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The Association Between Protein Intake and the Prevalence of Frailty Among Community-Dwelling Lebanese Older Adults

By

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DEDICATION PAGE

To Growing Old in Lebanon

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The Association Between Protein Intake and the Prevalence of Frailty Among Community-Dwelling Lebanese Older Adults

Alexandra Daccache

ABSTRACT

Nutrition and in particular protein intake are shown to be key determinants of frailty. Nevertheless, the current daily protein recommendation of 0.8 g/kilogram (kg) BW has been proven to be inefficient in providing the required needs of the older population, and intake of 1 g/kg BW of protein was demonstrated to be more representative of the needs of older adults. Thus, this cross-sectional study aimed at examining the association between frailty and protein intake among Lebanese community-dwelling older adults. Dietary intake was assessed using an FFQ based on which protein intake was calculated using the USDA food database and frailty was determined via Fried's Frailty Phenotype. A convenience sample of a total of 112 community-dwelling, older-adults were recruited through word-of-mouth, interviewed face to face, and screened in some areas of Greater Beirut and Byblos. SPSS software was used to conduct bivariate analyses and logistic regressions that either had frail or non-robust as outcomes, and protein intake was either entered as a cutoff (0.8 and 1 g/kg BW/d) or by protein source (animal protein corrected for plant protein intake, and plant protein corrected for animal protein intake). All the regressions were corrected for gender, age, educational level, BMI, number of chronic diseases, polypharmacy, dietary supplements, GDS score, RUDAS score, and MeDi score. Sixteen (14.41%) participants were identified as being frail, and the total participants, only 19.82% (n=22) reached a protein intake ≥0.8 g/kg BW and 11.7% (n=13) had an intake ≥1g/kg BW. Nevertheless, no association was found between total protein intake and the prevalence of frailty in this population. Only plant protein was positively associated with frailty with 6.2% (95% CI= 0.6% - 12.1%) higher frailty prevalence. In conclusion, it is important to further study the association between frailty and protein intake, within a larger sample size, considering protein distribution and timing as well as total energy intake, other macronutrients, physical activity, and diet quality.

Keywords: frailty, protein intake, protein sources, Lebanese older adults

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LIST OF ABBREVIATIONS

ADL- Activities of daily living

AT- Adipose Tissue

BMI- Body mass index

BW- Body Weight

CI- Confidence Interval

CVD- Cardiovascular disease

/d- Per Day

EAA- Essential Amino Acids

FI- Frailty Index

GB- Greater Beirut

h- Hour

Kcal- Kilocalorie

Kg- Kilogram

LBP- Lebanese Pounds

OR- Odds Ratio

p- Probability value

PA- Physical Activity

r- Correlation coefficient

RDA- Recommended Dietary Allowance

SD- Standard deviation

UK- United Kingdom

USA- United States of America

USDA- United States Department of Agriculture

Chapter 1

Literature Review

1.1 Prevalence of Older Adults

The world is on the verge of a demographic landmark. Enhanced medical, environmental, sanitary, economic, and social conditions have led to a population detonation for more than a hundred years. This shift in demographics characterizes a transition that is fundamental to a novel paradigm, with older adults currently being the fastest-growing age group worldwide (Maggini et al., 2018). According to the World Health Organization (WHO) (2020), driven by decreasing fertility rates and notable increases in life expectancy, today and for the first time, the number of individuals aged 65 and above has become more numerous than children under 5 years old. At this pace, by 2050, this number will double and even exceed the one of adolescents.

Based on data from the revision of World Population Prospects of 2020, individuals aged 60 years or older' number is on the rise, increasing on average by 3% per year, expected to double by 2050, and triple by 2100. Hence, the number of older adults will rise from 1 billion worldwide in 2019 to 1.4, 2.1, and 3.1 billion in 2030, 2050, and 2100, respectively (WHO, 2020). Although this demographic transition first took place in high-income developed nations such as Japan, where presently older adults above the age of 60 years comprise 30% of the whole population, it is now a commonly seen phenomenon in low and middle-income developing countries, which

are currently experiencing the utmost change and the most rapid increase. By 2050, projections show that 80% of the global older adult population will be composed of residents of developing countries, and several of its countries will have a percentage of older adults similar to that in Japan (WHO, 2018). That being said, the Middle East region constitutes a large portion of developing countries, which are often understudied and underreported in comparison to developed countries; and amid Arab countries, Lebanon holds the record for the fastest growth in the number of older adults (Boulos et al., 2017).

According to the WHO, Lebanon is a developing country where the current life expectancy in 2020 is 79 years, which has increased by 0.11% since 2019 (WHO, 2020). Moreover, older adults constitute 12% of the population (UN: World Population Prospects: The 2017 Revision). This fast growth in the rate of older adults is alarming for Lebanon, especially that the necessary support for this age group is not available (Abdulrahim et al., 2015). As a consequence, older adults' quality of life is compromised (Rondón & Ramírez, 2018). Life expectancy has indeed increased for older adults, but the quality of these added years is of the essence, thus, it is important to add healthy years to their lives and not just time. Research has shown an association between nutrition and healthy aging (Marsman et al., 2018). The WHO describes Healthy Aging as "the process of developing and maintaining the functional ability that enables wellbeing in older age. While the functional ability means having the capabilities that enable all people to be and do what they have reason to value" (WHO, 2020). Therefore, since the healthy aging paradigm comprises being free of physiological vulnerability and illness, frailty which ranges between a state of independence and physiological robustness to being at an increased risk of dependency and disability, hence hindering the process of healthy aging (Woolford et al., 2020).

Hence, getting better insight into the dietary needs of older adults will enable the tackling of several health issues, such as frailty, that might arise due to this fast increase in the population. Through interventive methods, frailty can be prevented and decreased allowing older adults to maintain robustness, productivity, and autonomy, and become an added value to the community rather than a burden. To better the lives of older adults, it is vital to comprehend aging and all physiological and biological alterations related to it first. Hence, by understanding this process, we will be able to promote the necessary measures needed to ensure that older adults undergo healthy aging, through preventing frailty and other challenges that often come with older age.

1.2 Changes Associated with Aging

Aging is best defined as "a universal, irreversible, progressive, inevitable, time-dependent, multi-factorial but also modular process, involving complex interactions between biological and molecular mechanisms" (Libertini, 2015; Wagner, et al., 2016; Weiss, 2018). Hence, it is understood best as "a process, whereby a gradual accumulation over the life-course of cellular and molecular damage may lead to an increased risk of age-related disorders" (Michel et al., 2019). Normal aging comprises sensory alterations (Davis et al., 2016), as well as changes in muscle strength, muscle mass, and fat mass (Dodds et al., 2017). Nevertheless, when these physiological changes induce functional changes such as mobility disability, decreased walking speed, continence, falls, or a compromised ability to conduct basic activities of daily living, the aging process is no longer considered normal and can result in frailty (Jaul & Barron, 2017), which Al Saedi et al. (2019) define as "a disorder of multiple inter-related physiological systems. Aging is indeed accompanied by a gradual decline in physiological reserve but, in frailty, this decline is accelerated, homeostatic

mechanisms start failing, and vulnerability increases to disproportionate changes in health status following relatively minor stressor events."

1.2.1 Changes in Appetite and Weight Loss

To begin with, as part of normal aging, sensory alterations emerge, creating thirst and appetite dysregulation, which is more prominent in older adults, making it more difficult for them to meet their necessary nutritional needs (Amarya, et al., 2015). With aging, tongue taste buds are progressively lost with the ones remaining primarily detecting bitter and sour tastes, thus accentuating the unpleasant flavors in food. This reduction in taste, which occurs in half of the older adult population, is often associated with an impaired appetite (Amarya, et al., 2015). Also, dry mouth (xerostomia) is common in older adults. It makes swallowing difficult which subsequently leads to an avoidance of certain foods. Another reason why an older adult may unconsciously change eating patterns is improperly fitting dentures, which results in struggles in chewing, leading to the adoption of a low-fiber diet, mainly composed of soft food, and the avoidance of essential food groups like vegetables and fruits. (Amarya, et al., 2015).

Several physiological systems are also altered throughout the digestive system (Nigam & Knight, 2017). Firstly, gastrointestinal changes such as atrophic gastritis, result in the malabsorption of essential nutrients. Secondly, a reduction in gastric acid secretion also limits the absorption of vitamin B12 and iron in specific (Cavalcoli et al., 2017). Thirdly, a reduction in Saliva production results in a slower peristaltic movement and increased constipation (Kim & Sung, 2015). Additionally, a decline in the esophagus's peristaltic movement results in greater satiety after a meal and delay in esophageal emptying (Maurer et al., 2015). Gastric emptying slows with aging as

well, which creates a potentially detrimental effect on appetite (Landi et al., 2016). As a result of the aforementioned changes that come about with aging, a decline in food intake in older adults is inevitable, which leads to various forms of weight loss, hence, contributing to nutritional and physical frailty (Norazman et al., 2020).

Regardless of which mechanism prevails, older adults who witness unintentional weight loss are at a greater risk for depression, infection, and death. A drastic reduction in weight in this age group, due to involuntary or voluntary causes, has been linked to mortality, and a rapid weight loss of ≥ 5% in 1 month is considered significant (Domingues-Faria et al., 2016). As a result of this significant weight loss, older adults undergo alterations in their body composition, which impacts their physical functions as well as their health significantly.

1.2.3 Changes in Body Composition and Decrease in Muscle Mass

Among the changes in body composition, is an increase in body fat and a reduction in organ mass (except for the heart) (Müller et al., 2014). Usually, the adipose tissue (AT) upsurges in middle age, then deteriorates in advanced ages, and through the process of aging, fat is reallocated to the abdominal storage units, as well as the liver, muscles, and other ectopic sites. This redistribution may translate into organ failure through lipotoxicity (Jura & Kozak, 2016). Moreover, aging also affects the AT of metabolically healthy people, meaning that a deterioration in pre-adipocyte replication decreases adipogenesis, and increases pro-inflammatory cytokines, which are known to alter insulin action (Mancuso & Bouchard 2019). Thus, lean individuals are as likely to experience age-related changes in their AT as obese individuals, which in turn impacts their energy metabolism (Jura, M & Kozak, 2016). Decreased physical activity (PA), among several other factors, additionally accounts for an increase in

body fat, also leading to a decrease in energy requirement and subsequently, intake with aging (Amarya et al., 2015).

Body composition changes in older adults not only include changes in fat metabolism but also tackle disturbances in protein metabolism. The decline of fat-free mass is mainly caused by the loss of skeletal muscles and is accompanied by a deterioration of muscle strength as well as an increased risk for many metabolic disorders (Domingues-Faria et al., 2016). Changes in muscle protein synthesis during anabolic conditions in aging populations have been identified as a major contributing factor to an imbalance in the skeletal muscle function and mass, which constitutes a hallmark characteristic of aging in humans (Shlisky et al., 2017). After reaching 30 years of age, an average of 3 to 5% of the muscle mass is lost, on average, every 10 years, with the rate of decline increasing after reaching 60 years of age, in such a way that 1 in every 20 older adults suffers from the effects of sarcopenia, one of the major drivers of disability in older adults (Lord, et al., 2018). Therefore, the age-related loss of skeletal muscle strength and mass are both highly prevalent and important risk factors for disability, functional limitation, frailty, and mortality in older adults (Shlisky et al., 2017). Prospective and cross-sectional studies evaluating the association between regional muscle mass and health outcomes consistently found that a low skeletal muscle index (skeletal muscle mass/body mass expressed as a percentage) is associated with an increased likelihood of functional impairment and disability (Wagner et al., 2016).

These body composition changes result in a decrease in their energy requirements because of a reduction in the basal metabolic rate; consequently, there is a decline in the levels of activity (Shlisky et al., 2017). Studies conducted in older

adults showed that almost 70% of the older adults whose age ranges between 60 and 69 years, have not practiced any type of outdoor activity in the 4 weeks before the study, and this scenario was even more prevalent in the participants who were above 70 years old (Amarya, et al., 2015). Physical inactivity is a serious concern, for it is implicated with minor illness in the older adult population and often results in the loss of muscle mass and tone, and, thereafter, initial PA levels may never be restored.

Although most factors related to aging lead to a decline in energy needs, the energy cost of daily activities has been shown to increase with age. Moreover, the requirement for some essential nutrients, such as protein, also increases due to aging-related inefficiencies in absorption and utilization (Cieslak et al., 2016). Hence, it is fundamental to monitor closely the food intake of the older adult generation to ensure they are getting the appropriate nutrition.

Unintentional weight loss, loss of muscle strength and mass, as well as slowness, and decrease in levels of PA are all components of normal aging (Siparsky et al., 2014). Nevertheless, when the rate of decline surpasses the norm, thus affecting the normal function and healthy living of older adults, the latter are considered frailty criteria. Older adults become more susceptible to relatively weak stressors, and the aging process becomes of concern (Cameron et al., 2013). As a result, to promote healthy aging it is important to understand what frailty is and how it manifests in individuals (Chen et al., 2014).

1.3 Frailty in Older Adults

Frailty is considered a health issue, usually emerging with aging that has "no universally agreed conceptual or operational definition". Nevertheless, there is a common consensus that frailty is "a crucial, clinically identifiable state that increases

the vulnerability to adverse outcomes due to the decline in reserve and functions in multiple physiological systems" (Gordon & Hubbard, 2019).

Clinically, frailty is defined as a "multidimensional syndrome characterized by decreased reserve and diminished resistance to stressors." (Morley et al., 2013). It is identified as "a treatable condition that may be reversible" (Michel et al., 2019). The identification and treatment of frailty, however, can be a challenge for clinicians since there is no current consensus as to a standardized tool for frailty measurement. By 2018, 89 different measures were being utilized in the acute care setting alone (Theou et al., 2018). The most prevalent tools used to assess frailty are summarized in table 1.

Table 1. *The Most Prevalent Frailty Assessment Tools (Dent et al., 2016)*

	Components	***Frailty Classification***
Frailty phenotype	Five items: weight loss, low physical activity, exhaustion, slowness, weakness	Frailty: ≥3 items: pre-frailty: 1-2 items; robust: 0 items
Frailty index	30 or more accumulated health deficits: scores range from 0 (no deficits) to 1 (all deficits)	Continuous score; suggested cutoff score for frailty >0.25
Electronic Frailty index	As for the Frailty Index, with variables derived from routine electronic health records in primary care; also considered to be a case-finding instrument	Severe frailty. score >0.36; frailty: score >0.24-0.36; mild frailty: score >0.12-0.24; fit: score ≤0.12
Clinical Frailty Scale	Visual and written chart for frailty with nine graded pictures. 1=very fit, 9=terminally ill	Frailty score ≥5
FRAIL scale	Five items: fatigue, resistance, ambulation, illness, loss of weight	Frailty: ≥3 items: pre-frailty: 1-2 items; robust: 0 items
Study of Osteoporotic Fractures frailty criteria	Three items: weight loss, exhaustion, unable to rise from a chair five times	Frailty: ≥2 items: pre-frailty: 1 item; robust: 0 items
PRISMA-7	Seven self-reported items: age (>85 years), male, social support, and ADLs	Frailty score ≥3
Tilburg Frailty Indicator	15 self-reported items in three domains: physical, psychological, and social	Frailty score ≥5
Geriatric 8 frailty questionnaire for oncology (G8)	Eight items: function (ADL and IADL), mobility, nutrition, comorbidity, cognition, depression, social support	Frailty score ≤14
Groningen Frailty Indicator	15 self-reported items in four domains: physical, cognitive, social, psychological	Frailty score ≥4
Short Physical Performance Battery	Three measured items: gait speed, standing balance, and repeated chair stands; each item scored from 0-4, maximum score of 12	Frailty score ≤9
Edmonton frailty scale	Nine items: cognition, health (2 x), hospitalization, social support, nutrition, mood, function, continence	Frailty score ≥7
Multidimensional Prognostic Index	Eight items: comorbidity, nutrition, cognition, polypharmacy, pressure sore risk, living status, ADL, IADL	Frailty: score > 0.66; pre frailty: score 0.34-0.66; robust: score < 0.34
Kihon Checklist	25 dichotomous items in seven categories: physical strength, nutrition, eating, socialization, memory, mood, and lifestyle; scoring as per the Frailty Index	Continuous score; suggested frailty cutoff score > 0.25
Frailty Risk Score	Formula: age (per 10 years) x 4 + male sex x 10 + no partner x 5 + body mass index <18.5 kg/m^2 x 12 + cardiovascular disease x 4 + diabetes x 4 + number of drugs≥2 x 5, EMS<20 x 5 +ADL motor deficit x 4 + ADL process deficit x 7. Also considered to be a case-finding instrument	Very good: score <45; good: score 45-50; moderate: score 51-55; poor: score 56-61; very poor: score >61
Hospital Frailty Risk Score	109 summed items from ICD-10 frailty-relevant codes from administrative hospital data. Also considered to be a case-finding instrument	Low risk: score <5; intermediate risk: score 5-15; high risk: score >15

Note: EMS, Elderly Mobility Scale; ADL, Activities of daily living; IADL, instrumental activities of daily living; ICD-10, International Statistical Classification of Diseases and related health problems, 10th revision.

Derived and modified from Dent and colleagues, 2016.

Although “no definition is universally accepted”, two main models have predominantly emerged to elucidate frailty further: “Fried’s phenotypical approach to physical frailty” (Fried et al., 2001) and “Rockwood’s operationalization of a model of accumulation of deficits or the frailty index (FI)” (Rockwood et al., 2005). The Fried phenotype of frailty is the most frequently used frailty assessment method in the literature (Clegg et al., 2013). Fried’s phenotype of frailty also labeled as “the cardiovascular health study index” has been implemented in numerous epidemiological studies where frailty is a predictive index of detrimental clinical outcomes, including mortality (Dent et al., 2016). The Fried model emphasizes the role of muscles as the primary reserve organ involved with frailty and hypothesizes a direct association between a reduced metabolic efficacy, muscle strength and mass, a slow walking speed, and related fatigue and exhaustion (Fried et al., 2001). It comprises five phenotypic criteria (self-reported exhaustion, unintentional weight loss, slowness, weakness, and low PA). Moreover, it has been used to test the stages of frailty (robust or non-frail, pre-frail, frail) of many different ethnicities and demographics (Majid et al., 2020). People are considered frail if they cross out three or more of these features, pre-frail if they identify for one or two of them, and robust or non-frail if they do not meet any of the criteria. Pre-frailty is “an intermediate state between frailty and non-frailty/robust that has a higher risk of progressing to frailty” (Siriwardhana et al., 2018). In their landmark study, falls, worsening disability, hospitalizations, and death were more common among both frail and pre-frail individuals (Fried et al., 2001).

1.3.1 Prevalence of Frailty

Currently, it is estimated that the number of frail older adults has reached 120 million people worldwide (Woolford et al., 2020). A systematic review and meta-analysis investigating the global incidence of pre-frailty and frailty in older adults

living independently, included data from 120, 000 older adults residing in 28 different countries, found that the incidence of pre-frailty and frailty was estimated at 151 and 43 new cases for every 1,000 people per year respectively, using Fried's Frailty Phenotype (Ofori-Asenso, et al., 2019). Another study conducted by Kojima and colleagues found that frail participants constitute on average 10% of older adults living independently. Nevertheless, this prevalence varies between 4% and 59% and that depends on the frailty criteria adopted in the study (Kojima et al., 2019). Hence, frailty prevalence was shown to vary based on the frailty scale used, the sample studied, and specific diseases or conditions (Handforth et al., 2015; Lee et al., 2016; Denfeld et al., 2017; Kojima et al., 2017). A review assessing the prevalence of frailty in developing countries was published in 2015. Researchers found limited studies available, yet they were able to prove that frailty is more prevalent in developing countries, when compared to developed nations where the prevalence of frailty has been extensively investigated (Nguyen et al., 2015). The first systematic review and meta-analysis published in 2018 assessing the prevalence of frailty and pre-frailty among community-dwelling older adults in low-income and middle-income countries, found that the prevalence of frailty and pre-frailty appears higher in community-dwelling older adults in upper-middle-income countries compared with high-income countries while there is limited evidence (Siriwardhana et al., 2018). Nevertheless, no research, so far, has gathered all available epidemiological findings from low or middle-income countries, such as Lebanon, to evaluate frailty's burden in these countries (Waltson, 2020).

1.3.2 Risk Factors of Frailty

The numbers and figures above demonstrate that frailty is highly prevalent worldwide. The identification of frailty determinants is critical for profiling clinical

risk indicators, targeting population subgroups for early intervention among people at risk of becoming frail, and exploring modifiable risk factors (Lee et al., 2018). Advanced age has been shown to be an important risk factor for frailty with a quarter of individuals who have reached the age of 80 years, being frail (Woolford et al., 2020). As frailty is "a biologic syndrome due to multisystem declines in physiological reserves, a large number of direct, indirect, and interacting risk factors are involved in its causation" (Ng et al., 2014). Frailty was also proven to be related to health variables, including comorbidities, namely diabetes, anemia, and heart failure, in addition to polypharmacy, falls, and a decrease in functional capacity (Veronese et al., 2017). The aforementioned health variables result in a physiological decline across different body systems, including the cardiorespiratory system, endocrine and immune systems, and skeletal bone and. Other important contributors to developing frailty can span non-physical domains as well (Woolford et al., 2020).

Moreover, some sociodemographic factors can also contribute to increasing the risk of frailty, such as having a low socioeconomic status, not having a partner, living alone, having a low education level, and smoking (Kendhapedi, & Devasenapathy, 2019). Frailty was also largely attributed to poor nutrition including micronutrient deficiencies, notably vitamin D and leucine, low protein intake, and excessive alcohol intake, among others (Ng et al., 2014, Fhon et al., 2018, Gordon & Hubbard, 2019). Early detection and nutritional interventions can potentially prevent negative health outcomes and increase the likelihood of healthy aging (Leslie & Hankey, 2015). It is essential to understand frailty risk factors, especially those that we can control and modify such as nutrition, mainly because frailty was shown to have detrimental consequences on health.

1.3.3 Consequences of Frailty

There is proof that weaker grip and lower extremity strength, and slower walking speed, components of the Fried phenotype of frailty, are associated with a higher risk for numerous conditions that have a detrimental effect on individual lives and society as a whole. In the United Kingdom (UK) Newcastle 85+ study, weak handgrip strength was associated with cognitive impairment, disability, and multi-morbidity (Wagner et al., 2016). Besides, longitudinal studies have determined numerous negative consequences associated with frailty, including worsening mobility, disability, falls, hospitalization, and increased risk of mortality (Fried et al., 2001, Rockwood et al., 2005). Henceforth, a frail older adult requires more time to recover after any type of insult (such as adverse drug reactions, infarctions, or infections) and is more vulnerable to further stressors during the period of recovery. (Gordon & Hubbard, 2019).

Frailty also independently leads to poorer outcomes post-surgery and is associated with higher health care use (Ofori-Asenso, et al., 2019). This is because frailty is also defined as "having a strong biological component that results from the accumulation of cellular damage over the life course" (Valdiglesias et al., 2019). Frail older people were shown to be at an increased risk for cognitive disorders when compared to robust older adults (Panza et al., 2018). An association between frailty and cardiovascular diseases (CVDs) has also been established (Afilalo, 2011). Khan et al. explored the relationship between frailty and heart failure incidence in a cohort of older adults between the age of 70 and 79 years, living independently (Khan et al., 2013). The cohort included both men and women and results showed that frailty increased the risk of heart failure. Other research studies with the same aim have demonstrated that frailty alters cardiac surgery outcomes in older people. Frail

individuals are at an increased risk of morbidity and mortality post-cardiac surgery (Finn & Green, 2015). Frailty is also affiliated with an increased risk of coronary artery disease in older adults (Sanchis et al., 2014). Like frailty, pre-frailty is also associated with negative health consequences. A recently published meta-analysis that includes 6 prospective cohorts showed that pre-frail participants were at a higher risk for faster onset of any type of CVD when compared to robust participants (Veronese et al., 2017). Another study with a longitudinal design also demonstrated that pre-frail older adults are more likely to exhibit new and persistent depressive symptoms (Feng et al., 2014).

1.3.4 Prevention of Frailty

Based on the available evidence, some interventions may have the potential to reduce the prevalence of frailty or prevent its progression in older adults (Apóstolo et al., 2018). At present, nutrition and exercise-based interventions show the most persistent evidence (Apóstolo et al., 2018). Frailty is without question one of the global public health challenges of concern that we will face this coming century (Kojima et al., 2019). Frail older adults unfortunately have an increased chance of lowered quality of life, falls and fractures, hospitalizations, iatrogenic complications, unmet care needs, and early mortality (Dent et al., 2019).

This higher risk of negative outcomes can take place even without the existence of comorbidities (Clegg et al., 2013). Therefore, adequate strategies targeting the management and prevention of frailty in the aging population will help reduce the condition's burden at the level of both the individual and the health system. Although the mean prevalence of frailty gradually increases with age (Ma et al., 2018, Kehler et al., 2017, Payne et al., 2017, Lewis et al., 2018), the course of frailty in an individual

fluctuates and can decline, even in old age (Kojima et al., 2019). Numerous population-based, longitudinal studies have demonstrated that between 8.3% and 17.9% of older individuals have succeeded in improving their frailty status and reversing it, (Liu et al., 2018, Pollack et al., 2017, Trevisan et al., 2017) and that some even made dynamic and frequent transitions over time (Kojima et al., 2018).

Healthy aging can be a reality for all, nevertheless, this will require a shift in focus from considering healthy aging as the absence of disease to fostering the functional ability that enables older people to be and to do what they value (Dent et al., 2019). Actions to improve healthy aging will be needed at multiple levels and in multiple sectors to prevent disease, promote health, maintain intrinsic capacity, and enable functional ability (WHO, 2020).

1.3.4.1 Prevention of Frailty Through Nutrition

Nutrition plays a major role in the prevention of frailty. Maintaining a healthy body weight throughout the lifespan is crucial in the prevention of frailty and can likewise prevent osteoarthritis, diabetes, as well as other chronic diseases that are threatening to healthy aging (Jaul & Barron, 2017). Moreover, many macro and micronutrients have been demonstrated to be directly interacting with or leading to frailty (Woolford et al., 2020). Evidence shows that frailty can be prevented by meeting caloric intake needs. To meet resting energy expenditure sufficiently in older adults, it has been estimated that, on average, 25 kilocalories (kcal)/kilogram (kg)/day (d) is required, which can reach around 32.5 kcal/kg/d when accounting for normal PA (Woolford et al., 2020). Many findings have demonstrated that a caloric intake lower than the aforementioned level is associated with an elevated chance of developing frailty in older adults. The InCHIANTI study demonstrated that an energy intake < 21

kcal/kg per day was linked to an increased frailty prevalence (Bartali et al., 2006). Furthermore, in a longitudinal study with 10 years of follow-up, older women who had an energy intake < 25 kcal/kg per day were more at risk of becoming frail or dying by three folds (Vellas et al., 1997) and in the recent Rotterdam study, researchers established that for every increase in 100 kcal, frailty prevalence decreased by 5% (Schoufour et al., 2019). Studies have shown that these can be prevented through nutrition. Aging is accompanied by inefficiencies in the utilization and absorption of some essential nutrients, meaning that the requirement for them increases, despite lower energy needs (Remond et al., 2015).

The need for more dietary protein, in particular, was shown to be prevalent among older individuals, partly due to the metabolic changes that accompany aging mentioned above, and in part due to a decline in the anabolic response to protein ingestion in older individuals (Franzke et al., 2018). This is of major concern because a shortage in protein supply compared to the needs of the individual is proven to results in the loss of lean body mass, particularly muscle loss, which can lead to a decline in muscle strength, walking speed, and PA, therefore putting older adults at an increased likelihood of frailty (Bauer et al., 2013).

1.3.5 Impact of Protein Intake on Frailty

Several studies have demonstrated that the current recommendation of 0.8 g/kg body weight (BW)/d is insufficient to ensure the increasing needs of older adults (Richter et al., 2019). These studies have also suggested more adequate cutoffs, all close to 1 g/kg BW/d of protein (Lonnie et al., 2018).

An adequate amount of protein is crucial for maximal stimulation of the muscle mass accretion and muscle protein synthetic response postprandially in older adults (Tieland

et al., 2015). In a systematic review assessing the association between nutritional status and frailty in older adults, 22, 270 older adults with a mean age of 75 years were included, among which 21,033 were community-dwelling living in Asia, Europe, and the United States of America (USA). Different frailty assessment tools were used, including Fried's Frailty Phenotype, the Study of Osteoporotic Fractures (SOF) Frailty Index, and the FRAIL scale. Several observational studies that reported data on the relationship between macronutrients and frailty demonstrated that increased levels of protein intake were linked to a lower risk of developing frailty, while a sole study showed that it was the overall protein distribution throughout daily meals that were significantly linked with frailty, (Lorenzo-López et al., 2017). As such, one study conducted by Bartali et al. in Italy, and it included 1,299 older adults. Dietary intake was assessed using an FFQ and frailty using Fried's frailty phenotype. Twenty percent of the participants were found to be frail. Results showed a relationship between low protein intake (lowest quintile; energy intake of ≤21 kcal/kg/d) and frailty, after adjusting for energy intake (odds ratio (OR) = 1.98; 95% confidence interval (CI)= 1.18 − 3.31) (Bartali et al., 2006). Another study was a cross-sectional, secondary analysis of the French Three-City cohort. It included 1,345 older-adult participants living independently. They explored the relationship between frailty and higher energy and protein intakes. Frailty was evaluated using Fried's Frailty Phenotype, while protein intake was measured via a dietary survey completed at home, where amounts of protein were estimated using a book of photographs. The protein intake suggested cutoff was then set at ≥ 1g/kg BW/d. Out of the total participants, 4.1% (n = 55) were identified as frail and results showed that a protein intake of 1 g/kg was linked a lower frailty prevalence after they adjusted for sociodemographic and clinical confounders (OR = 0.41; 95% CI= 0.19 − 0.89) (Rahi et al., 2016).

A recent meta-analysis included 4 cross-sectional studies and 50,284 older adults from 3 different continents between 2006 and 2018. Countries included France, Germany, Italy, Japan, and the USA. It also included 3 longitudinal studies in the USA and Spain, where participants were followed up for 3.7 years on average (2010-2016) in which 32,164 older adults living independently were investigated. All studies assessing the relationship between protein intake and frailty prevalence used Fried's Frailty Phenotype to estimate frailty prevalence, while dietary intake was first assessed by population-specific FFQs, followed by self-administered diet history questionnaires, and the 24h dietary recall. Nevertheless, high and low protein intakes were defined differently in the studies. While most cross-sectional and all longitudinal studies used measures of centrality (tertiles, quartiles, or quintiles), Rahi et al. employed pre-established cutoffs ($\geq$ 1g/kg BW). All studies concluded that protein intake was significantly negatively linked to frailty status in older adults (OR = 0.67; 95% CI= 0.56–0.82, p = $\leq$ 0.001) (Coelho-Júnior et al., 2018). Furthermore, due to the several metabolic and genetic changes that accompany aging previously discussed, including absorption, digestion, anabolic resistance, genetic decrease in muscle mass among others, the most recently suggested cutoffs for daily protein intake are set between 1.0 and 1.2 g/kg BW/d for healthy older adults, and between 1.2 and 1.5 g/kg BW/d for geriatric patients with acute and chronic diseases, since they exhibit higher states of catabolism that lead to increased muscle loss. Recommendations for protein intake for adults over the age of 70 years in Australia and New Zealand have been raised to a level 25% higher than those for younger adults (2005). Furthermore, given that muscle sensitivity to low levels of amino acids is blunted in older adults, the latter indicates that dietary protein should be adequately distributed to at least 25 - 30 g of

high-quality protein per meal containing around 2.5 to 2.8 g of leucine, to stimulate muscle protein synthesis (Bauer et al., 2015).

1.3.5.1 Impact of the Current Protein Recommended Dietary Allowance of Older Adults on Frailty

Evidence from large epidemiologic cohort studies suggests that the loss of lean mass that accompanies aging is, in part, mediated by the consumption of dietary protein. Houston and colleagues reported from the Health, Aging, and Body Composition study that a 3-year loss of lean mass was linked to average dietary protein intake and that this relationship remained even after adjusting for the change in body mass and daily energy intake (Houston et al. 2008). Subsequent analyses conducted by the Women's Health Initiative and InCHIANTI cohorts both confirmed these findings and suggested an association between protein intake and the development of frailty (Isanejad et al., 2015). Also, results from recent studies suggest that moderately elevated levels of protein intake are essential for preserving nitrogen balance and offsetting age-related lower energy intake, impaired insulin action, and decreased protein synthetic efficiency (Deer & Volpi, 2015).

Current recommendations call for unified protein intake for both adults and older adults. As such, recent evidence exploring the importance of protein intake suggests ameliorated health outcomes in older adults who have more elevated protein intakes. Houston and colleagues showed that among older adults aged between 70 and 79 years who are suffering from sarcopenia, participants with the highest protein intake lost 40% less lean muscle mass compared with those in the lowest quintile (Houston et al., 2008). Over three years, Tucker, 2010 demonstrated that the greater the relative loss of lean muscle mass, the greater the proportion of fat mass, and the higher the

likelihood of metabolic imbalances and related chronic conditions. Also, loss of lean muscle mass increases the risk of falls. She explained that preserving muscle mass in older adults is one of the most crucial preventative health measures that can be taken.

Additionally, a longer-term nitrogen balance study demonstrated that older adults consuming the protein recommended dietary allowance (RDA) over 14 weeks lost mid-thigh muscle mass, suggesting that muscle strength may be at stake for older individuals adopting the current protein intake recommendation (Skully, 2013). Hence, evidence shows that protein has been given much attention concerning the prevention of frailty and that is mainly due to its essential role in muscle metabolism and its major contribution to muscle anabolism and sarcopenia prevention in older persons (Woolford et al., 2020). Ensuring the right nutritional practices serves not only preventing the development of frailty but also maintaining a good functional status and promoting healthy aging.

1.4 Nutrition in Older Adults

Nutrition has an important role in the determination of healthy aging, with the association between the two being a bi-directional and complex one (Alam et al., 2019). Physiological changes related to aging can affect the person's nutritional status, with nutritional insufficiencies being frequent amidst older adults. Sensory defect (e.g. loss of smell and taste), loss of mobility, poor oral health, and delayed gastric emptying can seriously have an impact on dietary intake, while a decline in the secretion of gastric acid can affect the absorption of nutrients (Maggini et al., 2018). It is important to note that this growing population group is becoming increasingly diverse in their nutritional requirements. While a lot of elderly people manage to eat well and stay healthy, those in inferior health conditions typically undergo challenges in reaching

their nutritional needs. Hence, reaching the adequate diet and nutritional requirements of older adults is essential for maintaining functional independence, good health, and life quality. (Leslie & Hankey, 2015).

Chronic diseases are unfortunately becoming more prominent with aging and are frequently regarded as an unavoidable part of growing old. Nonetheless, increased research proves that the rise in the prevalence of many of these conditions at a young age is a consequence of the ineffective practice of necessary health behavior rather than a normal function of aging. (Shlisky et al., 2017).

1.4.1 Protein insufficiency in Older Adults

Observational cohort studies and national surveys have recognized many nutrients that may be poorly consumed, resulting in health threats amid elderly people, and these mainly include protein above all (Tucker, 2014). It is necessary to recognize that even intake levels of RDA may not consistently give ideal intake for the elderly population since, usually, RDAs are determined based on studies administered on healthier young people. Evidence implies that around 35% of over 50-year-olds in Canada, USA, and Europe have a deficiency of > 1 micronutrient, and with 1 million over-65-year-olds malnourished in the UK alone, adequate nutrition of older adult populations is of both public health and clinical significance (Maggini et al., 2018).

Nevertheless, with an increase in age, nutrient deficiencies become more prominent. Since malnutrition is more frequent and might become an important health problem in the future, adequate nutrition is essential for healthy aging, and its absence can also lead to detrimental effects on health and can even result in malnutrition, whose prevalence among older adults is particularly elevated in dependent and frail older adults. Increasing the recommendation for protein intake may prevent detrimental

health consequences and increase the likelihood of healthy aging (Leslie & Hankey, 2015).

Extremely low protein intake can go beyond its effects on healthy aging and can lead to undernutrition of protein, which has been linked to a higher chance of injury in older adults and has also been a known factor in the pathogenesis of osteoporotic fractures in older adults. Hence, adequate protein intake is crucial in the older adult population for protein is important for muscle building, body fluid replenishment, and wear and tear of the body. It is moreover needed for the metabolic body processes in the form of hormones and enzymes. Older adults are at risk of protein-energy malnutrition related to a progressive decrease in body protein shown by decreased fat-free mass (Wells & Dumbrell, 2006).

Nutrition has also drawn much attention with regards to preserving muscle regeneration capacity: studies have proven that amino acids can ameliorate the regeneration of skeletal muscle by targeting important functions of muscle cells, immune cells, or both (Domingues-Faria et al., 2016). Therefore, meeting the nutritional needs especially in terms of protein intake is essential for older adults to maintain good health and non-frailty.

Nutritional risk is usually explained as the existence of factors that impede the intake of food and conclusively, if not improved, lead to malnutrition. Irrespective of the terminology used (nutritional frailty, nutrition or malnutrition risk, under- or mal-nutrition), what is key, is that under-nutrition is preventable but more likely with the current protein recommendation for older adults (Huang et al., 2012) and if left unmanaged, further negative health, functional, and quality-of-life consequences take place (Marshall et al., 2014).

1.4.2 Nutritional State in Lebanese Older Adults

Researchers studying the nutritional state of older adults living independently in Lebanon mainly focused on malnutrition. Distinctively, two population-based surveys were performed to study the nutritional condition of the non-institutionalized, community-dwelling older adult population in Lebanon. The first survey included a sample of 1200 older adults 65 years-old or more selected randomly living in rural areas of Lebanon. The overall prevalence of malnutrition and the risk of malnutrition were 8.0% and 29.1%, respectively (Boulos et al., 2013).

1.5 Rationale

Little data exists on the differentiation between the adverse effects of human aging on health and its normal consequences.

What remains unclear is the influence of aging and age-related changes in muscle mass on chronic protein turnover and effects on dietary protein requirements.

The existing data on dietary protein requirements for older adults is based on a healthy population, which makes the generalization of these results inaccurate since that age group consists of an important number of individuals with comorbid conditions, functional limitations, and disabilities (Shlisky et al., 2017).

As previously demonstrated in several studies, muscle mass decreases with age and so does protein absorption and synthesis due to a diminished anabolic state that takes place with aging. Therefore, in this thesis, we are looking for a relationship between protein intake and prevalence of frailty using the cutoff of 1g/kg versus a lower daily protein intake to assess whether protein recommendations should be increased for older adults. Moreover, the aforementioned results are compared to the

association found between the prevalence of frailty and the protein intake based on the cutoff of the current recommendation of 0.8g/kg since studies have shown that the ingestion of the latter amount leads to the use of protein from the muscles themselves.

To our knowledge, data related to the protein intake of older adults in Lebanon and whether it is close to 1g/kg is still lacking, and studies associating protein intake with the prevalence of frailty in Lebanese older adults are also still lacking.

1.5.1 Aims and Hypothesis

The primary aim of the current study is to analyze the association between protein intake and the prevalence of frailty and robustness in a Lebanese older adult population living independently. It is hypothesized that adequate protein intake within a healthy diet quality is associated with a decreased prevalence of frailty in Lebanese older adults and that the recommended daily intake of protein of older adults should be higher than the one set for them (0.8g/kg BW/d).

1.5.2 Objectives

The first objective of this study is to conduct a descriptive analysis of the protein intake, segmented by cutoffs and by types, in older adults in Lebanon based on their sociodemographic, clinical, and dietary characteristics.

The second objective is to evaluate the relationship between protein intake and the prevalence of frailty and robustness among older Lebanese adults living independently while taking into consideration the protein source.

Chapter 2

Methodology

2.1 Study Design

The present study is a cross-sectional one that evaluates the association between protein intake and the prevalence of frailty in community-dwelling Lebanese older adults living in different Lebanese areas. In total, 112 participants living independently in GB and Keserwan areas were recruited. Due to the lack of resources available and difficulties in obtaining official documents required for a population-based study, as well as the limited time, material, and financial resources available, we opted for a convenience sample that would only cover GB. Nevertheless, due to the unstable situation that led to road-closures in Lebanon, we ended up recruiting participants who were accessible to us at the time. Hence, participants were selected from a convenience sample based on proximity and word-of-mouth, who were easier to reach especially after political instability emerged in Lebanon, leading to riots and road closure. Due to the above, the response rate cannot be estimated and does not apply to the recruitment method that was adopted.

2.2 Population

Eligible participants were men and women who understood Arabic, were 65 years old or above, and lived independently at home.

Participants were excluded from the study if they had severe neurological or psychiatric disorders, or were suspected of having a cognitive impairment (participants were screened for cognitive impairment using the Mini-Cog. A total score of 3 and

above is an indication of a lower likelihood of dementia. Participants scoring 2 or lower were not eligible for participation (Fage et al, 2015)). Moreover, participants who were unable to walk independently and safely had a history of bilateral hip replacements, or an acute illness, or were currently diagnosed with cancer patients were also excluded from the sample.

The sample size was calculated using the "A-priori Sample Size Calculator for Multiple regression" with a medium level anticipated effect size (f2) of 0.15, a statistical power level of 0.8, 15 predictors, and a probability level of 0.05. The total sample size as a result of this specification is 140. The missing data is accounted for by inflating the sample size by 1.2 and the non-response is accounted for by inflating the sample size by 1.25; leaving a final sample size of 210 participants.

Nevertheless, we were not able to reach the desired number of participants due to dire circumstances inflicting the country like the Lebanese October revolution, and the COVID19 lockdown, but were still able to reach 112 participants.

2.3 Ethical Approval

This study complies with ethical standards regarding human participant research and was reviewed and ethically approved by the Lebanese American University Institutional Review Board (IRB #: LAU.SAS.BR4.23/Jul/2019). All participants provided written consent before the enrollment and after being informed of the study objectives and procedures and of their right to withdraw from the study at any time.

2.4 Informed Consent Form

After recruitment, approval was sought out by providing informed consent that included the purpose and benefits of the study and ensured anonymity. Participants were asked to read the informed consent carefully and if participants had any questions, they were answered verbally. In the case of participants were unable to read, the informed consent form was read to them, and any questions they had were also answered. Trained dietitians then administered the questionnaire and participants had the right to withdraw consent and exclude themselves from the study at any point.

2.5 Nutritional Assessment

Nutritional data of all participants was collected by trained dietitians through a face-to-face interview using a semi-quantitative food frequency questionnaire (FFQ). This method was followed to achieve higher response and rates of completion and to increase the collected data's validity. The FFQ used was derived from prior studies conducted among the Lebanese population, and the cultural sensitivity and clarity of this FFQ have been previously tested by a panel of nutritionists on a sample population (Naja et al., 2011; Naja et al., 2015; Jomaa et al., 2016). The 61-item FFQ consisted of commonly consumed food items in Lebanese households. Participants were asked to indicate the consumption frequency (per day, per week, per month, per year, or never) for each food item along with the standard portion size (1cup, 1 piece, 1 teaspoon…) over the past year. Participants were also asked to provide information on their frequency of snacking, breakfast consumption, eating in front of the television per week, and eating out per week.

The daily intake of food items in grams was calculated manually. For each candidate in this study, each food item frequency was collected and listed in the data entry as the number of servings per day, per week, or month. First, these numbers were converted to servings per day for each item. To do so, for the items given as servings per week, frequencies were divided by 7 (1 week = 7 days), whereas for servings per month, the numbers were divided by 30 (1 month = 30 days). The items listed as servings per day remained the same.

The second step was to convert these frequencies (servings per day) into quantities per day in grams for each food item and each participant. This was done by multiplying each frequency by its associated weight (g) per serving size, using the table "weight of serving sizes - FFQ items" provided by the American University of Beirut. The final result was reported as grams per day for each food item and each participant.

2.6 Protein Intake

Daily intake of grams of protein per body weight was calculated manually using the USDA (United States Department of Agriculture) FoodData Central database. After having converted all food items to servings per day, serving sizes were compared with the serving size offered by the USDA for each food item to reach a common protein content per serving. The protein content (grams per serving) of each food item was multiplied by the frequencies obtained from the first step (serving per day) for each participant, resulting in the quantity (grams) of protein consumed per day by each candidate. Finally, these quantities were divided by the bodyweight (kg) of the corresponding participant. The resulting number represents the daily protein intake per body weight (g/Kg/d). This variable was used to create a dichotomous variable set a cutoff of 0.8 g/kg BW of protein daily, which is the current RDA for protein intake for

older adults. This helped distinguish between participants who had a daily protein intake lower than 0.8 g/kg BW and the ones who had a protein intake of 0.8 g/kg BW and above. Similarly, the daily protein intake per body weight of the participants was also studied based on the 1g/kg cutoff of daily protein intake, which is the daily protein intake that has been suggested for older adults (Campbell et al., 2008), to differentiate between participants who had a daily protein intake below 1 g/kg BW and the participants who reached this suggested cutoff. Moreover, the protein intake of participants was also compared based on the source of protein as assessed as grams per day: animal protein was computed by grouping all food items containing animal products and recoded into a new variable: milk, yogurt, cheese, Labneh, red meat, poultry, fish, eggs, organ, luncheon, sausage, butter/ghee, mayonnaise, desserts, ice cream, chocolate bar, Arabic sweets, manakeesh, shawarma sandwich, burgers, and pizza. Daily plant protein intake was represented by the intake of bread and cereals, fruits, vegetables, legumes, nuts and seeds, olives, Turkish coffee, beer, wine, French fries, chips, and falafel. Protein calculations are presented in table 10 (Appendix).

2.7 Frailty

The Cardiovascular Health study frailty index was followed to define Frailty, and the latter was assessed using the 5-item scale developed by Fried et al. with a slight modification with regards to PA criterion (Fried et al., 2001). Frailty was determined by the presence of three or more of the following criteria: feeling of exhaustion, unintentional weight loss, low muscle strength, slowness, and reduced PA. Pre-frailty was determined by the presence of either one or two of the five criteria, whereas the absence of any of the aforementioned criteria signals robustness. Unintentional weight loss was described as the self-reported loss of 4.5kg or more, in the past year, or a BMI

< 21 kg/m^2 upon the inability to recall any weight-loss. Exhaustion was measured using the Arabic CES-D scale which was validated in a Lebanese population (Kazarian & Taher, 2010). Exhaustion was considered if participants answered "yes" to any of the following questions: "I felt that everything I did was an effort" and "I could not get going" at least 3 to 4 days a week. A dynamometer was used to measure grip strength, and the average of the 3 measurements of the dominant hand was recorded. Low grip strength was defined based on the average grip strength measurement of the lowest 20% depending on gender and BMI. The cutoff values for grip strength were derived from the study's lowest sex-specific quintiles, and participants in the lowest quintile were considered as having low muscle strength. Walking speed was measured by the recorded time needed to walk six meters and slowness was defined based on the walking time of the lowest 20% depending on gender and height (Fried et al., 2001). The cutoff values for walking speed were also derived from the lowest sex-specific quintiles of the study and participants in the lowest quintile were considered slow. Reduced PA was considered for completing less than 1 hour (h) of physical activity or less than 3.5 hours of leisure activities weekly. PA estimation was based on a similar study conducted by Rahi et al. (Rahi et al., 2016).

2.8 Covariates

Trained dietitians conducted in-person interviews with all participants. Individuals completed brief sociodemographic and lifestyle questionnaires. Multi-component questionnaires for sociodemographic and lifestyle characteristics included questions on age (years), sex (male, female), marital status (married, single/divorced/separated/widowed), an education level (primary, elementary, secondary, higher education), income per month in Lebanese pounds (LBP)

(<1million, between 1 and 3 million, >3million), number of children and number of people living in the household. Also, participants answered questions about smoking status (current smoker, non-smoker, past smoker), and supplement use (Jomaa et al., 2016). Weight and Height were self-reported. Body mass index (BMI) was calculated as the ratio of weight (kg) to the square of height (meters). Older adults with a BMI<23kg/m^2 were classified as underweight, 23-31kg/m^2 as healthy, and >31kg/m^2 as overweight (Winter et al., 2014).

Participants were also asked to provide information regarding clinical characteristics, on the presence of chronic diseases such as obesity, diabetes, hypertension, cardiovascular diseases [heart failure, angina, myocardial infarction], cerebrovascular diseases, stroke, kidney disease, chronic obstructive pulmonary disease, arthritis, anemia, hyper/hypothyroidism, osteoporosis, fractures, Parkinson's disease, other [insulin resistance, peptic ulcer, chronic constipation, cholecystitis, hyperkalemia], and polypharmacy [dichotomous variable with a cutoff of 5 drugs/d] (Masnoon et al., 2017). Diabetes, hypertension, and cardiovascular diseases were assessed by protein intake, which was based on previous studies assessing protein intake and frailty prevalence intake (Beasley et al., 2010; Coelho-Júnior et al., 2018; Isanejad et al., 2019), also being the chronic diseases that are related and studied most with frailty (Halter et al., 2014; Benetos et al., 2019). In addition, the total number of diseases was used as a confounding variable in the regressions. Cognitive function was evaluated with the Arabic Rowland Universal Dementia Assessment Scale (RUDAS) which has been validated in Arabic-speaking populations, exhibiting good sensitivity (83%) and specificity (85%) (Chaaya et al., 2015). Participants were assessed for depression using the Arabic Geriatric Depression Scale (GDS-15), which has shown

to have high internal consistency reliability in Lebanese older adults (Chaaya et al., 2008).

We also computed the MeDi score of participants based on methods published in previous articles (Trichopoulou et al., 2003; Rahi et al., 2018). To compute the MeDi score 9 food groups were assessed as follows: cereals, vegetables, legumes, dairy, fruits and nuts, meat, fish, olive oil, and alcohol. Each group is composed of different items as presented in table 9 (Appendix). A score ranging from 1 to 9 computed by adding the serving per week of each food item, adjusted by gender. The median serves as a cutoff point, whereby a 0 means the threshold of servings per day is not met, and 1 means the threshold is met. All groups were scored with 0 for below the median and 1 above the median, except for meat and dairy where it is the opposite. As for alcohol, males above 14 servings per week and females above 7 servings per week, as well as participants who did not drink, had a score of 0. Scores on each category were summed up and the total MeDi score was divided into three categories: 0-3 as low adherence, 4-5 as normal adherence, and 6-9 as high adherence. In this thesis, the MeDi score, used as a confounding variable was entered as a continuous variable (MeDi score). Nevertheless, the 3 categories of adherence of participants were assessed in the bivariate analysis and compared by both protein intake cutoffs (1 g/kg BW and 0.8 g/kg BW) and well as protein intake by protein source (animal and plant protein).

2.9 Statistical Analysis

All statistical analysis was conducted via SPSS statistical software version 25. The significance level was set at 0.05 for the p-value.

Kolmogorov-Smirnov and Shapiro-Wilk tests were used to evaluate the assumption of normality. Continuous variables were described using means ± standard

deviations (SD) for those with normal distribution and median (minimum, maximum) for those with a skewed distribution. As for the categorical variables, they were described using frequencies and percentages.

Bivariate analysis using Chi-square or Fisher exact test was done to compare the categorical sociodemographic characteristics, clinical characteristics, and dietary characteristics between different proteins cutoffs and frailty categories. Additionally, independent t-test and Mann Whitney tests were used for continuous variables, whereby the independent t-test was conducted for variables that follow a normal distribution and Mann Whitney test for variables that follow a skewed distribution. Additionally, Pearson's correlations were used to check the level of correlation between two continuous variables. Moreover, we used ANOVA (One Way Analysis of Variance) to compare the means of 3 or more independent groups, followed by Bonferroni Post hoc.

Multivariate binary logistic regressions were conducted, with two outcomes being frail/non-frail and the other being robust/non-robust. All the regressions were adjusted for gender, age, educational level, BMI, number of chronic diseases, polypharmacy, dietary supplements, GDS score, RUDAS score, and MeDi score. Odds ratios (OR) and 95% Confidence Intervals (CI) were reported. In the first analysis, frailty was taken as a dichotomous variable with frail vs non-frail and assessed with protein intake set at 0.8 g/kg BW. The second analysis assessed frailty with protein intake at a cutoff of 1 g/kg BW. The third analysis assessed frailty with animal protein intake and the model was further adjusted for plant protein intake. The fourth analysis assessed frailty with plant protein intake and the model was further adjusted for animal protein intake. In the fifth analysis, frailty was also taken as a dichotomous variable,

but here with robust vs non-robust and assessed with protein intake set at 0.8 g/kg BW. The sixth analysis assessed the association between robustness and protein intake at a cutoff of 1 g/kg BW. The seventh analysis assessed non-robustness with animal protein intake and the model was further adjusted for plant protein intake. The eighth analysis assessed non-robustness with plant protein intake and the model was further adjusted for animal protein intake.

Sensitivity analysis regarding the intake of dietary supplements was conducted since our sample size did not enable us to correct for a considerable number of confounders. We assessed whether removing the intake of supplements from the model would affect the results, but they remained the same. This variable was chosen due to the lack of details available regarding the type of supplements taken, and since it was not corrected for in many previous studies. Nevertheless, since the results were not affected, we decided to keep it in the model.

Regarding the presence of outliers, an outlier was detected concerning grip strength, however, even though removing the participant increased the number of frail participants for the grip strength criterion, it did not affect the number of frail participants, hence, we kept the outlier. Three other outliers were observed about walking speed. Removing the participants led to a decrease in the number of frail participants by one participant, but since the number of frail participants was already small, we chose to keep them. Another outlier was observed for protein intake. The participant was a previous cancer patient who was underweight and adopted a vegetarian diet. The patient was therefore excluded from the analyses for it was altering the mean protein intake of the participants.

Chapter 3

Results

Among 112 participants having complete dietary data, 111 were included in the present study, and one was excluded for being an outlier. Among the 111 participants that were included in this study, 16 (14.4%) participants were identified as frail and 38 (34.2%) as non-robust (prefrail or frail). The most prevalent frailty criterion was low PA (n=40, 36.0%), followed by exhaustion (n=38, 34.2%). Twenty-two % (n=24) reported unintentional weight loss while 19.8% (n=22) and 17.3% (n=19) reported a slow walking speed and poor muscle strength, respectively.

The participants' sociodemographic and clinical characteristics by frailty status are presented in table 2. Compared to non-frail participants, frail participants were significantly older with a mean age of 80.94 ± 7.0, were more depressed, with a mean GDS score of 7.50 ± 2.9, and had lower cognitive performance, with 43.8% (n=7) of frail participants having a RUDAS score ≤ 22. Moreover, a higher percentage (56.3%, n=9) were taking at least 5 drugs per day compared to only 21.1% (n = 20) of non-frail participants(p=0.006). All other variables were not significantly different between frail and non-frail older adults (Table 2). Also, compared to robust participants, non-robust participants were significantly older with a mean age of 77.66 ± 8.2, were more depressed, with a mean GDS score of 6.03 ± 2.8, and had lower cognitive performance, with 31.6% (n=12) of them having a RUDAS score ≤ 22. Furthermore, a higher percentage (42.1%, n=16) of them were taking at least 5 drugs per day as compared to only 17.8% (n=13, p=0.006) of robust participants who did. All other variables were not significantly different between frail and non-frail older adults (Table 2).

Table 2. *Sociodemographic and Clinical Characteristics of Participants by Frailty Status*

Characteristics		Frailty					
	Total (N=111)	**Frail (N=16)**	**Non-Frail (N=95)**	**P-value**	**Robust (N=73)**	**Non-Robust (N=38)**	**P-value**
Gender				1.000			0.480
Male	40 (36.0)	6 (37.5)	34 (35.8)		28 (38.4)	12 (31.6)	
Female	71 (64.0)	10 (62.5)	61 (64.2)		45 (61.6)	26 (68.4)	
Age	74.82 ± 7.75	80.94 ± 6.96	73.79 ± 7.42	≤0.001*	73.34 ± 7.07	77.66 ± 8.29	0.005*
Educational Level				0.077			0.086
Complementary or less	76 (68.5)	14 (87.5)	62 (65.3)		46 (63.0)	30 (78.9)	
Secondary or more	35 (31.5)	2 (12.5)	33 (34.7)		27 (37.0)	8 (21.1)	
Marital Status				0.086			0.797
Married	60 (54.1)	5 (31.3)	55 (57.9)		41 (56.2)	19 (50.0)	
Single	15 (13.5)	4 (25.0)	11 (11.6)		9 (12.3)	6 (15.8)	
Widowed	36 (32.4)	7 (43.8)	29 (30.5)		23 (31.5)	13 (34.2)	
Children				0.133			0.649
Yes	93 (83.8)	11 (68.8)	82 (86.3)		62 (84.9)	31 (81.6)	
Income				0.832			0.779
<1million	44 (39.6)	7 (43.8)	37 (38.9)		30 (41.1)	14 (36.8)	
1-3million	42 (37.8)	5 (31.3)	37 (38.9)		28 (38.4)	14 (36.8)	
>3million	25 (22.5)	4 (25.0)	21 (22.1)		15 (20.5)	10 (26.3)	
Smoking				0.407			0.998
Never	56 (50.5)	10 (62.5)	46 (48.4)		37 (50.7)	19 (50.0)	
Past Smoker	26 (23.4)	4 (25.0)	22 (23.2)		19 (26.0)	10 (26.3)	
Current Smoker	29 (26.1)	2 (12.5)	27 (8.4)		17 (23.3)	9 (23.7)	
Weight	69.03 ± 12.90	66.49 ± 15.44	69.45 ± 12.47	0.397	68.34 ± 11.51	70.36 ± 15.30	0.477
BMI	26.04 ± 4.25	25.72 ± 5.79	26.09 ± 3.9	0.753	25.57 ± 3.60	26.92 ± 5.22	0.160
BMI Categories				0.272			0.272
≤23	24 (21.6)	5 (31.3)	19 (20.0)		15 (20.5)	9 (23.7)	

23-31	74 (66.7)	8 (50.0)	66 (69.5)		54 (74.0)	20 (52.6)	
≥31	13 (11.7)	3 (18.8)	10 (10.5)		4 (5.5)	9 (23.7)	
Number of Chronic Diseases	2.32 ± 2.00	2.97 ± 2.26	2.21 ± 1.94	0.180	2.27 ± 1.99	2.39 ± 2.02	0.764
Diabetes				0.768			0.472
Yes	31 (27.99)	5 (31.3)	26 (27.4)		22 (30.1)	9 (23.7)	
Cardiovascular Disease				0.126			0.572
Yes	37 (33.3)	8 (50.0)	29 (30.5)		23 (31.5)	14 (36.8)	
Hypertension				0.149			0.265
Yes	65 (58.6)	12 (75.0)	53 (55.8)		40 (54.8)	25 (65.8)	
Polypharmacy				0.006*			0.006*
Yes	29 (26.1)	9 (56.3)	20 (21.1)		13 (17.8)	16 (42.1)	
Intake of dietary supplements				0.151			0.676
Yes	73 (65.8)	8 (50.0)	65 (68.4)		49 (67.1)	24 (63.2)	
Number of dietary supplements	1.14 ± 1.13	1.25 ± 1.39	1.13 ± 1.09	0.739	1.12 ± 1.14	1.18 ± 1.14	0.790
GDS Score	5.00 ± 2.60	7.50 ± 2.85	4.58 ± 2.32	≤0.001*	4.47 ± 2.37	6.03 ± 2.76	0.002*
GDS Categories				≤0.001*			0.007*
≤7	91 (82.0)	8 (50.0)	83 (87.4)		65 (89.0)	26 (68.4)	
>7	20 (18.0)	8 (50.0)	12 (12.6)		8 (11.0)	12 (31.6)	
RUDAS Score				0.012*			0.014*
≤22	21 (18.9)	7 (43.8)	14 (14.7)		9 (12.3)	12 (31.6)	
>22	90 (81.1)	9 (56.3)	81 (85.3)		64 (87.7)	26 (68.4)	

Note: Continuous variables were reported as Mean ± Standard Deviation

Categorical variables were reported as N (%)

For categorical variables, either the Fisher exact test or Pearson Chi-square test was used depending on the sample size.

For continuous variables, we used the Mann Whitney test

*P-value ≤ 0.05

The dietary intake characteristics of participants by frailty status are presented in table 3. No significant differences were observed between frail and non-frail participants in terms of both total protein intake and intake by protein source. Similarly, no differences were found between robust and non-robust participants in terms of the aforementioned dietary characteristics. Moreover, there were no significant differences observed when protein intake was classified by animal or plant sources. Furthermore, no important differences were noted with regards to achieving neither the 1 g/kg BW nor the 0.8 g/kg BW protein intake. Regarding the other dietary intake characteristics, no significant differences prevailed between frail and non-frail participants or robust and non-robust, neither regarding their adherence to the Mediterranean diet (Table 3).

Table 3. *Dietary Characteristics of Participants by Frailty Status*

Characteristics	Frailty					
	Frail (N=16)	**Non-Frail (N=95)**	**P-value**	**Robust (N=73)**	**Non-Robust (N=38)**	**P-value**
Protein per Body Weight	0.65 ± 0.39	0.61 ± 0.26	0.554	0.61 ± 0.26	0.61 ± 0.37	0.921
Total Protein (g)	40.21 ± 18.60	40.33 ± 15.87	0.978	40.34 ± 15.27	40.26 ± 18.07	0.978
Animal Protein (g)	20.30 ± 17.18	18.17 ± 17.22	0.649	19.37 ± 15.11	16.76 ± 20.64	0.448
Plant Protein (g)	19.91 ± 8.46	22.16 ± 11.86	0.469	20.97 ± 10.59	23.50 ± 12.87	0.271
Total Protein (servings)	20.11 ± 8.89	20.60 ± 9.97	0.856	20.16 ± 10.04	21.22 ± 9.37	0.591
Protein Intake Cutoff 0.8			0.518			0.461
< 0.8	12 (75.0)	77 (81.1)		60 (82.2)	29 (76.3)	
≥ 0.8	4 (25.0)	18 (18.9)		13 (17.8)	9 (23.7)	
Protein Intake Cutoff 1			0.397			0.761
< 1	13 (81.3)	85 (89.5)		65 (89.0)	33 (86.8)	
≥ 1	3 (18.8)	10 (10.5)		8 (11.0)	5 (13.2)	
MeDi Score	4.63 ± 1.50	4.69 ± 1.69	0.877	4.67 ± 1.72	4.71 ± 1.54	0.906
MeDi Categories			0.510			0.128
Low Adherence = 0-3	5 (31.3)	21 (22.1)		14 (19.2)	12 (31.6)	
Medium Adherence = 4-5	5 (31.3)	44 (46.3)		37 (50.7)	12 (31.6)	
High Adherence = 6-9	6 (37.5)	30 (31.6)		22 (30.1)	14 (36.8)	

Note: Continuous variables were reported as Mean ± Standard Deviation

Categorical variables were reported as N (%)

For categorical variables, either the Fisher exact test or Pearson Chi-square test was used depending on the sample size.

For continuous variables, we used the Mann Whitney test

*P-value ≤ 0.05

The participants' sociodemographic and clinical characteristics by protein intake are presented in tables 4 and 5. Table 4 presents the participants' characteristics by protein intake as a dichotomous variable with cutoffs of either 0.8 g/kg BW or 1 g/kg BW. Only 19.8% (n=22) of the participants reached a protein intake of at least 0.8 g/kg BW. Compared to those with a protein intake lower than 0.8 g/kg BW, participants having 0.8 g of protein/kg BW or higher were mostly females (86.4%, p=0.015), and had an income between 1 and 3 million LBP (n=14, 63.4%), while most of the participants not reaching the intake of 0.8 g/kg BW had an income below 1 million LBP, (n= 40, 44.9%, p=0.017). Moreover, they had a significantly lower weight (57.44 ± 9.7 vs 71.89 ± 12.0 kg, ($p \leq 0.001$). Also, compared with participants who had a daily protein intake < 0.8 g/kg BW, participants reaching a daily protein intake ≥ 0.8 g/kg BW had a significantly lower mean BMI (23.24 ± 3.7, $p \leq 0.001$). In addition, only 2 (9.1%) out of the 22 participants reaching the 0.8 g/kg BW cutoff, had diabetes (p=0.033), and most of them took dietary supplements (n= 19, 86.4%, p=0.025) with an average number of 1.64 ± 1.3 supplement per day (p=0.022). Nevertheless, there were no significant differences were noted for all other characteristics.

Thirteen participants (11.7%) had an intake of at least 1g/kg BW with the majority being females (92.3 %, p=0.03). Compared to those having an intake <1g/kg BW, participants with an intake of ≥1 g/kg BW were older (mean age of 79.46 ± 7.4 vs 74.20 ± 7.6; p=0.021), most of them had an income between 1 and 3 million LBP (n= 9, 69.2%), had a significantly lower weight (54.21 ± 7.9 kg vs 70.99 ± 12.2 kg, ($p \leq 0.001$)). They also had a significantly lower BMI of 22.15 ± 3.8 kg/m^2 versus 26.55 ± 4.1 kg/m^2, ($p \leq 0.001$) and none of them were obese, (p=0.013). It is important to note that none of them had diabetes, (p=0.018) and all of them took dietary supplements daily,

(p=0.004). Nonetheless, no significant differences were noted for all other characteristics (Table 4).

Table 4. *Sociodemographic and Clinical Characteristics of Participants by Protein intake cutoff 0.8 g/kg BW and 1 g/kg BW*

Characteristics	Total (N=111)	Protein Intake Cutoff 0.8			Protein Intake Cutoff 1		
		< 0.8 (N=89)	≥ 0.8 (N=22)	P-value	< 1 (N=98)	≥ 1 (N=13)	P-value
Gender				0.015*			0.030*
Male	40 (36.0)	37 (41.6)	3 (13.6)		39 (39.8)	1 (7.7)	
Female	71 (64.0)	52 (58.4)	19 (86.4)		59 (60.2)	12 (92.3)	
Age	74.82 ± 7.75	74.30 ± 7.60	76.91± 8.18	0.159	74.20 ± 7.62	79.46 ± 7.38	0.021*
Educational Level				0.290			0.544
Complementary or less	76 (68.5)	63 (70.8)	13 (59.1)		68 (69.4)	8 (61.5)	
Secondary or more	35 (31.5)	26 (29.2)	9 (40.9)		30 (30.6)	5 (38.5)	
Marital Status				0.752			0.353
Married	60 (54.1)	49 (55.1)	11 (50.0)		55 (56.1)	5 (38.5)	
Single	15 (13.5)	11 (12.4)	4 (18.2)		12 (12.2)	3 (23.1)	
Widowed	36 (32.4)	29 (32.6)	7 (31.8)		31 (31.6)	5 (38.5)	
Children				0.192			0.220
Yes	93 (83.8)	77 (86.5)	16 (72.7)		84 (85.7)	9 (69.2)	
Income				0.017 *			0.013*
<1million	44 (39.6)	40 (44.9)	4 (18.2)		43 (43.9)	1 (7.7)	
1-3million	42 (37.8)	28 (31.5)	14 (63.4)		33 (33.7)	9 (69.2)	
>3million	25 (22.5)	21 (23.6)	4 (18.2)		22 (22.4)	3 (23.1)	
Smoking				0.499			0.076
Never	56 (50.5)	43 (48.3)	13 (59.1)		47 (48.0)	9 (69.2)	
Past Smoker	26 (23.4)	23 (25.8)	3 (13.6)		26 (26.5)	0 (0.0)	
Current Smoker	29 (26.1)	23 (25.8)	6 (27.3)		25 (25.5)	4 (30.8)	
Weight	69.03 ± 12.90	71.89 ± 11.98	57.44 ± 9.74	≤0.001*	70.99 ± 12.15	54.21 ± 7.94	≤0.001*

BMI	26.04 ± 4.25	26.73 ± 4.12	23.24 ± 3.66	≤0.001*	26.55 ± 4.05	22.15 ± 3.82	≤0.001*
BMI Categories				≤0.001*			0.013*
≤23	24 (21.6)	13 (14.6)	11 (50.0)		17 (17.3)	7 (53.8)	
23-31	74 (66.7)	63 (70.8)	11 (50.0)		68 (69.4)	6 (46.2)	
≥31	13 (11.7)	13 (14.6)	0 (0.0)		13 (13.3)	0 (0.0)	
Number of Chronic Diseases	2.32 ± 2.00	2.37 ± 2.04	2.09 ± 1.82	0.558	2.40 ± 2.05	1.69 ± 1.38	0.233
Diabetes				0.033*			0.018*
Yes	31 (27.9)	29 (32.6)	2 (9.1)		31 (31.6)	0 (0.0)	
Cardiovascular Disease				0.130			0.213
Yes	37 (33.3)	33 (37.1)	4 (18.2)		35 (35.7)	2 (15.4)	
Hypertension				0.810			0.379
Yes	65 (58.6)	53 (59.6)	12 (54.5)		59 (60.2)	6 (46.2)	
Polypharmacy				0.685			1.000
Yes	29 (26.1)	24 (27.0)	5 (22.7)		26 (26.5)	3 (23.1)	
Intake of dietary supplements				0.025*			0.004 *
Yes	73 (65.8)	54 (60.7)	19 (86.4)		60 (61.2)	13(100.0)	
Number of dietary supplements	1.14 ± 1.13	1.02 ± 1.08	1.64 ± 1.26	0.022*	1.08 ± 1.16	1.62 ± 0.77	0.111
GDS Score	5.00 ± 2.60	4.93 ± 2.56	5.27 ± 2.83	0.586	4.83 ± 2.55	6.31 ± 2.72	0.054
GDS Categories				1.000			0.247
≤7	91 (82.0)	73 (82.0)	18 (81.8)		82 (83.7)	9 (69.2)	
>7	20 (18.0)	16 (18.0)	4 (18.2)		16 (16.3)	4 (30.8)	
RUDAS Score				0.560			0.069
≤22	21 (18.9)	16 (18.0)	5 (22.7)		16 (16.3)	5 (38.5)	
>22	90 (81.1)	73 (82.0)	17 (77.3)		82 (83.7)	8 (61.5)	

Note: Continuous variables were reported as Mean ± Standard Deviation

Categorical variables were reported as N (%)

For categorical variables, either the Fisher exact test or Pearson Chi-square test was used depending on the sample size.

For continuous variables, either the Mann Whitney test or Pearson correlation were used depending on whether the protein variable is categorical or continuous

*P-value ≤ 0.05

Furthermore, in table 5, the participants' sociodemographic and clinical characteristics are presented by protein intake based on the source of protein, both animal or plant sources.

Males had more servings of protein per day (22.96 ± 11.3, p=0.049), and a higher plant protein intake (26.03 ± 12.8, p=0.003) compared to females. Compared with widowed participants, married participants had a higher plant protein intake (24.98 ± 12.8, p=0.001). Moreover, compared to participants with an income of < 1 million LBP, participants with an income between 1-3 million LBP had a higher mean total protein intake (47.55 ± 18.9, p≤0.001), and more servings of protein per day (22.94 ± 11.0, p≤0.001). Also, when compared to participants with an income of > 3 million LBP, participants with an income between 1-3 million LBP had a higher mean intake of grams of animal protein per day (22.06 ± 20.7, p=0.047). Moreover, compared to participants with an income between 1-3 million LBP and an income > 3 million LBP, participants with an income < 1 million LBP had a lower daily plant protein intake (15.4 ± 6.6, p≤0.001). Additionally, compared with participants who never smoked, participants who were smokers at the time had more servings of protein per day (24.35 ± 2.5, p=0.029), and a higher plant protein intake (26.93 ± 2.9, p=0.018). Nevertheless, no significant differences were noted for all other characteristics (Table 5).

Table 5. *Sociodemographic and Clinical Characteristics of Participants by Animal and Plant Protein Intake*

Characteristics	Protein Intake							
	Total (N=111)	Total Protein (g)	P-value	Animal Protein (g)	P-value	Plant Protein (g)	P-value	Total Protein (servings)	P-value
Gender			0.814		0.088		0.003*		0.049*
Male	40 (36.0)	40.80 ± 15.67		14.77 ± 19.04		26.03 ± 12.79		22.96 ± 11.31	
Female	71 (64.0)	40.04 ± 16.59		20.57 ± 15.76		19.48 ± 9.92		19.16 ± 8.60	
Age	74.82 ± 7.75								
Educational Level			0.198		0.280		0.114		1.141
Complementary or less	76 (68.5)	39.24 ± 14.63		37.41 ± 14.43		1.82 ± 1.24		4.08 ± 1.70	
Secondary or more	35 (31.5)	43.47 ± 18.63		40.91 ± 18.34		2.56 ± 2.56		4.69 ± 2.55	
Marital Status			0.086		0.350		0.002*		0.006
Married	60 (54.1)	43.37 ± 15.60		18.39 ± 19.19		24.98 ± 12.76 [h]		22.72 ± 10.69	
Single	15 (13.5)	34.99 ± 17.24		13.17 ± 13.87		21.82 ± 10.04 [h i]		21.83 ± 10.85	
Widowed	36 (32.4)	37.44 ± 16.10		20.84 ± 14.47		16.61 ± 7.11 [i]		16.32 ± 5.84	
Children			0.329		0.428		0.847		0.466
Yes	93 (83.8)	40.98 ± 15.94		19.05 ± 17.51		21.93 ± 11.79		20.83 ± 10.27	
Income			≤0.001*		0.052		≤0.001*		0.028*
<1million	44 (39.6)	34.37 ± 11.30 [a]		18.97 ± 10.95 [c d]		15.40 ± 6.58 [j]		17.54 ± 9.06 [f]	
1-3million	42 (37.8)	47.55 ± 18.88 [b]		22.06± 20.67 [c]		25.49 ± 12.48 [k]		22.94 ± 11.03 [g]	
>3million	25 (22.5)	38.62 ± 14.34 [a b]		11.60 ± 18.22 [d]		27.02 ± 11.29 [k]		21.73 ± 7.48 [f g]	
Smoking			0.790		0.439		0.018*		0.029*
Never	56 (50.5)	40.13 ± 2.27		19.94 ± 2.20		20.19 ± 1.21 [l]		18.44 ± 0.92 [o]	
Past Smoker	26 (23.4)	38.92 ± 2.68		19.23 ± 3.00		19.69 ± 1.82 [l m]		20.75± 1.87 [o p]	
Current Smoker	29 (26.1)	41.91 ± 3.19		14.98 ± 3.71		26.93 ± 2.86 [m]		24.35 ± 2.48 [p]	
Weight	69.03 ± 12.90								

BMI	26.04 ± 4.25							
BMI Categories			0.576		0.970		0.534	0.547
≤23	24 (21.6)	43.39 ± 17.88		19.25 ± 15.92		24.14 ± 10.10		21.31 ± 9.74
23-31	74 (66.7)	39.38 ± 15.88		18.26 ± 17.1		21.11 ± 11.46		19.86 ± 9.70
≥31	13 (11.7)	39.98 ± 15.33		18.26 ± 20.81		21.72 ± 13.76		22.85 ± 10.66
Number of Chronic Diseases	2.32 ± 2.00							
Diabetes			0.892		0.769		0.586	0.116
Yes	31 (27.9)	39.98 ± 11.82		19.10 ± 11.13		20.88 ± 11.04		23.57 ± 13.87
Cardiovascular Disease			0.810		0.888		0.606	0.895
Yes	37 (33.3)	39.84 ± 12.52		18.80 ± 14.98		21.04 ± 10.83		20.35 ± 9.15
Hypertension			0.490		0.317		0.603	0.647
Yes	65 (58.6)	39.42 ± 14.33		17.10 ± 15.12		22.31 ± 10.18		20.16 ± 10.24
Polypharmacy			0.302		0.284		0.884	0.254
Yes	29 (26.1)	42.99 ± 13.70		21.43 ± 14.08		21.57 ± 9.57		22.31 ± 9.33
Intake of dietary supplements			0.246		0.192		0.599	0.132
Yes	73 (65.8)	41.44 ± 18.20		20.02 ± 18.51		21.42 ± 10.38		19.35 ± 7.68
Number of dietary supplements	1.14 ± 1.13							
GDS Score	5.00 ± 2.60							
GDS Categories			0.691		0.771		0.316	0.653
≤7	91 (82.0)	40.60 ± 16.16		18.25 ± 17.94		22.35 ± 11.68		20.72 ± 9.87
>7	20 (18.0)	39.00 ± 16.74		19.50 ± 13.36		19.50 ± 10.16		19.63 ± 9.60
RUDAS Score			0.547		0.443		0.766	0.244
≤22	21 (18.9)	42.24 ± 20.69		21.08 ± 17.88		21.16 ± 8.94		22.77 ± 9.88
>22	90 (81.1)	39.86 ± 15.07		17.87 ± 17.03		21.99 ± 11.97		20.00 ± 9.74

Note: Continuous variables were reported as Mean ± Standard Deviation or Mean ± Standard Deviation and Median (minimum, maximum) when the sample size is small

Categorical variables were reported as N (%)

For categorical variables, either the Fisher exact test or Pearson Chi-square test was used depending on the sample size.

For continuous variables, either the Mann Whitney test or Pearson correlation were used depending on whether the protein variable is categorical or continuous

Mean ± Standard Deviation in a column followed by different letters are significantly different at P-value ≤ 0.05 based on protein intake using ANOVA test

*P-value ≤ 0.05

The dietary intake characteristics of participants by both cutoff points are presented in table 6. Compared to participants who had a daily protein intake < 0.8 g/kg BW, participants with an intake of ≥ 0.8 g/kg BW of protein/d were consuming more protein (1.10 ± 0.3, p ≤0.001. Additionally, compared to participants who had a daily protein intake < 1 g/kg/d, participants who ate ≥1 g/kg BW of protein/d had a higher average protein intake (1.26 ± 0.2), and a significantly higher average MeDi score (5.62 ± 1.1), reflective of a higher adherence to the Mediterranean diet. Nevertheless, no significant differences were noted for all other characteristics (Table 6).

Table 6. *Dietary Characteristics of Participants by Protein intake cutoff 0.8 g/kg BW and 1 g/kg BW*

Characteristics	Protein Intake						
	Total	Protein Intake Cutoff 0.8			Protein Intake Cutoff 1		
		< 0.8 (N=89)	≥ 0.8 (N=22)	P-value	< 1 (N=98)	≥ 1 (N=13)	P-value
Protein Continuous		0.49 ± 0.14	1.10 ± 0.25	≤0.001*	0.52 ± 0.18	1.26 ± 0.19	≤0.001*
MeDi Score	4.68 ± 1.66	4.65 ± 1.68	4.82 ± 1.59	0.675	4.56 ± 1.68	5.62 ± 1.12	0.030*
MeDi Categories				0.751			0.075
Low Adherence = 0-3	26 (23.4)	22 (24.7)	4 (18.2)		26 (26.5)	0 (0.00)	
Medium Adherence = 4-5	49 (44.1)	38 (42.7)	11 (50.0)		42 (42.9)	7 (53.8)	
High Adherence = 6-9	36 (32.4)	29 (32.6)	7 (31.8)		30 (30.6)	6 (42.2)	

Note: Continuous variables were reported as Mean ± Standard Deviation

Categorical variables were reported as N (%)

For categorical variables, either the Fisher exact test or Pearson Chi-square test was used depending on the sample size.

For continuous variables, we used the Mann Whitney test

*P-value ≤ 0.05

Associations between frailty (Frail vs. Non-Frail) and protein intake are presented in table 7. The present study showed no significant association between frailty and protein cutoff 1g/kg BW (OR = 1.74; 95% CI= 0.15 – 20.84) nor when protein intake was set at 0.8g/kg BW (OR = 0.86; 95% CI= 0.11 – 6.95) after adjusting for age, sex, education, BMI, number of chronic diseases, number of drugs, number of dietary supplements, depressive symptomatology, cognitive performance, and adherence to the Mediterranean diet. No significant association was found either between frailty and animal protein intake (OR= 1.00; 95% CI= 0.95 – 1.05) after adjusting for age, sex, education, BMI, number of chronic diseases, number of drugs, number of dietary supplements, depressive symptomatology, cognitive performance, adherence to the Mediterranean diet, and plant protein intake. Also, no significant association was found either between frailty and plant protein intake (OR= 0.97; 95% CI= 0.87 – 1.09) after adjusting for age, sex, education, BMI, number of chronic diseases, number of drugs, number of dietary supplements, depressive symptomatology, cognitive performance, adherence to the Mediterranean diet, and animal protein intake (Table 7).

Table 7. *Associations Between Protein Intake, set at 0.8 g/kg BW, Protein Intake, Set at 1 g/kg BW, Animal Protein Intake and Plant Protein Intake and Frailty Syndrome Among Community-Dwelling Lebanese Older Adults, N = 111 (2019-2020)* *

Protein Intake	Frail	OR (95% CI)	P-value
	n		
Protein Intake by Cutoff			
Protein Cutoff 0.8			
< 0.8 g/kg BW/d	12	Ref	
≥ 0.8 g/kg BW/d	4	0.864 (0.107 – 6.951)	0.891
Protein Cutoff 1			
< 1 g/kg BW/d	13	Ref	
≥ 1 g/kg BW/d	3	1.738 (0.145 – 20.843)	0.663
	Mean ± SD		
Protein Intake by Protein Source			
Animal Protein[a] (g/d)	20.30 ± 17.18	1.000 (0.949 – 1. 054)	0.995
Plant Protein[b] (g/d)	19.91 ± 8.46	0.974 (0.874 – 1.086)	0.639

Note: *Model adjusted for age, sex, education, BMI, number of chronic diseases, polypharmacy, number of dietary supplements, depressive symptomatology, cognitive performance, and adherence to the Mediterranean diet

[a] Animal protein intake adjusted for plant protein intake

[b] Plant protein intake adjusted for animal protein intake

Furthermore, we combined prefrail and frail participants in one group and compared them to those who are robust. The results are presented in Table 8.

The logistic regressions with this dichotomous variable also showed no significant associations with protein intake >1g/kg BW (OR = 0.72; 95% CI= 0.15 – 3.39) nor when protein intake was >0.8g/kg BW (OR = 1.60; 95% CI= 0.46 – 5.58), even after adjusting for age, sex, education, BMI, number of chronic diseases, number of drugs, number of dietary supplements, depressive symptomatology, cognitive performance, and adherence to the Mediterranean diet. No significant association was found either between frailty and animal protein intake (OR = 0.99; 95% CI= 0.96 – 1.02) after adjusting for age, sex, education, BMI, number of chronic diseases, number of drugs, number of dietary supplements, depressive symptomatology, cognitive performance, adherence to the Mediterranean diet, and plant protein intake. Nevertheless, plant protein intake was found to be significantly associated with 6.2% (95% CI= 0.6% - 12.1%) higher frailty prevalence, after adjusting for age, sex, education, BMI, number of chronic diseases, number of drugs, number of dietary supplements, depressive symptomatology, cognitive performance, adherence to the Mediterranean diet, and animal protein intake (Table 8).

Table 8. *Associations Between Protein Intake, set at 0.8 g/kg BW, Protein Intake, Set at 1 g/kg BW, Animal Protein Intake and Plant Protein Intake and Frailty Among Community-Dwelling Lebanese Older Adults, N = 111 (2019-2020) **

Protein Intake	Non-Robust [1] n	OR (95% CI)	P-value
Protein Intake by Cutoff			
Protein Cutoff 0.8			
< 0.8 g/kg BW/d	29	Ref	0.458
≥ 0.8 g/kg BW/d	9	1.603 (0.461 – 5.581)	
Protein Cutoff 1			
< 1 g/kg BW/d	33	Ref	0.679
≥ 1 g/kg BW/d	5	0.722 (0.154 – 3.387)	
	Mean ± SD		
Protein Intake by Protein Source			
Animal Protein[a] (g/d)	16.76 ± 20.64	0.990 (0.962 – 1.019)	0.488
Plant Protein[b] (g/d)	23.50 ± 12.87	1.062 (1.006 – 1.121)	0.030*

Note: *Models adjusted for age, sex, education, BMI, number of chronic diseases, polypharmacy, number of dietary supplements, depressive symptomatology, cognitive performance, and adherence to the Mediterranean diet

[1] Non-Robust: Frail + Pre-Frail

[a] Animal protein intake adjusted for plant protein intake

[b] Plant protein intake adjusted for animal protein intake

Chapter 4

Discussion

In the present cross-sectional analysis, the correlation between protein consumption and the prevalence of frailty and robustness among 111community-dwelling Lebanese older adults was evaluated. Sixteen (14.4%) participants were identified as frail. Twenty-two (19.8 %) of the participants had ingestion of ≥ 0.8 g/kg BW, and 13 (11.7%) had an intake of ≥ 1 g/kg BW of protein per day. This study has shown that a higher plant protein intake was significantly associated with a higher pre-frailty and frailty (robust vs. non-robust) prevalence, while no relationship between protein intake for the cutoffs of 1 g/kg BW, 0.8 g/kg BW, or animal protein and the prevalence of frailty was observed in neither frail nor non-robust participants.

The only study that tackled the prevalence of frailty in Lebanon, to our knowledge was a study conducted by Boulos et al. and had frailty as a secondary outcome. The main reported result was that frailty was a significant correlate of nutritional risk. Compared to our study, Boulos et al. found a higher frailty prevalence. The discrepancy in the results can be mainly attributed to the setting in which the studies were conducted. Boulos et al. assessed frailty in a rural setting where access to healthcare facilities is compromised, while our study was conducted in Beirut and Byblos, which are both urban areas. Additionally, we assessed frailty using Fried's Frailty Phenotype, while Boulos et al. adopted the SOF (Boulos et al., 2017).

Furthermore, the results of this study conform to various other studies where no connection between protein intake and frailty was observed (Shikany et al., 2014;

Hengeveld et al., 2019). A study of the Osteoporotic Fractures in Men cohort, Shikany et al. revealed that older men (n = 5, 900, 65+ years) with more energy from protein intake, also evaluated by FFQ were as probable to be frail as participants who had a low percentage of energy from protein after 4.6 years (Shikany et al., 2014). In the aforementioned study, frailty was also examined using the Fried's Frailty Phenotype, also labeled as the CHS frailty index, and dietary intake using an FFQ. Another study embedded in the Rotterdam population-based cohort, assessed the association between dietary energy intake, protein intake, and physical frailty in 2,504 participants above the age of 45, out of which 108 were classified as frail. Results showed that none of the total consumption of protein, nor that of plant protein, or animal protein were associated with frailty. In fact, neither a protein intake of 0.8 g/kg BW nor 1.2 g/kg BW were associated with a lower risk of frailty (OR= 1.34; 95% CI= 0.99-1.80 and OR = 1.04; 95% CI= 0.72 - 1.39; respectively) (Schoufour et al., 2018). Compared to our study, frailty was similarly diagnosed using Fried's Frailty Phenotype and dietary intake was determined with an FFQ. Additionally, a study examined potential links of diet quality with frailty incidence in community-dwelling older adults aged 70 to 81 (n = 2,154) living in the USA. After 4 years of follow-up, it was found that 277 (12.9%) participants developed frailty, assessed using Fried's Frailty Phenotype. Nevertheless, results showed no interdependence between protein consumption and frailty, whether when expressed in energy %, g/kg BW, g/d, or when using the cutoff value of 0.8g/kg BW/d (OR = 1.03; 95% CI= 0.77 – 1.37) (Hengeveld et al., 2019). Besides, the daily intake of protein cutoff of 0.8 g/kg BW was also used, and the chances of frailty among their participants were relatively similar to ours, being 12.9% and 14.4% respectively.

In contrast, several studies have shown a connection between protein intake and frailty. In a cross-sectional analysis of the InCHIANTI study among 802

participants, Bartali et al. (2006) observed that members in the lowest quintile of protein intake who had a mean protein intake of <66 g for men, and < 55 g women, had a notably higher threat of frailty (OR = 1.98; 95% CI= 1.18 – 3.31), which was assessed using only four of the five components of Fried's Frailty Phenotype (Bartali et al., 2006). Similar results were found in a prospective analysis of the non-experimental research of the Women's Health Initiative in a subgroup of 24,000 females whose ages ranged between 65- and 79-years old. Using Fried's Frailty Phenotype, frailty was defined and protein intake was first evaluated at baseline using an FFQ. Calibrated approximates of protein intake were rectified for computation error using regression calibration equations determined from unbiased measures of dietary protein (24-hour urinary nitrogen). Following an adjustment for potential confounders, a 20% rise in urinary nitrogen–calibrated total protein consumption (as % energy) was correlated with a statistically noteworthy 32% (95% CI=23-50%) lesser danger of frailty (Beasley et al., 2010). The difference between these outcomes and ours might be due to the different methodologies used in assessing protein intake (24-hour urinary nitrogen vs FFQ), in addition to the difference in sample size. Finally, a meta-analysis and systematic review conducted by Coelho-Júnior et al. (2018), assessing the relationship between the consumption of protein and the prevalence of frailty in older generations, included seven cross-sectional and three longitudinal studies. Altogether, the research explored a total of 50,284 older adults from three different continents between 2006 and 2018. Four cross-sectional studies were inserted in the meta-analyses, and the findings illustrated that an elevated protein consumption (participants in the highest tertile/ quartile/ quintile, or participants with a protein intake ≥ 1g/kg BW) was negatively associated with frailty status in older adults (OR = 0.67; 95% CI= 0.56 - 0.82) (Coelho-Júnior et al., 2018).

Total protein intake, in general, has been linked to frailty mainly for its role in bone and muscle metabolism. Moreover, low protein consumption has been related to imbalances in the growth hormone, hence leading to a reduced osteoblast activity (Morel et al., 1993). Lower protein intake was shown to reduce the amount of protein available to stimulate muscle protein synthesis (Schalk et al., 2005). Data highlighting that raising protein intake in older adults has possible benefits demonstrated that the latter are less responsive to low doses of amino acids when compared to their younger counterparts, which is termed as having low anabolic responsiveness to amino acids or anabolic resistance, suggesting that this insufficiency in sensitivity can be overcome by increasing the level of protein intake (Baum et al., 2016). Dietary protein affects muscle through the stimulation of muscle protein synthesis and/or suppression of protein breakdown by the absorption of amino acids ingested in the diet (Rasmussen et al., 2002).

Various studies demonstrated that the maximum level of stimulation of muscle protein synthesis can be reached with 15 g of essential amino acids (EAA), according to Wolfe (2002). This is represented by ~35 g of high-quality protein per meal intake ~15 g of EAA. A greater quantity of lower quality protein, which contains fewer amounts of EAA, would be needed to attain the same functional benefits. The inclusion of unnecessary amino acids to a supplement carrying EAA did not lead to further stimulation of muscle protein synthesis (Borsheim et al., 2002), suggesting that the amino acid profile quality of the protein, or its quality, is a key indicator of the functional potential of protein in muscle health (Baum et al., 2016). In other words, the quality of protein ingested, which is mainly defined by the source of protein, is of major importance with regards to muscle protein synthesis stimulation, particularly in the older adults whose protein synthesis is already compromised, and whose dietary

intake is relatively limited. For these reasons, the source of protein was investigated in our study, as we distinguished between the intake of plant and animal protein's relationship with the prevalence of frailty. Nevertheless, in the present study, no correlation was found between the prevalence of frailty and animal protein intake, while other studies observed such associations. A prospective Spanish cohort that included 1,822 community-dwelling older adults of which 48.7% were males with an average age of 68.7 years who were followed up for a mean duration of 3.5 years. With the help of a vindicated digitized face-to-face diet history, food consumption was evaluated, while frailty was assessed based on Fried's Frailty Phenotype. The researchers assessed the association between animal protein intake and the prevalence of frailty, with results showing that an increased intake of animal protein decreased the prevalence of frailty, with participants in the highest quartile of animal protein intake, compared to the lowest quartile, being the most protected from developing frailty (OR = 0.48; 95% CI= 0.26 − 0.87) (Sandoval-Insausti et al., 2016). Nevertheless, the lower intake of animal protein intake in our population as compared to the Spanish sample (41 vs 61 g, respectively) may partially describe the difference in the results (Sandoval-Insausti et al., 2016). Similarly, Isanejad et al. studied the relationships found between protein sources and frailty risk, with a 3-year follow up, using the 2012 Nordic nutrition protein recommendation for older adults' cutoff of ≥ 1.1 g/kg BW. Results showed that higher protein intake ≥ 1.1 g/kg BW was related to a decreased risk of frailty (OR = 0.09; 95% CI= 0.01 - 0.75) in comparison to protein intake < 1.1 g/kg BW. Also, participants in the higher tertile of animal protein intake, but not plant protein, had a decreased prevalence of frailty (OR = 0.18; 95% CI= 0.38—0.90). These results are different from ours because of several discrepancies, including the study

design, whereby the previously mentioned study was a longitudinal study with a much larger sample size, and their participants were all female, while we assessed both genders. Also, participants in the latter study had a much lower mean age compared to the current study and were Finnish, who have different dietary patterns than the Lebanese population (Isanejad et al., 2019).

In this study, we found a positive association between plant protein intake and frailty prevalence. The latter might be explained by the fact that plant proteins are incomplete proteins, and hence lack adequate amounts of EAAs necessary for protein synthesis and muscle mass preservation, especially in older adults since they are less responsive to low doses of amino acids when compared to their younger counterparts, which is termed as having low anabolic responsiveness to amino acids or anabolic resistance (Baum et al., 2016).

Nevertheless, these results are not in line with what has been observed in the literature, where other researchers either found no association or observed a positive association between plant protein intake and the prevalence of frailty.

A cross-sectional multicenter study that assessed the relationship between amino acid or protein intake and frailty had 2,108 older women who were either grandmothers or acquaintances of dietetic students from 85 different schools in 35 prefectures of Japan. Intakes of the total, animal, and plant protein and 8 selectively chosen amino acids were measured from an amino acid composition database and a validated self-administered diet history questionnaire, while frailty was identified based on Fried's Frailty Phenotype. Kobayashi and colleagues found that participants categorized to the third (OR = 0.64; 95% CI= 0.45 – 0.93), fourth (OR = 0.62; 95% CI= 0.43 – 0.90), and fifth (OR = 0.66; 95% CI= 0.46 – 0.96) quintiles of total protein

intake (> 69.8 g/d), had significantly lower ORs when compared to participants in the first quintile. Hence, superior total protein intake was significantly linked to a lower frailty prevalence in Japanese older women, regardless of the amino acid that composed the protein or the protein source. Although the highest quintile consumption of >54.8 g/d of animal protein (OR = 0.73; 95% CI= 0.50 – 1.06), > 33.9 g/d of plant protein (OR = 0.66; 95% CI= 0.45 – 0.95) protein, and >33.3 g/d of all selected amino acids (OR = 0.67 – 0.74; 95% CI= 0.46 – 1.08) was inversely linked to frailty, the relationship between total protein intake and frailty was more prominent than those of any individual amino acid. The authors concluded that although neither the protein sources nor the type of amino acids was particularly relevant in the prevention of frailty, the presence of plant-based amino acids supported the beneficial effects of total protein on the frailty criteria (Kobayashi et al., 2013). It is important to note that this study was conducted in Japan, where plant protein sources differ from the ones of Lebanese older adults tremendously. Also, plant protein intake was segregated by cutoffs, while in our study we considered the average intake.

Plant protein intake in specific has been linked to frailty for its role in preventing oxidative stress (Hernández et al., 2019), and detrimental chronic conditions such as cardiovascular diseases (Schoufour et al., 2019). Vegetable protein in particular was shown to have antioxidant effects that can improve muscle repair and muscle cell apoptosis (Miki et al., 2017) as well as anti-inflammatory effects that can reduce the risk of muscle deterioration (Schaap et al., 2006).

Therefore, current studies have been focusing more on protein distribution rather than bolus intake. It has been indicated that the timing of consumption of protein should also be thoroughly examined for older adults and that each meal should

comprise a minimum of 25-30 g of protein of high quality (Paddon-Jones & Rasmussen, 2009). The aforementioned requirement takes into consideration the probability of older adults to develop resistance to the positive consequences of dietary protein on protein synthesis (Paddon-Jones & Rasmussen, 2009), a process which supposedly takes place because of a defect in the S6K1 signaling pathway activation, ultimately developing an impeded ability of amino acids and insulin to initiate protein translation in older age (Guillet et al., 2004). Taking this hypothesis into account, measuring protein status through blood markers such as serum albumin, retinol-binding protein, prealbumin, transferrin, creatinine, and BUN levels, may constitute a higher predictor of the rates of protein deficiency than analyzing the data of dietary intake (Bharadwaj et al., 2016).

In the current study, no connection between the prevalence of frailty and protein consumption was observed. This can be justified by several factors. Firstly, we had a small sample size, although we aimed for a bigger sample, we were not able to reach the desired number of participants due to several obstacles related to the unsettling events that were taking place in Lebanon and then the COVID-19 pandemic. Thus, the main difference between our study and studies that did show an effect was the difference in sample size; all studies previously mentioned have considerably larger sample sizes compared to ours (Bartali et al., 2006; Beasley et al., 2010; Coelho-Júnior et al., 2018). Moreover, participants reaching the intake of 1 g/kg BW of protein per day had a relatively high mean age, and being 79.5 of age in itself is considered an independent risk factor for frailty (Woolford et al., 2020). Also, in this study, protein intake was calculated manually using the USDA food database, hence the numbers might not have been accurate and specific enough to reflect the exact protein intake of the participant (Hoffman & Flavo, 2004). Additionally, the protein intake of

participants was extracted from an FFQ which might not be the best way to calculate protein intake, because it was shown that using direct blood markers and nitrogen balance is considered to be more efficient methods, as previously discussed (Bharadwaj et al., 2016).Furthermore, the most prevalent frailty criterion in this study was low PA 36% (n = 40), which is not directly related to protein intake. Although protein intake and PA act closely in the preservation of muscle mass, however, it has been shown that they do not directly influence one another (Ten Haaf et al., 2018). Besides, the frailty criteria that are more related to protein intake such as walking speed (Kim & Park, 2020) and grip strength (Granic et al., 2018) were the least prevalent in this study, with a prevalence of 19.8% (n = 22) and 17.3% (n = 19), respectively. Moreover, in a comparison of these results to a study that did establish a correlation between the prevalence of frailty and protein intake, Rahi and colleagues found low PA (18.8%) to be the most prevalent frailty criterion among their participants as well, which was succeeded by low walking speed (18.1%), exhaustion (14.1%), unintentional weight loss (5.5%) and muscle weakness (5.2%), respectively (Rahi et al., 2016). Hence, the prevalence was shown to be more evenly distributed among different criteria in Rahi et al.'s study, unlike ours where low PA was shown to be distinctively more prevalent than the rest of the frailty criteria. Last but not least, income can be a major contributor to protein intake by contributing to purchasing power. In our study, 69% of participants reaching at least 1 g/kg BW/d of protein intake, had an income between 1 and 3 million LBP, whereby people with a lower income were shown to have a significantly lower protein intake. It is important to note that this is of concern because, on top of that, older adults, and Lebanese older adults in specific do not generate an income, and do not have access to post-retirement social security. The government does not provide them with any of the services and facilities

provided in developed countries, from medical care to monetary assistance. In contrast to the previously demonstrated results, individuals with a higher socioeconomic status in the sample of the study were shown to have a low protein intake, likely due to following certain nutritional trends. According to research published in the academic journal Appetite, those with lower socioeconomic status and less purchasing power consume more meat than those with a higher one. The authors speculated that this might be because they perceive meat as a symbol of power and status and not because they can afford it. Moreover, people who belong to a higher socioeconomic status have the means to choose whatever diet they want to follow they are more educated, health-oriented, and concerned about environmental healthy behaviors (Chan & Zlatevska, 2019), thus, shifting towards decreasing red meat and dairy intake. Even though this study might have given an insight into the link that was found in our results, it is important to point out that it was conducted in western populations and thus cannot be generalized to our Middle-Eastern one. Interestingly, older participants had a higher intake of protein. Moreover, people eating more protein had a lower average weight and a healthier BMI. None of the participants reaching an intake of 1 g/kg BW of protein per day had a BMI above 31, which shows that an increased protein intake also contributes to healthier body weight. Osteoarthritis, diabetes, and other chronic diseases can be prevented by maintaining a healthy body weight throughout the lifespan. These conditions are health consequences that are exacerbated in the presence of the frailty syndrome, and because of which frailty should be prevented. Hence, maintaining a healthy weight and preventing frailty are both of importance in preventing the onset of chronic diseases to which older adults are more prone (Rippe, 2018).

Moreover, none of the participants reaching an intake of 1 g/kg BW of protein had diabetes, which is a chronic disease that can further exacerbate the process of aging and stand in the way of healthy aging. Campbell & Rains determined that dietary protein acts as an insulin secretagogue, synergistically stimulating insulin secretion to reduce the blood glucose response to ingested carbohydrate, which gives it the ability to prevent or delay the onset of pre-diabetes and type 2 diabetes (Campbell & Rains, 2015).

Data also showed a moderate positive correlation between age and plant protein intake at the magnitude of 0.326, whereby plant protein intake was shown to have several beneficial effects on health as previously discussed.

Although the study presented did not show a relationship between total protein intake and the prevalence of frailty, analyzing each frailty criteria separately could provide insightful information about what could be a risk factor of frailty other than protein intake.

As previously discussed, low PA was shown to be the most prevalent frailty criterion in this study 36% (n=40). Out of 111 participants, 52.3% (n=58) reached adequate levels of PA through completing house chores, making it the most prevalent type of PA present in the study. Results also showed that PA was skewed by gender, where it was shown that females reached the PA level by just doing house chores; 91.4% (n=53) of the participants doing house chores were females. Studies have shown that to date, house chores are more commonly done by women in Lebanon. A population-based study examining the association between husbands' involvement in housework and the psychological health of their wives, was conducted in GB and included 1,652 married couples. The percentage of households where the wife only

exhibited household tasks was reported as follows: washing clothes (91.4%), cleaning the bathroom (90.3%), cleaning the kitchen (85.1%), ironing (84.6%), washing dishes (83.7%), preparing food (78.1%), and cleaning rooms (75.9%) (Khawaja & Habib, 2007). The aforementioned findings are of relevance because when put in the context of older adults, studies found a positive relationship between time devoted to housework activities, total housework, and health status among older-adult women and men. A study conducted by Adjei & Brand in 2018, examined the associations between housework activities, including house chores and health in 15,333 older men and 20,907 older women from Italy, UK, the Netherlands, France, Spain, Germany, and the USA who were participants in the Multinational Time Use Study (MTUS). Results showed that compared to those who spent between 1 and 3 h on total productive housework, older-adults who spent more than 3 to 6 h/d had an increased likelihood of reporting good health (OR = 1.25; 95% CI= 1.14–1.37 among men and OR = 1.10; 95% CI= 1.01–1.20 among women) (Adjei & Brand, 2018).

Walking speed is another frailty criterion that was prevalent in our sample, and 19.8% of the participants exhibited slowness. Studies have approved of walking speed as being a helpful method in detecting frailty, since lower extremity strength, especially of the quadriceps muscle, was shown to be critical for basic activities of daily living, when walking, bathing, and performing transfers, and older adults need these muscles for stability and preventing falls, thus they are essential in maintaining autonomy and good quality of life (Kostka et al., 2017). Studies have shown that individuals who exhibited slowness were also older with a mean age of 80.1 years old, as compared to participants with an adequate walking speed who had a mean age of 73.5 years. Meta-analyses further confirmed these findings and highlighted the

strength of the association between slower walking speed and increased mortality rates (Wagner et al., 2016).

Weak grip strength was also found to be prevalent among participants in this study, whereby 17.3% of the participants had a poor grip strength, which has been proven to hinder healthy aging in older adults. An association was found between having weaker grip strength and functional decline as assessed by self-reported difficulties performing activities of daily living (ADLs) (Wennie Huang et al., 2010). Moreover, different systematic reviews and studies assessing the risk for subsequent disability (by evaluating ADLs) demonstrated that older adults who perform badly physical capability tests were at higher risk of becoming functionally disabled (Gobbens et al., 2014).

The strengths of our study entail that the interviews were held face to face, which increased the response rate, heightened the chances of collecting accurate data, and allowed for the recruitment of more people since our population consists of older adults, most of whom are unable to read and have no access to modern means of technology and communication. Moreover, participants involved were community-dwelling older adults, hence, their food intake is representative of the food intake choice made by Lebanese older adults, contrarily to participants recruited from hospitals and nursing homes, whose food choices are limited by the institutions' offerings. Besides, most of the tools adopted have been validated to be used among the Lebanese population, except for Fried's Frailty Phenotype. Fried' Frailty Phenotype, although not validated in our population, is considered a robust tool that is widely published and shown to predict negative outcomes in frail older adults. Moreover, an intensive workshop was offered a few days before the onset of the interviewing

process, which could lower the interviewing bias. Nevertheless, the present study has several limitations. To begin with, due to the aforementioned events, we were unable to be on campus and had no access to the NutriPro software. Hence, we were not able to enter the 24-hour recall to estimate protein intake and study protein distribution, as well as total energy intake. We were also unable to study the prevalence of other macronutrients and micronutrients or assess their association with frailty prevalence. As such, there was no access to other important nutrients for bone and muscle health, such as vitamin D and calcium, to be able to assess and see if the population is deficient in these nutrients and whether they have a role to play in the association between protein and frailty prevalence. the small sample size and subsequently, a small number of frail participants as a result of an unexpected instability in the Lebanese political situation, which began with a revolution and exacerbated by the spread of Covid19, which prevented us from continuing data collection, as suggested by the LAU IRB committee. Reaching the sample size we had aimed for might have led to higher variability and better ability to conduct more extensive analysis such as the stratification of the age of participants to distinguish between the different age groups of older adults (youngest old: 65 - 74 years, middle old: 75-84 years and oldest-old: ≥ 85 years), the assessment of pre-frail participants independently instead of merging them with either robust or frail participants, the assessment of each chronic condition independently with regards to protein intake and frailty, instead of having to choose the most prevalently studied in the literature. Moreover, recall bias can be present since the FFQ is based on memory and the memory of older adults can be compromised even though we did exclude elderly people with cognitive impairment from the study to minimize this bias. Other biases that can be found in this study include selection bias since the recruitment was not randomized, and thus, not representative of the Lebanese

population. Also, this sample has been selected based on convenience. Moreover, the social desirability bias was present as some respondents tended to provide what they considered to be the more favored answer, especially with regards to behavioral aspects and health conditions. The participants in this study were informed that the trained individuals conducting the questionnaires were dietitians, hence they might have reported what they think is adequate or "healthy", fearing judgment. Furthermore, residual bias cannot be avoided despite that several confounders were corrected for. Furthermore, the cross-sectional nature of the present study does not allow us to establish a temporal association between protein intake and frailty. Also, the results cannot be generalizable as our participants are from either Beirut or Byblos, which do not represent all regions in Lebanon. Moreover, the FFQ implemented was semi-quantitative and only contained 61 items. Hence, we were unable to get a hold on fully detailed information regarding several food items. As such, the type of ice cream was not stated to analyze milk content, nuts and seeds were available as 1 variable, hence, we were not able to differentiate between them or between different types of each to estimate their protein content, and therefore had to take the average protein content of ice cream, and different nuts and seeds to include them in the plant protein variable. The use of an FFQ can also lead to under-reporting or over-reporting. Finally, weight and height were self-reported and this might have led to either under- or overreporting. Nevertheless, studies have reported a strong correlation between measured and self-reported weight and height (Olfert et al., 2018; Suemoto et al., 2015).

Despite all these limitations, this study is a pioneer and one of the first studies to look at the prevalence of frailty in community-dwelling older adults, let alone, one of the few studies in Lebanon that focus on older adults and looks at parameters that can positively influence and promote healthy aging in this age category.

Chapter 5

Conclusion

This study aimed at investigating the association between protein intake and frailty. The hypothesis predicted that the current protein recommendation for older adults of 0.8 g/kg BW should be substituted by a higher cutoff of 1 g/kg/BW that could contribute to the prevention of frailty in this age group. Research has demonstrated that the current recommendation is inadequate to ensure vitality and functionality, and preserve muscle mass in older adults, due to a manifested reduction in the functioning of the digestive systems in older adults such as a decrease in nutrient absorption, slower digestion, anabolic resistance and genetic changes in muscle regeneration and repair. Hence, the current protein recommendation of 0.8 g/kg BW is not enough to contribute to preventing frailty in older adults.

Nevertheless, this study found no relationship between total protein consumption and the chances of frailty, but only between plant protein intake and an increase in frailty prevalence. To date, there is no consensus as to what the recommendation cutoff of protein intake for older adults should be. Despite that, the current recommendation should certainly be revisited and reconsidered to further improve the quality of life of all people and promote healthy aging. Recommending an intake of 1 g/kg BW of protein for older adults is safer for the time being. Moreover, protein distribution and quality should be studied since current evidence shows that older generations tend to grow resistance to the benefits of protein intake on protein synthesis and can only process a limited amount of protein at a time. Hence, it is important to determine at what time intervals protein should be administered to be

continuously contributing to the pool of amino acids. The protein source should also be taken into consideration since protein ingestion from animal and plant sources was shown to be connected differently with frailty, and since older adults can generally consume limited amounts of food, and animal protein is of higher quality. Lebanese older adults have a higher consumption of plant protein when compared to animal protein, which could be contributing to them not reaching their protein requirements and hence to the development of frailty in this population. Concerning frailty, general healthy cutoffs for grip strength and walking speed should be developed for the Lebanese population to be used as a reference in future studies.

As we prepare for a new demographic reality, we hope this study sets grounds for other researchers in the field to investigate frailty further in the Lebanese population and to close gaps in our knowledge by replicating this study while using a longitudinal design, a larger and a randomized sample, considering protein distribution and timing, accounting for total energy intake, including other macro and micronutrients, as well as PA and diet quality, which are all essential factors for future studies on protein and frailty.

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Appendix

Table 9. *MeDi Food Groups Cutoffs*

Food Group	Food items	Cutoff
Whole Cereals and Grains:	Brown bread, Bulgur	**3**
Cereals and Grains:	White bread, Cereals, Rice, Pasta	**6**
Fruit:	Dried fruits, Citrus fruit, Orange fruit, Strawberry, Grapes, Other fruit, Fresh fruit juice	**2**
Vegetables:	Salad green, Dark green vegetables, Tomatoes, Starchy vegetables, Squash or eggplant, Cruciferous vegetables, Potato	**5**
Low Fat Milk and Dairy Products:	Milk low fat, Yogurt low fat, Cheese low fat	**2**
Protein-Rich Foods:	Nuts and seeds, Red meat, Poultry, Eggs, Legumes, Fish	**3**

Table 10. *Protein Content Calculations*

		ID #	1001	1002	1003	1004	1005	1006	1007	1008
		protein per bulk weight	0.70	0.45	0.55	0.47	1.61	0.38	0.45	0.85
		animal protein	43.63	18.78	32.17	2.15	65.34	14.05	8.64	24.20
		plant protein	14.14	11.08	13.26	23.34	20.21	11.48	23.52	24.18
		total servings per day	31.72	13.30	19.71	14.51	25.10	11.48	16.27	14.97
		total protein per day	57.78	29.87	45.43	21.19	85.55	25.53	32.16	48.37
pizza	10.5	Serving	0.03	0.03	0.03	0.03	0.07	0.03	0.07	0.00
burger	27.55	Serving	0.03	0.00	0.00	0.03	0.00	0.03	0.14	0.00
shawarma	17.16	Serving	0.03	0.00	0.00	0.00	0.03	0.00	0.03	0.00
Falafel	14	Serving	0.00	0.03	0.00	0.00	0.03	0.00	0.03	0.00
chips	1.81	Serving	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
french fries	2.12	Serving	0.14	0.00	0.00	0.07	0.14	0.07	0.29	0.00
manqeesh	6.87	Serving	0.07	0.02	0.03	1.00	0.07	0.03	0.07	0.03
wine	0.75	Serving	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Beer	1.66	Serving	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Hot chocolate	6.65	Serving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
coffee/Nescafeor	0.144	Serving	1.00	0.00	1.00	1.00	2.00	1.00	1.00	0.00
turkish coffee	0.068	Serving	15.00	5.00	0.00	0.07	3.00	1.00	1.00	1.00
Arabic sweets	5.18	Serving	0.07	0.03	0.00	0.00	0.07	0.03	0.14	0.00
chocolate bar	7	Serving	0.14	0.00	0.14	0.43	0.03	0.00	0.07	0.00
ice cream	5.18	Serving	0.04	0.01	0.03	0.00	0.03	0.02	0.15	0.00
Dessert	4.36	Serving	0.07	0.00	0.03	0.50	0.07	0.00	0.14	0.03
mayonaise	0.132	Serving	0.03	0.00	0.00	0.00	0.00	0.00	1.00	0.00
butter/ghee	0.2	Serving	0.00	1.00	1.00	0.00	0.03	0.00	0.00	0.00
olives	0.031	Serving	4.00	0.14	7.50	0.10	4.00	0.00	0.42	0.71
sausage	6.48	Serving	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
luncheon	4.72	Serving	0.07	0.00	0.00	0.00	0.29	0.07	0.00	0.00
organ	22.47	Serving	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00
eggs	6.28	Serving	0.29	0.03	0.14	0.21	1.00	0.14	0.29	3.50
fish	19.91	Serving	0.07	0.08	0.14	0.03	0.14	0.03	0.03	0.14
poultry	19.98	Serving	0.03	0.00	0.14	0.07	0.14	0.10	0.43	0.29
red meat	25.23	Serving	0.07	0.03	1.00	0.07	1.00	0.07	0.29	0.03
Nuts and seeds	22.64	Serving	0.00	0.03	0.14	0.14	0.14	0.03	0.14	0.14
beans	9.48	Serving	0.14	0.29	0.14	0.14	0.07	0.07	0.07	0.07
cruciferous	2.62	Serving	0.00	0.03	0.03	1.00		0.07	0.07	0.03
Squash	1.765	Serving	0.03	0.14	0.03	0.14		0.14	0.07	0.29
Potato	2.706	Serving	0.07	0.03	0.00	0.29		0.03	0.36	0.07
starchyvegetables	7.05	Serving	0.00	0.03	0.07	0.03		0.00	0.07	1.00
Tomato	1.08	Serving	1.00	0.03	1.00	1.00		1.00	0.57	1.00
Darkgreen	0.953	Serving	0.29	0.03	1.00	1.00		0.08	0.14	0.29
Salad green	0.866	Serving	0.29	0.03	1.00	1.00		1.00	0.57	0.29
Fresh juice	0.392	Serving	0.00	0.00	0.07	0.00	1.00	0.08	0.04	0.00
Driedfruits	0.617	Serving	0.00	0.03	0.00	0.14	0.00	0.00	0.14	0.14
Otherfruits	0.839	Serving	1.00	0.14	2.00	0.29	2.00	0.14	0.14	0.29
grapes	1.09	Serving	0.00	0.11	0.07	0.02	0.07	0.03	0.25	0.14
Strawberry	0.965	Serving	0.01	0.11	0.01	0.00	0.01	0.03	0.01	0.03
orangefruits	0.636	Serving	0.00	0.03	0.07	0.07	0.07	1.00	1.00	0.29
Citrusfruits	1.23	Serving	0.18	0.02	0.14	0.07	0.29	0.14	0.14	0.29
labneh	6.34	Serving	2.00	1.00	0.36	0.50	1.00	0.57	0.36	1.00
cheese low	7.13	Serving	1.71	2.50	0.36	0.07	2.00	2.00	0.71	1.29
cheese regular	6.66	Serving	0.10	0.00	0.71	0.29	0.00	0.13	0.00	0.00
yogurt whole	8.5	Serving	0.00	0.03	0.29	0.14	0.00	0.07	0.43	0.00
yogurt low	12.9	Serving	0.03	0.00	0.00	0.00	1.00	0.00	0.00	0.07
milk whole	7.69	Serving	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
milk low	8.05	Serving	1.00	0.00	0.00	1.00	1.00	0.00	0.29	0.00
Bulgur	4	Serving	0.05	0.14	0.03	0.00	0.03	0.03	0.03	0.03
Pasta	8.06	Serving	0.21	0.00	0.00	0.14	0.00	0.00	0.03	0.43
Rice	4.22	Serving	0.07	0.43	0.05	0.14	1.00	0.14	0.29	0.07
breakfastcereals	1.88	Serving	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Brown bread	2.94	Serving	2.00	0.03	0.43	3.00	0.03	0.03	0.57	2.00
White bread	2.73	Serving	0.00	1.00	0.43	0.29	3.00	2.00	4.00	0.00
		Weight	82	67	82	50	53	68	71	57

1009	1010	1011	1012	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025
1.19	0.55	0.89	1.18	0.49	0.82	0.44	0.59	0.48	0.80	0.53	0.36	0.24	0.56	0.26	0.38
35.66	17.15	31.96	49.05	15.79	33.93	19.69	6.49	20.50	31.32	31.10	12.22	1.50	19.76	9.90	8.83
26.44	21.31	11.63	24.27	19.76	19.52	15.68	34.20	18.66	13.32	13.53	18.54	13.37	9.52	8.65	17.79
20.00	19.70	28.64	14.16	11.73	15.60	15.61	23.78	15.62	22.43	22.25	12.22	13.23	11.99	6.12	13.89
62.10	38.45	43.60	73.31	35.55	53.45	35.37	40.68	39.17	44.64	44.64	30.75	14.86	29.28	18.54	26.62
0.08	0.00	0.05	0.43	0.00	0.00	0.07	0.03	0.07	0.07	0.07	0.13	0.07	0.00	0.00	0.00
0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00
0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.29	0.07	0.07	0.03	0.14	0.57	0.00	0.00	0.00	0.14	0.07	0.00	0.00	0.00
0.14	0.00	0.03	0.07	0.14	0.07	0.14	0.14	0.08	0.14	0.14	0.14	1.00	0.03	0.00	0.07
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.03	0.01	0.00	0.00	0.00
0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.08	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	0.03	1.00	0.50	0.00	1.00	0.00	1.00	0.07	0.07	0.07	0.29	0.00	1.00	0.14
3.00	1.00	6.00	0.00	0.00	3.00	4.00	7.50	0.00	3.50	3.50	1.00	4.00	3.50	0.00	3.00
0.03	0.00	1.00	0.03	0.00	0.03	0.03	0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.00	0.00
0.03	1.00	0.14	0.29	0.00	0.00	0.00	0.00	0.57	0.07	0.07	0.03	0.00	0.07	0.00	0.00
0.03	0.00	0.06	0.00	0.06	0.06	0.03	0.00	0.12	0.24	0.24	0.24	0.24	0.00	0.00	0.07
0.00	0.00	1.00	0.00	0.00	0.00	0.07	0.00	0.00	0.03	0.07	0.00	0.00	0.00	0.00	0.00
0.03	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.50	0.00	0.00	0.00	0.33	1.00	0.00	0.03	0.03	0.00	0.09	0.00	0.00	0.00
0.40	1.29	10.00	1.67	0.21	1.14	0.00	1.43	0.67	7.50	7.50	0.95	1.43	0.89	0.00	0.36
0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
0.07	0.00	0.00	0.29	0.00	0.10	0.57	0.07	0.00	0.14	0.14	0.14	0.00	0.00	0.03	0.00
0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
2.00	1.00	0.29	2.00	0.14	0.00	0.14	2.00	0.29	0.29	0.29	0.50	0.13	2.00	0.13	0.29
0.29	0.14	0.03	0.03	0.03	0.03	0.29	0.14	0.29	0.14	0.14	0.10	0.00	0.08	0.08	0.03
0.43	0.14	0.29	1.00	0.29	1.00	0.29	0.43	0.03	0.14	0.14	0.29	0.03	0.07	0.03	0.21
0.43	0.14	0.29	1.00	0.29	1.00	0.29	0.14	0.14	0.29	0.29	0.14	0.07	0.07	0.29	0.57
.43	.14	.00	.50	.07	.07	.00	.57	.29	.07	.07	.36	.14	.00	.00	.03
0.14	0.14	0.14	0.29	0.08	0.08	0.29	0.07	0.08	0.07	0.07	0.07	0.03	0.14	0.08	0.07
.03	.29	.14	.00	.07	.00	.14	.10	.07	.00	.00	.00	.07	.00	.00	.00
.03	.00	.14	.00	.05	.03	.07	.03	.00	.08	.08	.07	.07	.08	.03	.00
1.00	.14	.14	.00	.14	.14	.07	.08	.07	.07	.07	.21	.07	.64	.10	1.00
.03	.03	.07	.00	.03	.00	.03	.07	.00	.07	.07	.00	.03	.00	.03	.03
2.00	2.50	1.00	.14	.43	.29	.43	1.00	2.00	.43	.43	.29	.14	.64	.43	.43
.07	.10	.29	.07	.03	.07	.03	.07	1.00	.03	.03	.14	.00	.14	.03	.00
.57	2.50	1.00	.07	.43	.43	.43	1.00	2.00	.43	.43	2.00	.29	.36	.43	.14
.03	.00	.03	.00	.00	.43	1.00	.07	.50	.07	.00	.50	.14	.00	.00	.00
.43	.00	.00	.00	.00	.03	.00	.00	.10	.00	.00	.00	.00	.03	.03	.00
1.00	.12	.29	1.00	.29	1.00	.29	.36	.43	1.00	1.00	.57	.29	.43	.14	.57
.29	.04	.10	.04	1.00	.50	.11	.02	.11	.25	.25	.04	.02	.16	.02	.00
.00	.00	.03	.04	.00	.00	.00	.00	.11	.01	.01	.00	.00	.00	.00	.00
.07	.50	.07	.00	.07	.07	.14	.02	.11	.25	.25	.01	.11	.00	.11	.57
.29	2.00	.29	.00	.00	1.00	1.00	.21	.29	.57	.43	.57	.57	.14	.03	2.50
0.71	0.29	1.00	0.10	1.00	0.29	1.00	0.71	0.13	1.00	1.00	0.57	0.57	0.21	0.50	0.29
0.57	0.00	2.00	0.30	0.17	0.17	0.50	0.10	1.29	1.00	1.00	1.00	0.00	0.12	0.07	0.08
0.57	1.50	0.43	0.00	0.64	0.08	0.08	0.86	1.29	1.00	1.00	0.29	0.50	0.00	0.00	0.30
0.11	0.07	0.14	0.00	0.05	0.00	0.00	0.14	0.00	1.00	1.00	0.10	0.00	1.00	0.08	0.00
0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.03
0.03	0.14	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00
1.00	1.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00
.07	.07	.07	.07	.29	.14	.43	.43	.14	.13	.13	.00	.10	.00	.00	.07
.03	.00	.14	.14	.07	.03	.14	.07	.13	.03	.03	.14	.11	.07	.00	.03
.14	.36	.36	.02	.07	.07	.05	.29	.13	.14	.14	.14	.07	.36	.07	.01
.00	.00	.00	.00	.00	.00	.00	.00	.29	.00	.00	.00	.00	.00	.00	.00
2.00	.00	.03	2.50	4.00	4.00	.00	4.00	.57	.00	2.00	1.14	.00	.71	2.00	.00
.00	2.00	.36	.00	.00	.00	2.00	.00	.00	2.00	.00	.00	2.00	.00	.00	3.00
52	70	49	62	73	65	80	69	82	56	85	85	62	52	71	70

1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	104
0.16	0.60	0.61	0.42	0.60	0.56	0.74	0.53	1.19	0.40	0.43	1.00	0.57	0.66	0.60	0.63
1.92	12.81	2.14	2.27	29.73	13.58	10.80	3.07	16.43	-1.66	15.78	35.22	20.10	32.98	16.82	32.9
8.51	15.89	37.91	25.08	14.44	26.44	36.05	36.79	37.30	28.07	11.90	24.67	26.92	14.34	21.27	12.0
9.58	15.98	26.42	11.97	15.52	29.22	20.23	35.06	26.61	31.04	13.97	25.05	22.76	18.29	16.13	20.2
10.43	28.70	40.05	27.36	44.17	40.02	46.85	39.86	53.73	26.41	27.68	59.90	47.02	47.32	38.09	44.9
0.00	0.05	0.05	0.00	0.00	0.00	0.14	0.00	0.03	0.13	0.03	0.17	0.10	0.20	0.03	0.05
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.03	0.03	0.07	0.00	0.07	0.00	0.00	0.07	0.03	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.03	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.14	0.00	0.00	0.00	0.00	0.05	0.00	0.00
0.14	0.14	0.14	0.14	0.00	0.03	0.36	0.03	0.57	0.03	0.07	0.00	0.07	0.14	0.03	0.00
0.03	0.03	0.29	0.14	0.03	0.03	0.21	0.00	0.29	0.29	0.00	0.29	0.21	0.13	0.29	0.00
0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.29	0.01	0.29	0.00	0.00	0.00	0.05	0.00	0.02
0.25	0.00	0.00	0.00	0.00	0.14	0.07	0.29	0.03	0.29	0.00	0.00	0.50	0.00	0.00	0.02
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.36	0.00	1.00	1.00	0.00	0.00	0.14	0.07	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.06
2.00	6.00	0.00	1.00	3.00	8.00	3.00	8.00	6.00	7.50	4.50	10.00	3.00	2.50	2.00	2.00
0.00	0.00	0.00	0.14	0.00	0.00	0.03	0.00	0.03	0.00	0.02	0.13	0.71	0.08	0.36	0.00
0.07	0.00	0.00	0.57	0.03	0.03	1.00	0.00	0.36	0.00	0.03	1.00	0.36	0.14	0.21	0.00
0.42	0.00	0.00	0.00	0.01	0.00	0.15	0.00	0.27	0.06	0.06	0.00	0.15	0.15	0.00	0.02
0.00	0.07	0.07	0.00	0.07	0.29	0.07	0.00	0.07	0.00	0.00	0.00	0.07	0.08	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.07	0.07	0.00	0.03	0.00	0.00	0.03	0.00	0.00
0.03	0.14	0.14	0.00	0.00	0.00	0.43	0.29	0.43	0.00	0.00	0.43	0.07	0.33	0.07	0.00
0.10	2.14	4.29	0.00	2.00	9.00	0.00	10.71	2.86	8.57	0.00	0.00	1.00	0.36	2.50	5.00
0.00	0.00	0.00	0.00	0.03	0.03	0.10	0.00	0.07	0.03	0.00	0.00	0.00	0.00	0.03	0.00
0.00	0.00	0.00	0.00	0.00	0.00	1.71	0.00	0.13	0.43	0.03	0.71	0.00	0.00	0.00	0.00
0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.07	0.03	0.50	0.29	1.00	0.36	0.43	0.07	0.57	0.29	0.00	0.29	0.13	2.00	0.21	1.00
0.00	0.03	0.03	0.07	0.07	0.07	0.07	0.12	0.07	0.10	0.03	0.43	0.07	0.03	0.07	0.14
0.08	0.36	0.36	0.29	0.14	0.14	0.14	0.14	0.29	0.08	0.07	0.43	0.29	0.14	0.07	0.03
0.08	0.36	0.36	0.29	0.36	0.36	0.43	0.57	0.43	0.43	0.07	0.43	0.50	0.43	0.57	0.36
03	07	07	36	07	29	64	50	64	00	03	29	03	05	29	00
0.07	0.14	0.14	0.14	0.14	0.29	0.21	0.14	0.14	0.07	0.00	0.29	0.14	0.14	0.14	0.03
00	00	00	00	05	05	14	29	14	14	00	07	08	00	07	29
03	03	03	03	03	03	14	00	03	07	00	14	08	03	07	36
03	07	07	03	14	14	29	21	36	03	14	29	10	00	14	07
03	00	00	07	03	03	00	08	07	00	00	29	03	10	00	00
07	43	43	43	43	57	57	3.00	1.00	36	14	1.00	1.00	1.00	43	29
00	07	07	00	03	03	08	07	07	14	03	14	07	14	14	08
10	43	43	43	14	29	57	29	1.00	50	29	1.00	1.00	29	43	2.00
36	00	00	03	00	00	00	00	00	1.00	00	14	02	04	00	1.00
00	00	00	00	07	00	00	00	00	00	00	00	00	00	05	00
03	03	4.00	29	43	14	29	1.00	57	29	1.29	29	1.29	2.00	29	79
11	01	00	00	01	09	09	33	25	07	11	25	32	25	11	11
01	01	00	14	00	00	09	19	07	00	32	00	32	25	02	11
57	01	50	07	07	07	09	19	14	07	32	11	32	25	14	39
3.57	29	2.00	29	1.14	1.00	29	1.00	57	29	43	43	1.29	2.00	29	79
0.00	0.43	0.43	1.00	2.00	2.00	0.43	1.71	1.00	0.29	1.00	1.00	1.00	1.00	0.07	0.79
0.30	0.43	0.43	0.43	0.86	0.86	1.50	0.00	2.50	0.50	0.00	0.30	2.50	0.57	1.75	2.36
0.30	0.43	0.43	0.00	0.29	0.07	0.29	0.00	0.86	0.29	2.50	1.07	0.07	0.00	0.20	0.15
0.00	0.20	0.29	0.07	0.29	0.29	0.21	0.29	0.00	0.00	0.10	1.00	0.07	0.07	0.07	0.14
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
0.09	0.00	1.00	0.00	0.00	0.00	0.07	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.03
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.03
00	29	29	03	29	29	07	29	07	29	08	29	07	03	14	00
00	07	03	07	03	03	14	14	14	00	13	14	07	07	05	05
07	20	57	14	14	14	14	29	14	00	07	14	43	14	29	09
00	00	00	00	07	00	00	00	00	00	00	00	00	00	00	00
13	00	8.00	4.00	2.00	00	07	00	00	14	00	00	2.57	1.00	10	1.50
00	3.00	00	00	00	4.00	4.00	4.00	4.00	8.00	2.00	2.00	2.57	00	3.00	00
66	48	66	65	74	72	63	75	45	66	64	60	82	72	63	71

1042	1043	1044	1045	1046	1047	1048	1049	1050	2001	2002	2003	2004	2005	2006	2007	2008
0.57	0.34	0.67	0.65	0.69	0.65	0.83	0.83	0.60	0.56	0.28	0.48	0.34	0.20	0.50	0.59	1.19
28.25	20.54	14.01	29.30	7.78	15.29	30.69	32.00	22.38	10.07	-	-	-	-7.86	15.54	11.04	43.86
11.74	6.40	24.01	11.80	32.71	27.85	19.32	30.35	23.49	20.79	42.30	44.05	44.05	24.25	16.69	29.33	17.78
11.47	10.39	16.96	12.17	38.70	43.78	17.42	18.70	19.68	17.63	15.73	27.27	26.77	18.79	27.64	22.49	17.22
39.99	26.94	38.02	41.11	40.49	43.14	50.02	62.34	45.86	30.86	21.51	27.11	23.94	16.40	32.24	40.37	61.64
0.00	0.00	0.00	0.13	0.07	0.05	0.07	0.00	0.21	0.03	0.07	0.29	0.29	0.29	0.07	0.07	0.00
0.00	0.00	0.00	0.00	0.07	0.03	0.00	0.00	0.03	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.00	0.00	0.00	0.03	0.01	0.01	0.07	0.00	0.00	0.03
0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00
0.08	0.00	0.20	0.00	0.00	0.29	0.07	0.29	0.07	0.14	0.14	0.00	0.00	0.29	0.14	0.10	0.14
0.14	0.00	0.03	0.03	0.03	0.07	0.14	0.07	0.10	0.07	0.14	0.00	0.00	0.14	0.07	0.10	0.14
0.01	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.01	0.03	0.03	0.03	0.03
0.01	0.00	0.05	0.02	0.25	0.07	0.00	0.01	0.07	0.00	0.00	0.01	0.01	0.57	0.00	0.07	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.36	0.00	0.07	0.03	0.00	0.64	1.00	0.00	0.21	0.00	0.14	0.29	0.29	0.14	0.00	0.41	1.00
0.50	4.00	4.50	2.50	15.00	15.00	3.50	4.00	3.50	3.00	2.00	0.00	0.00	1.00	3.00	3.00	0.14
0.29	0.00	0.00	0.00	0.00	0.07	0.03	0.03	0.00	0.29	0.00	0.00	0.00	0.00	2.50	0.13	0.12
0.29	0.00	0.00	0.03	0.00	0.00	0.14	0.00	0.00	0.00	0.43	0.03	0.03	0.14	0.07	0.07	0.00
0.21	0.00	0.03	0.00	0.00	0.06	0.02	0.01	0.03	0.11	0.07	0.41	0.41	0.00	0.14	0.11	0.00
0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.14	0.14	0.14	0.00	0.05	0.03	0.00
0.08	0.00	0.00	0.00	0.03	0.00	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.03	0.00	0.14	0.05	0.14	0.14	0.07	0.43	0.07	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.29
0.08	1.39	1.63	0.45	10.00	12.50	1.07	0.00	2.89	3.00	0.36	10.00	10.00	7.00	10.00	5.50	1.07
0.00	0.00	0.07	0.00	0.14	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
0.00	0.00	0.00	0.00	0.43	0.29	0.13	0.12	0.00	0.43	0.29	0.14	0.14	0.47	0.29	0.13	0.17
0.03	0.00	0.00	0.03	0.07	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.07	0.29	0.05	0.13	0.03	0.43	0.14	0.13	2.00	0.29	0.14	0.29	0.29	0.29	0.57	0.50	0.43
0.07	0.14	0.05	0.14	0.00	0.13	0.14	0.00	0.07	0.21	0.14	0.14	0.14	0.03	0.03	0.03	0.36
0.21	0.29	0.29	0.14	0.14	0.14	0.29	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.07	0.29
0.21	0.29	0.36	0.36	0.43	0.43	0.29	0.29	0.57	0.43	0.14	0.14	0.14	0.07	0.29	0.36	0.29
00	00	36	07	64	14	14	64	29	00	1.00	1.00	1.00	50	00	29	07
0.12	0.14	0.14	0.14	0.10	0.10	0.08	0.10	0.14	0.29	0.14	0.29	0.29	0.07	0.14	0.50	0.14
03	07	15	03	14	29	00	00	03	14	14	03	03	14	1.00	1.00	14
03	03	03	14	07	07	07	03	07	03	14	29	29	00	03	03	08
50	00	07	07	43	43	14	03	14	43	14	14	14	29	03	14	29
08	03	00	00	07	03	43	03	07	03	00	03	03	00	03	03	00
43	36	43	50	1.00	1.00	43	43	50	1.00	57	1.00	1.00	50	29	43	1.00
07	07	07	07	43	29	05	03	08	29	29	14	14	29	14	14	14
43	36	43	79	1.00	1.00	43	43	64	1.00	57	1.00	1.00	1.00	2.00	1.00	1.00
00	03	03	00	14	00	07	00	25	36	00	00	00	00	00	47	14
03	00	05	00	00	00	00	00	00	00	1.00	2.00	2.00	00	00	00	00
79	57	43	57	1.00	2.00	43	14	2.00	57	1.57	2.00	2.00	2.00	1.30	1.00	43
04	04	07	14	00	02	18	01	01	00	25	25	25	14	05	07	25
00	04	03	14	01	02	01	00	01	00	00	03	03	00	00	00	10
04	04	11	14	04	14	02	01	07	07	37	49	49	1.00	50	25	13
14	13	43	57	1.00	57	43	03	14	29	74	2.00	2.00	03	49	00	99
0.64	1.00	0.57	0.50	1.00	1.00	0.10	0.57	0.43	0.14	0.43	1.50	1.00	0.00	1.50	2.00	0.36
2.25	0.07	2.29	1.50	1.29	1.29	4.00	6.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.12	0.86	0.29	0.07	0.12	0.71	0.64	0.43	0.29	0.29	0.86	0.86	1.14	2.00
0.21	0.14	0.03	0.09	0.00	0.14	0.00	0.00	0.07	0.14	0.36	0.14	0.14	0.00	0.00	0.07	1.50
0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.21	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
0.00	0.00	0.00	1.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	14	12	04	29	14	14	03	36	14	14	03	03	07	07	03	07
07	00	03	03	14	14	07	03	07	29	43	13	13	07	17	29	07
11	10	12	43	14	14	10	29	36	86	43	43	43	10	64	43	21
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
86	00	1.71	1.00	00	4.00	2.50	00	2.50	1.00	1.00	2.00	2.00	1.00	1.00	2.00	00
57	64	1.71	03	2.00	00	00	4.00	00	1.00	1.00	00	00	00	00	47	2.50
70	80	57	63	59	66	60	75	77	55	78	56	70	80	64	69	52

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
0.77	1.65	0.93	0.31	0.90	0.53	1.32	1.28	0.46	0.46	0.42	0.66	0.29	0.31	0.38	0.43
63.41	59.56	23.18	10.26	29.20	33.70	21.06	21.31	23.15	11.60	15.81	31.92	-1.71	1.53	17.46	9.35
17.48	34.68	53.36	11.71	16.64	13.05	38.44	37.75	7.04	24.04	16.22	16.41	17.98	19.27	21.39	24.94
27.94	47.03	74.32	9.28	19.02	18.33	33.44	27.51	10.32	44.26	15.07	30.33	17.55	32.70	21.73	22.68
80.88	94.23	76.54	21.96	45.84	46.75	59.51	59.06	30.19	35.64	32.03	48.32	16.27	20.80	38.84	34.30
0.00	0.20	0.43	0.00	0.13	0.00	0.05	0.05	0.00	0.07	0.07	0.07	0.20	0.03	0.00	0.00
0.00	0.00	1.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.00	0.00	0.03	0.00	0.00	0.00
0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.14	0.03
0.00	0.08	0.00	0.00	0.03	0.00	0.03	0.03	0.00	0.03	0.00	0.03	0.03	0.03	0.00	0.03
0.07	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.43	0.00	0.14	0.03	0.00	0.00	0.03
0.07	0.16	0.14	0.07	0.03	0.03	0.14	0.14	0.03	0.29	0.03	0.21	0.03	0.43	0.00	0.03
0.14	0.07	0.14	0.07	0.07	0.03	0.07	0.07	0.03	0.03	0.14	0.14	0.14	0.03	0.14	0.29
0.03	0.03	0.00	0.00	0.14	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.14	0.00	1.23	0.00	0.00	0.00	0.43	0.43	0.00	0.14	0.00	0.21	0.00	0.03	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.43	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
1.00	1.00	1.00	2.00	1.00	0.14	1.00	1.00	1.00	0.00	3.00	0.43	0.00	1.00	1.00	1.00
1.00	2.00	0.00	0.00	3.50	2.00	0.29	2.50	0.00	2.00	0.00	0.07	5.00	1.00	0.00	0.00
0.00	0.10	0.14	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.00	0.03	0.03	0.00	0.00
0.14	2.00	1.50	0.07	0.03	0.00	0.29	0.29	0.14	0.00	0.29	0.00	0.10	0.00	0.03	0.14
0.06	0.07	1.00	0.07	0.05	0.41	1.00	1.00	0.00	0.29	0.16	0.14	0.14	0.00	0.03	0.00
0.00	0.14	0.07	0.03	0.00	0.03	0.03	0.03	0.29	0.29	0.03	0.29	0.29	0.29	0.03	0.14
0.07	0.00	0.00	0.14	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
0.00	0.03	0.29	0.00	0.00	0.00	0.36	0.29	0.27	0.03	0.00	0.07	0.07	0.07	0.14	0.03
10.00	15.00	40.00	0.00	4.00	1.43	12.50	5.00	0.67	25.00	0.00	15.00	0.33	20.00	7.00	5.00
0.07	0.00	0.13	0.00	0.03	0.07	0.03	0.03	0.00	0.03	0.00	0.57	0.07	0.00	0.00	0.00
0.57	0.00	5.00	0.00	0.43	0.00	0.86	0.86	0.07	0.86	0.07	0.29	0.10	0.29	0.00	0.00
0.03	0.00	0.07	0.00	0.03	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.03	0.00	0.00
0.10	0.57	1.21	0.13	0.57	0.36	0.36	0.29	0.57	0.43	0.29	0.86	0.29	0.13	0.14	0.14
0.07	0.00	0.03	0.00	0.14	0.03	0.14	0.14	0.03	0.13	0.00	0.07	0.14	0.14	0.14	0.14
0.14	0.00	0.07	0.37	0.14	0.07	0.29	0.29	0.07	0.07	0.00	0.07	0.10	0.43	0.14	0.14
1.00	0.00	0.57	0.19	0.80	0.03	0.43	0.43	0.37	0.57	0.00	0.37	0.02	0.02	0.14	0.14
.00	.56	1.19	.00	.03	.03	1.00	1.00	.02	.07	.00	.03	.07	.03	.07	.03
0.14	0.21	0.14	0.00	0.14	0.14	0.07	0.07	0.03	0.07	0.14	0.07	0.07	0.29	0.43	0.29
.07	.43	.14	.00	.14	.03	.07	.07	.00	.14	.14	.00	.00	.14	.07	.14
.07	.07	.07	.00	.00	.07	.03	.03	.07	.14	.14	.14	.03	.14	.03	.14
.29	.71	.29	.25	.29	.14	.29	.29	.07	.29	.14	1.00	.43	.43	.29	.29
.00	.05	.03	.03	.00	.00	.00	.00	.00	.03	.07	.03	.03	.03	.03	.14
1.00	1.00	3.50	.11	.14	.29	.57	.57	.43	3.00	.29	1.00	1.00	1.00	.43	1.00
.14	.29	.43	.14	.00	.00	.07	.07	.08	.10	.14	.03	.07	.14	.29	.14
1.00	2.00	3.00	.51	.43	.29	1.00	1.00	2.00	2.00	.00	1.00	2.00	2.00	3.00	6.00
.00	.00	.49	.07	.00	.07	.14	.14	.20	.00	.14	1.00	.14	1.00	.00	.00
.00	2.00	1.00	.00	.14	.00	.00	.00	.00	.00	.00	.00	.74	.00	.00	.00
.14	1.50	1.00	1.00	1.50	3.50	1.50	1.50	.84	2.00	1.57	1.43	1.03	.00	1.00	1.00
.00	.25	.25	.00	.10	.14	1.00	1.00	.07	.01	.14	.02	.03	.09	.00	.00
.00	.00	.25	.00	.00	.00	1.00	1.00	.02	.02	.00	.00	.00	.03	.43	.10
.00	.37	.37	.00	.00	.87	.00	.00	.13	.02	.03	.00	1.00	.25	.00	.00
.00	.74	.00	.26	.49	.49	1.50	1.00	.07	1.73	.14	.13	.49	.00	.49	.00
2.50	5.36	1.80	0.30	0.29	2.00	0.64	0.64	1.14	0.43	1.00	3.00	0.43	0.29	1.29	1.29
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	6.00	0.00	0.56	0.14	4.00	3.00	3.00	0.29	0.56	2.00	0.36	0.03	0.14	1.00	0.29
0.36	1.50	1.50	0.14	0.14	0.07	0.14	0.14	0.43	0.03	0.14	0.07	0.02	0.07	0.00	0.43
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00
0.43	0.25	0.13	0.29	0.00	0.00	1.00	1.00	0.14	0.29	1.00	0.43	0.50	0.00	0.00	1.00
0.43	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
.14	.00	.03	.00	.07	.03	.21	.21	.00	.10	.29	.03	1.00	.03	.10	.10
.29	.21	.07	.13	.14	.07	.03	.03	.07	.03	.00	.29	.03	.07	.13	.13
.21	.54	.11	.86	.43	.43	.43	.43	.20	.43	.43	.21	.21	.43	.43	.86
.00	1.00	3.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.50	.00	.00	2.25	.00	.86	.86	.43	2.00	.00	.00	.00	.03	2.00	2.00
3.00	.00	1.50	1.50	.00	1.00	.00	.00	.00	.00	3.00	1.00	1.00	2.00	.00	.00
105	57	82	71	51	89	45	46	66	76.8	77	73.5	57	67	102	79

2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	3001	3002
0.43	0.26	0.66	0.50	0.44	0.48	1.25	0.58	0.25	1.36	1.18	1.01	0.71	0.47	0.24
28.66	4.00	4.69	6.55	17.19	-0.55	58.54	30.98	-1.57	41.46	41.54	35.85	24.87	25.95	11.90
15.64	12.00	34.04	39.24	16.03	41.50	32.45	12.68	18.91	27.46	28.08	14.69	21.27	17.92	5.55
17.16	15.54	20.95	29.32	19.42	40.73	26.88	11.38	20.46	36.30	20.77	17.46	16.59	17.31	8.59
44.30	16.00	38.74	45.80	33.23	40.95	90.99	43.66	17.34	68.91	69.62	50.53	46.15	43.87	17.45
0.07	0.03	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.14	0.29	0.07	0.23	0.00
0.00	0.00	0.00	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.03
0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.14	0.00	0.00	0.00	0.00
0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.03	0.03	0.00
0.03	0.00	0.29	0.07	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.05
0.14	0.00	0.00	0.14	0.29	0.14	0.00	0.14	0.00	0.43	0.14	0.14	0.14	0.57	0.03
0.14	0.29	0.43	0.03	0.10	0.03	0.29	0.14	0.03	0.29	0.14	0.29	0.03	0.36	0.03
0.03	0.00	0.03	0.07	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.03	0.00	0.03	0.14	0.00	0.00	0.00	0.00	0.03	0.00	0.14	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	0.43	0.00	0.00	0.00	0.29	1.00	0.03	0.00	1.00	1.00	0.43	1.00	0.03
0.00	1.00	0.00	3.00	6.00	0.43	5.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	2.50
0.00	0.00	0.03	0.03	0.07	0.03	0.03	0.07	0.00	0.07	0.00	0.00	0.43	0.03	0.00
0.03	0.14	0.29	0.03	0.00	1.00	0.00	0.00	0.29	0.00	0.14	1.00	0.00	0.03	0.03
0.03	1.00	0.00	0.43	0.00	0.05	0.00	0.00	0.00	0.43	0.03	0.29	0.57	0.14	0.15
0.03	0.03	0.10	2.00	0.10	0.00	0.03	0.03	0.03	0.29	0.03	0.14	0.00	0.00	0.10
0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.29	0.14	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.14	0.00	0.00	0.00
5.00	5.00	5.00	10.00	0.00	20.00	0.00	0.00	5.00	7.50	5.00	3.00	2.00	3.00	0.00
0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.29	0.86	0.00	0.00	0.00	0.86	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.03	0.00	0.00	0.14	0.00	0.00	0.00	0.00
0.29	0.43	0.43	0.71	1.07	0.29	0.00	1.00	0.43	0.10	0.00	0.29	0.14	0.14	0.03
0.00	0.03	0.00	0.29	0.00	0.00	0.00	0.29	0.00	0.03	1.00	0.03	0.07	0.14	0.00
0.14	0.00	0.14	0.43	0.29	0.29	0.29	0.14	0.29	0.00	0.14	0.29	0.71	0.29	0.03
0.18	0.03	0.14	0.14	0.43	0.29	1.50	0.00	0.00	0.29	0.29	0.43	0.14	0.57	0.36
00	03	43	1.00	03	1.00	00	24	00	00	03	02	14	00	00
0.43	0.14	0.43	0.14	0.10	0.14	0.14	0.14	0.03	0.14	1.00	0.43	0.14	0.14	0.05
07	00	00	14	03	03	14	00	1.00	03	10	00	00	03	03
07	00	43	14	07	03	14	00	16	14	10	00	14	07	00
20	29	57	14	53	50	1.57	00	53	14	43	43	07	57	03
00	00	03	00	00	00	03	00	00	14	00	00	29	14	07
29	43	00	29	1.00	1.50	14	43	1.00	1.00	1.00	1.00	1.00	1.00	08
14	03	29	14	00	03	14	07	00	29	43	13	1.00	05	05
29	43	1.00	71	1.00	7.58	00	57	1.00	1.00	1.00	43	29	1.00	36
17	00	00	07	07	00	00	00	00	14	00	00	00	57	00
00	00	14	00	03	1.00	00	14	00	00	00	00	03	01	00
1.00	1.00	57	1.00	29	43	2.00	1.00	1.22	4.00	1.00	1.00	00	1.00	3.00
00	00	14	03	25	25	14	14	62	25	00	00	57	25	07
00	03	14	00	13	00	00	00	00	00	00	25	43	00	07
00	25	00	99	62	00	00	00	99	3.00	00	00	43	18	04
1.48	49	14	1.00	4.00	00	00	43	2.00	3.00	49	1.48	1.00	50	00
1.29	1.29	0.71	0.14	0.00	0.50	2.00	0.29	0.21	2.00	1.28	1.28	1.00	1.00	0.29
0.00	0.00	0.71	0.00	0.00	1.00	0.00	0.00	0.00	2.00	1.00	0.00	0.00	0.00	0.00
0.29	0.14	0.57	3.00	0.96	2.00	4.00	2.00	0.43	2.00	0.00	0.43	1.00	0.57	0.75
0.00	0.00	0.00	0.14	0.14	0.00	0.14	0.57	0.43	0.14	0.00	1.00	0.43	1.00	0.03
0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.29	0.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.10	1.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00
10	14	29	03	07	07	29	00	07	00	03	03	14	03	00
13	13	00	29	00	07	14	00	00	29	07	07	00	00	00
43	43	86	21	43	10	50	03	21	86	86	14	43	50	12
14	00	1.00	00	14	14	00	00	29	00	00	00	00	14	00
00	1.00	00	2.00	14	00	00	57	00	1.00	00	1.00	1.00	00	13
1.00	00	3.00	00	14	1.50	7.00	43	2.00	1.00	2.00	00	1.00	2.00	03
102	62	59	92	75	86	73	75	70	50.7	59	50	65	94	74

3003	3004	3005	3006	3007	3008	3009	3010	3011	3012	3013	3014	3015	3016	3017
0.65	0.32	0.28	0.50	0.41	0.86	0.32	0.78	0.50	0.59	0.32	0.43	0.62	0.70	0.55
32.43	10.70	4.87	1.45	-36.92	7.72	-26.75	21.11	35.29	17.02	10.86	23.98	28.34	22.41	32.13
10.18	12.05	14.99	33.99	72.66	43.91	50.51	23.22	7.97	9.63	12.63	17.76	17.96	16.68	19.80
13.57	10.14	14.76	20.34	31.64	21.83	24.78	19.83	10.60	10.52	9.53	16.45	18.12	23.24	25.03
42.61	22.74	19.86	35.44	35.74	51.63	23.76	44.33	43.26	26.65	23.50	41.74	46.30	39.09	51.92
0.00	0.00	0.07	0.10	0.43	0.03	0.10	0.07	0.03	0.07	0.08	0.00	0.00	0.08	0.20
0.03	0.03	0.03	0.00	0.00	0.29	0.03	0.00	0.03	0.00	0.07	0.03	0.03	0.00	0.07
0.03	0.03	0.03	0.00	0.14	0.03	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.07
0.00	0.03	0.03	0.03	0.14	0.03	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.07
0.00	0.00	0.00	0.00	0.03	0.07	0.43	0.00	0.00	0.00	0.29	0.07	0.07	0.00	0.00
0.00	0.00	0.14	0.07	1.00	0.14	0.57	0.14	0.14	0.00	0.07	0.00	0.00	0.14	0.29
0.29	0.03	0.29	0.43	0.29	0.29	0.43	0.14	0.14	0.14	0.03	0.14	0.14	0.03	0.29
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0.00	0.00	0.03	0.00	1.00	1.50	1.00	0.03	0.00	1.00	0.00	0.00	0.00	1.00
0.00	2.50	1.00	6.00	6.00	1.00	1.50	0.00	1.00	1.00	0.00	2.50	2.00	3.00	1.00
0.03	0.07	0.14	0.13	0.03	0.03	0.14	0.20	0.03	0.03	0.00	0.00	0.00	0.14	0.10
0.00	0.00	0.57	0.00	0.43	0.00	2.00	0.14	0.14	0.00	0.14	0.03	1.00	0.00	0.43
0.03	0.27	0.08	0.00	0.14	0.00	0.42	0.00	0.15	0.00	0.06	0.00	0.00	0.14	0.00
0.00	0.00	0.36	0.00	0.03	0.00	0.43	0.14	0.03	0.00	0.29	0.03	0.00	1.00	0.57
0.03	0.00	0.00	0.00	0.36	0.03	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
0.50	0.03	0.14	0.00	0.03	0.29	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
2.86	0.00	5.00	0.20	6.50	2.50	6.50	4.71	1.29	4.29	0.03	2.29	2.36	9.00	8.00
0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.07	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.03	0.00	0.14	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.03	0.00	0.03
0.29	0.57	0.03	0.86	0.00	0.43	0.29	0.14	0.14	0.14	0.08	0.14	0.14	0.29	0.43
0.07	0.00	0.03	0.14	0.03	0.03	0.03	0.07	0.05	0.07	0.05	0.07	0.43	0.57	0.03
0.14	0.43	0.07	0.43	0.14	0.43	0.21	0.43	0.50	0.43	0.14	0.50	0.43	0.14	0.43
0.64	0.00	0.50	0.29	0.43	0.50	0.29	0.29	0.43	0.29	0.14	0.50	0.43	0.00	0.43
.03	.00	.05	.00	2.00	1.00	1.50	.07	.00	.00	.07	.00	.00	.29	.14
0.13	0.00	0.03	0.57	0.07	0.29	0.29	0.43	0.03	0.43	0.14	0.14	0.14	0.07	0.07
.12	.00	.03	.10	.00	.29	.03	.57	.03	.13	.03	.08	.08	.03	.07
.05	.03	.03	.10	.00	.07	.03	.07	.03	.07	.03	.07	.07	.07	.07
.21	.43	.43	.43	.36	.43	.14	.10	.29	.10	.14	.43	.43	.00	.14
.03	.03	.14	.10	.00	.03	.00	.29	.00	.03	.03	.07	.07	.03	.07
.71	.00	.57	.50	.14	2.00	1.00	1.00	.14	.43	.10	.57	.57	1.00	.57
.07	.50	.57	.10	.43	.64	.07	1.00	.03	.71	.29	.29	.29	.03	.14
.50	.29	.00	.43	.14	.14	.08	1.00	.36	.57	.29	1.43	1.43	1.00	1.00
.50	.00	.00	.07	.14	.03	.03	.29	.03	.03	.14	.00	.00	.00	.29
.00	.00	.00	.00	.00	.14	.03	.00	.00	.00	.00	.00	.00	.00	.03
.57	.57	.64	.29	.14	2.00	2.00	1.00	1.00	.14	1.00	1.50	2.50	1.00	1.00
.18	.14	.16	.04	.01	.25	.25	.18	.04	.04	.50	.04	.11	.07	.11
.14	.02	.16	.04	.01	.25	.00	.11	.04	.02	.01	.04	.04	.04	.11
.18	.00	.16	.04	.25	.11	.25	.05	.11	.02	.07	.11	.11	.04	.25
.50	.07	.50	.29	.50	.50	.50	.29	.00	.07	.50	.21	.07	.50	.50
0.50	1.00	0.29	0.29	1.14	1.00	0.57	0.86	0.50	0.20	0.57	0.50	0.50	1.00	1.00
0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.07	0.00	0.14	0.43	0.43	2.00	0.07	0.71	1.50	0.33	0.43	1.14	1.25	0.71	2.00
0.93	0.50	0.14	0.03	0.14	0.29	0.36	0.43	0.43	0.10	0.43	0.43	0.43	0.43	0.57
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.08	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.03	0.43	0.05	0.03	1.00	0.43
0.00	0.00	0.00	0.13	0.00	0.29	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00
.03	.07	.29	.07	.14	.03	.14	.14	.14	.14	.03	.07	.07	.03	.07
.07	.07	.00	.03	.00	.14	.07	.03	.03	.03	.00	.03	.03	.07	.07
.36	.43	.86	.57	.29	.50	.43	.29	.29	.29	.43	.71	.79	.29	.71
.00	.00	.00	.00	.00	.29	.29	.00	.00	.00	.07	.00	.00	.00	.03
.57	2.00	.00	7.00	.00	.00	.00	.43	.29	.14	.14	2.00	.00	.86	.00
.00	.00	1.00	.00	4.00	2.00	1.14	2.00	.71	.00	1.14	.14	2.00	.14	2.00
.66	.71	.72	.71	.87	.60	.75	.57	.87	.45	.74	.98	.75	.56	.95

3018	3019	3020	3021	3022	3023	3024	3025
0.83	0.65	0.59	0.42	0.41	0.44	0.34	0.41
40.04	22.81	24.96	15.96	14.41	19.74	14.12	4.09
9.60	26.13	13.27	17.43	9.92	9.28	10.49	23.98
13.71	31.11	13.43	16.34	8.69	11.08	9.77	18.53
49.64	48.94	38.23	33.39	24.33	29.01	24.61	28.07
0.10	0.07	0.17	0.20	0.07	0.20	0.07	0.86
0.03	0.03	0.03	0.07	0.00	0.07	0.00	0.00
0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
0.14	0.14	0.00	0.14	0.07	0.07	0.00	0.03
0.29	0.29	0.03	0.14	0.03	0.08	0.08	0.10
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0.00	1.00	1.00	0.43	1.00	0.00	1.00
0.00	8.00	0.00	2.00	1.00	0.00	1.00	3.00
0.10	0.12	0.03	0.03	0.00	0.07	0.07	0.07
0.43	1.00	0.57	0.29	0.14	0.29	0.29	0.43
0.03	0.03	0.00	0.00	0.03	0.00	0.00	0.00
0.29	0.29	0.03	0.14	0.00	0.00	0.03	0.07
0.07	0.07	0.03	0.03	0.00	0.05	0.03	0.03
0.07	0.07	0.03	0.00	0.00	0.08	0.00	0.00
1.29	6.50	2.00	1.71	1.29	2.86	2.29	3.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
0.00	0.00	0.13	0.00	0.00	0.00	0.57	0.03
0.03	0.07	0.00	0.03	0.00	0.00	0.00	0.00
0.14	0.29	0.14	0.14	0.03	0.07	0.29	0.57
0.14	0.29	0.03	0.07	0.03	0.03	0.03	0.00
0.29	0.29	0.43	0.43	0.29	0.57	0.29	0.29
0.43	0.43	0.29	0.29	0.29	0.29	0.29	0.29
00	43	00	14	07	03	07	29
0.07	0.03	0.14	0.07	0.14	0.07	0.14	0.14
07	07	10	07	03	07	03	03
07	07	07	07	03	07	05	07
07	07	29	29	14	14	14	29
00	00	07	03	03	00	03	03
29	1.00	29	71	29	43	29	64
07	14	10	10	10	14	07	14
43	1.00	64	71	29	64	43	43
43	43	00	14	03	07	10	00
00	07	00	00	00	03	07	00
1.00	2.50	71	2.00	1.00	43	50	1.00
07	25	07	02	04	04	01	11
07	25	04	04	04	04	00	04
04	04	07	11	04	04	01	04
50	50	50	50	07	29	21	50
1.00	1.00	0.71	0.50	0.29	0.57	0.43	0.64
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	1.00	1.43	1.50	0.86	0.43	0.29	0.50
0.03	0.29	0.10	0.10	0.07	0.00	0.07	0.29
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1.00	0.00	0.00	0.14	0.29	0.00	0.00
1.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00
14	36	14	03	07	07	14	14
03	03	00	03	03	00	03	03
49	29	43	57	29	57	43	86
00	36	00	07	07	29	03	00
00	00	00	00	71	00	57	00
1.00	2.00	2.00	1.79	14	64	29	2.50
60	75	65	80	60	66	72	68

Table 11. *Protein Intake by Place of Residence*

Protein Intake	Residence			p-value
	Jbeil (N=76)	Beirut (N=35)	Total (N=111)	
	N (%)			
<1	33 (33.7)	65 (66.3)	98 (100.0)	0.222
≥1	2 (15.4)	11 (84.6)	13 (100.0)	
<0.8	31 (34.8)	58 (65.2)	89 (100.0)	0.200
≥0.8	4 (18.2)	18 (81.8)	22 (100.0)	

Table 12. *Dietary Habits of All Participants*

Dietary habits	**Frequency- N (%)**			
	0 times	**1-3 times**	**4-6 times**	**7 times**
Consumption of breakfast per week	6 (5.4)	11 (9.9)	10 (9.0)	84 (75.7)
Consumption of snacks per day	31 (27.9)	76 (68.5)	4 (3.6)	NA
Meals consumptions while watching TV per week	40 (36.0)	22 (19.8)	9 (8.1)	40 (36.0)
Eating outside per week	73 (65.8)	31 (27.9)	5 (4.5)	2 (1.8)

LAU
اللجنة اللبنانية الأميركية
Lebanese American University

Institutional Review Board (IRB)

لجنة الأخلاقيات

NOTICE OF IRB APPROVAL

To:	Dr. Berna El Rahi Assistant Professor School of Arts and Sciences	**APPROVAL ISSUED:** 23 July 2019 **EXPIRATION DATE:** 23 July 2020 **REVIEW TYPE:** EXPEDITED – Initial
Date:	July 23, 2019	
RE:	***IRB #:*** *LAU.SAS.BR4.23/Jul/2019* ***Protocol Title:*** *Associating Between Dietary Patterns and Micronutrient Intake, and Frailty and Cognitive Decline in Community-Dwelling Lebanese Older Adults*	

The above referenced research project has been approved by the Lebanese American University, Institutional Review Board (LAU IRB). This approval is limited to the activities described in the Approved Research Protocol and all submitted documents listed on page 2 of this letter. **Enclosed with this letter are the stamped approved documents that must be used.**

APPROVAL CONDITIONS FOR ALL LAU APPROVED HUMAN RESEARCH PROTOCOLS

LAU RESEARCH POLICIES & PROCEDURES: *All individuals engaged in the research project must adhere to the approved protocol and all applicable LAU IRB Research Policies & Procedures. PARTICIPANTS must NOT be involved in any research related activity prior to IRB approval date or after the expiration date.*

PROTOCOL EXPIRATION: *The LAU IRB approval expiry date is listed above. The IRB Office will send an email at least 45 days prior to protocol approval expiry - Request for Continuing Review - in order to avoid any temporary hold on the initial protocol approval. It is your responsibility to apply for continuing review and receive continuing approval for the duration of the research project. Failure to send Request for Continuation before the expiry date will result in suspension of the approval of this research project on the expiration date.*

MODIFICATIONS AND AMENDMENTS: *All protocol modifications must be approved by the IRB prior to implementation.*

NOTIFICATION OF PROJECT COMPLETION: *A notification of research project closure and a summary of findings must be sent to the IRB office upon completion. Study files must be retained for a period of 3 years from the date of notification of project completion.*

IN THE EVENT OF NON-COMPLIANCE WITH ABOVE CONDITIONS, THE PRINCIPAL INVESTIGATOR SHOULD MEET WITH THE IRB ADMINISTRATORS IN ORDER TO RESOLVE SUCH CONDITIONS. IRB APPROVAL CANNOT BE GRANTED UNTIL NON-COMPLIANT ISSUES HAVE BEEN RESOLVED.

If you have any questions concerning this information, please contact the IRB office by email at irb@lau.edu.lb

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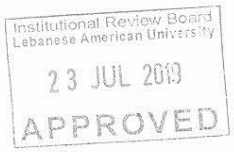
The IRB operates in compliance with the national regulations pertaining to research under the Lebanese Minister of Public Health's Decision No.141 dated 27/1/2016 under LAU IRB Authorization reference 2016/3708, the international guidelines for Good Clinical Practice, the US Office of Human Research Protection (45CFR46) and the Food and Drug Administration (21CFR56). LAU IRB U.S. Identifier as an international institution: FWA00014723 and IRB Registration # IRB00006954 LAUIRB#1



Dr. Joseph Stephan
Chair, Institutional Review Board

DOCUMENTS SUBMITTED:

LAU IRB Initial Protocol Application	Received 27 June 2019
Research Proposal submission form	Received 2 July 2019
Research Protocol	Received 27 June 2019
Letter to companies	Received 2 July 2019
Flyer Educational Material	Received 2 July 2019
Informed Consent Form	Received 2 July 2019, updated 23 Jul 2019
Survey	Received 2 July 2019
IRB Comments sent: 16 July 2019 18 July 2019	**PI response to IRB's comments dated:** 16 July 2019 19 & 23 July 2019
CITI Training – Berna Rahi & CV	Cert.# 30878363 Dated (23 April 2019)
NIH Training – Alexandra Daccache	Cert.# 2911649 Dated (11 September 2018)
CITI Training – Tracy Daou	Cert.# 31004116 Dated (22 March 2019)
NIH Training – Mariam Kanso	Cert.# 2926878 Dated (13 September 2018)