.73-9.76)
Any Falls (Past 90 Days)		1.18 (0.57-2.43)	0.49 (0.20-1.24)
Traumatic Injury		3.82 (1.14-12.77)	0.41 (0.05-3.31)
Daily and Severe Pain		0.62 (0.22-1.76)	0.49 (0.20-1.20)
Dyspnea	Pre-Morbid	1.13 (0.52-2.43)	1.08 (0.45-2.59)
	Admission	1.11 (0.53-2.33)	1.60 (0.70-3.65)
Unstable Conditions		0.49 (0.23-1.05)	0.54 (0.15-1.92)
Decreased Food/Fluid Intake		2.75 (1.17-6.46)	2.26 (0.86-5.97)
Weight Loss		1.51 (0.74-3.09)	1.91 (0.84-4.34)
ED Use (Prior 90 Days)	2	0.35 (0.14-0.87)	1.12 (0.43-2.88)
	1	0.80 (0.32-2.00)	1.56 (0.55-4.42)
	0 (Reference)	1	1

Determinants of Re-Admission to ED 28 Days Following Discharge

Table 8 indicates that traumatic injury, decline in food/fluid intake, and two or more ED hospitalizations in the last 90 days prior to admission were significant individual predictors of re-admission to ED within 28 days of discharge. While decreased food intake and traumatic injury were positively associated with the odds of re-admissions, two or more ED hospitalizations was negatively correlated.

The multi-variate logistic regression model included self-report anxiety, trauma, and significant decline in food and fluid intake. As shown in Table 9, all the ORs indicated a significant increase in the probability of ED re-admission. Overall, 31.89% (N=59) of older adults reported feeling anxious on a daily basis within the past three days of assessment, 8.64% (N=14) had traumatic injury at admission, and 66.49% (N=123) had significant decline in food/fluid consumption. The model demonstrated good fit and moderate predictive accuracy (AUC=0.71).

Table 9: Multi-Variate Model for Any ED Re-Admissions Within 28 Days Post-ED Discharge

Covariate	Standard Logistic	
	AOR	95% CI
Self-Report Anxiety	2.42	1.03-5.65
Trauma	5.09	1.34-19.32
Significant Decline in Food Intake	3.23	1.22-8.57
ROC AUC (95% CI)	0.71 (0.61-0.81)	
Hosmer-Lemeshow Goodness of Fit	$X^2=1.64, p=0.65$	

Determinants of Mortality

Table 8 highlights that in almost all ADL domains (both pre-morbid and most admission) and IADL deficits, self-report anxiety and recent episodes of hallucinations or delusions were significantly predictive of mortality within 28 days of ED discharge.

The best multi-variate model, however, included the presence of hallucinations or delusions and requiring supervision with managing a full flight of stairs as the main predictors of mortality within 28 days of post-discharge. In the overall sample, the proportion of older adults

with the presence of hallucinations or delusions and managing full flight of stairs was 28.11% (N=52) 64.32 (N=119) respectively. The model had a good fit and demonstrated a moderate overall predictive accuracy (AUC=0.70).

Table 10: Multi-Variate Model for Death Within 28 Days Post-ED Discharge

	Standard Logistic	
Covariate	AOR	95% CI
Hallucinations or Delusions	3.12	1.30-7.49
IADL: Difficulty with Full Flight of Stairs	3.20	1.02-10.03
ROC AUC (95% CI)	0.70 (0.60-0.80)	
Hosmer-Lemeshow Goodness of Fit	$X^2=0.02$, p=0.99	

Discussion

As an extension to the interRAI multi-national ED study, the sample included in this project represents older patients' functional status from a large, public, and urban ED in Iran. To the knowledge of investigators, this is the first study in the Middle East that evaluates older patients' functional, mental, and clinical status at an ED. In the context of a rapidly aging world, Iran was thought of as an important country to investigate, particularly considering the structure of its current health care system, with a virtually absent primary care sector and a poorly integrated referral systems. In an era of a growing chronic disease burden, there is limited emphasis on patient-centered chronic disease self-management, and geriatric medicine and research are very novel, though Iran has recently begun to implement a nation-wide electronic medical records system (Behzadifar et al., 2019; Noori Hekmat et al., 2016). Finally, because of its complex relationship with many Western countries, there has been limited opportunity for such direct comparisons. It is anticipated that this study's findings will be informative as they provide preliminary insight into the current state of older ED patients at a well-known, urban acute care setting in Iran. Within this context, older ED patients at Shariati were frail, highly dependent, and as expected, had functional and clinical characteristics of patients for whom a more comprehensive approach to health and aging would be beneficial.

Objective 1: Understanding Clinical and Functional Status of Older Acute Care Patients in Iran

Older patients at Shariati hospital were frail and the majority of them required some supervision to perform their daily activities. The level of frailty among ED patients was distributed unevenly. While the majority of participants were moderately frail, the number of those struggling with extreme frailty was surprisingly high, suggesting the need for a comprehensive approach to stabilizing the sickest patients before discharge.

High level of frailty is also reflected by the commonness of geriatric syndromes. Geriatric syndromes destabilize patients and complicate self-management (Fried et al., 2001; Inouye, Studenski, Tinetti, & Kuchel, 2007). Among geriatric syndromes, functional decline was most noticeable. More than half of patients had functional limitations in the pre-morbid stage; however, such functional deficits deteriorated at presentation to ED, which highlights functional

decline and vulnerability to acute illness. However, this manifestation of frailty is potentially reversible (Buchner & Wagner, 1992; Gill et al., 2002) and with adequate community-based and acute care such adverse outcomes could be prevented. Further, functional decline was common among all age-groups. Despite significant differences between age-groups in the pre-morbid stage, all cohorts were almost equally as dependent at admission. Therefore, it could be inferred that younger age-groups were more independent at the community stage, even though both groups were more similar in their functional capacity at admission.

Risk of delirium seemed to be considerably high among Shariati's older ED patients. More than 60% of older adults indicated some acute mental status change, suggesting potential episodes of delirium. However, it is important to note that in this study, there were no direct methods of identifying delirium; in fact, mental status change was used as an indirect indication. Although change in mental status could only suggest the potential presence/emergence of delirium, considering the high rates of functional decline, ADL dependency, and frailty of patients, it is speculated that the actual proportion of patients with delirium would be lower than 60% but still large enough to require further clinical attention.

Another common geriatric syndrome linked to frailty was malnutrition. Malnutrition is highly associated with frailty, further functional decline, higher dependency, and death (Fried et al., 2001). A considerable portion of older patients experienced significant weight loss and reduction in food intake. It is speculated that struggling with depressive symptoms, lower functionality, cognitive impairment and higher level of dependency could have accounted for lower food intake among participants (Buchner & Wagner, 1992; Gill et al., 2002); however, further investigations are required to determine the underlying contributors to such high rates of malnutrition among Shariati ED patients.

With the large number of patients requiring supervision for locomotion, and frequent history of falls among participants, it could be inferred that mobility is one of the major issues among older Iranians at Shariati ED. Impaired mobility could be related to the high rates of weight loss, delirium, drug interactions, deconditioning, and overall functional decline among patients (Banerjee, Conroy, & Cooke, 2012; Fried et al., 2001). As immobility could complicate routine clinical assessments, increase the risk of falls, lead to ED re-admissions, and affect patients social and mental health (Banerjee et al., 2012), identifying effective mobilizing strategies could be beneficial to Iranian EDs.

Co-morbidity was also high and it is thought that the co-occurrence of multiple chronic conditions with geriatric syndromes could have exacerbated the functional status of older patients (Lee, Cigolle, & Blaum, 2009). Cardiovascular diseases and type 2 diabetes are linked to immobility and lack of locomotion (Araki & Ito, 2009; Carey & Potter, 2001; Fried et al., 2001; Inouye et al., 2007; Lee et al., 2009; New York Heart Association, 2018). Cardiovascular complications and mobility issues were the most common types of diagnoses among older ED patients at Shariati hospital. Similarly, these two conditions, alongside traffic accidents, are identified as the leading causes of morbidity and disability in Iran (Institute of Health Metrics and Evaluation, 2017; Teymoori, Dadkhah, & Shirazikhah, 2006). High prevalence of mobility and cardiovascular complications alongside older adults' polypharmacy (average of 5.76 medications per patient) emphasized the high prevalence of disability and frailty at Shariati's ED. Patients with unstable cardiovascular conditions are more likely to experience difficulty with climbing stairs and maintain independence with ADLs and IADLs (Carey & Potter, 2001; New York Heart Association, 2018). Meanwhile, immobility could lead to instability in chronic disease management and increases the chance of cardiovascular events (Inouye et al., 2007; New York Heart Association, 2018). Type 2 diabetes is also considered as a major risk factor for functional disabilities, depression, falls, urinary incontinence, and malnutrition (Araki & Ito, 2009). Further, as indicated by Figure 4 and interRAI ED-CA results, about 15% of patients were diagnosed with cognitive impairment. Similarly, cognitive impairment complicates care-provision and could increase older patients' dependency (Desai, Grossberg, & Sheth, 2004; LaMantia, Stump, Messina, Miller, & Callahan, 2016; Saka, Kaya, Ozturk, Erten, & Karan, 2010). In fact, many of the presented geriatric syndromes are highly associated with un-managed cognitive impairment (Mecocci et al., 2005). Overall, it could be inferred that co-morbidities were also common among Shariati ED patients, indicating the need for a comprehensive disease management towards such conditions.

This study's results aligned with Teymoori et al.'s findings, where older adults' instability is identified as the leading cause of morbidity in Iran (2006). Although similar to the existing findings on community-dwelling older Iranians', older ED patients seemed more frail, dependent, and susceptible to delirium. In comparison with current statistics on community-dwelling older adults in Iran, participants were almost twice as dependent and cognitively impaired in the pre-morbid stage (Habibi, Nikpour, Seiedoshohadaei, & Haghani, 2008;

Abbasian et al., 2016; Habibi Sola, Nikpoor, Rezaei, & Haghani, 2007; Soleimani, Shokrgozar, Fallahi, Kafi, & Kiani, 2018; Tanjani, Motlagh, Nazar, & Najafi, 2015). Additionally, despite the well-established association between acute morbidity and functional decline, the proportion of patients experiencing functional decline was higher among the Iranian population in comparison with the global literature (Gray et al., 2013; Mudge, Laracy, Richter, & Denaro, 2006; Wellens et al., 2013). Similarly, other studies on older adults who were admitted to inpatient hospital units in urban areas of Iran indicated much lower rates of delirium, ranging from 22%-30.8% (Asaei, Nazari, & Hosseini, 2008; Foroughan & Mohammadi Shahbolaghi, 2016). It is important to note that these studies have pre-dominantly focused on hospitalized older adults above the age of 60, instead of 65, targeting more functional cohorts. Therefore, it is speculated that delirium would have been more common if these studies focused on older adults above 65.

Functional dependency, decline, cognitive impairment, potential delirium, and frailty indicate that older Iranian patients at Shariati ED have unique needs that require an interdisciplinary approach. Frailty and geriatric syndromes among older ED patients are associated with longer hospital stay, functional decline, and mortality (Brousseau et al., 2018; Costa et al., 2014; S Nicole Hastings, Purser, Johnson, Sloane, & Whitson, 2008; Li et al., 2018). Geriatric syndromes also complicate care-provision and policy-making (Anpalahan & Gibson, 2008; Gray et al., 2008; Inouye et al., 2007; Smith, Shokoohi, & Holliman, 2007; Young & Inouye, 2007), making it difficult for typical acute care settings to completely stabilize older patients and to fully address their physical, mental, and social needs. About 9% of this study's participants died in the ED, the majority of patients were hospitalized, and 25% referred back to the same or other EDs after being hospitalized in an inpatient unit. Although this high hospitalization rate likely reflects Iran's hospital-based health system (Smith et al., 2007), high rates of mortality, frailty, and referrals to ED might be also indicative of the ED's sub-optimal ability to stabilize patients, potentially due to the complexity of their condition. Further, with the lack of primary care, patients are driven to utilize acute care units more often. Community-based interventions could empower older adults and their caregivers for better self-care, reduce hospitalizations, and allow for a more comprehensive approach to address such complexities in older adults.

Such need for community-based care becomes even more urgent considering the current socio-cultural characteristics of the Iranian population. With the absence of community-based care programs in Iran, rapid post-ED admission functional decline could have a significant

impact on older adults' disease self-management (Gray et al., 2008). Older patients' growing dependency leads to higher care responsibilities for their caregivers. However, due to the collectivist familial values, transferring frail, dependent older adults to residential facilities is considered a taboo in Iran (Kiwi, 2017); this cultural outlook on long-term care was potentially the primary reason for the lack of referrals to residential facilities in Table 4. Therefore, regardless of the patient's level of need, families choose to live together despite limited community-based support, which could lead to caregiver stress and increase the risk of neglect and abuse (Comijs, Smit, Pot, Bouter, & Jonker, 1999; Morowatisharifabad, Rezaeipandari, Dehghani, & Zeinali, 2016). Lack of community support could be even more burdensome for those older adults living alone. Although a great majority of older adults had a caregiver at the time of admission, Iran's familial dynamics are changing rapidly, presenting a challenge to future older populations that will have a lack of informal support. For instance, family sizes are shrinking, the proportion of women in the labor force is rising, families are adopting individualistic values, and the age gap between children and parents is increasing (Kathryn & Rashad, 2008; McGoldrick, Giordano, & Garcia-Preto, 2005; Shavazi & McDonald, 2008). As a result, without a comprehensive care plan that addresses older adults' rapid decline at acute care, many older adults could be discharged with increased dependency and no support.

Objective 2. Comparing Clinical and Functional Characteristics of Shariati Hospital Older ED Patients with Other Countries: An Extension to the Multi-National Study

In comparison with other countries, older Iranians presenting to the ED utilized hospitals more often. Similar to the German sample, Shariati hospital transferred about 80% of the admitted patients to in-patient units. High rates of admission to acute care settings, in addition to the large proportion of older patients being admitted back to ED from acute care settings, suggests frequent utilization. This pattern could be attributed to the hospital-based health system in Iran (Noroozian, 2012). With shortage of community-based structures, most older Iranians visit hospitals or EDs to address their health issues. Moreover, Shariati ED sometimes acts as a waiting area for older patients who are going to be hospitalized in inpatient units with no urgent needs. This referral system could explain the shorter length of stay and the lower number of re-admissions, as many of the participants were initially referred to an inpatient unit, but due to lack

of vacancy they were hospitalized in ED for a short period of time. Additionally, at Shariati, many specialists visit their patients at the ED. Therefore, despite the overall high frailty among most participants, other patients visited the ED to gain access to their clinician, even though their condition was not highly urgent. This hospital structure could explain the bimodal distribution of frailty index, highlighted in Figure 3.

Functional dependency was high in all ED study countries, indicating the need for a comprehensive approach towards older patients in acute care. Similarly, it is evident that older adults' functionality declines significantly between the pre-morbid and admission stages, regardless of the geographic context. However, the Iranian cohort demonstrated even higher dependency, functional decline, and frailty in comparison with other nations. Based on Figure 7, the Iranian sample had the second highest mean FI-ED, after India. This pattern was fairly consistent when comparing ADL and IADL deficits, cognitive impairment, weight loss, and dyspnea. In almost all measures, Iran was placed between India and other participating countries, like Germany, Sweden, and Canada, with relatively higher proportion of ADL deficits. Such rapid decline could also explain why Iran had the second highest proportion of overwhelmed caregivers and death rate within 28 days of discharge from the hospital. Mosallahnezhad also found that community-dwelling older adults in Iran were more dependent in ADL than a similar Swedish community (Mohammad, Dabbaghi, & Nikraves, 2008). Higher risk of falls was also observed among the Iranian cohort (Mohammad et al., 2008).

Further research is required to investigate the underlying mechanisms for lower functional capacity in the Iranian sample. Such patterns could be associated with lower life expectancy in Iran and India, as many older adults experience rapid decline prior to death. It is speculated that lack of primary care in Iran and India deprives older adults from adequate and timely chronic disease management planning (Zarrin, Turchian, & Heckman, 2019), and thus leads to exacerbation of symptoms and acute decline.

Objective 3: Identification of Variables that Estimate the Probability of ED Re-Admission and Death among Older Patients.

In the first two objectives of this thesis, the clinical characteristics and functional capacity of older patients at Shariati's ED were explored. While this information is a valuable first step towards understanding older adults' in Iranian EDs and acute care, investigating the relationship

between these characteristics and some of post-discharge adverse outcomes adds depth to this analysis.

The results from the logistic regression indicate that geriatric syndromes have prognostic values and could be utilized as key indicators of older patients' health, as well as estimates of the likelihood of post-discharge adverse outcomes, such as imminent mortality and ED re-admissions in Iran. Table 8 demonstrate the predictive power of geriatric syndromes as assessed with the ED-CA questionnaire, as many items demonstrate a significant association with re-admissions to Shariati's ED and mortality. Further, both multi-variate models had moderate predictive ability. The significance of these items in predicting post-discharge outcomes has also been shown in a study by Costa et al., using interRAI ED-CA's multinational study (Costa et al., 2014). As highlighted by their study, geriatric syndromes predicted older patients' excessive length of stay, re-admission to EDs or hospitals, and discharge to a higher level of care. These findings suggest that identifying geriatric syndromes earlier in the older patients' care would enable clinicians to gain insight into older ED patients' interdisciplinary, complex needs and devise effective care plans to address them. However, it is important to note that these models are not intended to replace clinicians' judgement nor question Shariati Hospital staff's diagnostic abilities (Costa et al., 2014). In fact, they are useful to inform clinicians and future trainees on the importance of considering older patients' functional capacity and risk of decline in acute care, and thus support better care planning (Biese et al., 2011; Costa et al., 2014; Hogan et al., 2010).

Table 8 indicates that pre-morbid ADL deficits are predictors of mortality on their own. This finding aligns with the current literature regarding the significance of older patients' pre-morbid health status in predicting their experiences of adverse post-discharge outcomes (Costa et al., 2014; Jonsson et al., 2008; Lakhan, Jones, Wilson, & Gray, 2013). In addition, previous ED hospitalizations had a negative association with ED re-admissions. It is speculated that this negative correlation could be associated with the bimodal distribution of FI-ED. Considering the Iranian hospital-based health system and the absence of primary care, many patients utilize ED regardless of the need for acute care; such pattern in use could have attributed to this negative relationship, corresponding to the first mode of the distribution (Figure 2). Otherwise, it is speculated that patients with two or more hospitalizations in the past 90 days were too frail: either hospitalized for an extremely long period or deceased following discharge, resulting in

lower re-admission rate, corresponding to the second mode of the Figure 2. The final multivariate model, composed of trauma, self-report anxiety, and decline in food/fluid intake was the most optimal combination of predictors to predict ED re-admissions. The majority of trauma cases were due to falls or mobility-related limitations. Both trauma and lower food/fluid consumption are associated with higher levels of frailty in older adults (72-76). Consequently, it is hypothesized that the presence of these indicators in patients is indicative of their frailty, and thus the higher chances of them experiencing adverse outcomes, such as ED readmissions. Meanwhile, Costa et al., highlighted that trauma was associated with longer hospital stays instead of ED re-admissions (Costa et al., 2014). Finally, high levels of anxiety could be associated with more ED re-visits, as some older adults might be more concerned with their conditions and seek frequent clinical attention to ensure their health. Another explanation for this relationship could be potential inadequate community support among these patients; lack of social support is associated with exacerbation of depressive symptoms, re-hospitalization, and higher dependency (Wilcox, Kasl, & Berkman, 1994).

The re-admission model aligns with similar investigations in developed countries (78-80). In two separate studies, Deschodt et al. and Mudge et al., concluded that 30-day ED re-admissions among older adults is best predicted by the presence of chronic conditions, depressive symptoms, and being underweight (Caplan, Brown, Croker, & Doolan, 1998; Deschodt et al., 2015; Mudge et al., 2011). Despite focusing only on re-admissions to ED, this model is also similar to Costa et al.'s: both emphasize decline and patient's self-reported mood as indicators of ED or hospital re-visitations, suggesting the correlation between older ED patients' mental health and admission. However, the two models differ in their specific variables, which could be due to different referral systems in the participating countries. As mentioned earlier, hospitals and sometimes EDs in Iran act as outpatient clinics for patients to visit their physicians. As a result, re-admission patterns differ significantly between the multinational sample and this project.

The strongest model for mortality includes experiences of past episodes of hallucinations or delusions, as well as the lack of ability to ascend a full flight of stairs. Climbing stairs is indicated as an overall level of fitness, cardiovascular health, and independence (New York Heart Association, 2018). Falls and lack of locomotion were also some of the major complications among Shariati ED patients, so this model re-emphasizes the necessity for

addressing instability in cardiovascular symptoms and mobility among older adults in this institute. Furthermore, with potential delirium being more prevalent in the Iranian sample, there is a need for additional assessments and comprehensive discharge planning to lower the risk of mortality rate among older adults with higher chances of psychotic/delirious episodes. Similar studies indicate that increasing dependency and delirium are strong predictors of mortality post-ED discharge (Drame et al., 2008; García-Peña et al., 2018; Kennedy et al., 2014). For instance, Kennedy et al., indicate that ED delirium among older adults is associated with higher ICU admissions and hospital re-admissions. These findings, once again, highlight the importance of identifying delirium in ED and intervening with a comprehensive care plan as early as possible.

Future Direction

According to this project's findings, older adults visit Shariati ED with a cluster of pre-existing deficits; upon admission, these patients also experience rapid decline with multiple comorbidities and caregiver stress leading to many adverse outcomes, such as re-admissions and death. Further, the regression models emphasize the importance of addressing older ED patients' functional deficits and mental status indicators. Several interventions on various levels of care are recommended to facilitate such comprehensive care-provision.

From a health systems perspective, the Iranian healthcare system is predominantly hospital-based, with lack of focus on primary or community care. Consequently, propagation of primary and community care support could stabilize patients in pre-hospitalization and prevent adverse events at acute care settings. Currently, primary care practice is limited in Iran and most patients visit specialists at the onset of their disease. Promoting primary care practices and engaging patient communication with such professionals could be a promising start to community-based care in Iran. Moreover, with further research in other acute care sectors, rural areas and the Iranian private healthcare, policy-makers could map the level of acute care use across the country and develop a systematic protocol for hospitalization among frail older adults. It is speculated that rural geographic areas should be prioritized, considering their lack of access to healthcare and disease management resources. Also, to appreciate older patients' complexity,

such protocols should address functional, social, and mental health issues that are associated with older adults' co-morbidities.

At the community level, homecare in highly populated areas would allow patients to receive care longitudinally and prevent rapid functional decline following the presentation of an acute illness (Kemper & Murtaugh, 1991). This intervention could be mainly effective in more urban areas of Iran with better transportation and shorter travel distances. A more inclusive strategy could be educating caregivers to engage with patients' self-management. Considering the collectivist familial values in Iran, patients and caregivers tend to interact closely. As a result, patient and caregiver empowerment could be a cost-effective approach towards chronic disease management and reducing frailty (Zarrin et al., 2019). Additionally, with the widespread use of smartphones across the country, tele-medicine could enhance the communication between older patients and care providers (Zarrin et al., 2019).

Despite the importance of primary care, hospital-level interventions are needed as well. In fact, considering the current health system of Iran, a "senior-friendly" ED could be the most feasible first step. With more than 200 specialists, 30 departments, and 500 beds, Shariati hospital is well-equipped with resources (Tehran University of Medical Sciences, n.d.-b, n.d.-a). To ensure an interdisciplinary care, communication with health professionals and engaging patients and caregivers into treatment plans could be a challenging, yet effective solution to address older adults' issues in ED. To do so, care providers could standardize and embed clinical decision support systems in their Health Information System (HIS): it has been identified as one of the most under-utilized features of HIS in Iran (Behzadifar et al., 2019; Noori Hekmat et al., 2016). Organizations that offer compatible, inter-disciplinary tools, such as those developed by interRAI, could be beneficial for the Iranian health system since they provide clinicians, investigators, and policy-makers with a comprehensive and standardized picture of complex patients' functional and clinical characteristics. As noted in the results, , the ED -CA took about six minutes to conduct and throughout data collection many patients expressed found the questions meaningful. Future investigations could focus on acceptability of such tools in Iranian acute care settings and its compatibility with other interRAI tools in other contexts, such as community health. Effective communication among professionals and care-recipients would create the infrastructure for implementing preventive strategies. For instance, non-pharmacological risk factor assessment could be an effective approach to preventing delirium

and thus the subsequent adverse outcomes (Inouye, Westendorp, & Saczynski, 2014; Young, Murthy, Westby, Akunne, & O'Mahony, 2010). Another strategy to address high immobility among Shariati ED patients is early mobility program for those recovering from fall-related traumas or cardiac events (Clark, Lowman, Griffin, Matthews, & Reiff, 2013; Santos, Ricci, Suster, de Moraes Paisani, & Dias Chiavegato, 2017). Additionally, better discharge planning for older adults and comprehensive geriatric assessment would address the high levels of morbidity among older Iranians (Caplan, Williams, Daly, & Abraham, 2004; Collard, Bachman, & Beatrice, 1985; Conroy et al., 2013; Ellis, Whitehead, Robinson, O'Neill, & Langhorne, 2011; Hastings & Heflin, 2005; McCusker & Verdon, 2006). Although time is an important factor at ED, utilizing screener tools, such as interRAI ED, could allow for selecting those who would benefit from a comprehensive geriatric assessment. Involving caregivers in discharge planning is also encouraged, as it empowers older adults and their families in chronic disease management (Karimi, Hanifi, Behraminejad, & Faghizadeh, 2015; Kaya et al., 2018; Mohammad et al., 2008). Caregiver involvement can be particularly important considering the high rates of caregiver stress in the sample. Shariati hospital is one of the pioneers of rehabilitation medicine in the country. Therefore, encouraging collaboration between Shariati ED and their rehab center would facilitate better management of mobility-related and cardiovascular complications among older patients. Last, as Figure 5 indicates, Furosemide was one of the most common prescriptions. The loop diuretic is significantly associated with increased risk of falls, so engaging clinical pharmacists with older adults' care plan at ED is also suggested.

It is important to note that the aforementioned hospital-level interventions are more applicable to large, urban teaching hospitals. Geriatrics, is a novel field in Iran; currently, there are less than 15 geriatricians in the country and overall, this field requires further growth to facilitate a successful implementation of above suggestions (Noroozian, 2012). In addition, with the scarcity of resources, adaptations of more resource-intensive, comprehensive strategies would be more feasible at similar settings as Shariati rather than other acute care centers in deprived areas of Iran. It is recommended that future research initiatives identify more sustainable, cost-effective strategies that ensure appreciation of older ED patients' multi-disciplinary nature in poorer areas of Iran.

Limitations

In many cases, patients' medical charts were incomplete and the only available data sources were the patient or their caregivers. The electronic medical records were also not updated frequently. Throughout collecting data for these participants, student researchers had to rely solely on patients' or caregivers' answers. It is speculated that recruiting these patients could have diminished the quality of final data, due to recall bias, particularly with respect to diagnostic and medication data were not included in the final model. It would have been more informative if the investigators considered the correlation of patients' clinical information with the outcomes. Future studies should aim to reach a higher quality of data for such variables and include them in addition to functional characteristics in model selection.

In Iran, there are no legal obligations for clinicians to fully disclose poor prognosis to patients, particularly if they are suffering from a terminal illness at an old age. Consequently, some older adults who were struggling with severe neoplasms or other terminal conditions were not aware of their health issues. Also, when assessing these patients, their caregivers may have not described the full extent of their patient's health, in order to conceal their poor prognosis. Although in such cases data collectors attempted to communicate with the patients' health providers, it is expected that the severity of participants' health issues was slightly under-reported. The study also excluded patients with the highest level of acuity. Despite their small proportion, it is important to note that the results will exclude the most urgent patients with the worst prognosis, leading to further under-representation of the frailest patients.

Another limitation of this project took place during the 28-day follow-ups. The main source of information for follow-ups were electronic medical records and phone-calls. Throughout the follow-up phase, there was a high rate of missing data for many older adults, diminishing the statistical power of analysis.

Although Shariati hospital is an adequate initial setting to examine a diverse range of patients from all geographic and socio-economic statuses, relying solely on one site in an urban area was a main limitation of the study. Subsequent work will need to replicate these methods in a broader, more representative sample of EDs throughout Iran .

The lack of a triage system in Shariati hospital was another limitation: the hospital did not utilize any triage or emergency assessment tools, such as CTAS, so data collectors could not record participants' level of acuity in a standardized manner. Using this data could have been informative to categorize older adults in terms of their level of acuity. Further, having access to

this data would have eased the screening process, while also helping researchers to validate the correlation between the triage screening tool and interRAI items in Iran.

Finally, similar to Gray et al., (Gray et al., 2008), most of the data collection was conducted from morning to afternoon on weekdays. This method of data collection could have potentially led to missing certain types of patients that were admitted and/or discharged throughout the entire day.

Conclusion

To the knowledge of investigators, this project was the first study to characterize functional and clinical capacity of older patients presenting to a large ED in Iran. Our findings emphasize the complexity of many of these patients. Most older patients presented to Shariati ED with either preventable frailty that could be potentially addressed at primary care or high levels of dependency requiring immediate intervention. This study's results reinforce the importance of key geriatric syndromes and functional decline in prognosis and care planning. Further, findings highlight areas where system change needs to be considered, including promoting primary care and community support, senior-friendly EDs, and a better integration of EMRs.

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Appendices

Appendix A: Study Forms and Documents

Information Letter and Consent Form

Dear potential participant,

We are writing to ask your permission to participate in a collaborative study between the University of Waterloo in Canada and University of Tehran's School of Pharmacy. This study is focused on older adults' acute care in Iran and the data for this project will be collected at an acute care facility affiliated with Tehran's University of Medical Sciences. Through this research project we are aiming to investigate the health status of older acute care patients.

This research study will take place through utilization of a standardized questionnaire, called InterRai Contact Assessment Form. The questionnaire is estimated to take about 15-20 minutes and will be conducted at the acute care clinic. Throughout this questionnaire, we will ask you short questions regarding your demographic background, your lifestyle, and your health. Some of these questions might be redundant or personal; however, you could refuse to answer any of these questions with no penalties. Some of the answers for this questionnaire could found on your medical charts, such as your diagnoses, or through the researchers' observations of the participant. Therefore, we are also asking for permission to assess your medical chart. All individuals that participate in this survey will be will be given a gift card worth of \$10 to a local bookstore.

It is important to note that individual participant's personal information will not be shared with anyone except for those within the research team. However, information based on the results of the group of participants will be provided. Please note that the researchers will break confidentiality when there is a threat of harm to the participant or others. The collected data from this study will be kept for at least 7 years from the data of collection. This data will be stored in secured databases at University of Waterloo, School of Public Health and Health Systems. Only individuals, who consent to participate in this research, will be involved. Also, participants may withdraw their permission at any time prior to publication of the study results without penalty by indicating this decision to the researcher or contacting the Ministry of Health and Medical Education's Office of Ethics. We would also like to emphasize that your answers, participation

or refusal to participation in this study will not affect the care you receive at all. There are no known or anticipated risks to participation in this study.

Once all the data are collected and analyzed for this project, I plan on sharing this information with the research community through seminars, conferences, presentations, and journal articles. If you are interested in receiving more information regarding the results of this study, or would like a summary of the results, please provide your email address, and when the study is completed, anticipated by September 30th, 2018, I will send you the information. This study has been reviewed and received ethics clearance through Iranian Ministry of Health and Medical Education and a University of Waterloo Research Ethics Committee (ORE#32443). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

We appreciate your participation in this study as your contribution will enhance our understanding of the geriatrics acute care in Iran and will pave the way for further enhancements. If you have any questions about the study, or if you would like additional information to assist you in reaching a decision, please feel free to call the research team at the University of Waterloo, 519-888-4567, Ext.31028 or email the study supervisor, Dr. George Heckman, at ggheckma@uwaterloo.ca. Thank you in advance for your interest and support of this project.

To participate, please read the consent statement below and provide us with your name and signature. By signing this consent form, you will allow us to initiate the 20 minute interview with you, look into your chart, and observe your actions at the Emergency Department for the next 2 hours.

Yours sincerely,

Dr. George Heckman, Dr. Niayesh Mohebibi, Kian Mohajeri, & Aein Zarrin

Assistant Professor
School of Public Health and Health Systems, Faculty of Applied Health Sciences, University of Waterloo

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Aein Zarrin and Dr. George Heckman of the Faculty of Applied Health Sciences at the University of Waterloo located in Ontario, Canada. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that my answers to this questionnaire may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#32443). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca. For all other questions contact Aein Zarrin at azarrin@edu.uwaterloo.ca

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

YES NO

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name: _____ (Please print)

Witness Signature: _____

Date: _____

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee

End of Questionnaire Letter

Dear Participant,

We would like to thank you for your participation in this study entitled Investigating the Health status of Iranian acute care older patients and the healthcare system's needs to provide older adults with an optimal acute care. As a reminder, the purpose of this study is to determine the needs of the Iranian healthcare system to provide older adults with an optimal care.

The data collected during the questionnaire will contribute to a better understanding of the stakeholders' perspective towards the Iranian geriatrics acute care. Thus, your contribution will create the initial steps towards enhancing the care provided for older adults.

This study has been reviewed and received ethics clearance through Iran's Ministry of Health and Medical Education and a University of Waterloo Research Ethics Committee (ORE#32443). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca. You could also contact the office of ethics at the Ministry of Health and Medical Education at (the #).

For all other questions, please contact us at azarrin@edu.uwaterloo.ca

Please remember that any data pertaining to you as an individual participant will be kept confidential. Once all the data are collected and analyzed for this project, I plan on sharing this information with the research community through seminars, conferences, presentations, and journal articles. If you are interested in receiving more information regarding the results of this study, or would like a summary of the results, please provide your email address, and when the study is completed, anticipated by September 30th, 2018, I will send you the information. In the meantime, if you have any questions about the study, please do not hesitate to contact me by email or telephone as noted below.

Thank you,

Aein Zarrin, Kian Mohajeri, Dr. Niayesh Mohebbi, Dr. George Heckman

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee

