Frailty Status and Rehabilitation Outcomes among Older Adults:

A Systematic Review

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Thesis Abstract

Background: Frailty has an impact on outcomes in the acute care and in the community setting but there is minimal research that examines frailty in the geriatric rehabilitation setting.

Purpose: The purpose of this thesis was to answer the question "What is the association between frailty status and rehabilitation outcomes among older adults?"

Methods: A systematic review using the Cochrane Handbook's guidelines and adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guideline was completed. Four databases were searched as well as grey literature. Screening, extraction, and quality assessments were completed by two reviewers. Data synthesis was completed through vote counting.

Results: Twelve studies met the inclusion criteria from which data were extracted. There is a negative association between frailty and discharge functional status, functional change, discharge to home, and a positive association between frailty and length of stay.

Conclusion: Further research is needed on this topic to replicate these findings through meta-analyses. Frailty needs to be addressed in the geriatric rehabilitation setting to improve the functional status of frail patients and reduce extended stays in rehabilitation and decrease discharges to a new place of residence.

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List of Abbreviations

ADL: Activities of Daily Living

AMSTAR: A MeaSurement Tool to Assess Systematic Reviews

AUC: Area Under the Curve

BI: Barthel Index

BPOMA: Balance Performance Oriented Mobility Assessment

CDSR: Cochrane Database of Systematic Reviews

CFS: Clinical Frailty Scale

CGA: Comprehensive Geriatric Assessment

CI: 95% Confidence Interval

CIHI: Canadian Institute for Health Information

CINAHL: Cumulative Index to Nursing and Allied Health Literature

DOC: Director of Care

EFS: Edmonton Frail Scale

FI: Frailty Index

HR: Hazard Ratio

IADL: Instrumental Activities of Daily Living

ICC: Intraclass Correlation Coefficient

ICU: Intensive Care Unit

LOS: Length of Stay

NOS: Newcastle-Ottawa Scale

NRS: National Rehabilitation Reporting System

OR: Odds Ratio

PRESS: Peer Review of Electronic Search Strategies

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROSPERO: International Prospective Register of Systematic Reviews

RR: Risk Ratio

TFI: Tilburg Frailty Indicator

TSFI: Trauma Specific Frailty Index

UCP: Unregulated Care Provider

Chapter One

Introduction

Introduction

This chapter is an introduction to my thesis, including the background, a description of frailty, a literature review, the research rationale, the purpose of this review, my personal impetus for the review, and a discussion of the conceptual influence that informed my view of frailty.

Background

In 2019, older adults aged 65 years and older represented 18% of the Canadian population (Statistics Canada, 2021). This number is expected to keep increasing due to the baby boomer generation (Statistics Canada, 2018). By 2036, older adults could represent 23% – 25% of the population (Statistics Canada, 2018).

Older adults are a distinct patient population with complex health care needs (Bachmann et al., 2010). After an acute episode of hospitalization, an older patient may not be physically or mentally prepared to cope with living independently once discharged. Geriatric rehabilitation is defined as a set of interventions with the purpose of restoring or maintaining functioning for older adult populations that are affected by disability or disease (Bachmann et al., 2010; Paraschiv et al., 2015). Inpatient geriatric rehabilitation is a treatment program that can be provided as an intermediary step between discharge from acute care and return to home. The Canadian Institute for Health Information (CIHI), through the National Rehabilitation Reporting System (NRS), collects standardized information on adult inpatient rehabilitation patients across Canada. Between 2019 – 2020, 30 915 cases aged 65 and over required inpatient rehabilitation in Canada (Canadian Institute for Health Information, 2021).

Frailty

The Canadian Frailty Network states that over 1.6 million Canadians are living with frailty (2021). Frailty is associated with many negative health outcomes among older adults in the community setting as will be discussed in the literature review section. There are multiple definitions of frailty that exist in the literature but the definition used in this thesis is based on Tocchi's concept analysis of frailty in older adults (2015). Frailty in older adults is "a tenuous state of health that is the result of the complex interplay of physiological, psychosocial, and environmental stressors that increases an older adult's susceptibility to adverse health outcomes" (Tocchi, 2015, p. 79). Tocchi looked at 43 articles in which 15 were past frailty conceptual frameworks. She examined several known models/frameworks of frailty such as Fried's Phenotype (Fried et al, 2001), the Accumulation of Deficits Model (Rockwood & Mitnitski, 2007), and the Integral Conceptual Model of Frailty (Gobbens et al., 2012).

Attributes of Frailty

Two attributes of frailty are discussed in Tocchi's concept analysis: 1) state and 2) traits (2015). The 'state' of frailty refers to the variability of frailty. It is not a static condition. While a person can go through periods of increased frailty, they can also return to a state of robustness. The state of frailty reflects the level of frailty a person is currently experiencing. This variability in frailty is sometimes referred to as fluctuations, a continuum, a balance beam, etc.

The 'traits' of frailty refer to the qualities of frailty, which Tocchi described as complexity, synergy, cumulative effects, and susceptibility (2015). Complexity refers to the intricate nature of frailty and how it is multifactorial. There is no specific number of factors nor specific factors themselves that cause frailty. These factors can be physiological, psychological, social, environmental, etc. The synergy trait refers to the interactive effects of these factors that

lead to frailty. The cumulative effects trait refers to the various deficits in multiple health domains that are superimposed on the ageing process leading to frailty. Susceptibility refers to a person's increased vulnerability to negative outcomes. It is at times referred to as a person's decrease in reserve.

Antecedents of Frailty

Tocchi describes 7 different categories of antecedents: sociodemographic, pathophysiology, physical capacity, comorbidity, habitus, sociak networks, and environment (2015). Sociodemographic refers to a person's individual variables of age, gender, race, ethnicity, education and it can predict frailty (Tocchi, 2015). Pathophysiology refers to abnormal physiology (ex. inflammatory markers, reduced hormone levels) (Tocchi, 2015). Physical capacity relates to the ability to engage muscles, to strength and balance, to overall endurance (Tocchi, 2015). Comorbidity relates to the presence of 2 or more concurrent diseases in the same patient (Tocchi, 2015). Habitus speaks to a person's lifestyle as well as their coping skills (ex. low physical activity, poor nutrition) (Tocchi, 2015). Social networks refers to a person's social supports whether formal or informal. Finally, environment refers to someone's living arrangement and finances (access to health care, food security, neighbourhood safety, etc.). Some of the literature explored by Tocchi saw these factors as antecedents to frailty and other times were described as components of frailty or at times could even be bidirectional factors. This further shows the complexity of frailty and the interplay of all these stressors. Furthermore, Tocchi found that comorbidity was identified as a related term to frailty in some of the literature and as an antecedent in others (2015).

Consequences of Frailty

Tocchi categorizes seven consequences of frailty: disability, fiscal, existential, mortality, morbidity, care environment, and advanced directives (2015). Frailty can increase the development of disability and decrease ability to function day to day independently (Tocchi, 2015). The fiscal consequence refers to the increased health care costs (ex. increased hospitals admissions) (Tocchi, 2015). The existential consequence refers to someone's self-report of quality of life (Tocchi, 2015). Frailty can increase the risk of death (mortality) and the development of medical conditions (morbidity) (Tocchi, 2015). Tocchi also notes the consequence of frailty of increased requirements for higher levels of care (ex. long-term care) (2015). Lastly, frailty can bring about the need to address someone's advance directives (Tocchi, 2015).

Instruments

Currently, there exists an abundance of frailty screening instruments, but no one tool is recognized as a designated standard. Common frailty screening tools include the Phenotype Model (Fried et al., 2001), frailty indexes (Rockwood & Mitnitski, 2007), the Edmonton Frail Scale (Rolfson et al., 2006), and the Clinical Frailty Scale (Rockwood et al., 2005).

Fried et al. developed the Phenotype Model where frailty is based on five physical characteristics (2001). The five characteristics are shrinking, weakness, poor endurance and energy, slowness, and low activity level (Fried et al., 2001). Shrinking is characterized as the unintentional weight loss of greater than 10 pounds or of 5% of body weight in the past year (Fried et al., 2001). With gender and body mass index adjusted, weakness is grip strength in the lowest 20% of the older adult population (Fried et al., 2001). Poor endurance and energy are determined by a participant's self-report of exhaustion (Fried et al., 2001). Slowness is described

as the walking time over 15 feet in the lowest 20% of the older adult population with adjustments for gender and height (Fried et al., 2001). Low activity level is based on the expenditure of kilocalories. Females spending less than 270 kilocalories per week and males spending less than 383 kilocalories per week are considered to have low activity level (Fried et al., 2001). A patient's frailty level is classified by an ordinal measurement where a person with none of the characteristics is robust or not frail, a patient with one or two of the characteristics is prefrail or intermediate, and a patient with three or more characteristics is considered frail (Fried et al., 2001). The convergent validity of Fried's Phenotype Model was assessed by testing the correlation between the Phenotype Model and a frailty index (Rockwood et al., 2007). The data used came from the clinical examination cohort from the second wave of the Canadian Study of Health and Aging (comprised of a mix of participants from long-term care and community-dwelling older adults) (Rockwood et al., 2007). The correlation between the two instruments was $r = 0.65$ (Rockwood et al., 2007).

In the Accumulation of Deficits Model, one calculates a frailty index (FI) score that indicates the proportion of deficits a participant has (the numerator) in relation to the total of deficits they could have (the denominator) (Rockwood & Mitnitski, 2007). With this FI, a person's frailty level measures on an interval level between 0 to 1 where the degree of frailty increases as the value approaches 1 (Rockwood & Mitnitski, 2007). Examples of deficits can be dependence in activities of daily living or the presence of comorbidities like osteoporosis, congestive heart failure, etc. (Chamberlain et al., 2016; Rockwood & Mitnitski, 2007). A researcher can develop their own FI or they can use one already in existence so long as the FI follows certain criteria. A good FI has greater than 40 potential deficits as the denominator (Chamberlain et al., 2016; Rockwood & Mitnitski, 2007). Appropriate deficits must be health-

related, must increase in prevalence with age, and must not saturate too early (Searle et al., 2008). Overall, the deficits must cover a range of physiological systems (Searle et al., 2008). A FI can be challenging to use in clinical practice as they can be time-consuming given that one would have to assess if a participant had any of the 40 (at a minimum) chosen deficits. The larger amount of deficits chosen in the development of the FI, the more time-consuming the tool becomes. In addition, creating or choosing an appropriate FI for an intended setting can be difficult as one needs to choose deficits that meet a FI criteria while also being data that is being collected in that setting. One cannot be certain that the needed data will always be collected consistently. There is no guidance on what to do if there is missing information. Each individual FI would need to ascertain that their FI provided valid results.

The Edmonton Frail Scale (EFS) is a multidimensional instrument that contains a 17-point interval measurement (score ranges 0 – 17) assessing 10 domains (Rolfson et al., 2006). A higher score represents higher levels of frailty (Rolfson et al., 2006). The 10 domains are cognition, general health status (2 items for this domain), functional independence, social support, medication use (2 items under this domain), nutrition, mood, continence, functional performance (Rolfson et al., 2006). The domain of cognition and functional performance are evaluated using performance-based tests (clock drawing for cognition, 'Timed Up and Go' for functional performance), while the remaining domains are completed via question-based assessments (Rolfson et al., 2006). In a sample aged 65 and older referred for a comprehensive geriatric assessment, the EFS's inter-rater reliability was $\kappa = 0.77$ and the internal consistency Cronbach's alpha was 0.62 (Rolfson et al., 2006). In the same study, the EFS's construct validity was assessed in which the authors reported the EFS had a significant correlation with the geriatrician's clinical impression of frailty ($r = –0.64$) (Rolfson et al., 2006).

The Clinical Frailty Scale (CFS) is a 9-point ordinal scale ranging from ‘very fit’ (1) to ‘terminally ill’ (9) (Rockwood et al., 2005). Higher scores represent higher levels of frailty. The instrument itself provides descriptions and pictograms at each level to help to screener assign the appropriate level of frailty. The original instrument ranged only from 1-7 with a value of 7 was titled ‘severely frail’ (Rockwood et al., 2005). In 2007, the authors added the two additional levels of ‘very severely frail’ and ‘terminally ill’, noting that these individuals required their own distinct care plans (Church et al., 2020; Dalhousie University, n.d.). The intraclass correlation coefficient of the CFS was 0.97 in a study of older adults with data used from the second wave of the Canadian Study of Health and Aging (Rockwood et al., 2005). The CFS’s criterion validity area under the curve (AUC) was 0.77 for 18-month and 0.70 for 70-month mortality (Rockwood et al., 2005). The authors reported the construct validity as the CFS’s correlation with a FI (r = 0.80) (Rockwood et al., 2005).

Summary

Older adults are a growing population with complex health care needs. They frequently require inpatient rehabilitation after hospitalization to regain and restore their functional health. Frailty in older adults is a fluctuating state of health that increases one’s vulnerability to negative health outcomes due to multiple intertwining stressors. The attributes of frailty include the state and traits of frailty. The traits of frailty are complexity, synergy, cumulative effects, and susceptibility. Antecedents of frailty include sociodemographic, pathophysiology, physical capacity, comorbidity, habitus, sociak networks, and environment. The consequences of frailty are disability, fiscal, existential, mortality, morbidity, care environment, and advanced directives. Frailty can be measured with various instruments such as but not limited to Fried’s phenotype

model, a FI, the EFS, and the CFS. The next section will explore many of the negative patient outcomes with which frailty is associated.

Literature Review

In this section, I provide a description of the overall literature review that was undertaken prior to the start of the systematic review that comprised my thesis study. The goals of the literature review were twofold: 1) search the literature to see if my desired systematic review was already completed and 2) summarize the existing literature on the association between frailty and patient outcomes among older adults.

Methods for Goal 1

Search Strategy

The first step was to search the literature for past systematic reviews and/or meta-analyses related to frailty in the rehabilitation setting. The databases searched were Medline, Pubmed, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL). The Cochrane Database of Systematic Reviews (CDSR) and the International Prospective Register of Systematic Reviews (PROSPERO) were also searched.

Initial Search

I initially searched Medline, using the keyword frail*, which yielded over 20 000 results. After limiting the search to “meta-analysis” or “systematic review” or “review”, to the English language, and to aged 65 and over, I still obtained nearly 2500 results. I decided to seek out assistance from an experienced librarian (L.S.)

Search with Librarian

The librarian (L.S.) from the University of Ottawa showed me a tool found on Pubmed called “Clinical Queries”. It is a tool with validated filters that sorts results through study design.

We then searched within this tool “frail* and rehab*” which yielded 27 systematic reviews. We then searched CINAHL “frail* and rehab*” and limited the search to English language, “meta-analysis”, ‘meta-synthesis”, “reviews”, “systematic reviews” which returned 68 results. We searched PROSPERO together using again the keywords “frail* and rehab*” which yielded 76 results.

Screening and Additional Searches

I screened the titles of all these results with the librarian. We were looking for an older adult population and the rehabilitation setting, but if this could not be assured by the title, then the abstract was screened to determine the population of interest, the appropriate setting, as well as to ascertain that the study examined frailty and outcomes. The screening of abstracts with titles of relevance yielded no systematic reviews with the same topic as my thesis. The librarian indicated that I could feel confident that my research question and thesis topic has not been covered yet. I, however, decided on my own to search the same databases again, but I swapped out “rehab*” for different potential terminology for the rehabilitation setting (ex. subacute, post-acute). I also searched the CDSR for “frail*” which returned under 200 results. These additional searches did not generate any systematic reviews identical to my topic. I now felt more assured that I was not repeating a current systematic review. Refer to Appendix A for the search strategies.

Methods for Goal 2

The second goal when reviewing the literature was to summarize the existing research relating to frailty and patient outcomes among older adults. What do we know about how frailty affects an older adult? I was interested in a general overview and not relating to specific disease groups (ex. older adult patients with kidney disease).

Inclusion and Exclusion

The population was limited to adults aged 65 and over. As indicated above, I wanted to explore a general overview of the research between frailty and outcomes among older adults; therefore, articles surrounding populations with disease-specific states were excluded. I wanted a broad sense of the existing literature on frailty. The exposure of interest was frailty. For this search, the exposure of frailty was not limited to one definition or instrument of use to get a more comprehensive understanding of the existing literature. While the search in Goal 1 was tailored to the rehabilitation setting, this search was not limited by setting. I was interested in general patient outcomes and not hospital outcomes (ex. hospital budget-related outcome). The search was not limited by outcome however as an experienced librarian (L. S.) indicated not to limit as such to prevent missing valuable studies in which the authors used different terminology to describe similar outcomes. Reports, editorials, and abstract-only articles were excluded.

Search Strategy

The databases searched were Pubmed and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) using key search terms:

1. keywords related to frailty: frail*
2. keywords related to older adults: elder* OR senior* OR aged OR geriatric* OR older adult*

The search occurred at the end of July 2018. An initial search of Pubmed with the keywords frail* AND (elder* OR senior* OR aged OR geriatric* OR older adult*) limited by title and abstract yielded over 10 000 results. Similar results occurred with the search in CINAHL (>14 000 results). The search strategy was then adjusted to be more feasible by limiting to ‘meta-

analysis', 'meta-synthesis', 'reviews', 'systematic review'. Refer to Appendix B for search strategies.

Study Selection

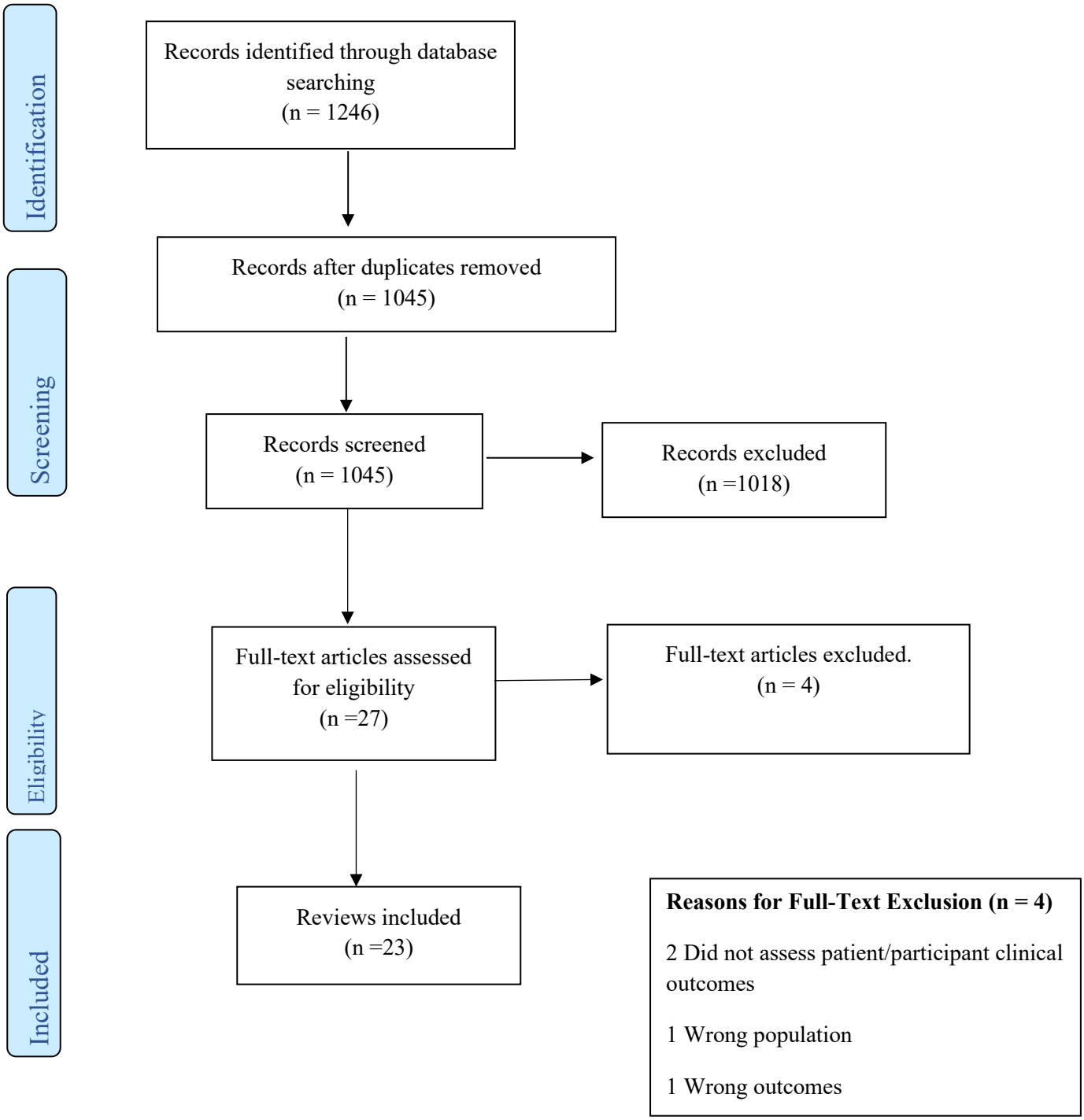
The database search yielded 1246 reviews. Once duplicates were removed, 1045 results remained to review. After title and abstract screening, 27 reviews remained for full-text screening. After a full-text review, 23 articles remained for data extraction. See Figure 1.1 for the PRISMA flow diagram. See Appendix C for list of excluded full-text reviews and reasons.

Characteristics of Included Reviews

The data extracted included but was not limited to the study reference, the population of interest, the sample setting, the number of studies included in the review, the type of frailty assessments completed, the list of the outcomes of interest, and the summary of the results. See Table 1.1 for a brief summary of the characteristics of included reviews. See Appendix D for the complete data extraction table.

Twelve (52.1%) of the reviews were based in the community setting (Chang & Lin, 2015; Cheng and Chang, 2017; Kane et al., 2012; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Shamliyan et al., 2013; Vermeiren et al., 2016; Vermeulen et al., 2011). Four (17.4%) reviews were based in the perioperative setting where frailty was assessed in the preoperative phase and outcomes were assessed either postoperatively or a year or more after (Buigues et al., 2015; Lin et al., 2016; Oakland et al., 2016; Oresanya et al., 2014). Three (13%) reviews did not have an outright specified setting as they did not limit by such (Chang et al., 2018; Chen et al., 2017; Gutiérrez-Valencia et al., 2018). One (4.4%) review identified the setting as people who 'lived in different contexts" (Fhon et al.,

Figure 1.1 PRISMA Flow Diagram of Included Reviews



2016), one (4.4%) required that over half of the participant cohort come from the community (Kojima et al., 2018), one (4.4%) looked at the community and institutionalized setting (Lorenzo- López et al., 2017), and one (4.4%) was in the intensive care unit (ICU) setting(Muscedere et al., 2017).

Twenty-two (95.6%) of the reviews included articles that cited either the phenotype model or a modified version of it (Buigues et al., 2015; Chang & Lin, 2015; Chang et al., 2018; Chen et al., 2017; Cheng & Chang, 2017; Fhon et al., 2016; Gutiérrez-Valencia et al., 2018; Kane et al., 2012; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Lin et al., 2016; Lorenzo- López et al., 2017; Muscedere et al., 2017; Oakland et al., 2016; Oresanya et al., 2014; Shamliyan et al., 2013; Vermeiren et al., 2016; Vermeulen et al., 2011). Twenty (87%) of the reviews included articles that used some form of a frailty index (Buigues et al., 2015; Chang et al., 2018; Chen et al., 2017; Cheng & Chang, 2017; Fhon et al., 2016; Gutiérrez-Valencia et al., 2018; Kane et al., 2012; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Kojima et al., 2018; Lin et al., 2016; Lorenzo- López et al., 2017; Muscedere et al., 2017; Oresanya et al., 2014; Shamliyan et al., 2013; Vermeiren et al., 2016). Fifteen (65.2%) reviews completed meta-analyses (Chang & Lin, 2015; Chang et al., 2018; Chen et al., 2017; Cheng & Chang, 2017; Fhon et al., 2016; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Kojima et al., 2018; Muscedere et al., 2017; Oakland et al., 2016; Vermeiren et al., 2016) and eight (34.8%) only completed systematic reviews (Buigues et al., 2015; Gutiérrez-Valencia et al., 2018; Kane et al., 2012; Lin et al., 2016; Lorenzo- López et al., 2017; Oresanya et al., 2014; Shamliyan et al., 2013; Vermeulen et al., 2011). Kane and colleagues did

complete a meta-analysis with different variables in their review but not when summarising data relating to frailty (Kane et al., 2012). Among the studies that completed meta-analyses, some reviews reported odds ratio, some hazard ratio, some risk ratios, but the review by Vermeiren and colleagues reported the hazard ratio and risk ratio together (written as HR/RR) (Vermeiren et al., 2016).

Table 1.1 Characteristics of Included Reviews

Characteristics					
First author, year	**Population**	**Setting**	**Number of included studies**	**Frailty Assessment**	**Outcomes of interest**
Buigues, 2015	people aged 65 +	perioperative	32	phenotype model, modified frailty index (FI), comprehensive geriatric assessment (CGA), Edmonton Frail Scale (EFS), Groningen Frailty Indicator, Hopkins frailty score, comprehensive assessment of frailty, MacArthur Study of Successful Aging frailty, other markers of frailty	postoperative mortality, postoperative complications
Chang, 2018	people aged 65+	not specified, not limited by setting	8	phenotype model, study of osteoporotic fractures frailty index, 2 other frailty criteria	hospitalization risk
Chang, 2015	people aged 65+	community	11	frail phenotype	mortality
Chen, 2017	people aged 55 + (4/5 included studies with participants aged 65+)	not specified, not limited by setting	5	phenotype model, study of osteoporotic fractures frailty index	fracture risk
Cheng, 2017	people aged 65 +	community	10	phenotype model, study of osteoporotic fractures frailty index	fall risk, recurrent falls

Fhon, 2016	people aged 60 + (16/19 included studies with participants at least 65 +)	states "who lived in different contexts"	19	phenotype model, study of osteoporotic fracture frailty index, FRAIL index, Edmonton Frail Scale (EFS), handgrip strength, Longitudinal Aging Study Amsterdam frailty instrument frailty instrument, Conselice Study of Brain Aging index, SNAC instrument	frailty, fall
Gutiérrez-Valencia, 2018	people with mean age 65 +	not specified, not limited by setting	25	Phenotype, Edmonton Frail Scale (EFS), FRAIL scale, Tilburg frailty indicator, frailty index, Groningen frailty indicator	frailty, polypharmacy
Kane, 2012	people aged 65 +	community	123	phenotype model, accumulation of deficit model	mortality
Kojima, 2018	noninstitutionalized older adults aged 65 +	community	5	phenotype model, study of osteoporotic fracture frailty index, the Conselice Study of Brain Aging index	nursing home placement
Kojima, 2017	people with mean age 60 + (18/20 included studies with participants at least 65+)	community	20	phenotype (original, modified), modified Study of Osteoporotic fracture frailty index, FRAIL scale	future disability risks
Kojima, 2016a	people with a mean age of 65 +	community	6	Longitudinal Aging Study Amsterdam frailty instrument, modified phenotype, Conselice Study of Brain Aging Study frailty index	fracture risk
Kojima, 2016b	People with mean age 65 +	community	13	phenotype (original and modified), modified Study of Osteoporotic Fractures frailty index	hospitalization risk
Kojima, 2015	people aged 60 years or older or mean age of 70 years or older (10/11	community	11	phenotype (original and modified), Clinical Frailty Scale, Longitudinal Aging Study Amsterdam frailty instrument (LASA), modified Study of Osteoporotic fractures frailty index	fall risk

	included studies with participants at least 65 +)				
Kojima., Iliffe, 2018	people aged 20+ (>half of the included studies with participants > 65 +)	> half of the cohort needed to come from the community	19	frailty index	mortality
Kojima, Iliffe, 2016	people aged 60 +, or with a mean age of 70 + (all included studies had mean age 70 +)	community	13	Fried criteria, Frailty Index (FI), the Tilburg Frailty Indicator, the Study of Osteoporotic Fractures frailty index, and the Canadian Study of Health and Aging Clinical Frailty Scale. One study defined frailty based on a combination of three different criteria	quality of life
Lin, 2016	mean participant was aged 75 and older, patient population had a surgical procedure	perioperative, community (some studies measured outcomes postop, some at 1 year, 2 year, 1 at 5 year)	23	measured 21 different ways (frailty had to assess more than one domain of health deficit, phenotype model and frailty index the most common tools)	any postoperative adverse outcome (most common was mortality and postoperative complications)
Lorenzo-López, 2017	people aged 65 +	community and institutionalized	19	phenotype model (original and modified), FRAIL scale, the Study of Osteoporotic Fractures frailty index	nutritional status
Muscedere, 2017	18 + admitted to an ICU (50% of studies have participants aged 65+)	ICU	12 publications from 10 studies	frailty index, Clinical Frailty index, phenotype model	primary outcomes: in-hospital and long-term mortality (≥6 months following ICU admission. secondary outcomes: ICU mortality and health related quality-of-life (HRQL), ICU and hospital length of stay, receipt of vasoactive agents, receipt and

					duration of mechanical ventilation (MV), and discharge disposition
Oakland, 2016	Patients undergoing all forms of surgery (elective and emergency) except surgery for fractured neck of femur (8/12 studies had participants with mean age at least 65 +)	perioperative (pre-op evalutation of frailty, postop outcomes)	12	various, many unfamiliar methods (skeletal muscle mass, edmonton frailty scale, impairment in ADL, phenotype, total psoas area, etc.)	1-year mortality and early mortality (ie in-hospital mortality), 30-day mortality or mortality 'following surgery', length of stay, requirement for step-down rehabilitation placement, overall and organ specific complication rates
Oresanya, 2014	patients 60 year + that underwent surgery (> 50% of studies had participants aged at least 65 +)	perioperative	54 (most do not discuss frailty)	ICD-9 codes for 12 conditions, modified frailty index, frailty measure based on comprehensive geriatric assessment, modified phenotype, comprehensive assessment of frailty score	postoperative mortality (within 1 year of surgery), postoperative complications (ex. delirium, discharge to an institution, cognitive and functional decline)
Shamliyan, 2013	people aged 65 +	community	24	phenotype, frailty index	survival
Vermeiren, 2016	people aged 65 +	community	31	> 20 different instruments (modified phenotype, modified Study of Osteoporotic Fractures frailty index, Tilburg frailty indicator, Groningen frailty indicator, frailty index, etc.)	any potential outcome (mortality, hospitalization, disabilities in ADLs, falls, institutionalization, fractures, physical limitation, ED visits, etc.)
Vermeulen, 2011	people aged 65 +	community	28	physical frailty indicators: weight loss, exhaustion, gait speed, muscle strength, physical activity, balance, other	ADL disability

Quality Assessment

The included reviews were assessed using the AMSTAR 2 tool (A MeaSurement Tool to Assess Systematic Reviews) (Shea et al., 2017). See Appendix E for the quality assessment table. AMSTAR 2 does not provide a rating system for low, moderate, high. All of the reviews that completed meta-analyses (n=15) used appropriate methods for statistical combination (Chang & Lin, 2015; Chang et al., 2018; Chen et al., 2017; Cheng & Chang, 2017; Fhon et al., 2016; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Kojima et al., 2018; Muscedere et al., 2017; Oakland et al., 2016; Vermeiren et al., 2016), thirteen out of those fifteen (86.6%) assessed the potential impact of risk of bias in individual studies on the results of the meta-analysis (Chang & Lin, 2015; Chang et al., 2018; Chen et al., 2017; Cheng & Chang, 2017; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Kojima et al., 2018; Muscedere et al., 2017; Vermeiren et al., 2016), and eleven out of fifteen (73.3%) carried out adequate publication bias investigations (Chang & Lin, 2015; Chang et al., 2018; Chen et al., 2017; Cheng & Chang, 2017; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Kojima et al., 2018; Muscedere et al., 2017). Twenty (86.7%) of the twenty-three reviews either provided a satisfactory explanation of heterogeneity in their results or did not obtain heterogeneity (Buigues et al., 2015; Chang & Lin, 2015; Chang et al., 2018; Chen et al., 2017; Cheng & Chang, 2017; Gutiérrez-Valencia et al., 2018; Kane et al., 2012; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Kojima et al., 2018; Lin et al., 2016; Muscedere et al., 2017; Oresanya et al., 2014; Shamliyan et al., 2013; Vermeiren et al., 2016; Vermeulen et al., 2011).

Nine (39.1%) reviews indicated that they used some sort of written guide that was established prior to the conduct of the review (Fhon et al., 2016; Gutiérrez-Valencia et al., 2018; Kojima, 2015; Kojima, 2016a; Kojima, 2016b; Kojima, 2017; Kojima, 2018; Kojima et al., 2016; Kojima et al., 2018), but only one (4.3%) used a registered protocol (Muscedere et al., 2017). Most of the time, the reviews provided a PRISMA flow diagram for their study selection and indicated their reasons for inclusion, but the authors did not include the citations of the excluded articles. Overall, the search strategies in the reviews tended to lack grey literature searches and consultations with experts in the field.

Literature Synthesis between Frailty and Outcomes

The following is a synthesis of the results of the literature review assessing the relationship between frailty and patient outcomes.

Mortality

Ten (43.5%) of the reviews assessed the association between frailty and mortality (Buigues et al., 2015; Chang & Lin, 2015; Kane et al., 2012; Kojima et al., 2018; Lin et al., 2016; Muscedere et al., 2017; Oakland et al., 2016; Oresanya et al., 2014; Shamliyan et al., 2013; Vermeiren et al., 2016). Four (40%) out of the ten reviews were within the community setting (Chang & Lin, 2015; Kane et al., 2012; Shamliyan et al., 2013; Vermerien et al., 2016), four (40%) were in the perioperative setting (Buigues et al., 2015, Lin et al., 2016; Oakland et al., 2014; Oresanya et al., 2014), one (10%) required that over half of the participant cohort come from the community (Kojima et al., 2018), and 1 (10%) was in the ICU setting (Muscedere et al., 2017). Out of the ten reviews, 5 (50%) had populations aged 65 and over (Buigues et al., 2015; Chang & Lin, 2015; Kane et al., 2014; Shamliyan et al., 2013; Vermeiren et al., 2016), 1 (10%) was 60 and older (Oresanya et al., 2014), 1 (10%) had a mean age of 75 and older (Lin et al.,

2016), 1 (10%) study examined a population with ages ranged 20 and older but over half of the included studies had populations aged 65 and older (Kojima et al., 2018), 1 (10%) accepted studies aged 18 and older but 50% of the studies had populations aged 65 and older (Muscedere et al., 2017), and finally one (10%) was not limited by age (Oakland et al., 2016). Interestingly, all the reviews except for one (Kojima et al., 2018) included the phenotype model (original or modified) as one of the frailty assessment tools.

Overall, whether the authors completed their systematic review in the community setting, perioperative, or in the ICU, frailty had a significant association with mortality. Many of the reviews also had meta-analyses which statistically showed the significant association between frailty and mortality(premature mortality odds ratio (OR) = 2.34 [95% confidence interval (CI) 1.77 -3.09] (Vermeiren et al., 2016), OR per 0.01 FI increase = 1.054 [CI 1.040–1.068] and OR per 0.1 FI increase = 1.706 [CI: 1.547–1.881] (Kojima et al., 2018), in-hospital mortality OR = 2.77 [CI 1.62-4.73], 1-year postoperative mortality OR = 1.99 [CI 1.49-2.66] (Oakland et al., 2016)), hazard ratio (HR) = 2 [CI 1.727 – 2.316] (Chang & Lin, 2015), HR per 0.01 FI increase = 1.039 [CI 1.033–1.044] and HR per 0.1 FI increase = 1.282 [CI 1.258–1.307] (Kojima et al., 2018), risk ratio (RR) with hospital mortality = 1.71 [CI 1.43-2.05], long-term mortality RR = 1.53 [CI 1.40-1.68], and ICU mortality RR = 1.51 [CI 1.31-1.75] (Muscedere et al., 2017), HR/RR = 1.83 [CI 1.68-1.98] (Vermeiren et al., 2016)).

These findings are similar to Tocchi's concept analysis. Tocchi examined past literature and determined that one of the consequences of higher levels of frailty is mortality (2015). One of the qualities of frailty is susceptibility which talks about about someone's decrease in reserve (Tocchi, 2015). As someone with higher levels of frailty is more vulnerable to negative health outcomes due to their decrease in reserve, it is not surprising to see that frailty is significantly

associated with mortality. The person with high frailty levels has less capability and reserve to recover against whichever medical condition and/or disease that they are facing therefore will have greater potential for severe negative outcomes (mortality). Tocchi also discusses the consequence of the need for advance directives (2015). As the literature indicates frailty is associated with mortality, it confirms the importance of having the discussion of advance directives with hospitalized older adults so their health care choices are considered as part of their care plan.

Falls

Four reviews (17.4%) assessed the association between frailty and fall risk among older adults (Cheng & Chang, 2017; Fhon et al., 2016; Kojima, 2015; Vermeiren et al., 2016). Three (75%) out of the four reviews were within the community (Cheng & Chang, 2017; Kojima, 2015; Vermeiren et al., 2016) and one (25%) review identified the setting as people who 'lived in different contexts' (Fhon et al., 2016). All four of these reviews found significant associations between frailty and falls (OR = 1.70 -2.50 [CI 1.18-3.96] (Cheng & Chang, 2017; Fhon et al., 2016; Kojima, 2015; Vermeiren et al., 2016), HR = 1.24 [CI 1.10-1.41] (Kojima, 2015), HR/RR = 1.24 [CI 1.12-1.37] (Vermeiren et al., 2016)). Two reviews examined prefrailty and determined that prefrailty was associated with falls (OR = 1.25-1.47 [CI 1.01 – 1.79] (Cheng & Chang, 2017; Kojima, 2015)). Prefrailty was described as someone with 1 or 2 of the fraily criteria as part of either the phenotype model and/or the study of osteoporotic fractures frailty indicators (Cheng & Chang, 2017; Kojima, 2015).

Nursing Home Placement/Institutionalization

Three (13%) reviews assessed the association between frailty and nursing home placement among older adults (Kojima, 2018; Lin et al., 2016; Vermeiren et al., 2016). Two (66.7%) reviews were in the community setting (community-dwelling people) (Kojima, 2018;

Vermeiren et al., 2016) and one (33.3%) review was in the perioperative setting (patients who had a surgical procedure) (Lin et al., 2016). Kojima provided a p-value instead of a confidence interval in his review. The two reviews that completed meta-analyses and were in the community setting found that frailty was significantly associated with nursing home placement (OR = 1.69 – 5.58 [CI 1.02-2.81, $p < 0.00001$] (Kojima, 2018; Vermeiren et al., 2016), HR/RR = 1.67 [CI 1.47-1.89] (Vermeiren et al., 2016)). Kojima also found that prefrailty significantly predicted nursing home placement (OR=3.26 [$p = 0.02$]) (2018). In the systematic review with patients of mean age of 75, there was evidence for an association between frailty and discharge to institutional care (2 studies examined this outcome) (Lin et al., 2016).

Tocchi discusses how frailty can have several consequences such as worsened disability, increased morbidity, and increased health care costs (2015). Tocchi indicates that the consequences of frailty are interactive (2015). These consequences of higher frailty levels will likely lead to more people requiring higher levels of care and increased need for nursing home placement. Increased care environments is another consequence of frailty as described by Tocchi (2015). It is not surprising therefore to see that past reviews found a significant association between frailty and nursing home placement.

ADLS/IADLS (Activities of Daily Living/ Instrumental Activities of Daily Living)

Three (13%) reviews assessed the association between frailty and ADL/IADLs (Kojima, 2017; Vermeiren et al., 2016; Vermeulen et al., 2011). All (100%) of these reviews were in the community setting. Two of the three reviews found that among older adults frailty was significantly associated with functional status as defined as ADL/IADL (ADL: OR = 2.05-2.76 [CI 1.73-3.44] (Kojima, 2017; Vermeiren et al., 2016), HR = 2.23 [CI 1.42 – 3.49] (Kojima, 2017), HR/RR = 1.62 [CI 1.50 - 1.76] (Vermeiren et al., 2016)), (IADL: OR = 2.52-3.62 [CI 2.08

– 5.64] (Kojima, 2017; Vermeiren et al., 2016), HR = 1.55 [CI 1.08 – 2.21] (Kojima, 2017)). The third review, a systematic review of 28 studies, found that physical frailty indicators such as slow gait speed, low physical activity, weight loss, lower extremity function, balance, muscle strength predict ADL disability among community-dwelling people aged 65 and over (Vermeulen et al., 2011).

These findings are similar to the consequence of frailty named disability (Tocchi, 2015). Tocchi's examination of past literature also found that frailty was associated with difficulties with day to day function (2015). The included above-mentioned reviews examining ADLs/IADLs were only set in the community and none were in the hospital nor the rehabilitation setting. It further shows the need to explore the impact of frailty on functional status in the rehabilitation setting to see if this association is consistent amongst all settings.

Fractures

Three (13%) reviews assessed the association between frailty and fracture risk (Chen et al., 2017; Kojima, 2016a; Vermeiren et al., 2016). Two (66.6%) of the three reviews were in the community setting (Kojima, 2016a; Vermeiren et al., 2016), and one (33.3%) was not limited by setting (Chen et al., 2017). There was a significant association between frailty and fracture risk among all three reviews (OR = 1.70-2.78 [CI 1.30 – 5.99] (Kojima, 2016a; Vermeiren et al., 2016), HR = 1.55-1.67 [CI 1.31-1.91] (Chen et al., 2017; Kojima, 2016a), HR/RR = 1.37 [CI 1.21-1.54] (Vermeiren et al., 2016)). Prefrailty was also associated with fracture risk (OR = 1.31 [CI 1.18 – 1.46] (Kojima, 2016a), HR = 1.30 [1.12-1.51] (Chen et al., 2017; Kojima, 2016a)). Of note, the participants in Chen and others's review are aged 55 and older and the other two reviews have populations aged 65 and older (Vermeiren et al., 2016) or mean age 65 and older (Kojima, 2016a).

Hospitalization

Three (13%) reviews examined the association between frailty and hospitalization (Chang et al., 2018; Kojima, 2016b; Vermeiren et al., 2016). Two (66.6%) of the three reviews were in the community setting (Kojima, 2016b; Vermeiren et al., 2016) and one (33.3%) was not limited by setting (Chang et al., 2018). All three reviews completed meta-analyses with significant results for an association between frailty and risk of hospitalization among older adults (OR = 1.82-1.9 [CI 1.53-2.15] (Kojima, 2016b; Vermeiren et al., 2016), HR = 1.30 [CI 1.12–1.52] (Kojima, 2016b), RR = 1.49 [CI: 1.26–1.76]) (Chang et al., 2018), HR/RR = 1.18 [1.10-1.28] (Vermeiren et al., 2016)). Two of the reviews also had results where prefrailty was significantly associated with hospitalization risk (OR = 1.26 [CI 1.18-1.33] HR=1.13 [CI 1.04 – 1.24 (Kojima, 2016b), RR= 1.20 [CI 1.07 – 1.34] (Chang et al., 2018)).

Increased hospitalizations requires additional health care costs which is a consequence of frailty (Tocchi, 2015). Hospitalizations of older adults can introduce the need for advance directives which is another consequence of frailty (Tocchi, 2015). Clearly, frailty is associated with negative health outcomes but one poor outcome can lead to many other potential negative outcomes.

Discharge Destination

Two (8.7%) reviews assessed the relationship between frailty and discharge destination (Muscedere et al., 2017; Oakland et al., 2016). One (50%) review was based in the perioperative setting (Oakland et al., 2016) and the other one (50%) was in the ICU setting (Muscedere et al., 2017). Among people aged 18 and older admitted to an ICU (50% of studies have participants aged 65+), frailty had a significant negative association with discharge to home (4 studies) (RR: 0.59[CI 0.49-0.71], $p<0.00001$]) (Muscedere et al., 2017). A meta-analysis of six studies found,

among surgical patients, an association between frailty and discharge rate to further rehabilitation/step-down care (OR = 5.71 [CI 3.41–9.55] (Oakland et al., 2016).

One thing to note with these reviews is that neither contained only studies with populations aged 65 and older. Even though the findings showed an association between frailty and discharge destination, there is a need to further examine this outcome among solely older adults aged 65 and older.

Length of Stay

Two (8.7%) reviews assessed the relationship between frailty and length of stay (Lin et al., 2016; Oakland et al., 2016). Both (100%) reviews were based in the perioperative setting. Frailty was associated with the length of stay in these two reviews. A meta-analysis of four studies found a significant association between frailty and length of stay (mean difference 1.05 days [CI 0.02 – 2.07]) in surgical patients (Oakland et al., 2016). In a systematic review, five out of six studies found an association between frailty and length of stay in the postoperative setting among older adults with a mean age of 75 (Lin et al., 2016).

Tocchi does indicate that a consequence of frailty is increased health care costs which would be the case with long lengths of hospital stays. The findings here are consistent with Tocchi. Again however, the review by Oakland and colleagues (2016) does not solely include studies with populations aged 65 and older. There is a further need to examine this outcome among this population.

Nutritional Status

One (4.3%) systematic review looked at the relationship between frailty and nutritional status (Lorenzo- López et al., 2017). The authors examined the association between frailty and nutritional status among people aged 65 and over who lived in the community or were

institutionalized (Lorenzo- López et al., 2017). Frailty was associated with low intakes of specific micronutrients (5 studies). Higher protein intake (4 studies), higher quality of diet (3 studies), and higher dietary antioxidant capacity (2 studies) were associated with a lower risk of frailty. Using the Mini Nutritional Assessment (MNA) and the MNA-SF (Short Form) to assess nutritional status, frailty was found to be associated with malnutrition (seven studies).

Polypharmacy

Only one (4.3%) review reported on frailty and polypharmacy (Gutiérrez-Valencia et al., 2018). This review was not limited by setting. This systematic review found that out of the 25 included studies, twenty-one studies found a significant association between frailty and polypharmacy among older adults with mean age 65 and over (Gutiérrez-Valencia et al., 2018).

Quality of Life

One review (4.3%) examined the association between frailty and quality of life (Kojima et al., 2016). The review was based in the community setting. Frailty and prefrailty (as defined by Fried's phenotype) were significantly inversely associated with quality of life in a systematic review of 13 studies (4 for meta-analysis) among community-living older adults aged 60 and over or with a mean age of 70 (Kojima et al., 2016). For physical component summary: pooled mean differences= −12.74 [CI −15.04 to −10.44], $p<0.00001$ for frail, and −4.18 [CI −7.00 to −1.37], $p=0.004$ for prefrail (Kojima et al., 2016). For mental component summary: pooled mean differences = −10.69, [CI -16.35 to −5.04], $p=0.0002$ for frail and −3.82, [CI −5.62 to −2.03], $p<0.000$ for prefail (Kojima et al., 2016).

Summary of Literature Review

In this literature review, I sought to do two things. The first goal was to demonstrate that no systematic review examined the association between frailty and rehabilitation outcomes

among older adults. The second goal of this literature review was to summarize the existing literature on the association between frailty and patient outcomes among older adults.

I found 23 systematic reviews that examined the relationship between frailty and patient outcomes among older adults. While many of the reviews included a small number of studies in their meta-analyses, there were consistent results among the various reviews. The literature presented here showed significant relationships between frailty and mortality, falls, nursing home placement, ADL/IADL disability, fractures, hospitalization, discharge destination, length of stay, nutritional status, polypharmacy, and quality of life.

Research Rationale

As I was narrowing down my thesis topic, I needed to ascertain whether I wanted to do a systematic review or a primary study. I did a broad search on Medline using keywords related to frailty, older adults, and rehabilitation. After scrolling through several pages of results, I was able to find a few primary studies that seemed of relevance to my thesis topic (Haley et al., 2014; Kawryshanker et al., 2014; Singh et al., 2012). These studies will be discussed further in chapter three. As there were primary studies that existed already on this particular topic, the decision was made to do a systematic review instead of a primary study. The idea would be to summarize the current literature to gain a better understanding of the impact of frailty on older adults' rehabilitation outcomes in the inpatient geriatric rehabilitation setting.

While there are reviews analyzing frailty among the older adult population in the community setting and in acute care postoperatively, to the author's knowledge, no systematic review has examined the effect of frailty in older adults within the inpatient rehabilitation setting and specifically on how frailty can affect rehabilitation outcomes.

I chose the inpatient geriatric rehabilitation as it was my area of interest. Also, there is limited research on frailty in this setting. I saw the gap in practice that frailty was not being measured. A comprehensive geriatric assessment (CGA) is commonly use with older adults needing rehabilitation (Rehabilitative Care Alliance, 2020). A CGA is a multidisciplinary process that looks at a person's medical, psychological, and functional capabilities so you can develop an appropriate care plan (Parker et al., 2018). One could derive a frailty level subjectively from a CGA, but it would not be a formal frailty screening. A systematic review showing that frailty is related to poor rehabilitation outcomes may demonstrate the need for frailty screening prior to/upon admission to inpatient geriatric rehabilitation or it can be even incorporated into the CGA. This relationship can impact the eligibility criteria for a rehabilitation program or influence patient-specific tailored interventions perhaps leading to a modified rehabilitation program for frailer populations. Health care providers, specifically nurses, will be able to identify which patients may have poorer rehabilitation outcomes.

Past systematic reviews did show the association between frailty and negative health outcomes in the community and perioperative setting but does this association still exist in the inpatient geriatric rehabilitation setting? Patients in inpatient geriatric rehabilitation are generally medically stable so they can participate as fully as possible in the program (Rehabilitative Care Alliance, 2020). Acute care is usually a short inpatient stay that provides treatment for illness/disease (CIHI 2021). It is a different type of patient in acute care to inpatient geriatric rehabilitation with different goals. I was genuinely interested in seeing if there was an association between frailty and functional status in this setting. Tocchi indicates a consequence of frailty among older adults is reduced functional capabilities (2015). Similar results were seen in the just discussed literature review (3 reviews based in the community setting) but I still

wasn't completely convinced that the results would be the same in the inpatient geriatric rehabilitation setting as these patients are being set up to go back to living in the community. The geriatric rehabilitation setting is a structured program where the goal is to optimize functional status. The program is actively trying to improve functional status. People in the community may not necessarily be working daily on trying to improve their functional status. Is frailty influencing the goal of rehabilitation? If yes, then frailty is a concept that needs greater focus in this setting.

The additional included outcomes in this systematic review needed to be reflect appropriate outcomes for the inpatient geriatric rehabilitation setting. The chosen outcomes of length of stay, discharge destination, and readmission to acute care are common outcomes measures in the inpatient geriatric rehabilitation setting (Ghogomu et al., 2016). Tocchi speaks to the fiscal and the care environment consequences of frailty in which frailty leads to increased health care costs and health care resources. Similar results were seen in my literature review where frailty was found to be associated with length of stay, hospitalization, discharge destination, and nursing home placement (Chang et al., 2018; Kojima, 2016b; Kojima, 2018; Lin et al., 2016; Muscedere et al., 2017; Oakland et al., 2016; Vermeiren et al., 2016). Given the limited research of frailty in the geriatric rehabilitation setting, it is not conclusive that frailty is associated with these outcomes in this particular setting. As stated previously, the inpatient geriatric rehabilitation program is focused on increasing level of independence with ideally returning a patient to their previous living arrangement (Bachmann et al., 2010; Paraschiv et al., 2015; Rehabilitative Care Alliance, 2020). Will frailty still impact a patient's ability to return home when the program itself is trying to counteract this effect?

Other outcomes that were seen in the literature that potentially could have been explored further was mortality. Tocchi does discuss mortality as a consequence of frailty (2015). The ten included reviews in the literature review also indicated that frailty is associated with mortality whether in the community setting or in the hospital setting. Given the abundance of evidence that already establishes the relationship between frailty and mortality, I did not deem mortality as an outcome that would bring forth any new information. I therefore chose not to include mortality as an outcome of interest.

Purpose

The purpose of this thesis was to synthesize the evidence on the association between frailty and rehabilitation outcomes among older adults in the inpatient rehabilitation setting. The primary outcome was functional status. The secondary outcomes included length of stay, discharge destination, and readmission to acute care.

Personal Impetus

I began working with older adults in the second year of my undergraduate degree in nursing school. I started in a retirement home as an unregulated care provider (UCP). I administered oral medications, did simple dressing changes and treatments, monitored patients who were unwell, and reported back to the Director of Care (DOC), a registered practical nurse. This retirement home setting was classified as independent living. For the most part, the residents were independent functionally. A portion of the residents required assistance in the morning and at bedtime with dressing/undressing and bathing which was provided by a community personal support worker. Over time, certain residents either fell ill, became deconditioned, declined cognitively or a combination of all three, which meant they developed

increased functional care needs. These residents often remained at the retirement home long after they lost their functional independence as they waited for an empty bed in long-term care.

I worked on an inpatient geriatric rehabilitation unit for approximately five years as a registered nurse. The most common reasons for patient admission into geriatric rehabilitation that I saw included hip fracture, post pneumonia recovery, deconditioning, congestive heart failure or chronic obstructive pulmonary disease exacerbation, and falls.

In these two settings, retirement home and inpatient geriatric rehabilitation, I would hear the term 'frail'. "This patient is very frail." "The resident is now frail." "He was admitted to us in a frail condition." No one explained further as to what they meant by 'frail'. It was expected that everyone mutually understood the terminology. During my early nursing career, I saw the terms 'frail' and 'frailty' being often attributed to patients in a subjective 'I know it when I see it' way versus using objective assessments or measurements. Similarly, we might say "This patient is sad/depressed" but we can screen for this using the Geriatric Depression Scale (Yesavage et al., 1982). I did not always see a change functionally or physically in patients in rehabilitation at discharge. I thought perhaps since I worked part-time, my limited time with the patients did not allow me to observe this change. However, when thinking about a thesis topic, I began to think what if this "frailty" was involved in a patient's progress. Maybe this rehabilitation program is not sufficient nor appropriate for certain patients. Perhaps, the program that is being offered needs to be adapted for patients with higher levels of frailty. Should there be alternative options developed for highly frail populations? In addition, many of the rehabilitation patients live in a retirement home prior to their acute hospitalization and return to this setting upon discharge. Should frailty be assessed in the community on all older adults? Before I could answer these questions, I needed to find out if frailty had an impact on rehabilitation outcomes.

Conceptual Influence

While there is no explicit frailty framework used in this review, Tocchi's concept analysis of frailty among older adults encompasses the overall essence of frailty. Therefore, the underlying knowledge base that informed this review was Tocchi's concept of frailty (Tocchi, 2015)..

This concept analysis was the most comprehensive; it was clear and concise. In addition, it was targeted to the context of older adults. Other definitions and/or frameworks either lacked the tenuous nature of frailty and/or the multidimensional component, were overly complex, or not as comprehensive. Of the frameworks that speak to the multidimensional nature of frailty, it was difficulty to find one that included an environmental stressor component as part of frailty. I did not want to limit the types of studies to include in the systematic review if they focused on domains other than physical and psychological. If I chose one of the previous frailty frameworks in the literature, I might be limiting the review even further and missing some aspects of frailty.

The interplay of multiple stressors causing frailty which can affect outcomes underpins my view of frailty. It was important to include studies in which frailty screening incorporated more than one item. Based on Tocchi's concept analysis of frailty, it is clear that frailty is multidimensional (ex. physiological, psychological, social, etc.); however, based on my literature review, it is also noticeable that many researchers focus solely focus on the physical domain (ex. Fried's phenotype). If a study used a tool with multiple items, whether it was only within the physical domain or multiple domains, the interplay of the different items looked to be of value as this would still encompass the traits of frailty of complexity, synergy, and cumulative effects. As seen in the literature review, these stressors will impact on a patient's outcomes thereby implicating the fourth trait of frailty of susceptibility.

Thesis Outline

The thesis is comprised of four chapters:

Chapter One: This chapter includes the introduction of the thesis, the general background, the description of frailty, a literature review, the rationale for the review, the purpose of the review, my personal impetus, and the description of the conceptual influence.

Chapter Two: This chapter provides a description of the methodology of the thesis including the study design, the eligibility criteria, the search strategy, the screening process, the data extraction, the quality assessment, and the data synthesis process.

Chapter Three: This chapter describes the results of the systematic review including the study selection, the characteristics of the included studies, the findings from the quality assessment, a review of the included frailty screening instruments, and the results from the examination of the association between frailty and rehabilitation outcomes among older adults.

Chapter Four: This chapter includes an integrated discussion of the findings in the review and its implications for geriatric rehabilitation, nursing practice, future research, education, and a review of the limitations and strengths of the thesis.

Chapter Two

Methods

Methods

This chapter provides a detailed description of the methods for this systematic review including the research question, the study design, the eligibility criteria, the search strategy, the screening process, the data extraction, the quality assessment, and the data synthesis process.

Research Question

What is the association between frailty status and rehabilitation outcomes among older adults?

Protocol and Registration

This systematic review was developed using the Cochrane Handbooks and the Preferred Reporting Items for Systematic Reviews, Meta-Analyses (PRISMA) standardized reporting format as a guides (Higgins et al., 2019; Moher et al., 2009). The Cochrane Handbook for Systematic Review of Interventions details the steps to completing a systematic review/meta-analysis on the effects of health care interventions (Higgins et al., 2019). The PRISMA reporting format includes a checklist and a flow diagram (Moher et al., 2009). The checklist describes the different sections to report in a systematic review/meta-analysis and the flow diagram shows how to illustrate the study screening/selection process (Moher et al., 2009). These guides were chosen to add structure and rigour to the systematic review. See Appendix F for the PRISMA checklist. The protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO, # CRD42019121179) (Centre for Reviews and Dissemination, 2018).

Eligibility Criteria (See Appendix G for the eligibility document)

Inclusion Criteria

Participants. The population of interest was adults aged 65 years and older. If a population in an article was a range (ex. 18-80 years) or is 60 years and over, it needed to be evident that at least 50% of the participants are 65 years and older.

Intervention [Exposure]. The exposure of interest was frailty. Frailty in older adults was defined by Tocchi's (2015, p.79) concept analysis as a "a tenuous state of health that is the result of the complex interplay of physiological, psychosocial, and environmental stressors that increases an older adult's susceptibility to adverse health outcomes." Studies needed to have screened patients' frailty level using a screening tool to be eligible for inclusion in the systematic review. Frailty did not need to be screened multiple times to reflect the tenuous nature of this concept, as we did not want to eliminate the potential for cross-sectional designs to be included. Frailty screening tools should include multiple health items (ex. cognition, gait speed, weakness, social support) versus a single item (ex. grip strength) to reflect the complex interplay of stressors as noted in the definition. Items could be classified as all physiological, all psychosocial, etc. if there was more than one item for frailty screening. Examples of tools include Fried's Phenotype Model (Fried et al., 2001), frailty indexes (Rockwood & Mitnitski, 2007), the Edmonton Frail Scale (Rolfson et al., 2006), and the Clinical Frailty Scale (Rockwood et al., 2005).

Context. The setting was inpatient rehabilitation which was defined as an in-hospital program that provides a set of interventions with the purpose of restoring or maintaining functioning for populations that are affected by disability or disease (Bachmann et al., 2010; Paraschiv et al., 2015). Day hospital, outpatient rehabilitation programs, acute care of the elderly

units, and geriatric monitoring units were excluded as these units are different than an inpatient rehabilitation program (ex. day hospital/outpatient programs patients are based in the community, acute care of the elderly/geriatric monitoring unit patients require higher degrees of medical management) (Health Quality Ontario and Ministry of Health and Long-Term Care, 2013). Should an article include both inpatient rehabilitation and another setting, it needed to be evident that over 50% of the population come from the inpatient rehabilitation setting. As previously mentioned, there is limited research on frailty in this setting.The initial thought was that there would be limited studies based solely in the inpatient geriatric rehabilitation setting and there would be more primary studies involving multiple settings. This strategy was developed to assist with screening to include studies that primarily focused on the inpatient geriatric rehabilitation setting even if multiple settings were included in one particular study.

Outcomes. Since the goal of rehabilitation is to maintain and/or restore function, the primary outcome was functional status. Functional status was defined by Wang's (2004, p. 462) concept analysis where functional status is the "activities performed by an individual to realize needs of daily living in many aspects of life including physical, psychological, social, spiritual, intellectual, and roles." This review's focus was functional status either at discharge or the change in functional status over the course of the rehabilitation stay. Secondary outcomes included length of stay in rehabilitation, discharge destination, and readmission to acute care. Length of stay in rehabilitation was defined as the duration, in days or months, of a single stay in the inpatient rehabilitation program. Discharge destination was the location where a patient is sent upon either completion of the rehabilitation program or due to medical instability. Examples of discharge destinations may include home, long-term care facility, hospice, etc. Readmission to acute care signified whether a patient was admitted for acute hospitalization as their discharge

destination or within a year of discharge. An expert (A.H.) in inpatient geriatric rehabilitation was also consulted to ascertain if the chosen outcomes were appropriate.

Types of Studies. Quantitative, qualitative, and mixed method studies were included in this review including randomized, non-randomized, quasi-experimental, cohort (both retrospective and prospective), cross-sectional, case-control, correlational, descriptive, phenomenology, grounded theory, ethnography, narrative, and mixed method study designs.

Exclusion Criteria

Excluded studies included case reports as they focus solely on individual patients which would provide limited information as well as possibly introduce bias. Editorials, systematic reviews, and reviews were not excluded at the title and abstract screening as they were reviewed to see if their content or their references would discuss any articles that could be eligible for inclusion in the review. They were excluded at the full-text review stage. Studies were not limited by date nor by language.

Literature Search

An experienced librarian (L.S.) helped complete the primary search strategy of the electronic databases. The search strategy was peer-reviewed by a second librarian using the Peer Review of Electronic Search Strategies (PRESS) (Mcgowan et al., 2016). See Appendix H for PRESS guideline. Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Embase were searched on Jan 24th, 2019 and Scopus was searched on Jan 29th 2019 using the medical subject headings (MeSH) and using keywords relating to older adults, rehabilitation, frailty, and inpatient. The search was not be limited by language (translated as needed into English) or date. See Appendix I for the search strategies.

A secondary search of the included studies' reference lists was also conducted to identify additional eligible studies. Grey literature was also searched, specifically Open Access Theses and Dissertations, Proquest Dissertations and Theses Global, EthOS – Electronic Theses Online Service, and the websites The Canadian Frailty Network, the National Institute on Aging, and the Canadian Association on Gerontology. Grey literature databases used a similar search strategy as the one used for Scopus. Websites were examined for any past publications, past or ongoing projects, and for any other references of studies of relevance. There was no restriction by date for the search of grey literature.

Screening

Search results were uploaded into Covidence, an online systematic review software, to facilitate the screening process and duplicates were removed. Two reviewers (E.S. and R.A.) independently screened the titles and abstracts against the inclusion and exclusion criteria. See Figure 2.1 for the screening questions. Full-text copies were retrieved of all citations identified as: having potential relevance to the objective of the review and where there was insufficient information to decide as to relevance. All discrepancies with respect to relevance were resolved through consensus.

Figure 2.1 Questions for Title and Abstract Screening

1. Is the study design appropriate (all but case control)? Y/N/Unsure

If yes or unsure, continue to #2

If no, exclude

2. a) Is the population 65 and older? Y/N/Unsure

If yes or unsure, continue to #3

If no, go to b)

b) Is over 50% of the population aged 65 and older?

If yes or unsure, continue to #3

If no, exclude

3. a) Is the setting inpatient rehabilitation? Y/N/Unsure

If yes or unsure, continue to #4

If no, go to b)

b) Does 50% of the population come from the inpatient rehabilitation setting Y/N/Unsure

If yes or unsure, continue to #4

If no, exclude

4. Does the study examine any of these outcomes: functional status, length of stay, discharge destination, readmission to acute care? Y/N/Unsure

If yes or unsure, continue to #5

If no, exclude

5. Does the study assess frailty? Y/N/Unsure

If yes or unsure, include

If no, exclude

Full-text screening was then conducted independently by the two reviewers (E.S. and R.A.) to assess eligibility of the articles to be included in the final review. Screening questions were similar except frailty needed to be assessed more thoroughly where the authors of the included studies needed to use a screening tool to measure frailty and this tool needed to include more than one health item. Editorials, systematic reviews, and reviews were excluded at full-text review. An attempt to find potential accompanying publications to conference abstracts that were being kept for data extraction was done. Authors of conference abstracts that yielded no full-text publication were contacted directly via email to confirm no publication was available. Once the total full-text articles were assumed, I contacted an expert (A.H.) in inpatient rehabilitation to

review the obtained resulting citations. The goal was to assess whether any seminal or other articles were missing.

Data Extraction

A data extraction form was drafted, and revisions were made based on the feedback received from the review team. Data extraction was completed in Excel. The data extracted included, but was not limited to, the study reference, the country of study, the study purpose or objectives, the study design as described by the author, the setting, sample characteristics (sample size, type of population, average age, including age frequencies for female and male if available), the type of frailty assessment (name of tool, number of items, list of items, timing of the frailty screening [prior to admission, at admission, discharge], frailty results), the outcomes of interest (functional status [type of instrument used, functional status scores, timing of functional status measurements], length of stay in rehabilitation [average length of stay per frailty level if available], discharge destination [community, long-term care, hospice/palliative care, other including a frequency for each], readmission to acute care [yes/no, frequency for each] and the study results (overall results and significant results should include either a p-value/confidence interval, and/or test statistic). Two reviewers (E.S. and R.A.) independently extracted the data. The two reviewers (E.S. and R.A) discussed any discrepancies and adjusted results accordingly. Authors of abstract-only texts were contacted directly via email to obtain any missing information needed for data extraction.

Quality Assessment

Articles with a cohort design were evaluated for quality using the Newcastle-Ottawa Scale (NOS) (Wells et al., 2008). This tool was designed for nonrandomized studies where one version is applicable to cohort studies and another version applies to case-control studies (Wells

et al., 2008). The scale contains eight items over three domains (selection, comparability, and outcome) (Wells et al., 2008). The scale is a nine-star rating system where one can apply a maximum of one star per item, except with comparability for which one can apply a maximum of two stars (total possible score 9) (Wells et al., 2008). Several experts completed a critical review of the included items of the scale and determined good face and content validity (Wells et al., 2008). See Appendix J for the Newcastle-Ottawa Scale and see Appendix K for the Newcastle-Ottawa coding manual (Wells et al., 2008).

The first domain 'Selection' covers 4 items: representativeness of the exposed cohort, selection of the non-exposed cohort, ascertainment of exposure, and demonstration that the outcome of interest was not present at the start of the study. The second domain 'Comparability' contains 1 item: comparability of cohorts on the basis of the design or analysis. The last domain 'Outcome' has 3 items: assessment of outcome, was follow-up long enough for the outcomes to occur, and adequacy of follow up of cohorts (Wells et al., 2008).

Under the item, representativeness of the exposed cohort, one needs to identify the percentage that one will accept as truly representative of the average in the community and the percentage for somewhat representative of the average in the community. Determining appropriate values proved to be challenging as there is limited frailty research in the rehabilitation setting. I did not find a prevalence study of frailty within the geriatric rehabilitation setting. Siriwardhana and colleagues found a 17.4% prevalence of frailty in community-dwelling older adults aged 60 years and over from low-income to middle-income countries (Siriwardhana, et al., 2018). Collard and colleagues found an overall weighted prevalence of frailty of 10.7% in community-dwelling older adults aged 65 years and over (Collard et al., 2012). In another study, the prevalence of frailty on four clinical wards with patients aged 75 and over ranged 50%-80%

(Andela et al., 2010). Dent and colleagues found the prevalence of frailty ranged from 24% – 94% in hospitalized older adults aged 70 and over depending on the tool used to measure frailty (Dent et al., 2014). Moreover, 51% of patients aged 65 and over in a community hospital recovering from a hip fracture were identified as frail (Kistler et al., 2015). With all the varying ranges of frailty, it was decided that the prevalence should be at least 50% to be truly representative of the average in the community so as to reflect the higher frailty rates in hospital and 10% for somewhat representative to achieve at least similar values to what would be seen in the community for older adults. A star was applied if the frail population in the study (the exposed cohort) was either truly representative of the average in the community (50%) or somewhat representative of the average in the community (10%).

For the item referring to the selection of the non exposed cohort, a star was applied if the non frail (non exposed cohort) group came from the same community as the frail groupings (exposed cohort). If it was unclear, not reported, or the non frail cohort came from a different source, then no star was applied. Under the ascertainment of exposure item, we applied a star if a patient used an instrument to screen for frailty. No star was applied if participants were subjectively described as frail. For comparability, a star is applied if a study controls for a predetermined 'most important' factor and another star is assigned if the study controls for any additional factor (Wells et al., 2008). We ascertained that age/sex were the most important factors. Frailty increases with age and is more common in women than men (Siriwardhana et al., 2018, Collard et al., 2012). We applied a star if they controlled for both age/sex and an additional star if the researchers controlled for any other factors. For the final item, adequacy of follow up of cohorts which essentially refers to attrition, we kept the same cutoff as seen in the Quality Assessment and Validity Tool for Before/After Cohort Design Studies of 30%. The total possible

score is 9 or 9/9 = 1. A score a 0.5 or less was identified as a study of low quality, 0.51 -0.65 low moderate quality, 0.66 – 0.79 high moderate quality, and 0.80 and above as high quality. These cutoff values were chosen so as to be consistent with the cutoff values in the Quality Assessment and Validity Tool for Before/After Cohort Design.

To assess the quasi-experimental pretest/posttest study, the Quality Assessment and Validity Tool for Before/After Cohort Design Studies was used adapted from previous systematic reviews (Cummings et al., 2008; Wulff et al., 2011). See Appendix L to see the tool. This tool contained 6 domains (sampling, design, control of confounders, data collection and outcome measurement, statistical analysis and conclusions, drop-outs) and 13 items. Most of the items can score either 1 or 0 points except for 3 items (representativeness of the population, number of pre/post-tests, and comparison strategy) which can be allotted 2, 1, or 0 points. The item that assesses if group comparisons were the same for all occasions can be give a score of 2 or 0. The item which assesses if the dependent variable was reliably and validly measured can be give 1 point if the variable was reliably measured and 1 point if the variable was validly measured. The total possible score is 18 or 18/18 = 1. A score a 0.5 or less was identified as a study of low quality, 0.51 -0.65 low moderate quality, 0.66 – 0.79 high moderate quality, and 0.80 and above as high quality.

Data Synthesis

Quantitative study' results were grouped by frailty instrument, and by outcome (functional status, length of rehabilitation stay, discharge destination, readmission to acute care). A vote counting approach was undertaken for data synthesis (Grimshaw et al., 2003). In this review, we counted the number of studies that resulted in statistically significant effects as well as the number of studies that showed nonsignificant effects between frailty and each outcome of

interest (Grimshaw et al., 2003). Vote counting has its downfalls as it will not demonstrate an estimate of the effect size of frailty on each outcome (Grimshaw et al., 2003). To supplement this approach, tables were developed to illustrate the magnitude of effect for statistically significant results (Grimshaw et al., 2003).

To determine if frailty was related to a specific outcome, we first required that at least 3 articles assessing that particular outcome be present before making a decision. This cut-off point was chosen based on a previous review by Godin and colleagues (2008). Secondly, over 50% of the studies needed to show a significant relationship between frailty and an individual outcome to conclude that frailty was related to this outcome. If bivariate and multivariate statistical analyses were done in an individual study, we used the results of the multivariate findings to determine whether there was a relationship between frailty and that outcome of interest. If results showed equal findings in each possible category for a particular outcome (ex. one study with a significant positive relationship with frailty, one with a significantly negative relationship, and one with a nonsignificant relationship) then the decision on the association between frailty and this outcome was deemed inconclusive. These processes were adapted from previous reviews (Godin et al., 2008; Squires et al., 2011). Sensitivity analyses were completed when appropriate to see if the same conclusion was obtained when low to low-moderate studies were excluded (low: <= 0.5; low-moderate: 0.51-0.65).

Chapter Three

Results

Results

This chapter describes the results of the systematic review including the study selection, the characteristics of the included studies, the findings from the quality assessment, a description of the included frailty screening instruments, and the results relating to the association between frailty and rehabilitation outcomes among older adults.

Study Selection

The database search yielded 1783 titles and abstracts and the grey literature search yielded 305 titles, abstracts, and projects found on websites to review. Once duplicates were removed, 1569 titles, abstracts, and projects remained to review. Of these 1569 results, 96 articles remained for full-text review. After full-text review, 12 articles remained for data extraction. See Figure 3.1 for the PRISMA flow diagram. See Appendix M for the list of excluded articles and the reasons for exclusion. No additional articles were found through searching the included articles references' lists. After discussion with an expert (A.H.) in inpatient rehabilitation, she determined that no seminal research was missing from the included articles.

Characteristics of Included Studies

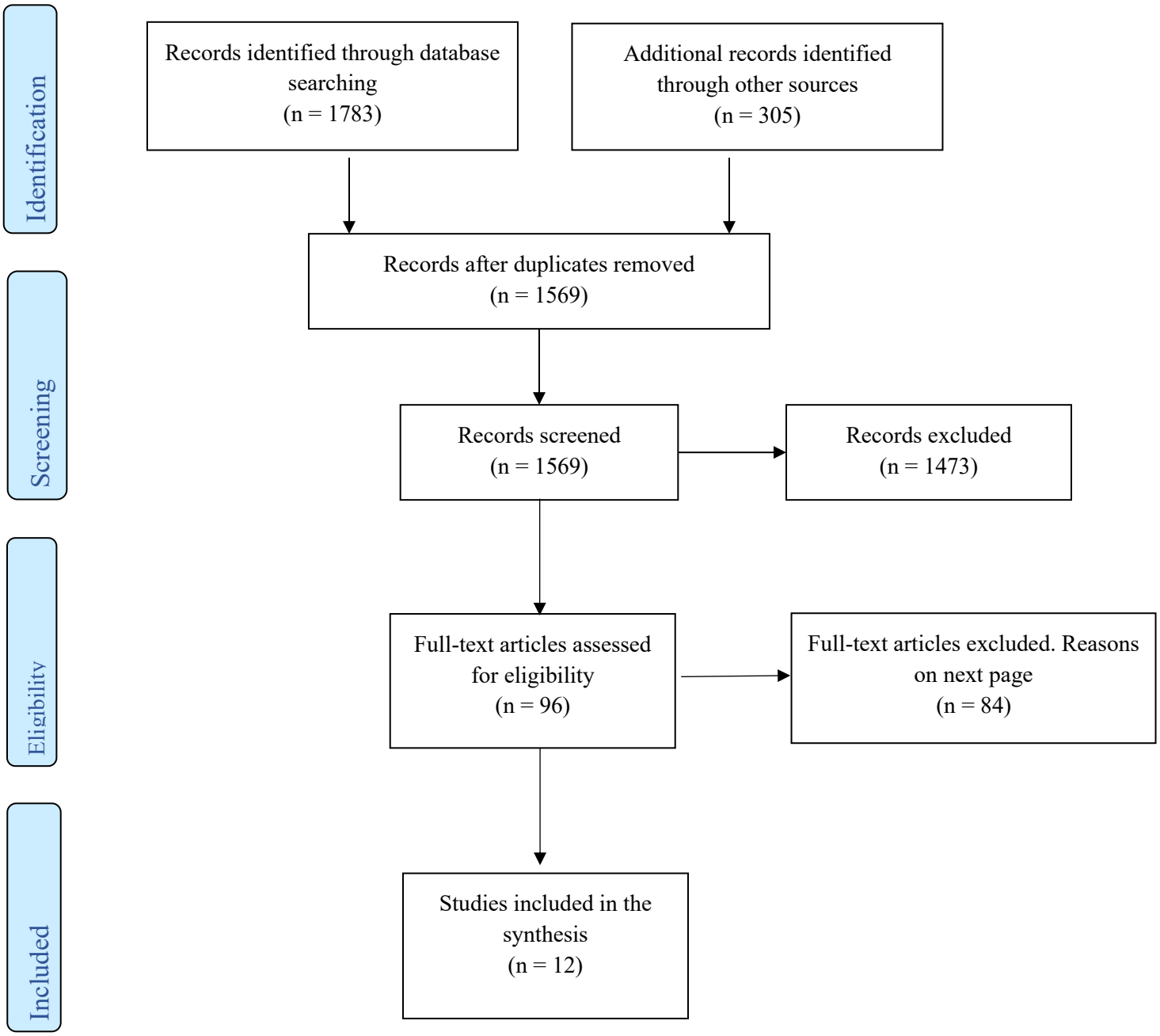
Two articles from the same authors (Arjunan, Peel, & Hubbard), both published in 2018, provided the same information and therefore data was extracted as if the articles were one entity (Arjunan et al., 2018a; Arjunan et al., 2018b).

Country

Four (33.3%) of the 12 articles were conducted in Australia (Arjunan et al., 2018a; Arjunan et al., 2018b; Haley et al., 2014; Kawryshanker et al., 2014), two (16.7%) in Ireland (Cogan et al., 2014; Nolan et al., 2016), two (16.7%) in the United Kingdom (Roberts et al.,

2012; Singh et al., 2012), and 1 (8.3%) each in New Zealand (Heppenstall, 2011), Italy (Opasich et al., 2010), USA (Hamidi et al., 2018), and the Netherlands (van der Ploeg, van der Velde, & Gobbens, 2017).

Figure 3.1 PRISMA Flow Diagram of Included Studies



Full-text articles excluded, with reasons
(n = 84)

20 Did not screen/assess for frailty or frailty was not a concept of interest

14 Did not compare frailty to outcomes of interest/Did not assess outcomes of interest

13 Not in the geriatric rehab setting (acute care, outpatient, home, trauma center, skilled nursing facility, various medicine units)

12 Used the term 'frail elderly', 'frail nature of population' but does not screen or assess for frailty or explain why participants are frail

10 Were literature reviews/discussions of a project/presentations/volume in a journal

6 Were duplicate Articles

5 Did not meet the definition of frailty

3 Were abstracts only where the author did not provide additional data upon contacting them

1 Was the wrong age range

Study Design

Ten (83.3%) of the included articles were prospective cohort studies (Arjunan et al., 2018a; Arjunan et al., 2018b; Haley et al., 2014; Hamidi et al., 2018; Heppenstall, 2011; Kawryshanker et al., 2014; Nolan et al., 2016; Roberts et al., 2012; Singh et al., 2012; van der Ploeg et al., 2017), one (8.3%) was a retrospective cohort study (Cogan et al., 2014), and one (8.3%) was a quasi-experimental pretest/posttest study (Opasich et al., 2010).

Publication Year

All of the articles were published within the past 10 years with 5 (41.6%) articles published in the past 5 years (Arjunan et al., 2018a; Arjunan et al., 2018b; Hamidi et al., 2018; Nolan et al., 2016; van der Ploeg et al., 2017).

Setting

Seven (58.3%) of the 12 studies were conducted on a single unit/ward (Cogan et al., 2014; Heppenstall, 2011; Kawryshanker et al., 2014; Nolan et al., 2016; Opasich et al., 2010; Roberts et al., 2012; Singh et al., 2012) while four (33.4%) were completed on multiple wards within the same hospital (2 to 3 wards maximum) (Arjunan et al., 2018a; Arjunan et al., 2018b; Haley et al., 2014; van der Ploeg et al., 2017). One study identified the setting as a single rehabilitation center which is not clear whether this encompassed only one ward or included multiple units/wards within the center (Hamidi et al., 2018). See Table 3.1 for a brief summary of the characteristics of the included studies. A comprehensive detailing of the 12 articles characteristics are included in Appendix N and Appendix O.

Table 3.1 Characteristics of Included Studies

Characteristics					
First author	**Year**	**Country**	**Study Design**	**Setting**	**Frailty Screening Tool**
Arjunan	2018a, 2018b	Australia	Prospective cohort	Multiple wards within the same hospital	Frailty Index (FI)
Cogan	2014	Ireland	Retrospective cohort	Single unit/ward	Frailty Instrument for primary care of the Survey of Health, Ageing and Retirement in Europe (SHARE-FI)
Haley	2014	Australia	Prospective cohort	Multiple wards within the same hospital	Edmonton Frail Scale (EFS)
Hamidi	2018	USA	Prospective cohort	Single rehabilitation center	Trauma Specific FI
Heppenstall	2011	New Zealand	Prospective cohort	Single unit/ward	EFS
Kawryshanker	2014	Australia	Prospective cohort	Single unit/ward	EFS
Nolan	2016	Ireland	Prospective cohort	Single unit/ward	Clinical Frailty Scale (CFS)
Opasich	2010	Italy	Quasi-experimental (pretest/post-test)	Single unit/ward	Stratification of frailty based off results of Balance Performance Oriented Mobility Assessment (BPOMA) and Get Up and Go test
Roberts	2012	UK	Prospective cohort	Single unit/ward	Strawbridge Frailty Questionnaire

Singh	2012	UK	Prospective cohort	Single unit/ward	FI
van der Ploeg	2017	Netherlands	Prospective cohort	Multiple wards within the same hospital	Indicators of frailty

Quality Assessment

Six (50%) of the 12 articles were rated as high quality (Hamidi et al., 2018; Kawryshanker et al., 2014; Nolan et al., 2016; Roberts et al., 2012; Singh et al., 2012; van der Ploeg et al., 2017). Five (41.7%) articles rated as high- moderate quality (Arjunan et al., 2018a; Arjunan et al., 2018b; Haley et al., 2014; Cogan et al., 2014; Heppenstall, 2011) and one (8.3%) rated as low-moderate (Opasich et al., 2010). The main reasons studies lost points for quality assessment among the cohort studies was a failure to indicate that the exposed cohort was representative of the average in the community and a failure in the design to indicate matching of cohorts and/or a failure to adjust for confounders with their statistical analysis. The pretest/post study design lost points in various areas including probability sample use, appropriateness of sample size, number of pre/posttests, group comparison, reporting of confidence intervals, and treatment of missing data. See Appendix P and Q for the results of the quality assessment.

Frailty Screening Instruments

Nine different methods and/or tools were used to screen for frailty. While four (33.3%) studies used a frailty index (Arjunan et al., 2018a; Arjunan et al., 2018b; Hamidi et al., 2018; Singh et al., 2012), the authors of each article developed their own frailty index following the appropriate criteria for creating a frailty index (Searle et al., 2008). There were only 3 (25%) articles that used the same frailty screening instrument, the Edmonton Frail Scale (Haley et al., 2014; Heppenstall, 2011; Kawryshanker et al., 2014). Frailty was reported in some articles as a mean (Arjunan et al., 2018a; Arjunan et al., 2018b; Haley et al., 2014, Hamidi et al., 2018; Heppenstall, 2011; Kawryshanker et al., 2014; Singh et al., 2012). The study by Heppenstall also reported frailty as median (2011). The study by Nolan and others reported an admission frailty score and discharge fraitly score as a median (Nolan et al., 2016). Some authors reported frailty also as frequencies and/or percentages (per frailty group, or per gender, or per each frailty indicator) (Hamidi et al.,2018; Kawryshanker et al., 2014; Nolan et al., 2016; Opasich et al., 2010; Roberts et al., 2012; van der Ploeg et al., 2017). It was unclear how the abstract by Cogan and colleagues reported frailty (Cogan et al., 2014).

Frailty Stratification

Of the six studies that compared frailty with functional status, four of them stratified frailty into three groupings (Hamidi et al., 2018; Kawryshanker et al., 2014; Nolan et al., 2016; Opasich et al., 2010). Hamidi and colleagues (2018) broke down frailty results into non-frail (TSFI $\leq$ 0.12), prefrail (TSFI = 0.13 – 0.24), and frail (TSFI $\geq$ 0.25) groupings. The categories in another study were prefrail (EFS 0-5), frail (EFS 6-9), and severely frail (EFS 10-17) (Kawryshanker et al., 2014). Mild (CFS score 5), moderate (CFS 6) and severely frail (CFS 7) were the categories in Nolan et al. (2016). Opasich et al. (2010) classified frailty as non-frail

(BPOMA>19 and Get Up and Go ≤ 10), moderate (BPOMA ≤19 or Get Up and Go > 10s), and severe (BPOMA ≤ 9 and Get up and Go > 10s). See Table 3.2 for a summary of the frailty screening instruments and how the frailty results were presented in the articles.

Table 3.2 Frailty Screening Instruments in the Included Studies

Frailty			
Frailty instrument	**Definition**	**Information on reliability and validity of instrument**	**Measurement**
Frailty index (FI)	A person's total number of deficits divided by the total of potential deficits provides the value of the FI. Deficits used in the FI should cover a range of systems, not saturate with age, accumulate with age, and related to adverse health outcomes. A higher score means higher level of frailty **Arjunan 2018a+b:** Items from FIM, number of comorbidities, number of medications were used as deficits for this FI. Total number of deficits considered: >36	Patient 65+ admitted to 3 geriatric rehabilitation wards of a tertiary hospital: **Criterion validity:** area under the curve (AUC) = 0.61 for delirium, 0.71 for longer length of stay, and 0.61 for poorer discharge outcome (discharged to a higher level of care or death) **Predictive validity**: length of stay, poor discharge outcome, delirium **Construct validity**: determined by "its agreement with the usual	**Arjunan 2018a + b**: FI mean **Singh, 2012:** Mean

		characteristics (distribution and theoretical maximum) of a FI". This FI was normally distributed around a mean (SD) of 0.42 (0.13), reaching a submaximal limit of 0.69 (99th percentile) similar to previous FI studies. (Arjunan, 2018a+b)	
	Singh, 2012: For this FI, 15 comorbidities, dependence in ADLS, number of medications, 3 or more falls, poor timed up and go, items in cognition, registered blind, over or underweight, pressure sores, alcohol excess, poor mobility were used as deficits for a total of 40 possible deficits	No information on reliability and validity of the FI in the study by Singh.	
Frailty Instrument for primary care (SHARE-FI) of the Survey of Health, Ageing and Retirement in Europe	Literature indicates it examines exhaustion, loss of appetite, grip strength, walking, low physical activity similar to Fried phenotype	Sample of Europeans aged 50 + in primary care setting: **Criterion validity**: For mortality: women AUC 0.77, $p<0.001$, men AUC 0.76, $p < 0.001$	**Cogan, 2014** (abstract only): No information

		Predictive validity: mortality **Construct validity**: correlation with a FI based on a CGA: two-tailed Spearman's rank correlation coefficient: women = 0.70, p< 0.001, men = 0.59, p <0.001 (Romero-Ortuno, 2013)	
Edmonton Frail Scale (EFS)	11 items, 17-point scale looking at domains like mood, cognition, social support, polypharmacy, IADLS, nutrition, continence, score ranges from 0-17, higher scores indicate higher levels of frailty	In a sample referred for comprehensive geriatric assessment (CGA) aged 65+: **Inter-rater reliability** κ = 0.77, p = 0.0001) **Internal consistency Cronbach's** α = 0.62 **Construct validity**: significant correlation with Geriatrician's clinical impression of frailty (r = –0.64, p < 0.001	**Haley, 2014:** Mean **Heppenstall, 2011:** Mean and median **Kawryshanker, 2014:** Frequencies and percentages per frailty groups (prefrail, frail, severely frail) Mean for overall frailty

		(Rolfson et al., 2006)	
Trauma Specific Frailty Index (TSFI)	15 variables chosen for this index derived from a 50-variables modified Rockwood frailty index, domains include: comorbidities, daily activities, health attitude, function, nutrition. Frail >= 0.25, prefrail 0.13-0.24, non-frail<=0.12	Sample of inpatient trauma patients aged 65+: **Criterion validity**: AUC = 0.829 (CI 0.774–0.884) for unfavorable discharge disposition (discharge to skilled nursing facility or in-hospital mortality) **Predictive validity:** unfavorable discharge disposition (Joseph et al., 2014)	**Hamidi, 2018:** Frequency and percentages per frailty group (non-frail, prefrail, frail) Mean via TFSI per frailty groups
Clinical Frailty Scale (CFS)	Clinical frailty scale is a subjective measurement of frailty ranging from 1-9 with higher scores indicating higher level of frailty	Elderly patient cohort aged 65+ that participated in the second stage of the Canadian Study of Health and Aging: **Intraclass reliability: intraclass correlation**	**Nolan, 2016:** Frequencies per frailty group (mild, moderate, severely frail) Median used for admission and discharge frailty scores

		coefficient (ICC): 0.97, $p < 0.001$ **Criterion validity**: AUC = 0.77 for 18-month and 0.70 for 70-month mortality **Predictive validity**: mortality, institutionalization **Construct validity**: correlation with a frailty index ($r = 0.80$ $p < 0.01$) (Rockwood et al., 2005)	
Stratification of frailty based off results of Balance Performance Oriented Mobility Assessment (BPOMA) and Get Up and Go test	BPOMA: Assessment of static balance. Tests: sitting balance, attempting to rise, rising, immediate standing balance (first 5s), standing balance, nudge, closed eyes, turn 360, and sitting down. Scored 0-16. Assessment of dynamic balance. Test: "The patient stays next to the examiner, walks along the corridor or across the room at 'usual' pace, then goes back at 'rapid, but safe' pace. Hesitancy at initialization, step length, symmetry and continuity, path, trunk and walked distance are scored"	No information. Frailty scorings/stratification developed for this study only.	**Opasich, 2010:** Frequencies per frailty group (non-frail, moderate, severe)

	Scored 0–12. Total score 0–28. Total score <19 indicates risk of fall Get up and go: "Measure of the time taken for a return trip to a pole placed 5m ahead, with the patient starting from a seated position in a chair" Non-frail: BPOMA>19 and Get Up and Go <= 10s Moderately frail: BPOMA <=19 or Get Up and Go > 10s Severely frail: BPOMA <= 9 and Get up and Go > 10s		
Strawbridge Frailty Questionnaire	Reference mentioned in the article defines frailty as having problems or difficulties in two or more of four domains (physical functioning, nutritive, cognitive functioning, and sensory), 16 items in total, items scored 1 - 4 with a higher score meaning more difficulty	Sample of elderly outpatients: **Agreement between physician subjective frailty assessment and Strawbridge classification**: kappa=0.294 **Construct validity**: with physical performance measures (mean Timed Up and Go r= 0.321, p=0.026, mean Sit-to-Stand r=0.499,	**Roberts, 2012:** Frequencies and percentages of frail participants per gender

		p<0.001, mean bimanual dexterity r=0.343, p=0.017) (Matthews et al., 2004)	
Indicators of frailty (fatigue, mobility, balance, weight loss): yes or no questions that the physiotherapist and the patient each would answer	Fatigue: Does the patient experience problems in his/her daily life because of physical tiredness? Mobility: Does the patient experience problems in his/her daily life because of difficulty walking? Balance: Does the patient experience problems in his/her daily life because of difficulty in maintaining balance? Weight loss: Has the patient lost a lot of weight recently without wishing to do so?	No information. Frailty screening developed for this study only. Elements from the Tilburg Frailty Indicator used.	**van der Ploeg, 2017:** Frequencies and percentages for each indicator and for patient and physiotherapist answers

Outcomes

Overall, 6 (50%) articles examined the relationship between frailty and functional status (Cogan et al., 2014; Hamidi et al., 2018; Kawryshanker et al., 2014; Nolan et al., 2016; Opasich et al., 2010; Singh et al., 2012), 7 (58.3%) between frailty and length of stay (Arjunan et al., 2018b; Cogan et al., 2014; Haley et al., 2014; Hamidi et al., 2018; Nolan et al., 2016; Opasich et al., 2010; van der Ploeg et al., 2017), 8 (66.7%) between frailty and discharge destination (Arjunan et al., 2018a; Arjunan et al., 2018b; Cogan et al.,

2014; Haley et al., 2014; Kawryshanker et al., 2014; Roberts et al., 2012; Singh et al., 2012; van der Ploeg et al., 2017), and 2 (16.7%) on frailty and readmission to acute care (Cogan et al., 2014; Heppenstall, 2011).

Primary Outcome

Frailty and Functional Status. Of the six articles that examined frailty and functional status, each of them measured frailty using a different method. Half (50%) of the articles measured functional status with the Barthel Index (Cogan et al., 2014; Nolan et al., 2016; Singh et al., 2012), 2 (33.3%) used the Functional Independence Measure (FIM) (Hamidi et al., 2018; Kawryshanker et al., 2014), and 1 (16.7%) used nursing needs (Opasich et al., 2010). The Barthel index is a 10-item instrument that measures a person's performance in ADLs (Bouwstra et al., 2019). The FIM is an 18-item instrument that measures the amount of functional assistance required for a person to perform ADLs (Kohler et al., 2010). The Barthel index will score some activities from 0-1, some 0-2, and others 0-3 with 0 always representing total assistance and the highest number representing total independence with scores ranging 0-20. The FIM scores activities from 1 (total assistance) to 7 (total independence) with scores ranging 18 to 126. Nursing needs, as seen in Opasich and colleagues, was defined as an 8-item test that assessed the ability to communicate and to perform self-care activities (Opasich et al., 2010). The test scored items from 0-3 with a total score ranging 0-24 where a higher score indicates higher levels of nursing needs.

Four articles (66.7%) presented the functional status as a mean (Hamidi et al., 2018; Kawryshanker et al., 2014; Opasich et al., 2010; Singh et al., 2012), and two (33.3%) presented functional status as a median (Cogan et al., 2014; Nolan et al., 2016). Three studies (50%) examined the relationship between frailty and the discharge functional status (Hamidi et al., 2018; Kawryshanker et al.,

2014; Nolan et al., 2016), three studies (50%) analyzed the association between frailty and functional change (the difference between discharge functional status from the admission functional status score) (Cogan et al., 2014; Hamidi et al., 2018; Singh et al., 2012), one (16.7%) examined the association between frailty and an admission functional status score (Opasich et al., 2010), and one (16.7%) assessed the association between frailty and functional gain (average gain in functional status on each day in rehabilitation) (Hamidi et al., 2018).

Of the three studies that examined the association between frailty and discharge functional status (Hamidi et al., 2018; Kawryshanker et al., 2014; Nolan et al., 2016), all (100%) of them found a significant negative association (β = - 0.304-3.7, p values 0.001-0.044). Two (33.3%) out of the three studies that examined the association between frailty and functional change (discharge-admission) found a significant negative association (no test statistic provided, p value $\leq$ 0.001) (Hamidi et al., 2018; Singh et al, 2012). Opasich et al. (2010) found a significant association between frailty level and admission nursing needs (no test statistic provided, p value < 0.0001) meaning the higher the frailty level, the more nursing needs required. Hamidi et al. (2018) found a significant negative relationship between frailty level as well as prefrailty level and functional status gain (average change per day in functional status) (frail status: β = - 2.9, p value 0.001, prefrail status: β = -1.8, p value 0.01). The abstract by Cogan, Tiernan, and Romero-Ortuno (2014) found a nonsignificant relationship between frailty and functional change while the study by Hamidi and others (2018) found a nonsignificant relationship between prefrailty status and discharge functional status. See Table 3.3 for findings.

In order to decide if there is an association between frailty status and functional status, there first needs to be a minimum of 3 articles that assessed the association between frailty and functional status per the stated guidelines developed in the ‘Methods’ section.

There are three articles that assessed this association between frailty and discharge functional status (Hamidi et al., 2018; Kawryshanker et al., 2014; Nolan et al., 2016), and three articles that assessed the association between frailty and functional change (Cogan et al., 2014; Hamidi et al., 2018; Singh et al., 2012) thereby satisfying the first requirement. Secondly, over 50% of the studies needed to show a significant relationship between frailty and an individual outcome to conclude that frailty was related to this outcome. All three studies examining discharge functional status found a negative relationship between frailty status and discharge functional status. This result means patients with higher levels of frailty have worse discharge functional status compared to patients with lower levels of frailty.This negative relationship was found on multivariate analysis in each article which lends to a stronger case of the presence of an association between these variables. In addition, all the included studies were determined to be of high quality (>=0.80). Two out of three studies found a significant negative association between frailty and functional change (Hamidi et al., 2018; Singh et al., 2012). This was found on bivariate analysis only. Both studies were found to be of high quality (>=0.80) and the study that found a nonsignificant relationship was determined to be high-moderate quality (0.66-0.79) (Cogan et al., 2014). There was limited information to account for the different findings as the included study by Cogan and others was an abstract only and did not have a full-text publication available. One of the differences that can be noted however is that the other two studies had larger number of participants in their included studies (Hamidi: 267, Singh: 265) compared to Cogan (172). The smaller sample size in the study by Cogan and colleagues lowers the statistical power meaning the association between frailty and functional change may not be seen on statistical testing even if it might possibly be related (Polit & Beck, 2017). Based on the presenting results, we can say there is evidence of a negative association between frailty status and discharge functional status as well as between frailty and functional

change. Higher levels of frailty lead to lower discharge functional status scores and poorer functional change in the geriatric rehabilitation setting among older adults.

Table 3.3 Summary of Findings – Functional Status

Association between frailty and functional status									
First Author, year	**Frailty Screening Method**	**Functional Status Tool Used**	**Functional Status Tool Definition**	**Measurement of Functional Status**	**Significance**	**Test**	**Direction and Magnitude**	**Comment**	**Quality of study**
Cogan, 2014 (abstract only)	SHARE-FI	BI	10 item instrument that measures the degree of assistance required by a person to perform ADLs and mobility, some activities scored 0-1, some 0-2, 0-3 with 0 always representing total assistance and the higher number	Median BI change: $BI_{discharge} - BI_{admission}$	Nonsignificant	No information	N/A	P= 0.247	High-moderate

			representing total independence, score ranges from 0-20 but can be multiplied by 5 to get a result on a 100 point scale						
Hamidi, 2018	TSFI	FIM	18 item instrument which measures the amount of functional assistance required for a person to perform ADLs in domains such as self-care, sphincter function, mobility, communication, and social cognition	Mean delta FIM (Delta $FIM_{discharge}$ - $FIM_{admission}$)	Significant	ANOVA (if parametric) or Kruskal-Wallis (if non-parametric), the study did not say if the data was normally distributed	- (no test statistic provided)	P value = 0.001	High
				Discharge FIM	Significant (for frail status)	Linear regression	– (β = -3.7) (frail status)	P value = 0.001	

			Each activity is scored from 1 (total assistance) to 7 (total independence), total score can range from 18 to 126		Nonsignificant (for prefrail status)			P value = 0.12
				Mean gain FIM (Gain FIM: average change in FIM on each day in rehab)	Significant (for both prefrail and frail status)	Linear regression	- (β = -2.9) (frail) -(β = -1.8) (prefrail)	P value = 0.001 (frail) 0.01 (prefrail)
Kawryshanker, 2014	EFS	FIM	Same definition as the one for Hamidi, 2018	Mean FIM change ($FIM_{discharge}$ - $FIM_{admission}$)	Significant (**with discharge FIM**)	Stepwise regression	- (β = -1.151)	P value = 0.014	High
Nolan, 2016	CFS	BI	Same definition as the one for Cogan, 2014	Median Discharge FIM	Significant	Linear regression	- (β= -0.304)	P value < 0.044	High

			BI measured on a 100-point scale here.						
Opasich, 2010	Stratification of frailty based off results of Balance Performance Oriented Mobility Assessment (BPOMA) and Get Up and Go test	Nursing needs	8 items which assess the ability to communicate and to perform self-care, scored from 0-3 with total score ranging 0-24, higher scores indicate higher levels of nursing needs	Mean baseline nursing needs	Significant	two factor analysis of variance, Fisher's least significance difference test	+ (no test statistic provided)	P value < 0.0001	Low-moderate
Singh, 2012	FI	BI	Same definition as the one for Cogan, 2014	Mean	Significant (**with functional gain i.e. change in BI**)	ANOVA	- (no test statistic provided)	P value < 0.001	High

	Measured on a 20-point scale here

Secondary Outcomes

Frailty and Length of Stay. Among the studies that examined frailty and length of stay, all (n= 7, 100%) of them used a different method to measure frailty. One (14.3%) out of the seven studies classified length of stay as long stay in rehabilitation meaning a length of stay in rehabilitation >= 75th percentile (Arjunan et al., 2018b) as opposed to the duration, in day, of the rehabilitation stay. The 75th percentile was determined based on the distribution frequency of rehabilitation length of stay (in days) (Arjunan et al., 2018b). The remaining studies (85.7%) measured length of stay in days as the total length of time spent in rehabilitation (Cogan et al., 2014; Haley et al., 2014; Hamidi et al., 2018; Nolan et al., 2016; Opasich et al., 2010; van der Ploeg et al., 2017). Four (57.1%) of the studies reported length of stay as a mean with some as an overall score (Arjunan et al., 2018b; Hamidi et al., 2018) and others as a mean per frailty group (non-frail, moderate, severe) (Opasich et al., 2010)/frailty indicators(fatigue, mobility, balance, weight loss) (van der Ploeg et al., 2017). Three studies (42.8%) reported length of stay as a median as either an overall measurement (Cogan et al., 2014; Haley et al., 2014) or per frailty groups (mild, moderate, severe) (Nolan et al., 2016). Long length of stay was reported as a frequency and percentage.

Four (57.1%) studies showed a positive relationship between frailty and length of stay ($\beta = 0.299$ (from Nolan et al., 2016 only, no test statistic from other articles), p values 0.0001-0.047) (Cogan et al., 2014; Hamidi et al., 2018; Nolan et al., 2016; Opasich

et al., 2010). One (14.3%) found a significant relationship between frailty and long length of stay (regression OR 6.07 [CI 3.06-12.06]) (Arjunan et al., 2018b). Haley et al. (2014) found a nonsignificant relationship between frailty and length of stay. The statistical analysis in the study may not have been able to detect an association between the two variables due to the small sample size of only 86 participants (low statistical power) (Polit & Beck , 2017). Van der Ploeg and colleagues demonstrated a significant relationship between their frailty indicator of weight loss and length of stay (no test statistic provided, $p < 0.05$) but they also found nonsignificant relationships between the frailty indicators of fatigue, mobility, and balance and length of stay (van der Ploeg et al., 2017). See Table 3.4 for findings.

There are over three articles (n=7) examining the outcome of length of stay, which meets the minimum required to make a decision on the association between frailty and length of stay. Four (80%) out of the five articles that solely looked at frailty and length of stay found a significant relationship (Cogan et al., 2014; Hamidi et al., 2018; Nolan et al., 2016; Opasich et al., 2010) which is more than half of the total articles which satisfies the second requirement. Two (50%) of the studies gave bivariate results (Hamidi et al., 2018; Opasich et al., 2010) and the remaining two (50%) presented multivariate data (Cogan et al., 2014; Nolan et al., 2016). Two (50%) of the studies were of high quality (Hamidi et al., 2018; Nolan et al., 2016), one (25%) was high-moderate (Cogan et al., 2014) and one (25%) was low-moderate (Opasich et al., 2010). Based on the presenting results, we can conclude that there is an association between frailty status and length of stay. Higher levels of frailty lead to longer length of stay in the geriatric rehabilitation setting.

If we do a sensitivity analysis and exclude the low-moderate study by Opasich and colleagues (2010), we still meet both criteria of a minimum number of articles (n=6), and greater than 50% of the studies showing a significant association (3/4 articles, (75%) between frailty and length of stay (not including long length of stay). Our conclusion remains the same. Frailty is associated with length of stay in the geriatric rehabilitation setting among older adults.

Table 3.4 Summary of Findings – Length of Stay

Association between frailty and LOS								
First Author, year	**Frailty Screening Method**	**Definition of LOS**	**Measurement of LOS**	**Significance**	**Test**	**Direction and Magnitude**	**Comment**	**Quality of Study**
Arjunan, 2018b	FI	Long stay in rehabilitation, measured as days in rehabilitation >= 75th percentile (based on the frequency distribution of rehabilitation length of stay)	Long length of stay: frequencies and percentages LOS in rehab: mean	Significant **(with long length of stay)**	Logistic regression	+ (Odds ratio (OR) = 6.07)	CI 3.06-12.06	High-moderate

Cogan, 2014 (abstract only)	SHARE-FI	LOS in days	Median per frailty group	Significant	Linear regression	+ (no test statistic provided)	P value = 0.047	High-moderate
Haley, 2014	Edmonton Frail Scale (EFS)	LOS, in days	Median	Nonsignificant	Spearman's rho and linear regression	N/A	P value = 0.24 for bivariate and 0.09 for regression	High-moderate
Hamidi, 2018	Trauma Specific Frailty Index (TFSI)	LOS in rehab, in days	Mean per frailty group	Significant	ANOVA (if parametric) or Kruskal-Wallis (if non-parametric), the study did not say if the data was normally distributed	+ (no test statistic provided)	P value = 0.001	High

Nolan, 2016	grip strength and Clinical Frailty Scale (CFS)	LOS in rehab, in days	Median overall and per frailty group	Significant	Linear regression	+ (β = 0.299)	P value < 0.024	High
Opasich, 2010	Stratification of frailty based off results of Balance Performance Oriented Mobility Assessment (BPOMA) and Get Up and Go test	LOS in rehab, in days	Mean per frailty group	Significant	two factor analysis of variance, Fisher's least significance difference test	+ (no test statistic provided	P value = 0.0001	Low-moderate
van Der Ploeg, 2017	Indicators of frailty (fatigue, mobility, balance, weight loss): yes or no questions that the physiotherapist and the patient	Time until discharge home (subtracted discharge date from admission date), in days	Mean per each frailty indicator reported by patient and physiotherapist	Significant **(with frailty indicator weight loss and LOS)** Both patient and physio reported that	Kaplan-Meir survival analysis (time until death and time until discharged home as DV)	+ (no test statistic)	P value <0.05	High

each would answer	weight loss was associated with time until discharge home			
	Nonsignificant **(with frailty indicators fatigue, mobility, balance, and LOS)**	Kaplan-Meir survival analysis (time until death and time until discharged home as DV)	N/A	N/A

Frailty and Discharge Destination. Two (25%) of the eight studies measured frailty using the EFS (Haley et al., 2014; Kawryshanker et al., 2014). The two studies by Arjunan, Peel, and Hubbard (2018a; 2018b) used the same frailty index. The remaining studies measured frailty using different frailty screening methods (Cogan et al., 2014; Roberts et al., 2012; Singh et al., 2012; van der Ploeg et al., 2017). The studies by Arjunan et al. (2018a; 2018b) examined discharge destination as patients requiring higher level of care (requiring residential aged care or higher level of support on discharge). Singh and colleagues examined discharge destination based on whether patients went to their original residence within a certain time frame or not (good/intermediate outcome)

or whether they required a new care home placement, or they died (poor outcome) (Singh et al., 2012). The studies all presented the discharge destinations as frequencies and/or percentages.

Four (50%) of the eight studies found a significant relationship between frailty status and change in residence (described in the studies as either higher level of care, change in dependency, worsening outcome) (OR=1.38 [CI 1.11-1.7], X^2 = 22.442, p values <0.001) (Arjunan et al., 2018a; Arjunan et al., 2018b; Kawryshanker et al., 2014; Singh et al., 2012). One study (12.5%) found a negative relationship between frailty status and discharge rates to home (no test statistic provided, p value = 0.009) (Cogan et al., 2014). Roberts and colleagues found a negative association between frailty level and discharge to usual residence among female participants (HR=0.39, p value= 0.01) (nonsignificant among male participants) (Roberts et al., 2012). One (12.5%) article found a negative significant relationship between their frailty indicator of physiotherapist reported weight loss and discharge to home (HR=0.67, p<0.05) (van der Ploeg et al., 2017). One (12.5%) study found a nonsignificant relationship between frailty and discharge destination (Haley et al., 2014). See Table 3.5.

Overall, five (83.3%) out of the six studies that examined frailty and discharge destination found a significant association (whether positive towards higher level of care or negative towards discharge to home) (Arjunan et al., 2018a; Arjunan et al., 2018b; Cogan et al., 2014; Kawryshanker et al., 2014; Singh et al., 2012). Three of the studies presented multivariate data (Arjunan et al., 2018a; Arjunan et al., 2018b; Cogan et al., 2014) and two presented bivariate data (Kawryshanker et al., 2014; Singh et al., 2012). The study that presented a nonsignificant relationship only completed a t test and again here, included a small sample size which may account for the nonsignificant results (Haley et al., 2014; Polit & Beck, 2017). Out of the five significant studies, two were of high

quality (Kawryshanker et al., 2014; Singh et al., 2012), and three were of high-moderate quality (Arjunan et al., 2018a; Arjunan et al., 2018b; Cogan et al., 2014). The minimum number of studies required to make a decision of an association is met with six studies and over 50% of the studies finding a significant association between frailty and discharge destination. One can conclude there is evidence of an association between frailty status and discharge destination. Higher levels of frailty lead to lower discharge rates to home and higher risk of change in residence in the geriatric rehabilitation setting among older adults.

Table 3.5 Summary of Findings – Discharge Destination

Association between frailty and discharge destination								
First Author, year	**Frailty Screening Method**	**Definition of discharge destination (if needed)**	**Measurement of Discharge Destination**	**Significance**	**Test**	**Direction and Magnitude**	**Comment**	**Quality of Study**
Arjunan, 2018a and b	FI	Requiring higher level of care (requiring residential aged care or higher level of support on discharge)	Frequencies and percentages	Significant **(with higher level of care)**	Logistic regression	+ (OR = 1.38)	CI 1.11-1.70	High-moderate

Cogan, 2014 (abstract only)	SHARE-FI		Discharged home percentages per frailty group	Significant **(discharge rates to home)**	Linear regression	- (no test statistic provided)	P value = 0.009	High-moderate
Haley, 2014	EFS		Frequencies and percentages	Nonsignificant	T test	N/A	P value = 0.19	High-moderate
Kawryshanker, 2014	EFS		Frequencies	Significant **(with change in dependency/change in domicile)**	Chi-square	+ (X^2 = 22.442)	P <0.001	High
Roberts, 2012	Strawbridge Frailty Questionnaire		Frequencies and percentages	Significant **(with discharge to usual residence for female participants)**	Cox's proportional hazard model	- (HR = 0.39)	CI 0.21-0.76 P value = 0.01	High
Singh, 2012	FI	Good outcome: discharged to original residence	Frequencies	Significant	ANOVA	+ (no test statistic provided)	P value < 0.001	High

		within 28 days Intermediate outcome: discharge to original residence but LOS more than 28 days Poor outcome: New care home placement or inpatient mortality		**(with worsening outcome)**				
van der Ploeg, 2017	Indicators of frailty (fatigue, mobility, balance, weight loss): yes or no questions that the physiotherapist and the		Frequencies and percentages	Significant **(physio reports of the frailty indicator weight loss with discharged to home)**	Cox regression	- (HR = 0.67)	CI 0.48-0.95 P value <0.05	High

patient each would answer

Frailty and Readmission to Acute Care. The two studies (Heppenstall, 2011; Cogan et al., 2014) that examined frailty and readmission to acute care measured frailty with a different tool. Cogan et al. (2014) looked at transfers to acute care during their rehabilitation stay, while Heppenstall (2011) looked at hospital admissions 1-year post discharge. Readmission to acute care was presented as percentages in one article (Cogan et al., 2014) and frequencies and percentages in the other (Heppenstall, 2011).

Both studies (n=2, 100%) found a significant relationship between frailty status and readmission to acute care (no β provided, $R^2 = 1.2$, p values 0.004-0.04). Even though both studies found significant relationships on multivariate analysis, there are too few studies to conclude that there is an association between frailty status and readmission to acute care. See Table 3.6.

Table 3.6 Summary of Findings – Readmission to Acute Care

Association between frailty and readmission to acute care							
First Author, year	**Frailty Screening Method**	**Measurement of Readmission to Acute Care**	**Significance**	**Test**	**Direction and Magnitude**	**Comment**	**Quality of Study**
Cogan, 2014 (abstract only)	SHARE-FI	Transfer to hospital percentages per frailty group	Significant **(with emergency transfer to acute hospital)**	Linear regression	+ (no test statistic provided)	P value = 0.004	High-moderate
Heppenstall, 2011	EFS	Frequencies and percentages of people with at least one further admission to any hospital during the year post discharge	Significant	Stepwise regression	+ (R^2 = 1.2), no β provided	CI 1.01 – 1.42 P value = 0.04	High-moderate

Chapter Four

Integrated Discussion

Integrated Discussion

This chapter includes an integrated discussion focused on an in-depth discussion of the review's findings, on the use of frailty in the articles, on the implications for geriatric rehabilitation, for nursing practice, for future research, and for education as well as a discussion of the limitations and strengths of this thesis.

Summary of Thesis Findings

The purpose of this systematic review was to answer the question, "What is the association between frailty status and rehabilitation outcomes among older adults?" The primary outcome of interest was functional status while the secondary outcomes were length of stay, discharge destination, and readmission to acute care. In chapter three, I showed with my results that there was a significant negative association between frailty and discharge functional status, functional change (the difference between discharge functional status from the admission functional status score), discharge to home, and a positive association with length of stay. There was not enough evidence to conclude an association between frailty and readmission to acute care.

Discussion of Findings

As previously mentioned in chapter one, there is no other systematic review, to the author's knowledge, that examines the association between frailty and functional status, length of stay, discharge destination, and readmission to acute care within the rehabilitation setting among older adults. This systematic review is the first review on this topic. I did not complete meta-analyses to strengthen this case due to heterogeneity of instruments and summary statistic findings. Although our systematic review obtained few studies and no meta-analysis was completed, previous research in different settings found similar results. The literature review

presented in chapter one of this thesis found similar results with frailty being associated with ADLs/IADLs, length of stay, and discharge destination in the community/perioperative settings. The results from this review show frailty's negative impact on a patient's rehabilitation outcomes which in turn coincides with Tocchi's description of frailty where various stressors interact together to increase an older adult susceptibility to negative health outcomes.

Functional Status

The findings from this review align similarly with the consequence of frailty of disability. Tocchi describes how frailty can affect day to day functioning (i.e. functional status). Other studies have similar findings in the community setting relating to frailty and functional status among older adults. As seen in the literature review, Vermeiren and colleagues' meta-analyses found frailty increased the risk for decline in basic activities of daily living (ADL) (8 studies: OR = 2.05 [CI 1.73-2.44]), (3 studies: HR/RR = 1.62 [CI 1.50-1.76]) among older adults aged 65 and older (Vermeiren et al., 2016). Furthermore, in a cross-sectional study of 267 community-dwelling older adults aged 65 and older, these authors found that that phenotype model of frailty as well as the Tilburg Frailty Indicator (TFI) were correlated with the disability in ADLs/instrumental ADLs (phenotype: r=0.423, TFI: r= 0.475, p values <0.001) as measured by the Groningen Activity Restriction Scale (Roppolo et al., 2015). One can see that frailty's association to functional status is not unique to the inpatient rehabilitation setting. The findings in this systematic review and in the studies above are not unexpected as one would subjectively think a frailer person would struggle more in terms of their functional status.

It is more surprising that there was a negative association between frailty and functional change. This finding means that a frailer older adult patient on admission would have shown less improvement by discharge in terms of their functional status than someone who began the

rehabilitation program in a less frail state. I thought initially that there would be a positive association between frailty and functional change meaning that a patient with higher levels of frailty would have a greater difference in their functional status from admission to discharge. As the frailer patient starts out in a 'poorer' condition, one could think that there is room for greater improvement than someone who is admitted with lower frailty levels. However, typically rehabilitation begins in acute care. It may be that once patients are discharged from acute care and admitted to an inpatient rehabilitation program that patients are closer to their 'new baseline' as they have already begun their rehabilitation therapy. Therefore, patients in an inpatient rehabilitation program can improve in functioning by discharge but it is unlikely that a frailer patient on admission will surpass a less frail patient in terms of improvement/maintenance of functional status.

A concern to account for is the possible overlap between elements of the tools used to screen for frailty and to measure functional status in the study by Kawryshanker and colleagues. Frailty was measured using the Edmonton Frail Scale (EFS) and functional status with the Functional Independence Measure (FIM). One of the questions in the EFS tool assesses the number of instrumental ADLs in which someone requires assistance (ex. meal preparation, housekeeping, laundry, finances, shopping). The EFS also assesses if a person is continent or not. The FIM codes a person's level of independence in different areas with bladder management, bowel management, meal preparation (optional), housework (optional), financial management being a few of the items included in this tool. Both the EFS and the FIM have additional items not mentioned here but one can see there is an overlap. The concern is whether the tools are measuring too many of the same elements thereby preventing knowing for certain if the association between frailty and functional status is merely due to this overlap. One needs to

be certain that the instruments are measuring different constructs. Frailty score and admission FIM had a significant negative relationship ($r = -0.456$, $p<0.001$) and frailty had a significant negative relationship with discharge FIM ($\beta = -1.151$, $p= 0.014$) (Kawryshanker et al., 2014). If the two instruments were measuring similar constructs, one would expect the correlation values to be much closer to 1. This is not the case with these instruments. There is likely enough various items in the EFS to distinguish it from the FIM (ex. clock drawing, medication use, mood, nutrition, etc.). In addition, the EFS's inter-rater reliability is $\kappa = 0.77$ and the internal consistency Cronbach's alpha is 0.62 (Rolfson et al., 2006). There was also indication of good construct validity of the EFS (see Table 3.2) (Rolfson et al., 2006). Based on this information, the EFS and FIM do not appear to be measuring the same constructs. I feel I can uphold the results and conclusions of my review.

Length of Stay, Discharge Destination, and Readmission to Acute Care

The results pertaining to the secondary outcomes from this systematic review are consistent with previous findings. A prospective cohort study including 1418 patients aged 70 and older, across 11 hospitals in Australia, found that an increase of 0.1 in a FI was significantly associated with length of stay greater than 28 days (OR = 1.29 (CI 1.10 – 1.52) and new discharge to residential care (OR = 1.31 (CI 1.10 – 1.57) (Hubbard et al., 2017). The association between frailty and readmission to hospital within 28 days was nonsignificant (Hubbard et al., 2017). In addition, a systematic review of six studies found an association between frailty and length of stay in the postoperative setting among older adults with a mean age of 75 (Lin et al., 2016). Rose, Pan, Levinson, and Staples's prospective cohort study on a general medical unit, among 133 adults aged 70 and older, determined frailty to be associated with length of stay ($\beta = 0.49$, p value <0.05) (2014). Another study found in a sample of 125 patients that higher

preoperative frailty status was associated with longer postoperative length of stay (no test statistic provided, p=0.004) and inability to be discharged home (no test statistic provided, p = 0.01) among older adults aged 70 and older that obtained elective non-cardiac surgery (Dasgupta et al., 2009).

It is not surprising that increased frailty levels in inpatient rehabilitation led to lower discharge rates to home among older adults. As noted with the primary outcome of this review, frailty is negatively associated with functional status and functional change. These patients will therefore have more difficulties with re-establishing their previous level of independence. Formal supports in the home can be provided for some (Ex. personal support services for morning, bedtime self-care), but others may choose to relocate to a retirement home, or a long-term care setting. These frailer patients likely fit in this category. As they have poorer functional status upon discharge from the rehabilitation program, they require a discharge to a residence with a higher level of care. Often, there is a long wait list to move into a long-term care home. From 2018-2019 in Ontario, people living in the community waited a median of 161 days, and people in hospital waited a median of 90 days to get a bed in a long-term facility (Health Quality Ontario, 2019). Frailer patients will therefore have an extended length of stay in both acute care and in inpatient rehabilitation which is consistent with the findings in this review and in the literature. Inpatient older adults that have completed their rehabilitation programming but are waiting placement no longer have the same intensive physiotherapy. The fewer scheduled physical activities while in the hospital can lead a patient to become further deconditioned (loss of muscle mass/strength, decreased in functional and cognitive status (Falvey et al., 2015). As a patient becomes deconditioned, this likely increases the number of stressors imposed on a patient

which can further increase their frailty level. The patient may lose some of the gains that were established initially at the end of the rehabilitation program.

The results from this review are consistent with the consequences of frailty as described in Tocchi's concept analysis. Tocchi explained that frailty can increase health care costs (fiscal) and can increase then need for higher levels of care (care environments) (2015). This results in this review show that frailty is associated with increased length of rehabilitation stay which in turn implies increased health care costs overall. In addition, frailty was found to be associated with discharge destination where higher levels of frailty were associated with lower discharge rates to home meaning patients with high frailty levels in the inpatient geriatric rehabilitation setting are more likely to require supportive care environments upon discharge which is consistent with Tocchi's consequence of frailty of care environments.

Surprisingly, there were only two studies that looked at the association between frailty and readmission to acute care. Both studies found a positive significant association between frailty and readmission to acute care on multivariate analysis. CIHI indicates that 9.6% of patients return to acute care within 30 days of discharge (CIHI, 2018). Gruneir et al. (2018)' retrospective study found that 12.6% of older adults aged 65 and over, discharged from an unplanned hospital stay in Ontario, were readmitted to acute within 30 days. No data was found relating to readmissions to acute care within the inpatient rehabilitation setting in Canada. Perhaps, this outcome is measured in the community and tracked in acute care but has not received as much focus in the inpatient rehabilitation setting. This would account for the limited number of studies that assessed the association between frailty and readmission to acute care. In addition, frailty research in the geriatric rehabilitation setting appears to only be in its infancy. As indicated earlier, the included studies were published in the past 10 years with nearly half

(5/12) of the studies published within the past 5 years. This area of research is growing and is far from saturation.

More research needs to be completed in the inpatient rehabilitation setting examining frailty and readmission to acute care among older adults. I am not convinced that every future study will also obtain a significant association. These patients are 'hospital' patients as inpatients therefore they are monitored by nurses at all hours and followed by physicians. These ongoing and frequent assessments may pick up on medical concerns before they a critical thereby preventing the need for a transfer to acute care. In addition, some medical events may be able to be managed on an inpatient unit while a person living in the community with the same level of frailty may need to go to acute care to treat the same issue.

Frailty

The frailty definitions used in research are not comprehensive. While this systematic review applied the definition provided in Tocchi's evolutionary concept analysis of frailty in older adults, there were many different definitions encountered. Often, the definition in an article during the screening process was similar to our chosen definition to meet the inclusion criteria however it might lack some aspect of Tocchi's definition. For example, one study defined frailty as "multidimensional geriatric syndrome indicative of progressive decline, increased vulnerability to stressors, and increased risk of adverse health outcomes" (Kawryshanker et al., 2014, p. 1). Another study described frailty as "a multidimensional syndrome of loss of physiological and physical reserves (energy, physical ability, cognition, health) that gives rise to vulnerability" (Hamidi et al., 2018, p. 1070). The definitions seen in the included studies were all different to a certain extent but in the end similarly described frailty as having a decreased in reserve and lower threshold to stressors leading to poorer health outcomes.

The frequent missing element in an author's definition of frailty was the tenuous nature of frailty. Researchers typically did not discuss frailty as being on a continuum. Frailty was more often described as a static state in time or as a state that will progressively worsen. Only two studies measured frailty upon admission and at discharge (Nolan et al., 2016; Opasich et al., 2010). This review did not require frailty to be screened multiple times to reflect the tenuous nature of this concept. The literature review completed prior to this systematic review exposed me to this missing element from the definition of frailty seen in the available literature. However, as the instruments measured frailty, meaning gave a score of frailty, this shows that the authors possibly know that frailty could be reversed meaning returning a patient to a more robust state.

Another indicator of the lack of comprehensiveness of the definition of frailty was found during the abstract and full-text screening process. Many articles described their population as the 'frail elderly' but did not expand on why this population was frail, how they came to this conclusion, and what kind of research was completed to determine this population was frail. Their population was frequently ascertained to be frail due to age. Frailty does increase with frailty but not all older adults are frail.

While current research on frailty is shifting towards the utilization of more comprehensive definitions of frailty by describing frailty as a multidimensional concept with various stressors causing frailty, there still lacks a crucial piece which is the tenuous nature of frailty. For example, a person can be quite frail during the winter season but may cope quite well during the summer. Researchers need to acknowledge the fluctuating aspect of frailty as described in Tocchi's description of frailty.

Frailty Instruments

One interesting finding from this systematic review was the variety of frailty screening instruments used. Nine different tools were used. Only the EFS was a tool that was used in more than one study. Although, as previously mentioned in chapter one of this thesis that the Phenotype model (Fried et al., 2001) and the FI (Rockwood & Mitnitski, 2007) were common frailty screening tools, no study used the Phenotype Model to screen for frailty.

All of the included frailty screening tools were developed prior to Tocchi's concept analysis (2015). Past literature and many descriptions of frailty explore mostly the physiological aspects of frailty. There is limited literature that includes environmental stressors of frailty (ex. lack of accessibility). The aspect of physical frailty seems to be an easier concept to understand and measure. The Phenotype model is a tool that examines to a greater degree the physical domain of frailty (Fried et al., 2001). This model looks at shrinking, weakness, poor endurance and energy, slowness, and low activity level (Fried et al., 2001). The study by van der Ploeg and colleagues (2017) used indicators of frailty in their screening process. The indicators of fatigue and weight loss in van der Ploeg et al. (2017) resemble the items of poor endurance and energy and shrinking in the Fried Phenotype. Tocchi's concept analysis from 2015 of frailty in older adults discussed how frailty is multifactorial involving physiological, psychosocial, and environmental stressors. Only three articles used frailty screening methods that involved only one domain of health (physiological) (Cogan et al., 2014; Opasich et al., 2010; van der Ploeg et al., 2017). The remaining articles used tools that involved more than one health domain. Perhaps the minimal use of unidimensinal instruments is an indication of a shift in research from using unidimensional instruments to more multidimensional screening frailty instruments which is closer to Tocchi's definition of frailty.

Frailty Stratification

The Phenotype model described in chapter one includes a stratification of frailty. Frail patients have three or more of the frailty characteristics from the model, prefrail or intermediate have one or two characteristics, and not frail patients have none (Fried et al., 2001). Many of the included studies in this systematic review stratified their frailty results into three groupings however no study had identical groupings. The heterogeneity of the instruments used for frailty screening in the included studies as well as the variation in the stratification of frailty, made quantitative analysis challenging. In addition, some articles presented their outcome results as means, others as medians, some as means for an overall functional status or as a mean functional status seen per frailty group. The outcomes for discharge destination and readmission to acute care in most articles were described via frequencies and percentages. While vote counting is not the strongest approach to data synthesis, it was the most feasible with this data.

Implications for Geriatric Rehabilitation

This systematic review found higher frailty levels were associated with poor discharge functional status and lower functional change. Poor functional status is associated with higher levels of psychological distress and poor quality of life (Atkins et al., 2013). Higher levels of frailty lead to longer length of inpatient rehabilitation stay and lower discharge rates to home. This means a frailer older adult on admission to inpatient rehabilitation will have a harder time regaining their independence and are less likely to return home upon completion of the program. Frailer patients are likely not meeting the goal of rehabilitation to maintain and or restore function. A patient's level of frailty may possibly be an indicator of rehabilitation potential and thereby influence eligibility into a geriatric rehabilitation program. .

Frailty is a concept that needs to be incorporated into geriatric rehabilitation inpatient programs. Degree of frailty can potentially affect the individualized interventions needed to optimize a patient's therapy. Morley et al. does suggest interventions to help prevent and treat physical frailty such as exercise, protein-calorie supplementation, vitamin D, and reduction of polypharmacy (2013). The authors of a scoping review (n=14) found that exercise and exercise in combination with nutrition and/or memory training reduced frailty in community-dwelling older adults (Puts et al., 2017). The consulted stakeholders (people living with frailty, their caregivers, healthcare organization administrators) in the review were concerned that the interventions researched so far concentrated on the physical domain of frailty (Puts et al., 2017). They stated that additional focus needs to be given to the cognitive, social, and psychological domains of frailty. Perhaps this is an issue that is also occurring in the inpatient rehabilitation setting for older adults. While the evidence shows that exercise is an important intervention to help reduce frailty in older adults, there may need to be a greater emphasis on the various other domains of frailty. For example, maybe a dietitian referral should be mandatory for every patient as opposed to as needed. Perhaps memory training can be incorporated as part of a patient's care plan once a full cognitive assessment is ascertained. As patients with higher frailty levels are at risk of the negative outcomes examined in this review, then these patients may need a longer rehabilitation program overall in order to try to improve functional status and prevent discharge to a nursing home. The current length of stay may not be adequate for patients with high levels of frailty. The goal for these frail patients should be to have a care plan that addresses all the domains of frailty which ideally will reduce frailty levels and maximize their functional status potential.

Furthermore, frailty score should be measured throughout a patient's stay in the inpatient geriatric rehabilitation setting. As Tocchi indicates that frailty is tenuous in nature, it should be acknowledged that a patient's frailty level can fluctuate. It would be more beneficial to have several frailty scores versus only one score as one can see a patient's trend in regards to their frailty level. A patient may finish the program with a lower frailty score but is that reflective of their rehabiltiation progress or simply due to a 'bad day' perhaps due to increased fatigue/stress? Looking at the overall trend of a patient's frailty scores can be another way to show whether a patient did improve and make some gains or whether they didn't meet their rehabilitation goals. Further research would be needed however to determine the appropriate times and frequency of frailty measurements (ex. 1 per week versus at admission, midway, at discharge).

Implications for Nursing Practice

Nurses need to be aware how a patient's frailty level can affect their rehabilitation outcomes. For example, frailer patients will have poorer discharge functional status and functional change. Nurses need to realize that these patients will likely need more assistance with their ADLs throughout their rehabilitataion stay than patients who began their admission in a less frail state. Nurses sbould not assume that two patients with the same admitting diagnosis (ex. hip fracture) will achieve the same amount of progress in regards to their functional status. A less frail patient may achieve independence with many ADLs while in the inpatient rehabilitation program but a patient with higher levels of frailty may struggle. These patients will continue to need nurses to provide ongoing encouragement, assistance with various day to day tasks, and fall prevention strategies.

Patients will higher levels of frailty are more likely to have a change in residence whether from their home to a retirement home or to another location that provides higher levels of care.

Nurses spend the most time out of any other discipline with a patient. Due to the therapeutic nurse-patient relationship, nurses provide an atmosphere of trust and open communication with patients. Nurses can help these frail patients come to terms with the fact that they are not able to return to their previous residence and live without assistance anymore. Nurses can provide emotional support and help patients accept their new baseline in functional status.

Implications for Future Research

Further research is needed to help strengthen the argument of implementing frailty screening in the geriatric rehabilitation setting. While I did find an association between frailty and discharge functional status, functional change, length of stay, and discharge destination, there is still a need for more primary studies that replicate these findings using the same frailty screening tool and/or the same summary statistic for easier comparability. The addition of these primary studies can allow for the completion of a meta-analysis. The benefits of a meta-analysis is that one can make conclusions based on objective data and can determine how big of an effect frailty has on the examined outcomes (Polit & Beck, 2017). It can analyze heterogeneity between findings in different studies. The benefit of comparing multiple studies using the same screening tool is that the tool will contain all the same items. For example, if there are two different frailty screening tools and one contains items related to the psychosocial domain and one does not then you can't know how much of an influence the psychosocial element had within the frailty tool that influence the findings regarding the associations between frailty and rehabilitation outcomes. In addition, using the same screening tool would allow for similar stratification of frailty. Frailty was not classified into the same groupings from study to study. Also, some authors provided an overall score of frailty while others provided frailty scores for each level of frailty (ex non-frail, prefrail, frail). The hope initially was to complete a meta-analysis of the data but heterogeneity

of instruments, the stratification of frailty/outcomes, and due to missing data for the possibility of creating summary statistics precluded this option.

In addition, more studies are needed using frailty screening tools that provide valid results. There are numreous frailty screening tools but some are lacking satisfactory reliability and validity testing, in particular within the geriatric inpatient rehabilitation setting. There needs to be more reliability studies done on the frailty screening tools so that future primary studies examining the same variables in this review will be more rigorous in nature. For example, there can be future studies looking at the inter-rater reliability of some of the tools. Further research is needed to determine the most appropriate validated screening frailty tool to use in the geriatric rehabilitation setting. The most appropriate course may be to develop a new tool designed specifically for the inpatient geriatric rehabilitation setting which will encompass all the traits of frailty as described by Tocchi. This tool can include the often missing dimensions of frailty (ex. environmental) and/or give equal weight to the different dimensions of frailty.

None of the included studies were completed in Canada and only 1 was from the USA. Four studies were conducted in Australia, two in Ireland, two in the United Kingdom, and 1 each in New Zealand, Italy and the Netherlands. There is therefore limited information on these associations in North America. Further research is needed in Canada. In order to introduce a new screening tool in Canadian geriatric rehabilition programs, it would be beneficial to see if frailty has an impact on outcomes in these specific settings. The included studies did not all discuss in detail what their rehabilitation program entailed therefore there may be a wide variability in programs which may account for some of the nonsignificant findings.

There is also a lack of qualitative data in the inpatient geriatric rehabilitation setting examining frailty. Research can be completed looking at how a person feels on admission or

discharge regarding their perception of frailty and functional status. How does this patient see themselves in the rehabilitation setting? How does a patient feel about their functional status, about being in the hospital for such a long time, about their potential discharge to a new place of residence, and how would they describe frailty and how they see themselves in relation to this? For example, perhaps a person would rather stay in the hospital knowingly for longer if that meant that they would regain their indepedence, return home, and be less frail overall. However, maybe a person would rather return home even if they are not back to their baseline functionally instead of remaining in the hospital. A patient may score mildly frail on admission but a patient may feel frailer than their score. They can use descriptions to enhance our knowledge of their frailty and of their functional status. This can help the health care team individualize their care plan. The findings from these studies could be incorporated in the development of new care plans, interventions, rehabilitation programs.

Also, as only two articles examined the relationship between frailty and readmission to acute care, further research is needed assessing this outcome in the rehabilitation setting. It was surprising to see so few studies that addressed readmission to acute care. Often, if a patient became medically unstable and transferred back to acute care, they were excluded from the study analysis altogether. While I practiced nursing in the inpatient geriatric rehabilitation setting, I saw on a weekly basis new patients being sent back to acute care due to medical instability. I feel there needs to more research that looks at frailty and readmission to acute care. Perhaps, patients are being sent to the rehabilitation program too soon when they are not stable medically or too late because they became so much frailer while in acute care.

Implications for Education

Professors need to convey to undergraduate nursing students that frail older adults are a unique population. Similar to how students are taught to think of a person in a holistic manner, older adults are a specialized group and within that group are frail older adults. Nursing students need to be informed that older adults will not all recovery in the same way in the inpatient rehabilitation setting due to differing frailty levels. Frailer patients will tend to have poorer rehabilation outcomes. These students can be introduced to frailty screening tools and have them practice measuring frailty in their long-term care clinical placements. A course could also be developed in the undergraduate nursing program that solely focuses on geriatrics as it is a distinct patient population with their own health care needs.

For current nurses working in the inpatient geriatric rehabilitation setting, there needs to be more education/awareness provided on frailty. Whether it's a lunch and learn or biannual workshops for front line stafff, there needs to be further implementation of frailty education. The Regional Geriatric Program of Eastern Ontario (RGPEO) currently does provide a 2-day workshop/training sessions twice per year called Geriatric Eduction Series that discusses various topics related to older adults (ex. delirium, dementia, falls, etc.). A small portion is dedicated to frailty in the introduction but it does not address the concept comprehensively nor does it explain the various screening tools and when/how to use these tools. This workshop could be prime opportunity to review frailty in detail, the negative outcomes, and how to measure it.

This content also needs to be part of continuing nursing education whether it be for a graduate degree or specialization certifications in gerontology and/or rehabilitation. These nurses need to be aware of the impact of frailty on outcomes not only in the acute care and community settings but also in the rehabilitation setting as more and more older adults require this service.

This knowledge can give these nurses a more comprehensive understanding of the frail older adult population. They can use this expertise to help inform the care plans they develop. These nurses should be taught the skills of screening for frailty. These advanced nurses, once trained, can advocate for frailty screening in the inpatient geriatric rehabilitation setting.

Limitations and Strengths

Limitations

Although a comprehensive systematic review process was used, the search strategy was not exhaustive for the grey literature. While three grey literature databases and three websites were searched, there was only one website that was tailored specifically towards frailty.

Search terms were added in the search strategy to obtain studies geared towards an inpatient setting. Terms such as inpatient, hospitalization, patient admission, etc. (See Appendix I) were included in the search strategy with the goal to ensure a feasible search for a master's student to complete.

The inclusion criteria did allow for the inclusion of qualitative and mixed-method studies however the search resulted in only quantitative studies. As indicated in chapter two, the included studies needed to have screened patients' frailty level using a screening tool. This choice led the included articles to be more quantitative in nature as qualitative studies did not likely screen for frailty using a tool. This is issue could have been prevented had I not limited it to studies that measured frailty with a screening tool. I could have instead developed criteria that needed to be met in order for an author's description/definition of frailty to be adequate enough to be included in the review.

In addition, while an expert in inpatient rehabilitation (A.H.) was contacted to review our full-text screening results, an expert in frailty may have identified other seminal work.

Another limitation is that the authors of the included studies were not contacted for the missing data such as types of regression completed and for test statistic values. However, the search strategy was not limited by date nor by language.

Vote counting was completed for data synthesis which has its own limitations, but this was supplemented with extracting the magnitude and direction of significant associations.

Strengths

A protocol was developed prior to starting the systematic review which was registered in the International Prospective Register of Systematic Review (PROSPERO) (Center for Reviews and Dissemination, 2018). The development of the systematic review was also guided by the Cochrane Handbooks and the Preferred Reporting Items for Systematic reviews, Meta-Analyses (PRISMA) standardized reporting format (Higgins et al., 2019; Moher et al., 2009).

There were some strengths related to the search strategy. The search strategy was developed with the aid of an experience librarian (L.S.) and was peer-reviewed by a second librarian using the Peer Review of Electronic Search Strategies (PRESS) (McGowan et al., 2016). In addition, the reference lists of included studies were searched for potential additional studies.

Quality of studies was considered prior to making a conclusion on the presence of an association between frailty and an outcome.

Conclusion

My goal in conducting this thesis was to do a systematic review that examined the association between frailty and rehabilitation outcomes. The findings from this thesis are consistent with previous research that indicate that frailty is associated with functional status, length of stay, and discharge destination. Frailty was not concluded to be associated with readmission to acute care

due to lack of sufficient evidence therefore, this is an area that requires more research. Additional research replicating the findings in the included primary studies is needed using similar validated frailty screening tools, similar summary statistics, and similar rehabilitation programs to complete a meta-analysis. Frailty needs to be incorporated in the geriatric rehabilitation care plans to improve the functional status of frail patients as well as to reduce extended stays in rehabilitation and to decrease discharges to a new place a residence.

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interventions, or both. *BMJ*, *358*, j4008–j4008. https://doi.org/10.1136/bmj.j4008

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Appendix A – Search Strategies Looking for Previous Systematic Reviews on Topic

Database Searched	Search Strategy
Pubmed	Clinical Queries Tool →Searched under "Systematic Reviews" a) frail* AND rehab* b) frail* AND subacute c) frail* AND intermediate d) frail* AND restorative e) frail* AND reablement f) frail* AND re-ablement g) frail* AND stepdown h) frail* AND step down i) frail* AND postacute j) frail* AND post acute k) frail* AND habilitation
CINAHL	frail* AND rehab* Additionally, completed searches b) to k) Limiters: English Language; Publication Type: Meta-Analysis, Meta-Synthesis, Review, Systematic Review
Prospero	frail* AND rehab* Additionally, completed searches b) to k)
CDSR	frail*

Appendix B – Search Strategies Looking at Frailty and Outcomes

Database Searched	Search Strategy
Pubmed	Clinical Queries Tool →Searched under "Systematic Reviews" frail* AND (elder* OR senior* OR aged OR geriatric* OR older adult*)
CINAHL	TI frail* OR AB frail* AND TI (elder* OR senior* OR aged OR geriatric* OR older adult*) OR AB(elder* OR senior* OR aged OR geriatric* OR older adult*) Limiters: Publication Type: Meta-Analysis, Meta-Synthesis, Review, Systematic Review

Appendix C - Excluded Reviews

Excluded Reasons	Citations
Does not assess patient/participant clinical outcomes	Bonnefoy, M., Berrut, G., Lesourd, B., Ferry, M., Gilbert, T., Guérin, O., Hanon, O., Jeandel, C., Paillaud, E., Raynaud-Simon, A., Ruault, G., & Rolland, Y. (2015). Frailty and nutrition: searching for evidence. *The Journal of Nutrition, Health & Aging*, *19*(3), 250–257. https://doi.org/10.1007/s12603-014-0568-3 Lee, L., Heckman, G., & Molnar, F. J. (2015). Frailty: Identifying elderly patients at high risk of poor outcomes. *Canadian Family Physician*, *61*(3), 227–231.
Wrong population	Kojima, G. (2018). Frailty Defined by FRAIL Scale as a Predictor of Mortality: A Systematic Review and Meta-analysis. *Journal of the American Medical Directors Association*, *19*(6), 480–483. https://doi.org/10.1016/j.jamda.2018.04.006
Wrong outcomes	Tôrres, L. H. do N., Tellez, M., Hilgert, J. B., Hugo, F. N., de Sousa, M. da L. R., & Ismail, A. I. (2015). Frailty, Frailty Components, and Oral Health: A Systematic Review. *Journal of the American Geriatrics Society (JAGS)*, *63*(12), 2555–2562. https://doi.org/10.1111/jgs.13826

Appendix D – Data Extraction for Literature Review

Reference	**Population**	**Setting**	**Number of included studies**	**Frailty Assessment**	**Outcomes of interest**	**Results Summary**
Buigues, C., Juarros-Folgado, P., Fernández-Garrido, J., Navarro-Martínez, R., & Cauli, O. (2015). Frailty syndrome and pre-operative risk evaluation: A systematic review. Archives of Gerontology and Geriatrics, 61(3), 309–321. https://doi.org/10.1016/j.archger.2015.08.002	people aged 65 +	perioperative (pre-op evaluation of frailty, postop outcomes)	32	phenotype model, modified frailty index (FI), comprehensive geriatric assesment (CGA), Edmonton Frail Scale (EFS), Groningen Frailty Indicator, Hopkins frailty score, comprehensive assessment of frailty, MacArthur Study of Successful Aging	postoperative mortality, postoperative complications	Frailty is significantly correlated with postoperative mortality and many postoperative complications.

				frailty, other markers of frailty		
Chang, S., Lin, H., & Cheng, C. (2018). The Relationship of Frailty and Hospitalization Among Older People: Evidence From a Meta-Analysis. Journal of Nursing Scholarship, 50(4), 383–391. https://doi.org/10.1111/jnu.1239	people aged 65+	not specified, not limited by setting	8	phenotype model, study of osteoporotic fractures frailty index, 2 other frailty criteria	hospitalization risk	Risk for hospitalization was greater at the frail stage than at the robust stage (risk ratio (RR): 1.49; 95% confidence interval (CI): 1.26–1.76), greater at the frail stage than at the prefrail stage (RR: 1.25; 95% CI: 1.11–1.40), and greater at the prefrail stage than at the robust stage (RR: 1.20; 95% CI: 1.07–1.34).
Chang, S., & Lin, P. (2015). Frail phenotype and mortality prediction: A	people aged 65+	community	11	frail phenotype	mortality	Risk of mortality in the

systematic review and meta-analysis of prospective cohort studies. International Journal of Nursing Studies, 52(8), 1362–1374. https://doi.org/10.1016/j.ijnurstu.2015.04.005						frail stage was higher than that in the pre-frail stage (hazard ratio (HR): 1.478; 95% CI:1.339–1.632), the risk of mortality in the frail stage was higher than that in the robust stage (HR: 2.000; 95% CI:1.727–2.316), and the risk of mortality in the pre-frail stage was higher than that in the robust stage (HR:1.335; 95% CI:1.260–1.414).
Chen, K., Chang, S., & Lin, P. (2017). Frailty as a Predictor of Future Fracture in Older Adults: A Systematic Review and Meta-Analysis. Worldviews on	people aged 55 + (4/5 included studies with	not specified, not limited by setting	5	phenotype model, study of osteoporotic	fracture risk	Fracture risk in the frail stage was higher than that in both the robust stage

Evidence-Based Nursing, 14(4), 282–293. https://doi.org/10.1111/wvn.12222	participants aged 65 +)			fractures frailty index		(HR:1.67; 95% CI: 1.46–1.91) and prefrail stage (HR: 1.28; 95% CI: 1.16–1.40), and that the fracture risk in the prefrail stage was higher than that in the robust stage (HR: 1.30; 95% CI: 1.20– 1.41).
Cheng, M., & Chang, S. (2017). Frailty as a Risk Factor for Falls Among Community Dwelling People: Evidence From a Meta-Analysis. Journal of Nursing Scholarship, 49(5), 529–536. https://doi.org/10.1111/jnu.12322	people aged 65 +	community	10 (7 with Odds ratios (OR), 3 with HR)	phenotype model, study of osteoporotic fractures frailty index	fall risk, recurrent falls	Fall risk in the frail stage was higher than that in the robust stage (OR: 2.50; CI: 1.58–3.96) and higher than that in the prefrail stage (OR: 1.64; CI 1.18–2.28); and that the fall risk in the prefrail stage was also higher than that in the robust

						stage (OR: 1.47; CI 1.22–1.79). Hazard ratio results were all significant. Does not provide hazard ratio results nor CI but states results were similar to odd ratios.
Fhon, J. R., Rodrigues, R. A., Neira, W. F., Huayta, V. M., & Robazzi, M. L. (2016). Fall and its association with the frailty syndrome in the elderly: systematic review with meta-analysis. Revista da Escola de Enfermagem da U S P, 50(6), 1005–1013. https://doi.org/10.1590/S0080-623420160000700018	people aged 60 + (16/19 included studies with participants at least 65 +)	states "who lived in different contexts"	19	phenotype model, study of osteoporotic fracture frailty index, FRAIL index, Edmonton Frail Scale (EFS), handgrip strength, Longitudinal Aging Study Amsterdam frailty	frailty, fall	Frailty and falls are significantly associated (OR: 1.80; CI 1.51-2.13).

				instrument frailty instrument, Conselice Study of Brain Aging index, SNAC instrument		
Gutiérrez-Valencia, M., Izquierdo, M., Cesari, M., Casas-Herrero, Á., Inzitari, M., & Martínez-Velilla, N. (2018). [Review of The relationship between frailty and polypharmacy in older people: A systematic review]. British Journal of Clinical Pharmacology, 84(7), 1432–1444. https://doi.org/10.1111/bcp.13590	people with mean age 65 +	not specified, not limited by setting	25	Phenotype, Edmonton Frail Scale (EFS), FRAIL scale, Tilburg frailty indicator, frailty index, Groningen frailty indicator	frailty, polypharmacy	21/25 studies found a significant association between frailty and polypharmacy among older adults.
Kane, R., Shamliyan, T., Talley, K., & Pacala, J. (2012). The Association Between Geriatric Syndromes and Survival. Journal of the American Geriatrics Society, 60(5), 896–904.	people aged 65 +	community	123	phenotype model, accumulation of deficit model	mortality	Frailty is associated with mortality with people at higher risk of mortality

https://doi.org/10.1111/j.1532-5415.2012.03942.x						with increased levels of frailty.
Kojima, G. (2018). Frailty as a Predictor of Nursing Home Placement Among Community-Dwelling Older Adults: A Systematic Review and Meta-analysis. Journal of Geriatric Physical Therapy, 41(1), 42–48. https://doi.org/10.1519/JPT.0000000000000097	noninstitutionalized older adults aged 65 +	community	5	phenotype model, study of osteoporotic fracture, frailty index, the Conselice Study of Brain Aging index	nursing home placement	Both frailty (5 studies) and prefrailty (3 studies) predicted nursing home placement (pooled OR: 5.58, 95% CI: 2.94-10.60, p < .00001; pooled OR: 3.26, 95% CI: 1.21-8.78, p = .02)
Kojima, G. (2016). Frailty as a predictor of hospitalisation among community-dwelling older people: a systematic review and meta-analysis. Journal of Epidemiology and Community Health, 70(7), 722–729. https://doi.org/10.1136/jech-2015-206978	People with mean age 65 +	community	13	phenotype (original and modified), modified frailty index	hospitalization risk	Frailty and prefrailty were significantly associated with a higher hospitalisation risk (10 studies [pooled OR: 1.90, CI: 1.74–2.07, p<0.00001; pooled OR:

						1.26, CI: 1.18–1.33, p<0.00001]]. Of the 3 studies that presented hazard ratios, both frailty and prefrailty were significantly associated with hospitalization risk(pooled HR:1.30, CI:1.12–1.52, p=0.0007; pooled HR:1.13, CI:1.04–1.24, p=0.005).
Kojima, G. (2015). Frailty as a Predictor of Future Falls Among Community-Dwelling Older People: A Systematic Review and Meta-Analysis. Journal of the American Medical Directors Association, 16(12), 1027–1033. https://doi.org/10.1016/j.jamda.2015.06.018	people aged 60 years or older or mean age of 70 years or older (10/11 included studies with participants at least 65 +)	community	11	phenotype (original and modified), Clinical Frailty Scale, Longitudinal Aging Study Amsterdam frailty instrument,	fall risk	Frailty and prefrailty are significantly associated with higher risk for future falls (7 studies [pooled OR:1.84, CI: 1.43-2.38, p<0.001], 4 studies [pooled

				modified Study of Osteoporotic fractures frailty index		OR: 1.25, CI: 1.01-1.55, p = 0.005]). Of the 4 studies studies that reported hazard ratios, only frailty was associated with higher risk of future falls (pooled HR: 1.24, CI: 1.10-1.41, p <0.001).
Kojima, G. (2016). Frailty as a predictor of fractures among community-dwelling older people: A systematic review and meta-analysis. Bone, 90, 116–122. https://doi.org/10.1016/j.bone.2016.06.009	people with a mean age of 65 +	community	6	Longitudinal Aging Study Amsterdam frailty instrument, modified phenotype, Conselice Study of Brain Aging Study frailty index	fracture risk	Frailty and prefrailty are significantly associated with higher risk for fractures (5 studies [pooled OR:1.70, CI: 1.34-2.15, p<0.0001], 3 studies [pooled OR: 1.31, CI: 1.18-1.46, p < 0.00001]). With studies that presented

						hazard ratios, frailty and prefrailty also was significantly associated with fracture risk (4 studies [pooled HR: 1.57, CI: 1.31-1.89, p<0.00001], 3 studies [pooled HR: 1.30, CI: 1.12-1.51,p=0.0006]) .
Kojima, G. (2017). Frailty as a predictor of disabilities among community-dwelling older people: a systematic review and meta-analysis. Disability and Rehabilitation, 39(19), 1897–1908. https://doi.org/10.1080/09638288.2016.1212282	people with mean age 60 + (18/20 included studies with participants at least 65+)	community	20	phenotype (original, modified), modified Study of Osteoporotic fracture frailty index, FRAIL scale	future disability risks	Frailty was significantly associated with developing or worsening disability with ADLs (12 studies [pooled OR: 2.76, CI: 2.23-3.44, p<0.00001], 5 studies [pooled HR:2.23, CI:

						1.42-3.49, p<0.00001]) and with IADLs (6 studies [pooled OR: 3.62, CI: 2.32-5.64, p<0.00001], 5 studies [pooled HR: 1.55, CI: 1.08-2.21, p<0.00001]).
Kojima, G., Iliffe, S., Jivraj, S., & Walters, K. (2016). Association between frailty and quality of life among community-dwelling older people: a systematic review and meta-analysis. Journal of Epidemiology and Community Health, 70(7), 716–721. https://doi.org/10.1136/jech-2015-206717	people aged 60 +, or with a mean age of 70 + (all included studies had mean age 70 +)	community	13 (4 for meta-analysis)	Fried criteria, Frailty Index (FI), the Tilburg Frailty Indicator, the Study of Osteoporotic Fractures frailty index, and the Canadian Study of Health and Aging Clinical Frailty	quality of life	Frailty and prefrailty were significantly inversely associated with quality of life. For physical component summary: pooled mean differences: −12.74, CI: −15.04 to −10.44, p<0.00001 for frail, and −4.18, CI: −7.00 to −1.37, p=0.004.

				Scale. One study defined frailty based on a combination of three different criteria		For mental component summary: pooled mean differences:−10.69, CI: -16.35 to −5.04, p=0.0002 for frail and −3.82 , CI: −5.62 to −2.03, p<0.000 for prefail.
Kojima, G., Iliffe, S., & Walters, K. (2018). Frailty index as a predictor of mortality: a systematic review and meta-analysis. Age and Ageing, 47(2), 193–200. https://doi.org10.1093/ageing/afx162	people aged 20+ (>half of the included studies with participants > 65 +)	> half of the cohort needed to come from the community	19	frailty index	mortality	13 (out of 18) cohorts showed HR per 0.01 increase in frailty index (FI), 6 cohorts showed HR per 0.1 increase in FI and two cohorts each showed OR per 0.01 and 0.1 increase in frailty index. Results for all meta-analyses found that

						frailty was significantly associated with mortality risk. (pooled HR per 0.01 FI increase: 1.039, CI:1.033–1.044, p < 0.001; pooled HR per 0.1 FI increase: 1.282, CI: 1.258–1.307, p < 0.001; pooled OR per 0.01 FI increase: 1.054, CI = 1.040–1.068, p < 0.001; pooled OR per 0.1 FI increase: 1.706, 95% CI: 1.547–1.881, p < 0.001).
Lin, H., Watts, J., Peel, N., & Hubbard, R. (2016). Frailty and post-operative outcomes in older surgical patients: a systematic review.(Report). BMC Geriatrics, 16(1), 157.	mean participant was aged 75 and older, patient population had a	perioperative, community (some studies measured outcomes	23	measured 21 different ways (frailty had to assess more than	any postoperative adverse outcome (most common was	Frailty in older surgical patients predicts postoperative mortality (30

https://doi.org/10.1186/s12877-016-0329-8	surgical procedure	postop, some at 1 year, 2 year, 1 at 5 year)		one domain of health deficit, phenotype model and frailty index the most common tools)	mortality and postoperative complications)	days, 90 days, 1 year), postoperative complications, and increased length of stay.
Lorenzo-López, L., Maseda, A., de Labra, C., Regueiro-Folgueira, L., Rodríguez-Villamil, J., & Millán-Calenti, J. (2017). Nutritional determinants of frailty in older adults: A systematic review. BMC Geriatrics, 17(1), 108. https://doi.org/10.1186/s12877-017-0496-2	people aged 65 +	community and institutionalized	19	phenotype model (original and modified), FRAIL scale, the Study of Osteoporotic Fractures frailty index	nutritional status	Frailty was associated with low intakes of specific micronutrients (5 studies). Higher protein intake (4 studies), higher quality of diet (3 studies), and higher dietary antioxidant capacity (2 studies) was associated with lower risk of frailty. Using the Mini Nutritional

						Assessment (MNA) and the MNA-SF (Short Form) to assess nutritional status, frailty was found to be associated malnutrition (seven studies).
Muscedere, J., Waters, B., Varambally, A., Bagshaw, S., Boyd, J., Maslove, D., … Rockwood, K. (2017). The impact of frailty on intensive care unit outcomes: a systematic review and meta-analysis. Intensive Care Medicine, 43(8), 1105–1122. https://doi.org/10.1007/s00134-017-4867-0	18 + admitted to an ICU (50% of studies have participants aged 65+)	ICU	12 publications from 10 studies	frailty index, Clinical Frailty index, phenotype model	primary outcomes: in-hospital and long-term mortality (≥6 months following ICU admission. secondary outcomes: ICU mortality and health related quality-of-life (HRQL), ICU and hospital length of stay, receipt of vasoactive agents, receipt	Frailty was significantly associated with hospital mortality (9 studies) [relative risk: 1.71, CI: 1.43-2.05; $p < 0.00001$; $I2 = 32\%$], long-term mortality (6 studies) [RR: 1.53; CI: 1.40-1.68; $p < 0.00001$], and ICU mortality (6 studies) [RR: 1.51, CI: 1.31-1.75;

					and duration of mechanical ventilation (MV), and discharge disposition	p<0.00001]. Frailty had a negative significant association with discharge to home (4 studies) [RR: 0.59, CI: 0.49-0.71; p<0.00001].
Oakland, K., Nadler, R., Cresswell, L., Jackson, D., & Coughlin, P. A. (2016). Systematic review and meta-analysis of the association between frailty and outcome in surgical patients. Annals of the Royal College of Surgeons of England, 98(2), 80–85. https://doi.org/10.1308/rcsann.2016.0048	Patients undergoing all forms of surgery (elective and emergency) except surgery for fractured neck of femur (8/12 studies had participants with mean age at least 65 +)	perioperative (pre-op evalutation of frailty, postop outcomes)	12	various, many unfamiliar methods (skeletal muscle mass, edmonton frailty scale, impairment in ADL, phenotype, total psoas area, etc.)	1-year mortality and early mortality (ie in-hospital mortality), 30-day mortality or mortality 'following surgery', length of stay, requirement for step-down rehabilitation placement, overall and organ specific complication rates	Frailty was significantly associated with higher in-hospital mortality rate (6 studies) [pooled OR: 2.77, CI: 1.62–4.73)], a higher one-year mortality rate (5 studies) [pooled OR: 1.99, CI: 1.49–2.66], a longer hospital length of stay (4 studies) [pooled mean difference: 1.05

						days, CI: 0.02–2.07] and a higher discharge rate to further rehabilitation/step-down care (6 studies) [pooled OR: 5.71, CI: 3.41–9.55].
Oresanya, L., Lyons, W., & Finlayson, E. (2014). Preoperative Assessment of the Older Patient: A Narrative Review. JAMA, 311(20), 2110–2120. https://doi.org/10.1001/jama.2014.4573	patients 60 yr + that underwent surgery (> 50% of studies had participants aged at least 65 +)	perioperative	54 (most do not discuss frailty)	ICD-9 codes for 12 conditions, modified frailty index, frailty measure based on comprehensive geriatric assessment, modified phenotype, comprehensive assessment of frailty score	postoperative mortality (within 1 yr of sx), postoperative complications (ex. delirium, discharge to an institution, cognitive and functional decline)	Of the four studies that looked at frailty and postoperative mortality, all of them found a significant assocation between frailty and mortality within 1 year of surgery.

Shamliyan, T., Talley, K., Ramakrishnan, R., & Kane, R. (2013). Association of frailty with survival: A systematic literature review.(Report). Ageing Research Reviews, 12(2), 719–736. https://doi.org/10.1016/j.arr.2012.03.001	people aged 65 +	community	24	phenotype, frailty index	survival	Frailty was associated with poor survival (9 studies).
Vermeiren, S., Vella-Azzopardi, R., Beckwée, D., Habbig, A., Scafoglieri, A., Jansen, B., & Bautmans, I.(2016). Frailty and the Prediction of Negative Health Outcomes: A Meta-Analysis. Journal of the American Medical Directors Association, 17(12), 1163.e1–1163.e17. https://doi.org/10.1016/j.jamda.2016.09.010	people aged 65 +	community	31	> 20 different instruments (modified phenotype, modified Study of Osteoporotic Fractures, Tilburg frailty indicator, Groningen frailty indicator, frailty index, etc.)	any potential outcome (mortality, hospitalization, disabilities in ADLs, falls, institutionalization, fractures, physical limitation, ED visits, etc.)	Frailty was significantly associated with mortality (7 studies) [pooled OR: 2.34, CI: 1.77-3.09], (17 studies) [pooled HR/RR: 1.83, CI: 1.68-1.98], with hospitalization (8 studies) [pooled OR:1.82, CI: 1.53–2.15, (3 studies) [pooled HR, RR: 1.18, CI: 1.10–1.28], with institutionalization (2 studies) [pooled OR:

						1.69, CI: 1.02-2.81], (3 studies) [pooled HR/RR: 1.67, CI-1.47-1.89], with the development of disabilities in basic activities of daily living (8 studies)[pooled OR: 2.05, CI: 1.73–2.44], (3 studies) [pooled HR/RR: 1.62, CI: 1.50–1.76], with the developement of disabilities in instrumental activities of daily living (7 studies) [pooled OR: 2.52, CI: 2.08-3.06], with falls (3 studies) [pooled OR: 1.70, CI: 1.18-2.44], (3

						studies) [pooled HR/RR: 1.24, CI: 1.12-1.37] , and with fractures (2 studies) [pooled OR: 2.78, CI: 1.30-5.99], (3 studies) [pooled HR/RR: 1.37, CI: 1.21-1.54] .
Vermeulen, J., Neyens, J., van Rossum, E., Spreeuwenberg, M., & de Witte, L. (2011). Predicting ADL disability in community-dwelling elderly people using physical frailty indicators: a systematic review. BMC Geriatrics, 11(1), 33–33. https://doi.org/10.1186/1471-2318-11-33	people aged 65 +	community	28	physical frailty indicators: weight loss, exhaustion, gait speed, muscle strength, physical activity, balance, other	ADL disability	Physical frailty indicators such as slow gait speed, low physical activity, weight loss, lower extremity function, balance, muscle strength predict ADL disability.

Appendix E – Quality Assessment of the Included Reviews

	Study																					
AMSTAR Item	Buigues, 2015	Chang, 2018	Chang, 2015	Chen, 2017	Cheng, 2017	Fhon, 2016	Gutiérrez-Valencia, 2018	Kane, 2012	Kojima, 2018	Kojima,2017	Kojima, 2016a	Kojima, 2016b	Kojima, 2015	Kojima, Iliffe, 2018	Kojima, Iliffe, 2016	Lin,2016	Lorenzo-López, 2017	Muscedere, 2017	Oakland, 2016	Oresanya, 2014	Shamliyan, 2013	Vermeiren, 2016	Vermeulen, 2011
1. Did the research questions and inclusion criteria for the review include the components of PICO?	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2. Did the report of the review contain an explicit statement that the review methods were	N	N	N	N	N	P	P	N	P	P	P	P	P	P	P	N	N	Y	N	N	N	N	N

established prior to the conduct of the review and did the report justify any significant deviations from the protocol?																							
3. Did the review authors explain their selection of the study designs for inclusion in the review?	N	N	N	N	N	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
4. Did the review authors use a comprehensive literature search strategy?	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	N	P	P	P	P

5. Did the review authors perform study selection in duplicate?	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	Y	Y	N	N	Y	Y	Y
6. Did the review authors perform data extraction in duplicate?	Y	Y	Y	Y	Y	N	N	Y	N	N	N	N	N	N	N	Y	N	Y	N	N	Y	Y	N
7. Did the review authors provide a list of excluded studies and justify the exclusions?	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N
8. Did the review authors describe the included studies in adequate detail?	P	P	Y	P	Y	P	P	N	Y	Y	Y	Y	Y	Y	P	P	P	P	N	P	P	Y	Y

9. Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?	N	P	P	P	P	N	Y	N	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	N	N	Y	Y
10. Did the review authors report on the sources of funding for the studies included in the review?	Y	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
11. If meta-analysis was performed did the review authors use appropriate	N/A	Y	Y	Y	Y	Y	N/A	Y	Y	Y	Y	Y	Y	Y	Y	N/A	N/A	Y	Y	N/A	N/A	Y	N/A

methods for statistical combination of results?																							
12. If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	N/A	Y	Y	Y	Y	N	N/A	N	Y	Y	Y	Y	Y	Y	Y	N/A	N/A	Y	N	N/A	N/A	Y	N/A
13. Did the review authors account for RoB in individual studies when interpreting/ discussing the	N	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	N	Y	Y

results of the review?																							
14. Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y
15. If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias)	N/A	Y	Y	Y	Y	N	N/A	N	Y	Y	Y	Y	N	Y	Y	N/A	N/A	Y	N	N/A	N/A	N	N/A

and discuss its likely impact on the results of the review?																							
16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y

Appendix F - PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	

Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

Appendix G – Eligibility Document

Inclusion	**Exclusion**
Population 65 years and older **I**ntervention/exposure: Frailty • Uses a screening tool • Tool includes more than one health item **C**ontext: Inpatient rehabilitation Includes at least one of these **o**utcomes: • Functional status • Length of stay in rehabilitation • Discharge destination • Readmission to acute care Quantitative studies • Randomized • Non-randomized • Quasi-experimental • Cohort (both retrospective and prospective) • Cross-sectional • Case-control • Correlational Qualitative studies: • Descriptive • Phenomenology • Grounded theory • Ethnography • Narrative	Settings: • Day hospital • Outpatient rehabilitation programs • Acute care of the elderly units (ACE) • Geriatric monitoring units (GMU) • Acute care Studies: • Case reports

Mixed method: Any design Any language Any publication date	

*If a population in an article is a range (ex. 18-80 yrs) or is 60 yrs and +, it should be evident that at least 50% of the participants are 65 years and older.

†If a study includes both inpatient rehabilitation and another setting, it should be evident that over 50% of the population come from the inpatient rehabilitation setting.

**Definitions do not need to be identical but the concepts and ideas behind the terms the researcher is using should be fairly similar.

Appendix H – PRESS Guideline

***PRESS Guideline* — Search Submission & Peer Review Assessment**

SEARCH SUBMISSION: THIS SECTION TO BE FILLED IN BY THE SEARCHER

Searcher: Ericha Seidenz	Email:
Date submitted: Dec 19th 2018	Date requested by: ASAP *[Maximum = 5 working days]*

Systematic Review Title:

Frailty status and Rehabilitation Outcomes among Older Adults: A Systematic Review

This search strategy is …

x	My PRIMARY (core) database strategy — First time submitting a strategy for search question and database
	My PRIMARY (core) strategy — Follow-up review NOT the first time submitting a strategy for search question and database. If this is a response to peer review, itemize the changes made to the review suggestions
	SECONDARY search strategy— First time submitting a strategy for search question and database
	SECONDARY search strategy — NOT the first time submitting a strategy for search question and database. If this is a response to peer review, itemize the changes made to the review suggestions

Database

(i.e., MEDLINE,CINAHL…): *[mandatory]*

Medline, CINAHL, Embase, Scopus

Interface

(i.e., Ovid, EBSCO…): *[mandatory]*

Medline – Ovid, CINAHL – EBSCO, Embase – Ovid

Research Question

(Describe the purpose of the search) *[mandatory]*

What is the Association between Frailty Status and Rehabilitation Outcomes among Older Adults?

PICO Format

(Outline the PICOs for your question — i.e., Patient, Intervention, Comparison, Outcome, and Study Design — as applicable)

Participants	The population of interest will be adults aged 65 years and older.

Intervention, exposure	The exposure of interest is frailty. Frailty in older adults will be defined by Tocchi's (2015, p.79) concept analysis as a "a tenuous state of health that is the result of the complex interplay of physiological, psychosocial, and environmental stressors that increases an older adult's susceptibility to adverse health outcomes."
Context	The setting is inpatient rehabilitation which will be defined as an in-hospital program that provides a set of interventions with the purpose of restoring or maintaining functioning for populations that are affected by disability or disease (Bachmann et al., 2010).
Outcomes	The primary outcome will be functional status. Functional status will be defined by Wang's (2004, p. 462) concept analysis where functional status is the "activities performed by an individual to realize needs of daily living in many aspects of life including physical, psychological, social, spiritual, intellectual, and roles." Secondary outcomes will include length of stay in rehabilitation, discharge destination, and readmission to acute care. Length of stay in rehabilitation will be defined as the duration, in days or months, of a single stay in the inpatient rehabilitation program. Discharge destination will be the location where a patient is sent upon either completion of the rehabilitation program or due to medical instability. Examples of discharge destinations may include home, long-term care facility, hospice, etc. Readmission to acute care will signify whether a patient was admitted for acute hospitalization as their discharge destination

Inclusion Criteria

(List criteria such as age groups, study designs, etc., to be included) *[optional]*

Types of studies: Quantitative, qualitative, and mixed method studies will be included in this review including randomized, non-randomized, quasi-experimental, cohort (both retrospective and prospective), cross-sectional, case-control, correlational, review articles, descriptive, phenomenology, grounded theory, ethnography, narrative, and mixed method study designs.

Exclusion Criteria

(List criteria such as study designs, date limits, etc., to be excluded) *[optional]*

Types of studies: Excluded studies include editorials, case reports, case series, and conference reports.

Settings: Day hospital, outpatient rehabilitation programs, acute care of the elderly units, and geriatric monitoring units will be excluded as these units are different than an inpatient rehabilitation program.

Was a search filter applied?

Yes ■ No ■

If YES, which one(s) (e.g., Cochrane RCT filter, PubMed Clinical Queries filter)? Provide the source if this is a published filter. *[mandatory if YES to previous question — textbox]*

Other notes or comments you feel would be useful for the peer reviewer? ***[optional]*** No limitation by language or date.

Please copy and paste your search strategy here, exactly as run, including the number of hits per line. ***[mandatory]***

Medline

1	FRAILTY/	769
2	frail*.ti,ab.	17156
3	1 or 2	17219
4	aged/ or "aged, 80 and over"/	2885027
5	GERIATRICS/	28989
6	(elder* or senior or seniors or aged or geriatric* or gerontology or older adult*).ti,ab.	796672
7	4 or 5 or 6	3336318
8	rehabilitation/ or cardiac rehabilitation/ or early ambulation/ or exercise therapy/ or neurological rehabilitation/ or stroke rehabilitation/ or occupational therapy/	78549
9	Rehabilitation Centers/	7894

10	rehab*.ti,ab.		149486
11	occupational therap*.ti,ab.		12344
12	physiotherap*.ti,ab.		22587
13	Physical Therapy Modalities/		34417
14	physical therap*.ti,ab.		19854
15	habilitation.ti,ab.	919	
16	SUBACUTE CARE/	889	
17	subacute care.ti,ab.	353	
18	intermediate care.ti,ab.	1394	
19	restorative care.ti,ab.		370
20	(reablement or re-ablement).ti,ab.	69	
21	step down care.ti,ab.		24
22	stepdown care.ti,ab.		2
23	postacute care.ti,ab.		462
24	post acute care.ti,ab.		694
25	8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24		253355
26	Frail Elderly/		9875
27	3 and 7		13752
28	26 or 27		17691
29	INPATIENTS/		18856
30	(inpatient* or in-patient*).ti,ab.		1620805
31	HOSPITALIZATION/		95960
32	(hospitaliz* or hospitalis*).ti,ab.		216790

33	Patient Admission/	22611
34	admission*.ti,ab.	193615
35	admitted.ti,ab.	183213
36	29 or 30 or 31 or 32 or 33 or 34 or 35	2024246
37	25 and 28 and 36	483

CINAHL

S35	S34 AND S28 AND S25	436
S34	S29 OR S30 OR S31 OR S32 OR S33	1418542
S33	TI (admission* or admitted) OR AB (admission* or admitted)	89108
S32	TI (hospitaliz* or hospitalis*) OR AB (hospitaliz* or hospitalis*)	66446
S31	(MH "Patient Admission") OR (MH "Hospitalization")	41384
S30	TI (inpatient* or in-patient*) OR AB (inpatient* or in-patient*)	1343469
S29	(MH "Inpatients") OR (MH "Rehabilitation Patients")	76423
S28	S26 OR S27	10497
S27	S3 AND S7	7602
S26	(MH "Frail Elderly")	6393
S25	S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24	160989
S24	TI (post acute care OR postacute care) OR AB (post acute care OR postacute care)	1314
S23	TI step down care OR AB step down care	123
S22	TI stepdown care OR AB stepdown care	16
S21	(MH "Observation Units")	661
S20	TI re-ablement OR AB re-ablement	31
S19	TI reablement OR AB reablement	63

S18	TI restorative care OR AB restorative care	297
S17	TI intermediate care OR AB intermediate care	1129
S16	TI subacute care OR AB subacute care	461
S15	(MH "Subacute Care")	1343
S14	TI habilitation OR AB habilitation	383
S13	TI physical therap* OR AB physical therap*	19283
S12	TI physiotherap* OR AB physiotherap*	16883
S11	TI occupational therap* OR AB occupational therap*	18591
S10	TI rehab* OR AB rehab*	78404
S9	(MH "Rehabilitation Centers") OR (MH "Stroke Units")	7176
S8	(MH "Rehabilitation") OR (MH "Occupational Therapy") OR (MH "Physical Therapy") OR (MH "Early Ambulation") OR (MH "Rehabilitation, Cardiac") OR (MH "Rehabilitation, Geriatric") OR (MH "Rehabilitation, Pulmonary") OR (MH "Rehabilitation, Cognitive") OR (MH "Disability Management")	69791
S7	(S4 OR S5 OR S6)	828188
S6	TI (elder* or senior or seniors or aged or geriatric* or gerontology or older adult*) OR AB (elder* or senior or seniors or aged or geriatric* or gerontology or older adult*)	272148
S5	(MH "Geriatrics")	4594
S4	(MH "Aged") OR (MH "Aged, 80 and Over")	691299
S3	(S1 OR S2)	9462
S2	TI frail* OR AB frail*	9297
S1	(MH "Frailty Syndrome")	1208

Embase

1.	frailty/	5184
2.	frail*.ti,ab.	25648

3.	1 or 2	26400
4.	aged/	2695732
5.	geriatrics/	28030
6.	gerontology/	2831
7.	(elder* or senior or seniors or aged or geriatric* or gerontology or older adult*).ti,ab.	1073495
8.	4 or 5 or 6 or 7	3319596
9.	rehabilitation/ or cognitive rehabilitation/ or geriatric rehabilitation/ or heart rehabilitation/ or neurorehabilitation/ or occupational therapy/ or rehabilitation care/	119532
10.	physiotherapy/	75458
11.	stroke rehabilitation/	2043
12.	pulmonary rehabilitation/	5404
13.	rehabilitation center/	12320
14.	rehab*.ti,ab.	208245
15.	occupational therap*.ti,ab.	17648
16.	physiotherap*.ti,ab.	39187
17.	physical therap*.ti,ab.	28629
18.	habilitation.ti,ab.	1183
19.	subacute care/	515
20.	subacute care.ti,ab.	411
21.	intermediate care.ti,ab.	2017
22.	restorative care.ti,ab.	388
23.	(reablement or re-ablement).ti,ab.	87
24.	(step down care or stepdown care).ti,ab.	56

25. (postacute care or post acute care).ti,ab.	1610
26. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25	340819
27. frail elderly/	9326
28. 3 and 8	19978
29. 27 or 28	23657
30. hospital patient/	144885
31. hospitalization/	318324
32. (inpatient* or in-patient*).ti,ab.	2443843
33. (hospitaliz* or hospitalis*).ti,ab.	344173
34. hospital admission/	172654
35. (admission* or admitted).ti,ab.	544244
36. 30 or 31 or 32 or 33 or 34 or 35	3182852
37. 26 and 29 and 36	759

Scopus

frail* AND (elder* or senior or seniors or aged or geriatric* or gerontology or older AND adult*) AND (rehab* or occupational AND therap* OR physiotherap* OR physical AND therap* OR habilitation OR subacute AND care OR restorative AND care OR reablement OR re-ablement OR intermediate AND care OR stepdown AND care OR step AND down AND care OR postacute AND care OR post AND acute AND care) AND (inpatient* OR in-patient* OR hospitaliz* OR hospitalis* OR admission* OR admitted)
631

PEER REVIEW ASSESSMENT: THIS SECTION TO BE FILLED IN BY THE REVIEWER

Reviewer:	Email:	Date completed:
Marie-Cécile Domecq	mdomecq@uottawa.ca	Jan, 14th 2019

1. TRANSLATION

A ---No revisions	X
B --- Revision(s) suggested	☐
C --- Revision(s) required	☐

If "B" or "C," please provide an explanation or example:

2. **BOOLEAN AND PROXIMITY OPERATORS**

A ---No revisions	X
B --- Revision(s) suggested	☐
C --- Revision(s) required	☐

If "B" or "C," please provide an explanation or example:

3. **SUBJECT HEADINGS**

A ---No revisions	☐
B --- Revision(s) suggested	X
C --- Revision(s) required	☐

If “B” or “C,” please provide an explanation or example:

For some headings, I would EXPlode the term, to retrieve the articles from the subcategories:
Medline： exercise therapy/ (line 8) Physical Therapy Modalities/ (line 15)
CINAHL: (MH "Physical Therapy") (MH "Rehabilitation, Cardiac") (line S8)
Embase: neurorehabilitation/ (line 9) physiotherapy/ (line 10)

Also some headings could be added in the search:
Embase: aged hospital patient/ (line 30)

Last, in CINAHL: remove Heading (MH "Disability Management") from line S8

4. TEXT WORD SEARCHING

A ---No revisions	☐
B --- Revision(s)suggested	X
C --- Revision(s) required	☐

If “B” or “C,” please provide an explanation or example:

Few suggestions for text word:

- admitted change for admitt*
- (hospitaliz* or hospitalis*) change for hospitali*
- Remove gerontology from the list of patient search (i.e. line (elder* or senior or seniors or aged or geriatric* or ~~gerontology~~ or older adult*).ti,ab.

Scopus:
Using the search in the title and abstract fields: (TITLE-ABS (.....))

5. SPELLING, SYNTAX, AND LINE NUMBERS

A ---No revisions	☐
B --- Revision(s)suggested	X
C --- Revision(s) required	☐

If "B" or "C," please provide an explanation or example:

1) For all the database, re-organize the order of the line to regroup them by concept.
Medline : lines 26 to 28 should be after line 7
Cinahl : lines S26 to S28 should be after line S7
Embase : lines 27 to 29 should be after line 8

2) Suggestion for Ovid platform: using OR/ short syntax instead of the long list of OR.
Example OR/29-35

6. LIMITS AND FILTERS

A ---No revisions	X
B --- Revision(s) suggested	☐
C --- Revision(s) required	☐

If "B" or "C," please provide an explanation or example:

OVERALL EVALUATION (Note: If one or more "revision required" is noted above, the response below must be "revisions required".)

A ---No revisions	☐
B --- Revision(s) suggested	X
C --- Revision(s) required	☐

Additional comments:

Bravo Ericha, very good work ! I just suggested some "cosmetic" changes.

Also, we had a discussion about the possibility of exploding of some MeSH/Subject Heading terms, but Ericha is confortable as it is. So statu quo !

Appendix I - Search Strategies

Medline

1. FRAILTY/
2. frail*.ti,ab.
3. 1 or 2
4. aged/ or "aged, 80 and over"/
5. GERIATRICS/
6. (elder* or senior or seniors or aged or geriatric* or older adult*).ti,ab.
7. 4 or 5 or 6
8. Frail Elderly/
9. 3 and 7
10. 8 or 9
11. rehabilitation/ or cardiac rehabilitation/ or early ambulation/ or exp exercise therapy/ or neurological rehabilitation/ or stroke rehabilitation/ or occupational therapy/
12. Rehabilitation Centers/
13. rehab*.ti,ab.
14. occupational therap*.ti,ab.
15. physiotherap*.ti,ab.
16. exp Physical Therapy Modalities/
17. physical therap*.ti,ab.
18. habilitation.ti,ab.
19. SUBACUTE CARE/
20. subacute care.ti,ab.
21. intermediate care.ti,ab.

22. restorative care.ti,ab.
23. (reablement or re-ablement).ti,ab.
24. (step down care or stepdown care).ti,ab.
25. (postacute care or post acute care).ti,ab.
26. or/11-25
27. INPATIENTS/
28. (inpatient* or in-patient*).ti,ab.
29. HOSPITALIZATION/
30. hospitali*.ti,ab.
31. Patient Admission/
32. admission*.ti,ab.
33. admitt*.ti,ab.
34. or/27-33
35. 10 and 26 and 34

CINAHL

S33 S10 AND S26 AND S32

S32 S27 OR S28 OR S29 OR S30 OR S31

S31 TI (admission* or admitt*) OR AB (admission* or admitt*)

S30 TI (hospitali*) OR AB (hospitali*)

S29 (MH "Patient Admission") OR (MH "Hospitalization")

S28 TI (inpatient* or in-patient*) OR AB (inpatient* or in-patient*)

S27 (MH "Inpatients") OR (MH "Rehabilitation Patients")

S26 S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25

S25 TI (post acute care OR postacute care) OR AB (post acute care OR postacute care)

S24 TI (stepdown care OR step down care) OR AB (stepdown care OR step down care)

S23 (MH "Observation Units")

S22 TI (reablement OR re-ablement) OR AB (reablement OR re-ablement)

S21 TI restorative care OR AB restorative care

S20 TI intermediate care OR AB intermediate care

S19 TI subacute care OR AB subacute care

S18 (MH "Subacute Care")

S17 TI habilitation OR AB habilitation

S16 TI physical therap* OR AB physical therap*

S15 TI physiotherap* OR AB physiotherap*

S14 TI occupational therap* OR AB occupational therap*

S13 TI rehab* OR AB rehab*

S12 (MH "Rehabilitation Centers") OR (MH "Stroke Units")

S11 (MH "Rehabilitation") OR (MH "Occupational Therapy") OR (MH "Physical Therapy+") OR (MH "Early Ambulation") OR (MH "Rehabilitation, Cardiac+") OR (MH "Rehabilitation, Geriatric") OR (MH "Rehabilitation, Pulmonary") OR (MH "Rehabilitation, Cognitive")

S10 S8 OR S9

S9 S3 AND S7

S8 (MH "Frail Elderly")

S7 (S4 OR S5 OR S6)

S6 TI (elder* or senior or seniors or aged or geriatric* or older adult*) OR AB (elder* or s enior or seniors or aged or geriatric* or older adult*)

S5 (MH "Geriatrics")

S4 (MH "Aged") OR (MH "Aged, 80 and Over")

S3 (S1 OR S2)

S2 TI frail* OR AB frail*

S1 (MH "Frailty Syndrome")

Embase

1. frailty/
2. frail*.ti,ab.
3. 1 or 2
4. aged/
5. geriatrics/
6. (elder* or senior or seniors or aged or geriatric* or older adult*).ti,ab.
7. 4 or 5 or 6
8. frail elderly/
9. 3 and 7
10. 8 or 9
11. rehabilitation/ or cognitive rehabilitation/ or geriatric rehabilitation/ or heart rehabilitation/ or exp neurorehabilitation/ or occupational therapy/ or rehabilitation care/
12. exp physiotherapy/
13. stroke rehabilitation/
14. pulmonary rehabilitation/
15. rehabilitation center/
16. rehab*.ti,ab.

17. occupational therap*.ti,ab.
18. physiotherap*.ti,ab.
19. physical therap*.ti,ab.
20. habilitation.ti,ab.
21. subacute care/
22. subacute care.ti,ab.
23. intermediate care.ti,ab.
24. restorative care.ti,ab.
25. (reablement or re-ablement).ti,ab.
26. (step down care or stepdown care).ti,ab.
27. (postacute care or post acute care).ti,ab.
28. or/11-27
29. aged hospital patient/
30. hospital patient/
31. hospitalization/
32. (inpatient* or in-patient*).ti,ab.
33. hospitali*.ti,ab.
34. hospital admission/
35. (admission* or admitt*).ti,ab.
36. or/29-35
37. 10 and 28 and 36

Scopus

frail* AND (elder* or senior or seniors or aged or geriatric* or gerontology or older AND adult*) AND (rehab* or occupational AND therap* OR physiotherap* OR physical AND therap* OR habilitation OR subacute AND care OR restorative AND care OR reablement OR re-ablement OR intermediate AND care OR stepdown AND care OR step AND down AND care OR postacute AND care OR post AND acute AND care) AND (inpatient* OR in-patient* OR hospitaliz* OR hospitalis* OR admission* OR admitted)

Appendix J - Newcastle-Ottawa Quality Assessment Scale

COHORT STUDIES

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability

Selection

1) Representativeness of the exposed cohort

a) truly representative of the average _____ (describe) in the community ✵

b) somewhat representative of the average _____ in the community ✵

c) selected group of users eg nurses, volunteers

d) no description of the derivation of the cohort

2) Selection of the non exposed cohort

a) drawn from the same community as the exposed cohort ✵

b) drawn from a different source

c) no description of the derivation of the non exposed cohort

3) Ascertainment of exposure

a) secure record (eg surgical records) ✵

b) structured interview ✵

c) written self report

d) no description

4) Demonstration that outcome of interest was not present at start of study

a) yes ✵

b) no

Comparability

1) Comparability of cohorts on the basis of the design or analysis

a) study controls for _____ (select the most important factor) ✵

b) study controls for any additional factor ✵ (This criteria could be modified to indicate specific control for a second important factor.)

Outcome

1) Assessment of outcome

a) independent blind assessment ✵

b) record linkage ✵

c) self report

d) no description

2) Was follow-up long enough for outcomes to occur

a) yes (select an adequate follow up period for outcome of interest) ✵

b) no

3) Adequacy of follow up of cohorts

a) complete follow up - all subjects accounted for ✵

b) subjects lost to follow up unlikely to introduce bias - small number lost - > ____ % (select an adequate %) follow up, or description provided of those lost) ✵

c) follow up rate < ____% (select an adequate %) and no description of those lost

d) no statement

Appendix K – Newcastle-Ottawa Coding Manual for Cohort Studies

SELECTION

1) Representativeness of the Exposed Cohort

Item is assessing the representativeness of exposed individuals in the community, not the representativeness of the sample of women from some general population. For example, subjects derived from groups likely to contain middle class, better educated, health oriented women are likely to be representative of postmenopausal estrogen users while they are not representative of all women (e.g. members of a health maintenance organisation (HMO) will be a representative sample of estrogen users. While the HMO may have an under-representation of ethnic groups, the poor, and poorly educated, these excluded groups are not the predominant users users of estrogen).

Allocation of stars as per rating sheet

2) Selection of the Non-Exposed Cohort

Allocation of stars as per rating sheet

3) Ascertainment of Exposure

Allocation of stars as per rating sheet

4) Demonstration That Outcome of Interest Was Not Present at Start of Study

In the case of mortality studies, outcome of interest is still the presence of a disease/ incident, rather than death. That is to say that a statement of no history of disease or incident earns a star.

COMPARABILITY

1) Comparability of Cohorts on the Basis of the Design or Analysis

A maximum of 2 stars can be allotted in this category

Either exposed and non-exposed individuals must be matched in the design and/or confounders must be adjusted for in the analysis. Statements of no differences between groups or that differences were not statistically significant are not sufficient for establishing comparability. Note: If the relative risk for the exposure of interest is adjusted for the confounders listed, then the groups will be considered to be comparable on each variable used in the adjustment.

There may be multiple ratings for this item for different categories of exposure (e.g. ever vs. never, current vs. previous or never)

Age = ☆Other controlled factors = ☆

OUTCOME

1) Assessment of Outcome

For some outcomes (e.g. fractured hip), reference to the medical record is sufficient to satisfy the requirement for confirmation of the fracture. This would not be adequate for vertebral fracture outcomes where reference to x-rays would be required.

a) Independent or blind assessment stated in the paper, or confirmation of the outcome by reference to secure records (x-rays, medical records, etc.) ☆
b) Record linkage (e.g. identified through ICD codes on database records) ☆
c) Self-report (i.e. no reference to original medical records or x-rays to confirm the outcome)
d) No description.

2) Was Follow-Up Long Enough for Outcomes to Occur

An acceptable length of time should be decided before quality assessment begins (e.g. 5 yrs. for exposure to breast implants)

3) Adequacy of Follow Up of Cohorts

This item assesses the follow-up of the exposed and non-exposed cohorts to ensure that losses are not related to either the exposure or the outcome.

Allocation of stars as per rating sheet

Appendix L – Quality Assessment and Validity Tool for Before/After Cohort Study Designs

Quality Assessment and Validity Tool for before/after-Cohort Design studies			
Study: First Author: Publication Information: Date: Journal: N/A can only be scored if it is not applicable to the design of the study.			
	Yes	No	N/A
Sampling			
1. Was probability sampling used?	1	0	
2. Was sample size justified to obtain an appropriate power?	1	0	
3. Are the individuals selected to participate in the study likely to be representative of the target population?			
a. Very likely	2	0	
b. Somewhat likely	1	0	
c. Not likely	0	0	
Design			
a. One pre-test or baseline and several post-test measures	2	0	
b. Simple before-and-after study	1	0	
c. Post-test only			
Control of Confounders			
1. Does the study employ a comparison strategy?			
Attempt to create or assess equivalence of the groups at baseline by:			
a) Matching	2	0	
b) Statistical adjustment			

c) None	1 0	0 0	
2. The group comparisons were the same for all occasions (Pre, baseline, and post evaluations)	2	0	
Data Collection and Outcome Measurement			
1. Was the dependent variable (JS)			
a. directly measured, or observed	1	0	
b. self-reported	0	0	
2. Was the dependent variable reliably and validly measured? That is, measured using an instrument with reported (previously or for this study) a. Reliability indices	1	0	
b. Validity assessments	1	0	
Statistical Analysis and Conclusions			
1. Was (were) the statistical test (s) used appropriate for the main outcome?	1	0	
2. Were p values reported?	1	0	
3. Were confidence intervals reported?	1	0	
4. Were missing data managed appropriately?	1	0	N/A
Drop outs			
Is attrition rate < 30% (if no attrition code 1)	1	0	
Overall Validity Rating: 18 points Total number of items obtained № of items possible (Total – N/A) 18 Key: ≤ 0.50=weak; 0.51-0.65=low moderate; 0.66-0.79= high moderate; ≥0.80=strong	TOTAL: WEAK LOW MOD HIGH MOD STRONG		

DEFINITIONS FOR BEFORE –AFTER /COHORT TOOL

Sampling:

1. **Was probability sampling used?**
   A random sample of some form or a systematic sample with a random start is acceptable. Most researchers probably used a convenience sample, i.e., studying all the patients available to them in one or more setting(s) that agreed to participate which is scored zero.

   Score 1 if the authors stated that they used a probabilistic sample

   Score 0 if the authors stated that they used a convenience sample or if they did not report the use of probabilistic sample.

2. **Was sample size justified to obtain an appropriate power?**

   Score 1 if:

   Sample size is justified based on appropriate power calculations (power=80)
   Using a multivariate approach 10 cases per IV are used
   Using several correlations or t-tests, a sample of 80 or more reflects adequate power
   Study has sufficient statistical power to detect clinically important effects as statistically significant and record power > 80.

   Score zero if:
   Sample size and power are not reported.
   No one of the above cut-offs are not met.

3. **Are the individuals selected to participate in the study likely to be representative of the target population?**

   Score 2: if the authors have done everything reasonably possible to ensure that the target population is represented (e.g., Very likely).

   Score 1 if: participants may not be representative (i.e., if they are referred from a source within a target population even if it is in a systematic manner (e.g., Somewhat likely).

   Score 0 if: participants are probably not representative if they are self-referred or are volunteers or if you can not tell.

Design:

a) One pre-test or baseline and several post-test measures: score 2 if an initial measurement was done before starting the study or at the beginning of it and then if prospective measurements were conducted during study period

b) Simple before-and-after study: score 1 only when one measurement was conducted before and after the intervention.

c) Score zero if the above requirements are not met.

Control of Confounders

Does the study employ a comparison strategy?

Attempt to create or assess equivalence by:

a) Matching; Score 2 if the researchers matched the participating groups in the study. The authors have to state clearly that the groups were matched (i.e. gender, activity, age).

b) Statistically: Score 1 point if the groups were statistically adjusted for confounder variables (i.e. use of covariance).

c) Score 0 points if: If the authors did not state that groups were matched or statistically adjested.

The group comparisons were the same for all occasions (pre, baseline, and post evaluations).

Score 2 if the same groups of people were measured and compared in all occasions.

Score zero if this requirement was not met

Data Collection and Outcome Measurement

1. Were dependent variables
    a. directly measured or observed
    b. self-reported

    Score 1: If the outcomes were directly measured using an objective measurement or observed

    Score 0: if self reported.

2. Were the dependent variables reliably and validly measured? That is measured using an instrument with reported (previously through a reference or reported for this study)
    a. Reliability indices

    Score 1 if any of the following are reported:

        i. Some way of reliability was reported such as: intrarater and/or interrater reliability of the outcomes measures was > ICC 0.70 or kappa ≥0.70 or at least 80% agreement.
        ii. Internal consistency for a scale is >0.70
        iii.

    Score 0 if:

        i. If the assumptions made above are not accomplished, or not reported

    b. Validity assessments

    Score 1 if:

        i. some form of validation was described for the tools used to measure the DV (face, content, construct, and concurrent validity)

    Score 0 if:

    No tool validation reported.

Statistical Analysis

1. Was (were) the statistical test (s) used appropriate for the main outcome?

Score 1 if: the statistical analysis was appropriate for the main study outcome

Score 0 if: If the statistical tests used were not appropriate

Were p values reported?

Score 1: if these values were reported

Score 0: if these values were not reported

Were confidence intervals reported?

Score 1: if these values were reported

Score 0: if these values were not reported

Score N/A: if not applicable

4. Was any missing data managed?

Score 1 if: authors managed missing data through statistical analyses

Score 0 if: not reported or not done

Score N/A: if you are **certain** there are not missing data

Drop outs

Is attrition rate< 30%. If drop outs were reported to be less than 30% score 1. If not reported or unclear score zero

Appendix M – Excluded Articles

Exclusion reasons	Citations
Does not screen/assess frailty/frailty not a concept of interest **20**	Arinzon, Z., Fidelman, Z., Zuta, A., Peisakh, A., & Berner, Y. N. (2005). Functional recovery after hip fracture in old-old elderly patients. *Archives of Gerontology and Geriatrics*, *40*(3), 327–336. https://doi.org/10.1016/j.archger.2004.10.003 Atalay, A., & Turhan, N. (2007). Predictors of mobility in medically unstable elderly patients with hip fractures: a preliminary study in a geriatric ward. *Journal of the American Geriatrics Society*, *55*(7), 1140–1141. https://doi.org/10.1111/j.1532-5415.2007.01208. Bayon-Calatayud, M., & Benavente-Valdepeñas, A. M. (2018). Short-Term Outcomes of Interdisciplinary Hip Fracture Rehabilitation in Frail Elderly Inpatients. *Rehabilitation Research & Practice*, 1–7. https://doi.org/10.1155/2018/1708272 Baztan, J. J., Fernandez-Alonso, M., Aguado, R., & Socorro, A. (2004). [Outcome at year after rehabilitation of proximal femur fracture in older than 84 years]. *Resultados Al Ano de La Rehabilitacion Tras Fractura de Femur Proximal En Mayores de 84 Anos.*, *21*(9), 433–440. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med5&NEWS=N&AN=15476420 Baztán, J. J., Forcano, S., González, M., & Ruipérez, I (2003). Rehabilitation Outcomes in Frail Older Patients.

Journal of the American Geriatrics Society, *51*(2), 281–283. https://doi.org/10.1046/j.1532-5415.2003.51077.x

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Abstracts where author did not provide additional data upon contacting them **3**	Cacciatore, F., Abete, P., Mazzella, F., Langellotto, A., Furgi, G., Longobardi, G., … Rengo, F. (2011, April). Role of frailty in elderly patients with cardiovascular disease undergoing cardiac rehabilitation. Paper presented at EuroPRevent 2011, Geneva, Switzerland. https://journals-sagepub-com.proxy.bib.uottawa.ca/doi/pdf/10.1177/1741826711407007 Leung, P., Katz, R., Binns, M. A., Naglie, G., Karuza, J., Chan, A., Berall, A., Fallah, S. (2015, September). Predictors of Outcomes in Slow-Stream Rehabilitation. Paper presented at the 35th Annual Scientific Meeting of the Canadian Geriatrics Society, Montreal, Canada. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4597817/pdf/cgj-18-168.pdf Neira Alvarez, M., Lopez-Doriga, P., De Paz, A., Mansilla, S., Jimenez, P., & Andrino, N. (2011). Hip fracture and

	functional outcome after geriatric rehabilitation. European Geriatric Medicine, 2(SUPPL. 1), S87. https://doi.org/10.1016/j.eurger.2011.06.002
Wrong age range **1**	Weiner, D. K., Bongiorni, D.R., Studenski, S. A., Duncan, P.W., & Kochersberger, G.G. (1993). Does functional reach improve with rehabilitation? *Archives of Physical Medicine & Rehabilitation*, *74*(8), 796–800. https://doi.org/10.1016/0003-9993(93)90003-S

Appendix N – Data Extraction Results Part I

Reference	Country	Purpose/Objectives	Study Design	Setting	Participants				Frailty Screening Tool				
					Target population	Sample size	Frequency/% (M/F)	Age (M/F/)	Name of screening tool	Number of items	List of items	Timing of screening (prior to admission, at admission, at	Frailty results
Arjunan, A., Peel, N. M., & Hubbard, R. E. (2018). Gait Speed and Frailty Status in Relation to Adverse Outcomes in Geriatric Rehabilitation. *Archives of Physical Medicine and Rehabilitation*. 1-6. https://doi.org/10.1016/j.apmr.2018.08.187 Arjunan, A., Peel, N. M., & Hubbard, R. E. (2018). Feasibility and validity of frailty measurement in geriatric rehabilitation. Australasian Journal on Ageing, 37(2), 144–146. https://doi.org/10.1111/ajag.12502	Australia	"we aimed to examine the relationship between FI and GS, and to compare the predictive validity of both FI and GS in relation to adverse outcomes in hospital rehabilitation setting"	prospective cohort	3 geriatric rehabilitation wards of a tertiary hospital	patients 65 years + admitted between March 2015 and December 2015	258	Women: 139 (54%) Men: 119 (46%)	Mean age: 79 ±8	Frailty index	36	self-care, ADLs, bladder and bowel management, mobility, communication, social cognition, number of comorbidities, number of	admission	Mean FI ± SD: 0.42 ±0.13

											medications		
Cogan, L., Tiernan, C., & Romero- Ortuno, R. (2014, October). *The Impact of Frailty on Post-Acute Rehabilitation Outcomes in Older Adults.* Paper presented at Irish Gerontological Society 62nd Annual and Scientific Meeting, Galway. Ireland. https://journals-scholarsportal-info.proxy.bib.uottawa.ca/pdf/00211265/v183inone_7/269_i6aasmsfhaa.xml	Ireland	"Few studies have focused on frailty assessment tools as predictors of rehabilitation outcomes in older adults. Our study aimed to fill this gap."	retrospective cohort	22 bed Short-term Post Acute Rehabilitative Care (SPARC) Unit	patients aged >= 65, medically stable	172	N/A	N/A	Frailty Instrument for primary care (SHARE-FI) of the Survey of Health, Ageing and Retirement in Europe	N/A	N/A	admission	N/A
Haley, M. N., Wells, Y. D., & Holland, A. E. (2014). Relationship between frailty and discharge outcomes in subacute care. *Australian Health Review*, *38*(1), 25–29. https://doi.org/10.1071/AH13067	Australia	"to investigate the usefulness of the EFS as a measure of frailty for use with aged care inpatients "	prospective cohort	two subacute aged care wards of a large Melbourne rehabilitation hospital	patients admitted consecutively between February 2011 and July 2011	86	Women: 44 (51.2%) Men: 42 (48.8%)	Mean age: 81.3 ± 7.7 Median age: 84 Min: 63 Max: 96	Edmonton Frail Scale (EFS)	17 point scale	mood, cognition, social support	within 1 week of admission	Mean EFS: 8.65 ± 2.12

Hamidi, M., Zeeshan, M., O'Keeffe, T., Nisbet, B., Northcutt, A., Nikolich-Zugich, J., Khan, M., Kulvatunyou, N., Fain, M., & Joseph, B. (2018). Prospective evaluation of frailty and functional independence in older adult trauma patients. *American Journal of Surgery*. https://doi.org/10.1016/j.amjsurg.2018.10.023	USA	"to assess the association between frailty and functional status in geriatric trauma patients" "we hypothesize that frail older adult patients have poor functional recovery after trauma compared to non-frail patients"	prospective cohort	single rehabilitation center	all >= 65+ trauma patients admitted to the Level I trauma center and discharged to a single rehabilitation center (2013-2015)	267	Women: 36.4% Men: 63.6%	Mean age: 76.9 ± 7.1 Frail: 77.5 ± 8.4 Prefrail: 76.9 ± 7.9 Non-frail 76.5 ± 5.1	Trauma Specific Frailty Index (TSFI)	5 domains, 15 variables	comorbities, daily activities, health attitude, function, nutrition	admission	Frail: 61 (22.8%) TFSI: 0.38±0.11 Prefrail: 100 (37.4%) TFSI: 0.17±0.03 Non-frail: 106 (39.8%) TFSI: 0.06±0.03

Heppenstall, C. P. (2011). Maintaining Independence: Predicting and Preventing Residential Care Admission in Frail Older People Discharged from Hospital. (doctoral dissertation). The University of Otago. Christchurch.	New Zealand	"to describe the outcomes in the year following discharge for older people discharged from a specialist older persons' healthcare unit, to determine predictors of longer term outcomes and develop a predictive model. Specifically I wished to examine the role of function, frailty and cognition in longer term outcomes following discharge. I also wished to examine in a dynamic manner	prospective cohort	specialist Older Persons Health Unit	all patients being discharged from the 4 wards of the unit to home Feb - May 2007 (aged > + 65 and suffering from age-related illness or disability, with the potential for successful rehabilitation	159	N/A	Mean age: 81 ± 7.1	Edmonton Frail Scale (EFS)	11 item scale, 17 points	cognition, general health, functional dependence, social support, medication use, continence, functional performance, nutrition	discharge	Mean EFS: 8.8±2.5 Median EFS: 9 ±7

		the outcomes for older people over a period of one year following discharge and identify factors which may be identified at the time of discharge which contribute to adverse outcomes. "											

Kawryshanker, S., Raymond, W., Ingram, K., & Inderjeeth, C. A. (2014). Effect of Frailty on Functional Gain, Resource Utilisation, and Discharge Destination: An Observational Prospective Study in a GEM Ward. *Current Gerontology and Geriatrics Research*, *2014*, 1-8. https://doi.org/10.1155/2014/357857	Australia	"to examine frailty score as a predictor of functional gain, resource utilisation, abd destinations for GEM patients"	prospective cohort	geriatric evaluation medical unit (GEM) at a tertiary teaching hospital	patients aged >= 65 admitted to GEM between February 15th 2012 and May 15th 2012 with predicted discharge to usual place of residence within 14 days and in need of multidisciplinary rehabilitation	131	Women: 79 (61%) Men: 51 (39%)	Mean age: 82.8 ± 8.4 years	Edmonton Frail Scale (EFS)	10 domains, 17 point	clock test, timed up and go test, no additional information provided except which domains are involved	within 48 hours of discharge from GEM	Mean Frailty: 7.6 ±2.9 Prefrail: 32 (24%) Frail: 61 (46%) Severely frail: 34 (26%)
Nolan, M., Power, D., Long, J., & Horgan, F. (2016). Frailty and its association with rehabilitation outcomes in a post-acute older setting. *International Journal of Therapy & Rehabilitation*, *23*(1), 33–40. https://doi.org/10.12968/ijtr.2016.23.1.33	Ireland	"to evaluate changes in physical function, quality of life and falls self-efficacy in older adults	prospective cohort	36 bed post acute rehabilitation unit	convenience sample of patients aged >65 years admitted to inpatient rehab	41	Women: 23 (63.4%) Men: 18 (36.6%)	Mean age: 80.3 ± 7.1	grip strength and Clinical Frailty Scale (CFS), consensus of multidisci	scale ranges from 1 - 8, higher is more	N/A	within first week of admission and at discharge	CFS Admission Median (IQR): 6 (1) CFS Discharge Median

		undergoing post-acute rehabilitation. The secondary objective was to evaluate the relationship of frailty with rehabilitation outcomes "			unit between Aug 2013 - Jan 2014, they needed to be able to provide consent, and were moblie preadmission to acute care				plinary team	frail			(IQR): 5 (2) Significant change with a $p < 0.001$ Admission CFS scores: Vulnerable - CFS score 3: 1 Mildly frail - CFS score 5: 6 Moderately frail - CFS score 6: 24 Severely frail - CFS score 7: 10
Opasich, C., Patrignani, A., Mazza, A., Gualco, A., Cobelli, F., & Pinna, G. D. (2010). An elderly-centered, personalized, physiotherapy program early after cardiac surgery. *European Journal of Cardiovascular Prevention and Rehabilitation : Official Journal of the European Society of Cardiology, Working*	Italy	"First, we wanted to validate our approach for personalization of the physiother	quasi-experimental	cardiac rehabilitation unit	medically stable patients aged > 70 consecutively admitte	240	Group I (personalized program) : 150 (40% women, 60% men) Group	Mean age Group I: 74.6 ± 3.6 Mean age Group II:	Stratification of frailty based off results of BPOMA and Get Up and Go test: Non-frail	N/A	BPOMA and Get Up and Go test	admission and discharge	Group I Non-frail: 64 Moderately frail: 71 Severe

Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology, *17*(5), 582–587. https://doi.org/10.1097/HJR.0b013e3283394977		apy program by assessing the relationship between frailty level and the patient's functional impairment, disability, and postsurgery course. Second, we aimed at assessing the effect of the personalize program on independence and mobility, and to compare this effect with that of our traditional program."			d to the unit		II (control): 74 (45% women, 55% men)	75± 3.9	BPOMA> 19 and Get Up and Go <= 10s Moderately frail BPOMA <=19 or Get Up and Go > 10s Severely frail BPOMA <= 9 and Get up and Go > 10s				ly frail: 15

Roberts, H. C., Syddall, H. E., Cooper, C., & Aihie Sayer, A. (2012). Is grip strength associated with length of stay in hospitalised older patients admitted for rehabilitation? Findings from the Southampton grip strength study. *Age and Ageing*, *41*(5), 641–646. https://doi.org/10.1093/ageing/afs089	UK	"to prospectively investigate the relationship between grip strength and length of stay in older people admitted for rehabilitation'	prospective cohort	rehabilitation ward of a community hospital	patients aged => 70 consecutively admitted were recruited within 1 week of admission between Feb - Dec 2008	101	Women: 64 (63.4%) Men: 37 (36.6%)	Mean age women: 84.9 (range 70.3 - 99.4) Mean age men; 82.6 (range 73-92.6)	Strawbridge Frailty Questionnaire	N/A	N/A	admission	Women- Frail on Stawbridge score: 30 (50%) Men - Frail on Strawbridge score: 30 (50%)
Singh, I., Gallacher, J., Davis, K., Johansen, A., Eeles, E., & Hubbard, R. E. (2012). Predictors of adverse outcomes on an acute geriatric rehabilitation ward. *Age and Ageing*, *41*(2), 242–246. https://doi.org/10.1093/ageing/afr179	UK	" to compare the importance of chorological age, gender, co-morbidities and frailty in the prediction of adverse outcomes for patients admitted to an acute geriatric rehabilitation ward."	prospective cohort	acute geriatric medicine rehabilitation unit at tertiary care teaching hospital	patients admitted consecutively to an acute geriatric rehabilitation ward between Feb - Oct 2008	265	Women:159 (60%) Men: 106 (40%)	Mean age: 82.6 years	Frailty index	40	comorbitities (15), dependence in ADLs (10), number of medications (graded scale to 5), and one deficit for each of the following: 3 or more falls in the	admission	Mean FI ± SD: 0.34 ±0.09

											preceding year, Times Up and Go 9.4s or more, alcohol excess, 180 degree turn or 6 or more steps, Mini - Mental State Examination of 10 or less, unable to complete or fail to draw clock test, FIM 104 or less, registered blind, over or underweight, presence of		

											pressure sore		
van der Ploeg, E., van der Velde, Y., & Gobbens, R. (2017). Predictive Value of Gait Speed and Frailty Indicators on Survival Time and Time Until Discharge to Home in Ambulant Older Patients in a Specialized Rehabilitation Center. *Journal of Geriatric Physical Therapy (2001)*, *40*(2), 95–101. https://doi.org/10.1519/JPT.0000000000000074	Netherlands	"to identify simple and unambiguous predictors of time until discharge to home and time until death" "as a secondary aim, we also explored whether patients' and physiotherapists' scores	prospective cohort	Marnix Rehabilitation Centre for Older People (MRO), 3 wards: Geriatric Rehabilitation, Centre for Prevention and Recovery, Psychogeriatric Rehabilitation	all patients admitted to the 3 wards between Sept 15 2013 and Sept 10 2014	389	Women: 275 (71%) Men: 114 (29%)	Mean age: 80.1 ± 9.5	Indicators of frailty: yes or no questions that each physiotherapists and patients would answer Fatigue: Does the patient experience problems in his/her daily life because of physical tiredness? Mobility: Does the patient experience problems	4 indicators	fatigue, mobility, balance, weight loss	within first 7 days of admission	Fatigue (pt; PT): 208 patients (54%); 204 (53%) No fatigue (pt; PT): 169 (43%); 150 (39%) Problematic mobility:209 (54%); 206 (53%) Good

		were congruent or whether either predicted our outcomes better "							in his/her daily life because of difficulty walking? Balance: Does the patient experience problems in his/her daily life because of difficulty in maintaining balance? Weight loss: Has the patient lost a lot of weight recently without wishing to do so?				mobility: 166 (43%); 150 (39%) Problematic balance: 183 (47%); 189 (49%) Good balance: 189 (49%); 166 (43%) Weight loss: 121 (31%); 117 (30%) No weight loss: 240 (62%); 229 (59%)

Appendix O – Data Extraction Results Part II

Reference	Outcomes												
	List of outcomes in the study	Functional status					Length of stay in rehab			Discharge destination, per frailty group if possible		Readmission to acute care (yes/ no), per frailty group if possible	
		Instrument Used	Functional status score + SD, per frailty level if possible	Sample size per frailty level if available	Timing of measurement (admission, d/c, other)	Results	Length of stay, per frailty level if available with SD	Sample size per frailty level if available	Results	Frequency/%	Results	Frequency/%	Results
Arjunan, A., Peel, N. M., & Hubbard, R. E. (2018). Gait Speed and Frailty Status in Relation to Adverse Outcomes in Geriatric Rehabilitation. *Archives of Physical Medicine and Rehabilitation*. 1-6. https://doi.org/10.1016/j.apmr.2018.08.187 Arjunan, A., Peel, N. M., & Hubbard, R. E. (2018). Feasibility and validity of frailty measurement in geriatric rehabilitation. Australasian Journal on Ageing, 37(2), 144–146. https://doi.org/10.1111/ajag.12502	1) Long stay in rehabilitation, measured as days in rehabilitation >= 75th percentile (based on the frequency distribution of rehabilita	N/A	N/A	N/A	N/A	N/A	1)65 (25%) participants with long length of stay 2) Mean LOS: 41.6±35.9	N/A	FI and GS significant associations with long length of stay FI mean ± SD: 0.49 ± 0.1 FI OR (CI): 2.13 (1.60 -	109 (42%) participants requiring higher level of care	FI and GS significant association with discharge requiring higher level of care FI mean ± SD: 0.44 ± 0.11 FI OR	N/A	N/A

	tion length of stay) 2) poor discharge outcome (requiring higher level of care or inpatient mortality). Higher level of care: those requiring residential aged care or higher level of support on discharge, than had been required prior to admission								2.83) Frailty had a significant association present on univariate and logistic regression models (adjusted for age and sex)		(CI): 1.38 (1.11-1.70) Frailty had a significant association present on univariate and logistic regression models (adjusted for age and sex)		
Cogan, L., Tiernan, C., & Romero- Ortuno, R. (2014, October). *The Impact of Frailty on Post-Acute Rehabilitation Outcomes in Older Adults.* Paper presented at Irish Gerontological Society 62nd Annual and Scientific Meeting, Galway. Ireland. https://journals-scholarsportal-info.proxy.bib.uottawa.ca/pdf/00211265/v183inone_7/269_i6aasmsfhaa.xml	1) length of stay (LOS) 2)emergency transfer to the acute hospital due to medical destabilis	BI	N/A	N/A	admission and discharge	1) Frailty correlated with more disability on admission and discharge 2) No statistica	non-frail: median 30 days frail: median 42 days	N/A	After adjusting for age, SHARE-FI correlated with longer length	discharged home - non-frail: 97.6 % discharged home -frail: 81.9 %;	After adjusting for age, SHARE-FI correlated with lower discharge rates	transfer to hospital - non-frail: 2.4 % transfer to hospital -frail: 21.1 %	After adjusting for age, SHARE-FI correlated with higher rate of emergency

	ation during rehabilitation 3) change in Barthel Index (BI) (i.e. discharge BI minus admission BI).					l difference in BI improvement across frailty groups P = 0.247			of stay p = 0.047		to home p -0.009		transfer to acute hospital p = 0.004
Haley, M. N., Wells, Y. D., & Holland, A. E. (2014). Relationship between frailty and discharge outcomes in subacute care. *Australian Health Review*, *38*(1), 25–29. https://doi.org/10.1071/AH13067	1) LOS (days) 2) Discharge destination (community or residential care) 3) raw change and rate of change between admission and discharge of Elderly Mobility Scale (EMS) scores 4) proportion of physiotherapy	N/A	N/A	N/A	N/A	N/A	Median LOS: 19 days (IQR 13–34 days)	N/A	Frailty was not significantly related to LOS in bivariate analysis (rho = –0.13, P = 0.24), nor did it predict LOS in multivariate regression analysis (P = 0.09)	Residential care: 47 (54.7%) Community: 39 (45.3%)	Frailty did not significantly increase the risk of discharge to residential care (no p-value provided). Mean EFS - discharged to the community: 8.95 ± 1.99 Mean EFS- admitted from the community but discharg	N/A	N/A

	sessions attended										ed to residential care: 8.31 ± 2.25 --> the difference was not significant (t = –1.32, P = 0.19).		
Hamidi, M., Zeeshan, M., O'Keeffe, T., Nisbet, B., Northcutt, A., Nikolich-Zugich, J., Khan, M., Kulvatunyou, N., Fain, M., & Joseph, B. (2018). Prospective evaluation of frailty and functional independence in older adult trauma patients. *American Journal of Surgery*. https://doi.org/10.1016/j.amjsurg.2018.10.023	1) primary outcome: functional improvement (delta FIM: FIMout - FIMin) 2) secondary outcome: LOS in rehab 3) secondary outcome: Gain FIM (average change in FIM on	FIM	Frail: Mean Delta FIM: 7 ±9 Mean Gain FIM: 0.4±0.1 Prefrail: Mean Delta FIM: 21 ±7 Mean Gain FIM: 1.5±0.3 Non-frail: Mean Delta FIM: 23±11	Frail: 61 Prefrail: 100 Non-frail: 106	admission and discharge	1) frail patients had the smallest improvement in functional status p=0.001 2) frail patients had the lowest Gain FIM p=0.001 3) Frail status was independently associated with lower total discharge FIM on	Frail: 17.8 ± 4 Prefrail: 14.3± 5 Non-frail: 12.4±4	Frail: 61 Prefrail: 100 Non-frail: 106	frail patients had the longest LOS p=0.001	N/A	N/A	N/A	N/A

	each day in rehab)		Mean Gain FIM: 1.9±0.5			multiple linear regression analysis p=0.0014) prefrail status was not independently associated with discharge total FIM on multiple linear regression analysis p =0.125) frail and prefrail status are independently associated with lower FIM gain p = 0.001 and p= 0.01							

Heppenstall, C. P. (2011). Maintaining Independence: Predicting and Preventing Residential Care Admission in Frail Older People Discharged from Hospital. (doctoral dissertation). The University of Otago. Christchurch.	1) Change in residence (including death, whether or not this was preceded by residential care admission) 2) Residential care admission 3) Death (whether or not this was preceded by residential care admission) 4) Hospitalisation	FIM	Median FIM: 114 IQR (105-121)	N/A	discharge	N/A	N/A	N/A	N/A	N/A	N/A	103 patients (74.8%) had at least one further admission to any hospital (acute or older person's health services) during the year Mean EFS - hospital admissions: 9± 2.5 (CI 0.1 - 1.9) Mean EFS - no hospital admissions : 8 ± 2.4	EFS was a significant predictor of hospital admissions on both univariate (Mean difference= 1, CI 0.1 - 1.9 p=0.03) and multivariate analysis RR = 1.2 CI 1.01 - 1.42 p = 0.04 when adjusted for male gender, Charlson index, congestive cardiac failure, diabetes mellitus

Kawryshanker, S., Raymond, W., Ingram, K., & Inderjeeth, C. A. (2014). Effect of Frailty on Functional Gain, Resource Utilisation, and Discharge Destination: An Observational Prospective Study in a GEM Ward. *Current Gerontology and Geriatrics Research*, *2014*, 1-8. https://doi.org/10.1155/2014/357857	1) Functional gain: FIM change (difference between FIM at discharge and admission) 2) discharge destination 3) number of specialist referrals made per patient	FIM	Mean discharge FIM: 94.4 ± 20.1 M ean functional gain: 11.26 (CI 8.87 - 13.66) p < 0.0001 Prefrail mean discharge FIM: 105.7 ±12.3 Prefrail mean functional gain: 9.9±6.9 Frail mean discharge FIM: 96.7± 17.1 Frail mean functional gain: 12.4±11.1	Prefrail: 32 Frail: 61 Severely frail: 34	FIM measured at admission and discharge	1) Significant difference of mean discharge FIM scores across frailty status p < 0.001 2) No significant difference in mean discharge FIM between prefrail and frail groups p = 0.067 3) Significant difference in mean discharge FIM between prefrail and severely frail groups and between frail and severely	N/A	N/A	N/A	Home: 83 (prefrail 16, frail 44, severely frail 23) Home with additional services: 11 (prefrail 1, frail, 6, severely frail 4) Hostel (low care residential facility): 8 (prefrail 1, frail 3, severely frail 4) Nursing homes:14 (prefrail 5, frail 6, severely frail 3) Additional rehab: 12 (prefrail 7, frail	Frailty has a significant association with change in domicile from admission to discharge (p < 0.001)	Acute care: 3 (prefrail 2, frail 0, severely frail 1)	N/A

			Severely frail mean discharge FIM: 80.73 ± 22.8 Severely frail mean functional gain: 10.5±20.9			frail groups p <0.001 for both 3) Linear regression: gender, age, frailty score, admission FIM, geriatric syndrome, falls, dementia, other geriatric syndromes, and specialist referrals acounted for 60.6% of the variation in discharge FIM (adjusted R^2 = 0.606) with frailty score (p=0.045), admission FIM, and specialist referrals				3, severely frail 2)			

						being statistically significant. 4) Stepwise regression: admission FIM, frailty score (p=0.014), and specialist referral account for 60.7% of the variation in discharge FIM (R^2 = 0.607) 5) Frailty score is negatively correlated with discharge FIM p = 0.014							

Nolan, M., Power, D., Long, J., & Horgan, F. (2016). Frailty and its association with rehabilitation outcomes in a post-acute older setting. *International Journal of Therapy & Rehabilitation*, *23*(1), 33–40. https://doi.org/10.12968/ijtr.2016.23.1.33	1) Functional mobility: Timed Up and Go test 2) Frailty: grip strength via hydraulic hand dynamometer and Clinical Frailty Scale 3) Gait speed: 10 MWT 4) Balance: Tinetti Balance and Gait test 5) Functional mobility: Elderly Mobility Scale 6) Functional ability: Barthel index 7) Health related quality of life: EuroQol-	Barthel Index (BI)	Discharge Median Barthel index (IQR): 90 (25) Mildly frail BI: 82.5 Moderately frail BI: 67.5 Severely frail BI: 42.5	same breakdown as frailty cell	admission and discharge	1) Moderate negative correlation between admission CFS and Barthel index (r=-0.459, p=0.003) 2) On regression analysis adjusting for age,gender, number of co-morbidities, Mini Mental State Examination, mobility level, admission CFS was predictive of BI (b=-0.304, p<0.044)	Median LOS: 35 days (IQR 29 days) Mildly frail median LOS: 35.5 days Moderately frail median LOS: 33 days Severely frail median LOS: 54.5 days	same breakdown as frailty cell	1) Moderate positive correlation between CFS and LOS (r=0386, p=0.013) 2) On regression analysis adjusting for age,gender, number of co-morbidities, Mini Mental State Examination, mobility level, admission CFS was predictive of LOS (b=0.299, p<0.024)	95% discharge to previous residence	N/A	N/A	N/A

	5D 8) Fear of falling: Falls Efficacy Scale												
Opasich, C., Patrignani, A., Mazza, A., Gualco, A., Cobelli, F., & Pinna, G. D. (2010). An elderly-centered, personalized, physiotherapy program early after cardiac surgery. *European Journal of Cardiovascular Prevention and Rehabilitation : Official Journal of the European Society of Cardiology, Working Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology*, *17*(5), 582–587. https://doi.org/10.1097/HJR.0b013e3283394977	1) Nursing needs: index developed from Maslow's definition of physiological human needs, assessment of the ability to commuicate, independently eat, sleep, move, take care of themselves, defecare, urinate 2) Self-perceived well-being status: EuroQol	Nursing needs	Non-frail mean nursing needs: 3.6 ± 1.6 Moderately frail mean nursing needs: 4.6 ± 2.6 Severely frail mean nursing needs: 9.4± 3.6	same breakdown as frailty cell	admission and discharge	1) Frailty level is associated with nursing needs p<0.0001 2) Severely frail patients have more nursing needs P<0.0001	Non-frail mean LOS: 15 ± 0.7 Moderately frail mean LOS: 18 ± 7 Severely frail mean LOS: 24± 9	same breakdown as frailty cell	1) Frailty level is associated with LOS p= 0.0001 2) Severely frail patients have the longest LOS p = 0.0001	Usual place of residence: 224 Geriatric facility: 7 Surgical Deparment: 4	N/A	N/A	N/A

	Questionnaire 3)Fall riak: Balance Performance Oriented Mobility Assessment (BPOMA) 4) Motor ability: Get Up and Go test 5) Lower body strength: Chair stand test 6) Upper body strength: Arm curl 7) Functional ability: 6MWT												

Roberts, H. C., Syddall, H. E., Cooper, C., & Aihie Sayer, A. (2012). Is grip strength associated with length of stay in hospitalised older patients admitted for rehabilitation? Findings from the Southampton grip strength study. *Age and Ageing*, *41*(5), 641–646. https://doi.org/10.1093/ageing/afs089	1ength of stay	N/A	N/A	N/A	N/A	N/A	Median LOS: 26 days (range 2-98 days)	N/A	N/A	Discharged to usual residence: 74.3% Women Usual residence: 46 (71.9%) New care home: 12 (18.8%) Men Usual residence: 29 (78.4%) New care home: 5 (13.5%)	Lower Strawbridge frailty score in women was associated with increased likelihood of discharge to usual residence on univariate analysis (HR 0.49 (CI 0.29-0.90) p = 0.02) and after adjustment for age and height, height-for-weight) (HR 0.39 (0.21-0.76) p=0.01)	Women Hospital transfer: 5 (7.8%) Men Hospital transfer: 3 (8.1%)	N/A

Singh, I., Gallacher, J., Davis, K., Johansen, A., Eeles, E., & Hubbard, R. E. (2012). Predictors of adverse outcomes on an acute geriatric rehabilitation ward. *Age and Ageing*, *41*(2), 242–246. https://doi.org/10.1093/ageing/afr179	1) Good outcome: Discharged to original residence within 28 days 2)Intermediate outcome: Discharges to original residence but LOS > 28 days 3) Poor outcome: New care home placement or inpatient mortality 4) 28 day readmisson rate 5) inpatient mortality 6) mortality rates on patients 1 year follwoing completion of recruitment	Barthel Index (BI)	2 weeks prior to admission mean BI: 17 ± 2.7 admission mean BI: 10 ± 4.3 discharge mean BI: 15.7 ±3.9	N/A	2 weeks prior to admission, on admission, discharge	FI was a predictor of poor functional gain (change in BI) p <0.001	N/A	N/A	N/A	Home: 78% Good: 128 patients Intermediate: 74 patients Poor: 63 patients	FI was strongly associated with worsening outcome p <0.001 FI is negatively associated with good outcome OR of intermediate and poor outcome relative to good outcome was 4.42 (CI 3.05-6.41) p<0.001 after adjusting for age, sex, co-morbidity and albumin	N/A	N/A

van der Ploeg, E., van der Velde, Y., & Gobbens, R. (2017). Predictive Value of Gait Speed and Frailty Indicators on Survival Time and Time Until Discharge to Home in Ambulant Older Patients in a Specialized Rehabilitation Center. *Journal of Geriatric Physical Therapy (2001)*, *40*(2), 95–101. https://doi.org/10.1519/JPT.0000000000000074	1) time until death 2) time until discharge to home	N/A	N/A	N/A	N/A	N/A	Average LOS: 90 days Days till discharge mean: Fatigue (pt; PT): 112 (CI 90-135); 108 (89-127) No fatigue (pt; PT): 100 (79-123); 85 (68-103) Problematic mobility :103 (82-124); 106 (85-127) Good mobility : 113 (89-136); 100 (79-122) Problematic	Not needed	1) Fatigue, mobility status, and balance were not related to time until discharge to home. 2)Weight loss (both pt and PT reported) was associated with time until discharge home $p < 0.05$ 3) On multivariate analysis, PT reports of unintentional weight loss led to patients having significantly smaller chance	Home: 178 (46%) Nursing home: 27 (7%) Residential home: 22 (6%) Generic center for rehab: 2 (1%) Hospice: 1 (0%) Deceased: 31 (8%) Unknown: 100 (26%)	On multivariate analysis, PT reports of unintentional weight loss led to patients having significantly smaller chance of being discharged to home (HR 0.67 CI 0.48-0.95, P< 0.05)	Hospital: 28 (7%)	N/A

							balance: 96 (81-110); 114 (93-136) Good balance: 112(89-136); 90(72-108) Weight loss: 119 (89-151); 108 (88-129) No weight loss: (102 (83-120); 92 (75-109)		of being discharged to home (HR 0.67 CI 0.48-0.95, P< 0.05)				

Appendix P - Quality Assessment - Observational Cohorts

Newcastle-Ottawa Scale Quality Assessment - Observational Cohorts										
	Selection				**Comparability**	**Outcome**				
First Author, Year	**Representiveness of the exposed cohort**	**Selection of the non-exposed cohort**	**Ascertainment of exposure**	**Outcome was not present at the start**	**Comparability of cohorts on the basis of design or analysis**	**Assessment of outcome**	**Follow-up long enough for outcomes**	**Adequacy of follow-up of cohorts**	**Total (/9)**	**Quality**
Hamidi, 2018	*	*	*	*	**	*	*	*	9 (1)	High
Kawryshanker, 2014	*	*	*		**	*	*	*	8 (0.89)	High
Nolan, 2016	*	*	*		**	*	*	*	8 (0.89)	High
Roberts, 2012	*	*	*	*	*	*	*	*	8 (0.89)	High
Singh, 2012		*	*	*	**	*	*	*	8 (0.89)	High
van der Ploeg, 2017	*	*	*	*	*	*	*	*	8 (0.89)	High

Arjunan, 2018a and b		*	*	*	*	*	*	*	7 (0.78)	High-moderate
Haley, 2014		*	*	*	*	*	*	*	7 (0.78)	High-moderate
Cogan, 2014		*	*	*		*	*	*	6 (0.67)	High-moderate
Heppenstall, 2011		*	*	*	*	*	*		6 (0.67)	High-moderate

Appendix Q - Quality Assessment – Pretest/Posttest

Quality Assessment - Pretest/Posttest																	
First Author, Year	**Probability Sample Used**	**Sample size appropriate for**	**Representative of the pop (2)**	**Number of pre/post tests (2)**	**Comparison strategy (2)**	**Group comparisons**	**DV directly measured**	**Reliable DV**	**Valid DV**	**Approriate statistical test**	**p value reported**	**CI reported**	**Missing data managed**	**Attrition rate < 30%**	**Total Points**	**Score (/18)**	**Quality**
Opasich, 2010	0	0	1	1	1	1	1	1	1	1	1	0	0	1	10	0.56	Low-moderate