Social Integration and Cognitive Function Following Geriatric Traumatic Brain Injury

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ABSTRACT

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Background: Traumatic brain injury is one of the leading causes of life-long disability and death. The incidence of TBI in older adults has been increasing, in part due to the growing population of older adults. While numerous studies focus on the prevention of TBI in older adults, little is known about illness perception in TBI among older adults and how they return to daily life after TBI.

Purpose: The overall purpose of this dissertation is to better understand older adults' lives after traumatic brain injury (TBI). In particular, this dissertation aims to explore how older adults integrate the experience of injury into their lives and how social integration may influence cognitive functioning. The first paper (Chapter 2) describes the perceived meaning of TBI to older adults over the first-year post-injury. The second paper (Chapter 3) aims to clarify the

concept of social integration and to identify attributes, antecedents, and consequences. The third paper (Chapter 4) examines the interrelationship among social integration, functional outcome, and cognition in older adults in years 1- , 2- , and 5-year post-injury, and examines if there is a mediating role of social integration and cognition in overall functional outcome.

Methods: Three research papers in this dissertation include qualitative, concept analysis, and quantitative study. The first paper is a longitudinal multiple-case study using secondary data. This study utilized secondary data from 13 older adults who were interviewed over 12 months post-injury (n=57 interviews). The second paper is a concept analysis of social integration following Walker and Avant's framework. The third paper is a longitudinal mediation analysis using data from Traumatic Brain Injury Model System National Database (TBIMS-NDB). A total of 1469 older adults aged 65 and over were included in this study.

Results: In the first study, I revealed five main themes regarding how older adults process and perceive meaning from their TBI: 1) gratitude, 2) vulnerability and dependence, 3) slowing down and being more careful, 4) a chance for reflecting on life, and 5) an unexpected event. The majority of participants (12/13) did not change their perspective regarding their injury in the 12 months following injury. They had either consistently positive or negative illness perceptions about their injury. In the second study, the proposed concept of social integration was a process of incorporation and inclusion in society through productive activities, social relationships, community engagement, and leisure activities. The findings of the concept analysis suggest that social integration is affected by individual, social, and environmental factors. The analysis also found improved physical and mental health, healthy aging, and life satisfaction as a result of higher social integration. Finally, in the third study, I revealed significant positive interrelationships between social integration and concurrent functional outcome and cognition at

1-, 2-, and 5-year post-injury in older adults. Using longitudinal mediation analysis, I found that functional outcome mediated the pathway between social integration and concurrent cognition over time.

Conclusions: The findings from this dissertation contribute to understanding older adults' beliefs about their brain injury and the role of social integration in improving cognitive function following TBI. Future research is needed to understand the longitudinal interrelationships between illness perception, social integration, and cognitive function in older adults following TBI.

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Chapter 1. Introduction

Traumatic brain injury (TBI) refers to acquired brain damage that is caused by external forces.[1] TBI is one of the leading causes of life-long disability and death, requiring about 3 million persons in the US to seek treatment each year.[2] According to the Centers for Disease Control and Prevention (CDC), approximately 223,050 people are hospitalized in the US as a result of TBI, and more than 60,000 people die every year from TBI-related causes. In particular, older adults aged 75 or older have the highest rate of hospitalization and death.[3] The primary causes of TBI in older adults are falls and motor vehicle crashes.[4,5] The incidence of TBI in older adults has been increasing. In addition, the population of older adults is expected to double by 2030 with "Baby Boomers" entering into older adulthood;[6,7] this increase is also contributing to the growing number of older adults sustaining a TBI. While advances in medicine have increased the survival of people experiencing a TBI, it often affects them for the rest of their lives.

Older adults who sustain TBI may experience many life changes caused by long-term or lifelong disabilities following TBI.[8,9] Despite these change, older adults who experience a TBI may have a different view of their injury depending on illness perception that how they accept their injury. According to previous studies, illness perceptions are determined by various factors including the severity of the illness,[10] socioeconomic status,[11-13] and social support.[14] In particular, negative perceptions about the brain injury were found to be associated with worse cognitive function.[15] However, little research has been conducted regarding what perceived meanings of TBI are among older adults.

TBI is a sudden and unexpected event. Life after TBI may not the same as before. Older adults with TBI are more vulnerable to having difficulties with returning to everyday life and social integration. This difficulty is because of slower recovery trajectories as well as worse

functional and cognitive outcomes compared to younger adults with TBI. [16,17] A previous study reported that more than half of patients with moderate to severe TBI experience problems with cognitive functioning. [18] Symptoms of cognitive impairment include memory disturbance, difficulty completing familiar skills, and maintaining attention and complex decision-making. [18,19] Individuals following TBI may experience symptoms of cognitive deficits immediately after TBI. These deficits may improve over a period of days to weeks or months, or remain unchanged, resulting in significant disability. Cognitive deficits due to TBI interfere with not only everyday functioning, but also social integration including work, study, relationships, and leisure activities. [18,20]

Social integration is an important part of life for older adults to maintain health and well-being. [21] A great deal of research has identified social integration as a significant factor in a healthy life. [22-26] Studies note social integration is positively associated with healthy aging, [25] reduced risks of mortality, [24,25] and better health outcomes including physical function and mental health. [22,23,26] Moreover, social integration has been found to be positively related to cognitive function in previous studies across older adult populations. The association between social integration and cognitive function is well documented in older adults and individuals with neurological disorders, such as Alzheimer's disease. [8,21,27] One study showed evidence that high levels of social integration delay memory loss over six years among older adults without TBI. [21] The findings from these studies suggest that a higher level of social connection, including social integration, is associated with better cognitive function in healthy older adults.

However, social integration is a multidimensional and complex concept that currently does not have a standardized definition in human health research. Moreover, it is often used interchangeably with several terms such as social support, social networks, and social

engagement. Notably, several terms have been used to identify the association between social integration and cognitive function later in life such as social networks, [28,29] social support, [30-32] social relationships, [29] and social engagement. [33] In order to better understand older adults' life following TBI, it is essential to take into account the full breadth of social integration as a whole, and to clarify it as a concept.

While there have been numerous studies reporting the association between social integration and cognitive function in non-brain injured older adults, relatively little is known about this relationship after TBI. Since cognitive deficits are common sequelae following TBI, more robust research about the association between post-TBI cognitive impairments and social integration is needed to identify if this may be a potential area for intervention to improve cognitive health.

The overall purpose of this dissertation is to better understand older adults' lives after TBI and explore how older adults integrate the experience of injury into their lives and how social integration may influence cognitive functioning. The specific aims of the dissertation are to:

1) Explore the illness perception about TBI in older adults over the first-year post-injury;
2) Clarify the concept of social integration and identify attributes, antecedents, and consequences of the concept of social integration;
3) Examine the interrelationships among older adults' social integration, recovery outcome, and cognitive function in years 1-, 2-, and 5-year post injury, and to examine if there is a mediating role of social integration and cognition in overall functional outcome.

To meet these aims, three analyses are included in this dissertation. The first aim (Chapter 2) is addressed using a qualitative multiple-case study to explore the meaning of TBI in older adults over the first-year post-injury. The second aim (Chapter 3) is addressed via a concept analysis to clarify the concept of social integration and to identify attributes, antecedents, and consequences of the concept of social integration. The third aim (Chapter 4) is addressed using the Traumatic Brain Injury Model System National Database (TBIMS-NDB). In this study, I used longitudinal mediation analysis method to examine the interrelationships among social integration, recovery outcomes, and cognitive function in older adults in years 1-,2-, and 5- year post injury, and to examine if there is a mediating role of social integration and cognition in overall functional outcomes. Finally, the implications for practice and future research of the findings as a whole are included in Chapter 5.

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Chapter 2

The Perceived Meaning of Traumatic Brain Injury in Older Adults

Abstract

Background: The perception of illness refers to patients' thoughts and beliefs about illness and what illness means in their lives. How individuals perceive their injury and integrate the experience into their lives can influence traumatic brain injury (TBI)-related recovery. However, little is known about how older adults integrate the experience of injury into their lives over time, and how this relates to functional outcomes and quality of life. To better support recovery, it is important to understand the perceived meaning of TBI ascribed by older adults who have sustained injury.

Purpose: The aim of this study was to explore the perceived meaning of TBI among older adults and to explore if and how meaning changes over the first-year post-injury.

Methods: A longitudinal multiple-case study design was used. Participants were adults, aged 65 and over, who were diagnosed with mild to moderate TBI. To obtain participant perspectives on their injury over time, participants were interviewed at 1-week and 1-, 3-, 6-, and 12-months post-injury. During each interview, each participant was asked questions pertaining to the meaning of TBI and the differences in life after TBI over time. All transcripts analyzed by trained qualitative researchers using inductive thematic analysis and coded using NVIVO 12 software.

Results: Thirteen older adults (5 men, 8 women) participated in the study over 12 months. Based on 57 interviews, five different themes regarding the perceived meaning of TBI were identified: gratitude, vulnerability, and dependence, slowing down and being more careful, a chance for reflecting on life, and an unexpected event. Overall, most participants' perceived meaning of their TBI remained consistently either positive or negative over the year post-injury.

Conclusions: The rich interviews provided a deep understanding of five different themes in the

perceived meaning of TBI at the first-year post-injury and if there are longitudinally meaning changes among older adults. These findings can be used as a foundation for future research and intervention development for older adults in order to achieve optimal TBI recovery and overall health.

Background

Traumatic brain injury (TBI) is sudden damage to the brain that can be an unexpected and devastating event.[1] In the United States, older adults aged 75 or older have the highest rate of hospitalization and death, experiencing 32% of TBI-related hospitalizations and 28% of TBI-related deaths, despite representing only 13% of the population in the US.[2] TBI in older adults is considered to be a global public health issue.[3,4] The incidence of TBI in older adults has been increasing as well.[5,6] Depending on the severity, type and mechanism of TBI, recovery varies from a few days to several months to years.[7] Due to the natural effects of aging, higher number of comorbidities, and possible pre-existing cognitive impairment, older adults are more likely to have a complicated recovery following TBI compared to younger adults.[8]

Older adults who sustain a TBI can experience many life changes related to functional outcomes,[9,10] quality of life,[11,12] and cognition.[13,14] How individuals perceive their injury and integrate the experience into their lives can influence TBI-related recovery. In general, a number of studies demonstrate that an individual's perception of their illness influences their health outcomes,[15-17] the ability to cope with the illness,[15,18,19] well-being,[19,20] and health-related quality of life.[21]

The perception of illness refers to patients' thoughts and beliefs about illness and what illness means in their lives.[22] [22] Positive perception of illness plays a significant role in better adaptation to their illness and regaining self-esteem.[23,24] Patients can have positive or negative perceptions of their illnesses depending on several factors, such as socioeconomic status,[25-27] severity of illness,[28] and social support.[29] In TBI, having a negative perception of TBI is associated with developing post-concussion syndrome[30] as well as poor cognitive test

performance among individuals following moderate TBI with greater than 1 but less than 20-minute loss of consciousness. [31]

Substantial research has been dedicated to gaining a better understanding of the pathological mechanisms causing TBI[32] and preventing TBI in older adults. [8] However, little is known about the trajectory of their recovery after TBI, specifically as to how older adults integrate the experience of injury into their lives, and how this relates to functional outcomes and quality of life. To better support recovery, it is important to understand the perceived meaning ascribed to TBI and how that influences the overall quality of life after TBI in older adults. Therefore, the aim of this study was to explore the perceived meaning of TBI to older adults and to explore if and how these change over the first-year post-injury.

Methods

Research Design

A longitudinal multiple-case study design was used to explore the meaning of TBI and to describe if and how the perceived meaning changes in the first year following brain injury in older adults. The study employed secondary analysis of previously transcribed interviews.

Settings and Participants

Full detailed information on the setting, participants and recruitment procedures can be found elsewhere. [10] In brief, participants in the parent study were aged 65 or older who were diagnosed with mild-moderate TBI. Participants were recruited from a Level I Trauma Center located in Seattle, Washington. Inclusion criteria for participants were: a) aged 65 and older; b) provider-confirmed diagnosis of mild-moderate TBI within 24 hours of enrollment; and c) ability

to speak and understand English. The study protocol was approved by the University's institutional review board.

Data Collection

Following written informed consent, demographic and injury data were obtained from the individual and injury-related data from the electronic health record. Participants were interviewed face-to-face at 1-week and 1-, 3-, 6-, and 12 months post-injury. Semi-structured interviews were conducted by the principal investigator and a research assistant for the parent study. All participants were interviewed in the participants' personal residences or in a mutually agreed upon place that was private (e.g., conference room in clinic). During each interview, each participant was asked questions pertaining to the meaning of TBI and the differences in life after TBI over time. Questions such as "When you had your accident, is your life any different now from before that accident?", and "What does your head injury mean to you, or your accident, how do you feel about that?" were used to elicit participants' experiences regarding their injuries. To ensure confidentiality, each study participants was assigned a numerical identifier.

Data Analysis

Each interview was digitally recorded and then transcribed verbatim. All transcripts were reviewed independently by two investigators to verify accuracy and to confirm that the transcripts did not include participant identifiers. Inductive thematic analysis was used as the method of data analysis. Initially, repeated reading of transcripts from the parent study and open coding were performed to identify the keywords and initial ideas. Codes were generated by repeated patterns then themes were identified. Next, axial and selective coding was performed

following discussion and cross-verification by the two investigators. The list of codes and themes including definitions was developed and then reviewed for additional patterns. NVIVO 12 software[33] was used for data analysis. To improve rigor in this case study, four principles of data collection and analysis identified by Yin[34] were followed: 1) use multiple sources of evidence; 2) create a case study database; 3) maintain a chain of evidence; and 4) exercise care when using data from electronic sources.

Results

Demographics

A total of 13 individuals provided 57 interviews over the in the 12-month study. Five participants identified as male (38.5%), the remainder as female. The average age of participants was 76.6 years old (range 65 to 94). Of the 13 participants, 11 identified as White, and one each identified as Asian/Pacific Islander and More than One Race.

Qualitative findings

Perceived meaning of TBI in older adults

Based on interviews, five different themes regarding the perceived meaning of TBI were identified: gratitude, suffering from current vulnerability, slowing down and being more careful, a chance for reflecting on life, and a meaningless event. Each theme will be explored more in depth below. For exemplars, the quotes attributed to, participants are identified with participant number followed by the timing of interview 1-week (T1); 1-month (T2); 3-month (T3); 6-month (T4); and 12-month (T5).

Gratitude

Gratitude was one of the most prominent themes identified for the meaning of TBI among participants (see Table 1 for example quotes). The participants described how thankful and lucky they were to be alive even though their brain was injured. They felt gratitude that they are still alive, and the injury was not serious and did not get worse:

"It has opened my eyes to be more grateful, appreciative. Things that I used to take more granted, I don't. It's precious…the thing that's the most meaningful to a person's life." (P7, T2)

Also, they described gratitude for the recovery from the injury:

"Well, to me it meant that it couldn't be too bad, and this too will pass. It occurred and it was a difficult one, but it has improved very much and I'm living a satisfactory life." (P2, T3)
"It means that since I've recovered to this point, that I'm probably the most fortunate person on earth because I could have very well have ended it right there." (P8, T4)

Some participants expressed gratitude to social support from formal and informal caregivers that how good they were:

"I think that the caregiver, the one I have, is very good. She just comes right in and starts to work." (P10, T2)
"I am most grateful that...nurses once a week and physical therapists that came, department of labor and industries, there was another 2 guys that came and started me out on all these

exercises to get going, get your muscles and brain connected again and so I really appreciate all that." (P8, T5)

Vulnerability and Dependence

Another distinct theme was vulnerability and dependence. Six participants (P3, P5, P6, P7, P10, P12) reported negative perceptions of TBI related to their vulnerabilities and dependence from their injuries (Table 1). They described how they are limited to what they could do without any help:

"I used to go to [place name] by myself and I was told by my daughter that I can't do that anymore." (P3, T4)

Limitations were related to their age and symptoms including headache and post-traumatic amnesia (PTA) (Table 1):

"Something happened in there that I don't remember, and that bothers me." (P3, T4)

TBI also impacted daily function for some participants. They articulated complaints about their life changes because of their poor functional outcomes from TBI:

"If it's going to affect my driving, I'm going to have to go into early retirement…. I'm going to be checking on that." (P7, T2)

Slowing down and being more careful

Five participants (P3, P6, P9, P10, P12) noted the TBI was a warning sign for needing to be more careful and to slow down (Table 1):

"It means 2 things. It means I should be careful and try not to fall again. And it means to me personally, just to take things slower." (P6, T4)

A chance for reflecting on life

Through the experience following TBI, four participants (P7, P8, P11, P13) reported they were able to be reflective (Table 1):

"It means that I have had time to look into myself and into my way of life and my lifestyle and the word personality." (P8, T5)

An unexpected event

In some cases (P6, P10), older adults following TBI viewed the injury as an unexpected and life-changing event. They did not think that injury would happen to them (Table1):

"It's kind of pointed out to me how quickly things can change. You don't know from one day to the next, you don't know from one hour to the next". (P6, T5)

The meaning of TBI changes over the first-year post-injury for older adults

Overall, most participants perceived meaning of their TBI remained consistent over the first year post-injury. Five of the participants (P1, P2, P7, P8, P13) consistently noted appreciation for being alive after their TBI and expressed gratitude that the TBI was not worse. The consistent positive meaning over the year post-injury presented in many different ways. During the year older adults spent time for recovery, they thought of their TBI as a chance to look into their lives and expressed gratitude for support from family and health care providers such as doctors and nurses.

On the other hand, five participants (P3, P5, P10, P11, P12) articulated that TBI had a negative meaning to them across the year. For the most part, participants struggled with independent life with their physical limitations. Also, participants wondered why it happened to them, how the injury itself and life changed following TBI. Most participants did not experience a change in how they perceived their TBI. They either consistently viewed it positively or negatively.

In contrast, one participant (P6) had different insights related to the meaning of TBI over time. At the baseline interview, the participant had a negative view of the meaning of TBI and complained about symptoms related to injury:

"It's not a good thing to do and I don't know if I fell, and a pole wrapped itself around my head or if I fell and my head wrapped itself around a pole. Something happened in there that I don't remember, and that bothers me." (P6, T1)

As time went by, the participant described TBI as an unexpected event that occurred suddenly. In addition, although there was no dramatic recovery in relation to physical symptoms,

the participant accepted the injury itself and had a positive view through another individual's brain injury experience:

"My life did not change dramatically since the injury...It means that things can happen so suddenly…but as far as it being an injury, it seems to have healed." (P6, T3)

"I still want my legs to get more strength, but I'm working on that and they're getting better…it will take time. There's a woman in my art group that had 3 head injuries. I said, "how long did it take you to get back to normal?" and she said it takes a year. And see I have several months yet to go before…I think I'm doing quite well." (P6, T4)

Also, the participant emphatically commented about support from people around them. Below are direct quotes related to the gratitude to the people who cared for them:

"One good thing that has come out of it is how people do care about me. It is very heartwarming…There's always someone to say, 'can I help you?'" (P6, T2)
"My partner took good care of me. Very good." (P6, T5)

Discussion

The findings of this study discuss what TBI meant to older adults and how their perceived meaning changed over the year. This study fills an important gap in the literature as few studies have explored the perceptions of their brain injury in older adults. Five main themes were revealed by analysis: 1) gratitude, 2) vulnerability and dependence, 3) slowing down and being more careful, 4) a chance for reflecting on life, and 5) an unexpected event. Among five

themes, the most prominent themes were gratitude and vulnerability and dependence. Consequently, the vast majority of participants had either positive or negative feelings about their brain injury and the valance of those feelings tended to stay consistent over time.

For those viewing the TBI as a positive event, participants were thankful that they survived, and symptoms were not getting worse. Also, participants felt they had gained a chance to look back on their lives and reflect on them. These findings are consistent with prior studies which revealed that people's illnesses or injuries brought them to see their lives in a new way[35] and bring appreciation for being alive and recovering. [36] Other investigators have found that living with TBI means struggling to achieve a "new normal". [37-39] In the process of finding a new way of life, individuals following TBI have sought to understand why and how the injury happened and they felt surviving from TBI was a miracle. [38] In studies of persons experiencing other disease and injury such as burns, [37] cancer, [19] and other chronic diseases, [15,40] participant comments reflected how bad it could have been, and that they developed a greater appreciation for being alive. According to Frias et al. [41] people develop a deep appreciation when they are confronted with life-threatening circumstances which create awareness of their own mortality and when life cannot be taken for granted, people experience enhanced gratitude for the life they are able to live. [41] As shown by this study and previous research, we confirmed that gratitude could be regarded as an important factor of positive illness perception.

In contrast, some participants felt that the TBI was a deleterious event in their lives. Participants described how they struggled with their new vulnerabilities and loss of independence. Similar to previous findings, TBI survivors reported feeling down about their brain injury because of their increased dependence and inability to return to their life before TBI. [38] Furthermore, experiencing a TBI can contribute to life-long disabilities due to physical,

psychological, and emotional losses. [42] Several researchers have noted that older adults have increased functional dependence following TBI. [9,10,43-45] Moreover, increased functional dependence is correlated with lower physical performance in older adults. [46] In particular, cognitive deficits may cause slower reactions after TBI. Stuss et al. reported that patients who sustained TBI with a wide range of severity showed slower performance in attention and speed of information processing. [47] Ozen also reported adults with mild TBI took significantly longer to perform their working memory tasks. [48] Older adults in the present study also noted that they slowed down after their brain injury. As such, "slowing down" may be caused by not only the cognitive impairment by sequelae of TBI, but also age-related cognitive declines. Some individuals reported an additional perspective on this theme, that of "slowing down and being more careful". As TBI can be a devastating event, survivors may have anxiety and fear of situations that originally caused the injury, such as falls. Fear of falling is commonly experienced by older adults with a history of fall. [49] In addition, TBI has been associated with negative mental health outcomes, such as posttraumatic stress disorder (PTSD). [50-52] There have been several theories to explain the relationship between TBI and PTSD. Individuals who experience a traumatic event, such as TBI, may feel threatened or extremely frightened. [51,53] They may feel and react as if they are constantly in dangerous situations and do not want this exposure. As a result, individuals who experience traumatic events tend to be hypervigilant and more careful and sensitive to the environment around them. Though recurrent TBI is uncommon (5-10%) in the year post injury, [54,55] to prevent another injury, individuals frequently are more careful and cautious about their behavior. Excessive awareness, however, can have negative effects on health including sleep disturbance[56] and physical discomfort such as, pain[57] and gastrointestinal distress. [58] Since the present study did not explore how the perception of TBI, "being more

careful" affects health outcomes after TBI in older adults, future research should consider this potential association.

Some participants in this study identified the TBI as an unexpected event. While TBI is an unexpected and life-threatening event, they can be prevented. Clinicians should engage older adults in health promotion activities that focus on common causes such as fall prevention as well as pedestrian and driver safety to prevent TBI.

In terms of the trajectory of the meaning of TBI in older adults, most participants had perceptions of their injury that remained consistent over the first year post-injury. Only one participant's view changed from negative to positive over the 12 months as the individual accepted and integrated the sequelae of injury over time. This finding is consistent with the theory of post-traumatic growth (PTG) developed by Tedeschi and Calhoun in 1996. The PTG theory states that people can begin to see the positive aspects of life after they endure psychological struggles after trauma. [59] Powell et al also found that attitude changes continue to occur in survivors who sustained a brain injury. In their cross-sectional study, the survivors who were sustaining their brain injury for 10 to 12 years had a higher level of PTG and they noted living a richer and fuller life in some ways comparing those whose TBI was more recent. [60]

Moreover, the support from people around the participant played a significant role in framing the perception of their TBI more positively. This finding is aligned with prior studies that demonstrate that social support from family members, friends, and significant others is linked to illness perception. According to Ding et al., better perceived social support contributes to a positive illness perception in their cross-sectional study. [61] In addition, social support is positively associated with not only illness perception, but also life satisfaction[62] and quality of life. [63] According to previous studies, and in line with our results, individuals who perceived

better social support were likely to have a more positive view of their illness/injury. In general, a positive outlook on illness perceptions can influence the ability to cope with the life following illnesses, [15] and improve health outcomes[64] as well as the quality of life. [65] Bonsaksen et al. highlighted the importance of patients' beliefs about their illness in relation to adopting and maintaining coping strategies in persons with chronic illness. [15] In addition, Husain et al. noted that negative illness perceptions were significantly associated with mood symptoms such as depression and anxiety. [64] Finally, Wang et al. found that a patient with rheumatoid arthritis with negative illness perceptions had lower score of the health-related quality of life (HRQoL) in their cross-sectional study. They highlighted that illness perceptions can be a potential target of intervention to improve HRQoL. [65] Although the importance of illness perception has been obviously reported in many previous studies, there is a lack of research that focusing on the lived experience and perceptions of TBI in older adults.

Our findings demonstrate how older adults with mild-moderate TBI view their injury and its changes over the first year post-injury. There is now a need in TBI research to explore associations between one's illness perception about TBI with the lived experience and health outcomes in older adults. In addition, people have various views of their illness although they have same medical conditions or injury. It would be beneficial to assess if there are differences in illness perception associated with sociodemographic factors such as sex, age, and race/ethnicity in order to better understand older adults' beliefs about their brain injury. Moreover, we note that almost half of the participants had a negative perception regarding their TBI and this perspective did not change in the year following injury. A previous trial designed to change illness perception in adults with myocardial infarction had a positive effect on reducing disability. [66] Thus, new attention to interventions that address illness perceptions in older adults

following TBI should be made to seek to improve functional outcomes. Finally, this work suggests that health care providers may need to support in encouraging patients to reframe or build a more positive perception of TBI in order to achieve optimal recovery and overall health.

Limitations and areas for future research

This study has several potential limitations. First, most study participants self-identified as non-Hispanic White. As a person's cultural and ethnic identity has a potential impact on how one perceives injury, future research should include a diversity of perspectives. Second, there was a limitation in fully addressing the trajectory of the perceived meaning of TBI in older adults. Some participants were lost to follow up on the interviews, which could have affected interpretation of data. It has been recommended to initially oversample in the longitudinal qualitative studies of older adults, due to expected attrition for various reasons such as health problems and mortality. [67] Finally, 12 months of follow-up period would be considered a relatively short time to observe particularly PTG. TBI survivors who sustained TBI more than 10 years prior showed high levels of PTG in a previous study. [60] Therefore, future studies should include longer follow-up periods, additional participants, and more representation from ethnic minority groups and various cultures for a richer understanding of the process of making meaning following a TBI.

Conclusion

Evaluation of interviews from older adults following mild-moderate TBI provided a nuanced understanding of several different patterns in the perceived meaning of TBI. We believe that this study can contribute to understanding older adults' beliefs about their brain injury at the

first year post-injury. Findings will inform future research and can serve as a foundation for individualized intervention among older adults who have sustained a TBI.

Table 1. Themes and Quotes of Meaning of Traumatic Brain Injury in Older Adults

Themes	1-week post-injury	1-month post-injury	3-month post-injury	6-month post-injury	12-month post-injury
Gratitude	*"I was very lucky to not have become more severely hurt." (P8)*	*"I just thank God it did not get me any worse. I've always been really lucky." (P1)* *"It means grateful to be alive and grateful that nothing more serious happened." (P13)*	*"It means I am a very fortunate person to be alive…" (P8)* *"Well, to me it meant that it couldn't be too bad, and this too will pass. It occurred and it was a difficult one, but it has improved very much and I'm living a satisfactory life." (P2)*	"*I'm glad that it's healed up as well as it has, I'm thankful for that." (P2)* *"I'm just lucky, I guess I'd call it lucky, that it was not any worse than a little blood on the brain." (P1)*	*"I'm very pleased. Since my accident I'm particularly pleased that I've got a warm house and a roof over my head." (P8)* *"I was lucky I guess because there was nothing else hurting." (P1)* *"I'm lucky to be alive." (P13)*

A chance for reflecting on life	*"I guess in some ways it is making me reflect on where am I going and what am I going to do." (P11)*		*"I mean what really came into focus is when I had my crisis back in, well ancient history, but anyway I want to know what I'm gonna be facing." (P7)*	*"It was an awakening, total awakening. A new path, new life and new experiences." (P13)*	*"It means that I have had time to look into myself and into my way of life and my lifestyle and the word personality." (P8)*
Slowing down and being more careful		*"It gave me a warning sign, definitely!...it told me I'd better slow down." (P3)*		*"It means to slow down and be careful." (P9)* *"It sure slowed me down." (P10)*	*"It means I might not be the same as I was, and it means that I have to be extra careful." (P12)*
Vulnerability and Dependence	*"Something happened in there that I don't remember, and that bothers me." (P6)* *"I guess it makes me face my vulnerability that I don't like to look at." (P10)*	*"At my age I'm' not gonna get too much better. I'm too old to get like I was 40 again." (P12)*	*"I don't even remember that at all, which I find kind of confusing… It's been a headache." (P5)* *"Inconvenience. I'm just not able to do what I want to do…I'd probably be outside doing something." (P5)*	*"I used to go to [the name of the place] by myself and I was told by my daughter that I can't do that anymore." (P3)*	*"I couldn't do everything I wanted to do, that I was able to do before." (P5)*

An unexpected event			*"It was something that happened that I wasn't aware of going to happen." (P10)*		*"It is just one of those things that happens that you don't realize it's going to." (P10)*

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Chapter 3.

Social Integration: A Concept Analysis

Abstract

Background: In recent decades, social isolation has been increasingly linked to serious health conditions. However, social integration (SI) is a complex concept that has not been systematically explored or defined in nursing. It is essential for nurses and health care providers to have a clearer concept of SI in order to better provide holistic care in order to support optimal health.

Purpose: This concept analysis aimed to clarify the concept of SI in health research and to identify attributes, antecedents, and consequences of the concept of SI to enhance understanding of the concept and its implications for human health.

Methods: Walker and Avant's framework was used as the methodology for the concept analysis of SI. A literature search using PubMed, CINAHL, and Embase databases on SI was conducted with keywords: "integration", "social integration" "social relationships" "social participation" "community integration" "socialization". Studies included in the search were published from 2001 to 2021.

Results: SI is affected by multidimensional individual, societal, and environmental factors. Defining attributes are productive activities, social relationships, community engagement, and leisure activities. SI is effective in promoting multiple aspects of health as well as healthy aging and overall well-being.

Conclusion: The analysis contributes to a comprehensive and fundamental understanding of SI and contributes to helping nurses better understand patients' circumstances that promote or inhibit SI. This knowledge will support the development of interventions that support optimal health and well-being, in assisting patients to remain integrated or reintegrate into society during and following an illness or injury.

Keywords: social integration, concept analysis, social isolation

1 | INTRODUCTION

Humans are social beings who belong to society and live in harmony with others in many ways.[1] Social integration (SI) has been recognized as an essential part of life to maintain health and well-being. Several studies have suggested a high level of social integration is positively associated with health outcomes and well-being.[2,3]

In recent decades, social isolation has been increasingly linked to serious health conditions.[4] The risk for isolation has increased with the arrival of the COVID-19 pandemic, which required the world population to maintain long-term social distancing and quarantine to prevent the spread of the virus. A number of studies inform that social isolation and loneliness are generally linked with high risk for a variety of physical and mental illnesses: hypertension, obesity, dementia, depression, and anxiety.[4-6] Moreover, social isolation may contribute to increases in suicide attempts.[7]

With the pandemic, people have needed to adapt to rapid lifestyle changes and newly defined ideas of normalcy such as mandatory lockdowns, work-from-home, and home-schooling. As countries have taken enhanced precautions and begun to administer vaccines over the past year, life is gradually returning to a more pre-pandemic state in some places. However, some individuals may feel anxious and afraid about reintegrating into society and continue to be at risk for social isolation.

Although a great deal of research has identified SI is positively associated with healthy aging,[8] reduced risks of mortality,[8,9] and better health outcomes, including physical function and mental health,[2,10,11] the concept of SI does not have a standardized definition across these studies. Additionally, SI has not been systematically explored or defined as a concept in nursing. It is essential for nurses and health care providers to have a clearer concept of SI in order to provide

holistic care. Thus, defining and gaining a clear understanding of the concept is necessary to comprehend existing knowledge about SI as well as to support future research in this area to promote optimal health.

2 | AIMS

The purpose of this analysis is (1) to clarify the concept of SI in human health research (2) to identify attributes, antecedents, and consequences of the concept of SI to enhance understanding of the concept and its implications for human health and nursing science.

3 | METHODS

For the concept analysis of SI in this paper, Walker and Avant's framework[12] was performed in eight steps (Figure 1). A literature review was conducted using PubMed, CINAHL, and Embase to identify relevant articles published from 2001 to 2021. Searches of Google Scholar and bibliographic searches were also conducted to include relevant articles in this concept analysis. The following inclusion criteria were used if 1) the keywords included in the search of these databases were: "integration", "social integration", "social relationships", "social participation", "community integration", and "socialization", 2) peer-reviewed studies, 3) were written in English. The search process and outcome of the systematic literature review are presented in Figure 2.

4 | USE OF THE CONCEPT

The term "social integration" was first used in the 1890s by the French sociologist, Emile Durkheim. According to Durkheim, SI refers to people interacting and connecting with each

other within a community.[13] Additionally, Durkheim made a great contribution to the understanding of the association between SI and mortality in the fields of sociology and health.[14]

The Psychology Dictionary defines SI as "the process by which an individual is assimilated into a group".[15] In the field of Sociology, the term SI is used to refer to a process of agreement on the sharing system of meaning, language, and culture among immigrants; allowing new immigrants to be incorporated into the social structure of the host society.[16] For some individuals, SI can also imply an ultimate goal of equal opportunities and rights. In this case, people can potentially improve their life opportunities by becoming more integrated into society.[17] Regarding human health, considerable research has been conducted on SI; however, the definition of SI remains inconsistent. The specific commonalities in the definition of SI include the inverse of social isolation,[11,18] a process of coping and adaptation,[19,20] and a goal of rehabilitation for individuals with a variety of disabling conditions.[21,22]

5 | DEFINING ATTRIBUTES

Concept analysis includes identifying attributes that clarify the meaning of the concept and its unique characteristics.[12] From the review of the literature, SI encompasses four defining attributes: (1) productive activities; (2) social relationships; (3) community engagement; and (4) leisure activities.

5.1 | Productive activities

A productive activity refers to any type of paid or unpaid activity that produces such goods or services of value.[23] Previous studies have broadly identified productive activities as one of the types of activity: employment,[24-26] education,[27] and volunteer work.[24,26] The varied

productive activities can be determined by an individual's characteristics—such as age, gender, education, and health status. Education is more likely to be a factor involved in productivity in youth, employment is more likely linked with adults. Paid employment has been considered as the major indicator of productive activities. People view their job as part of their identity and independence as well as being engaged in the occupation allows individuals to contribute their abilities to society.[28] Older adults are stereotyped to have low productivity;[29] however, with increased life expectancy and a global workforce, many older adults are still employed even after the usual retirement age.[30] Some specific life transitions, such as retirement or unemployment, still allow individuals to be engaged in productive activities such as volunteer work or lifelong learning opportunities. Voluntary work has been acknowledged as an important productive activity which is needed for society both economically and socially.[31] Also, through volunteering, people have opportunities to gain new skills and increase their social contacts. Older adults are also more likely to be socially engaged via later-life learning.[32,33]

5.2 | Social relationships

Social relationships refer to the overall level of the individual's involvement with others.[34] They include personal (informal) social relationships, such as having a spouse and friends. In addition, formal social relationships, such as those with co-workers are also attributes of SI.[34-36] Vangel et al.[37] investigated the role of family functioning and caregiver characteristics, including social support, in predicting the well-being of individuals. The research has shown that supports from caregivers and family were associated with a person's life satisfaction. A decrease in the number and depth of social relationships over time has been an issue leading to social isolation.[38] In particular, throughout the global COVID-19 pandemic, perceived social isolation

has had an extraordinary role in psychological disorders such as panic, anxiety, and post-traumatic stress.[39]

5.3 | Community engagement

Community engagement can be defined as the frequency of participation in activities of the household, community, and wider society, and satisfaction with such participation.[40] Getting involved in the community may help develop a positive sense of oneself by providing social support and coping resources.[41] Participation in public life helps people achieve fulfillment and well-being.[42] Community engagement covers a variety of activities from involvement at the local level to the national organizational level—such as neighborhood park clean-ups, serving food at a shelter, religious activities, and decision-making in civic organizations or government.[40-42] Community engagement traditionally takes the form of in-person participation. However, digital community engagement has arisen with advances in technology, leading to increasingly accessible communities as well.[43,44] For example, among youth, social media can be an important source of community engagement in order to participate in local peer-level news and to understand local community conflicts.[45] Internet use can enable older adults to regain or maintain social ties and participate in community activities.[46,47] Previous studies showed that using the internet decreases perceived loneliness and increases social contacts among older.[48,49] In contrast, some people may experience drawbacks with virtual community engagement when compared to face-to-face which results in increased loneliness and social isolation. [50]

5.4 | Leisure activities

Recreation and leisure refer to purposeful activities for relaxation, pleasure, and emotional satisfaction. Taking part in leisure activities leads to improved physical and mental health.[51,52] Outdoor leisure activities such as walking, hiking, biking, swimming, and running help lower the risk of high blood pressure and cholesterol levels and maintain a lower body fat percentage.[53] In addition, mindfulness activities such as meditation and yoga have been found to have a positive effect on mental health: managing stress, improving mood, reducing anxiety and depression.[54] Leisure activities with other people can lead to building new relationships and enhancing existing ones.[55]

6 | CASE EXAMPLES

The Walkers and Avant's framework requires identifying model, borderline, and contrary cases of the concept.[12] Each type of case has been constructed below.

6.1 | Model case

The model case contains all attributes of the concept.[12] A recent gastric cancer survivor, Mr. PJ is a 59-year-old man who works at a bank. He suffers from an eating disorder since his sub-gastrectomy. Every day, his spouse prepares his meal and drives him to work. While working, he sometimes feels tired, but he remains engaged in full-time work. His colleagues have provided encouragement and support as well as accommodation at work, allowing him to do his work and encouraging him to achieve his work assignments. Every Sunday, he volunteers at his church. He describes volunteering at the church as the most enriching activity in his life. Sometimes when his schedule and the weather allow, his family enjoys being in nature, like

hikes or camping. The supportive social relationships have allowed him to perform his work; while volunteering and leisure activities have made him appreciate his life post-gastrectomy.

6.2 | Borderline case

The borderline case contains some attributes of the concept but not all of them. KK is a married 42-year-old woman with has 3 children. She works as a preschool teacher. She sustained moderate traumatic brain injury (TBI) from a motor vehicle crash 4 months ago. Her husband is very supportive and assists her with her instrumental activities of daily living. She was able to return to her work a month ago; however, she has some difficulties in her ability to cope at the workplace, complaining of memory issues and cognitive fatigue. Due to impaired cognition after TBI, she has had to transition her position from full-time to part-time. An avid participant in a hiking club prior to her injury, she has had to reduce the amount of time spent out with other members due to cognitive fatigue experienced following the TBI.

6.3 | Contrary case

JR is a single 37-year-old man, who lives alone in his apartment. Mr. JR was discharged from the hospital a week ago after surviving COVID-19 with significant respiratory complications that required mechanical ventilation. Although his condition is currently improved, he is afraid to return to his usual life after long-term hospitalization that required isolation. He fears social interaction with others including his family and friends as he is worried about getting sick again. This case is considered as a contrary case of SI since it does not include all attributes of SI.

7 | ANTECEDENTS

The next step of concept analysis is identifying the antecedents and consequents of SI.[12] A variety of antecedents are associated with SI including individual, societal and, environmental factors.

7.1 | Individual factors

Demographic and socioeconomic characteristics such as age, gender, health conditions, income, and education are antecedents of SI. Age has been widely reported as the major associated factor with SI.[56] SI differs by age group. Children and adolescents are more likely to build SI through friendships, school activities, and sports. As people get older, certain life transitions such as the death of support partners and retirement affect people's integration into society.[56] In addition, women are more likely to integrate into society than men.[57,58] Finally, individuals with higher education[59] and income levels[60,61] tend to have greater SI.

7.2 | Societal factors

Societal factors include social communication and social support. Social communication refers to the language(s) used in society to interact with other people and includes verbal and non-verbal skills. Social communication allows people to have interactions in new settings and build new social relationships as well as enhance existing ones. Examples of social communication skills include staying on topic, explaining the meaning of a saying in a different way when someone did not understand well, and listening when someone talks.[62,63] Social support is also an antecedent of SI. Higher levels of social support are associated with higher levels of SI.[64]

7.3 | Environmental factors

Environmental factors include accessibility of digital resources such as the internet and social media and neighborhood walkability. The Internet has become an essential resource and most people cannot imagine life without the benefits of the internet. Adolescents use the internet for academic and leisure activities as well as many aspects of their daily lives.[65] Certain kinds of media affect youth-wide social networks and strengthen their social relationships through online chatting or social networking sites.[66,67] Online social connections and social media activities are associated with reduced mortality risk in adults.[9] A positive association has also been demonstrated between internet use and SI in older adults. The internet and social media allow older adults to stay independent longer and manage everyday life situations.[49,68]

Neighborhood walkability refers to an environment where people can safely walk to various destinations such as workplaces, schools, amenities, and public spaces.[69] Residents living in walkable neighborhoods are more likely to interact with their neighbors and be involved in society.[70] In addition, walkability has been positively associated not only with leisure and physical activities[71] but also with social networks which allow individuals access to information regarding employment or daily life.[70]

8 | CONSEQUENCES

Consequences of being socially integrated include: improved physical and mental health, healthy aging, and life satisfaction. SI has been identified as an important precursor to healthy aging. This occurs through interaction with friends and family, helping others, and social

participation increases self-esteem and well-being. It can also allow people to be motivated to change and maintain healthier behaviors.[8,72]

SI can lead to improved physical and mental health. A number of studies provide evidence of the beneficial effect of SI on an individual's health such as lower morbidity and mortality.[9,14,73] In terms of physical health, SI is associated with better self-rated health,[9,74] reduced cardiovascular disease,[75] and improved cognitive function.[76] Mental health consequences of SI include improved mood, and reduced anxiety and depression.[77] Lastly, SI leads to improvements in life satisfaction and quality of life. All attributes of SI: productive activities, social relationships, community engagement, and leisure activities have been well documented to be positively related to an increase in life satisfaction and quality of life.[78-81]

9 | EMPIRICAL REFERENTS

The final step of concept analysis is determining empirical referents of the defining attributes of SI.[12] There are some comprehensive measures proposed for assessing SI such as the multidimensional scale of social integration in later life (SILLS)[82], the community integration questionnaire (CIQ),[83] and the Participation Assessment with Recombined Tools-Objective (PART-O).[84]

The SILLS is a comprehensive multidimensional measurement for assessing SI in older adults consisting of several domains: 1) family, 2) friends and neighbors, 3) leisure, 4) community, 5) productivity.[82] While the subscales are consistent with the attributes of SI identified in the concept analysis, SILLS does not address employment as a potential productive factor. As more older adults are working well past retirement age,[85] this is an important component that should be addressed.

The CIQ is a measurement for assessing community integration specifically for an acquired brain injury (ABI) population. It consists of three major domains: home integration, social integration, and integration into productive activities.[83] SI is included as a subscale in the instrument; however, the specific items are related to activities outside the home only.

The PART-O is an instrument to measure functional outcomes and participation in the community after brain injuries. The measurement includes productivity, social relations, and being out and about social participation.[84] It is a comprehensive measure that captures all four attributes of SI; however, both the CIQ and the PART-O have not been validated in non-ABI populations.

Since SI is a complex and multidimensional concept, empirical referents vary widely. Thus, multiple different instruments can also be used to assess the defined attributes of SI (Table 1).

10 | POTENTIAL CONTRIBUTION TO NURSING SCIENCE

Nurses not only provide nursing care but also have important roles as educators and supporters to assist patients in their reintegration into society. Especially at this historical moment with the COVID-19 pandemic, individuals experiencing mandatory social distancing and isolation may negatively affect health outcomes. The comprehensive concept analysis of SI may contribute to allowing nurses to assess individuals' circumstances such as limited resources for productive activities and community engagement, living alone in isolation with depression, and lacking any leisure activities. Also, a better understanding of SI will allow nurses to promote communication with patients, family members, and health care providers, as well as to develop interventions to improve optimal health.

11 | CONCLUSION

The aim of this paper was to provide an analysis of the concept of SI and clarify attributes using the Walker and Avant framework[12]. The proposed concept of SI is viewed as a process of incorporation and inclusion in society through productive activities, social relationships, community engagement, and leisure activities. The findings from this concept analysis indicate that SI is affected by various individual, social, and environmental factors. Furthermore, SI supports several aspects of health and well-being, including physical and mental components (Figure 3).

There are some limitations in the present analysis. First, since SI is a multidimensional concept, it is possible that some relevant articles were not found in the structured literature review. Second, this paper does not address cultural aspects as this was not addressed in the published literature identified in the review. Thus, future studies should be conducted to examine the cultural components of SI. The concept of SI is highly relevant at present given the global effects of the COVID-19 pandemic.

Table 1. Empirical referents of social integration

Phenomena	Measurements
Productive activities	• Vocational-independence scale (VIS) [86]
Social relationships	• Interpersonal support evaluation (ISEL) [87] • Loneliness scale[88]
Community engagement	• Impact on participation and autonomy questionnaire (IPAQ) [89]
Leisure activities	• Pittsburgh enjoyable activities Test (PEAT) [90] • Leisure activity participation scale (LAPS) [91]

Figure 1. Walker and Avant's eight-step framework

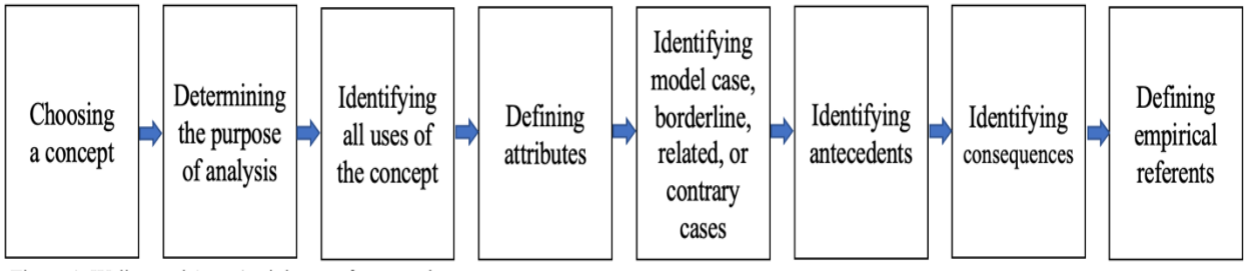


Figure 2. Systematic search strategy regarding concept analysis of social integration.

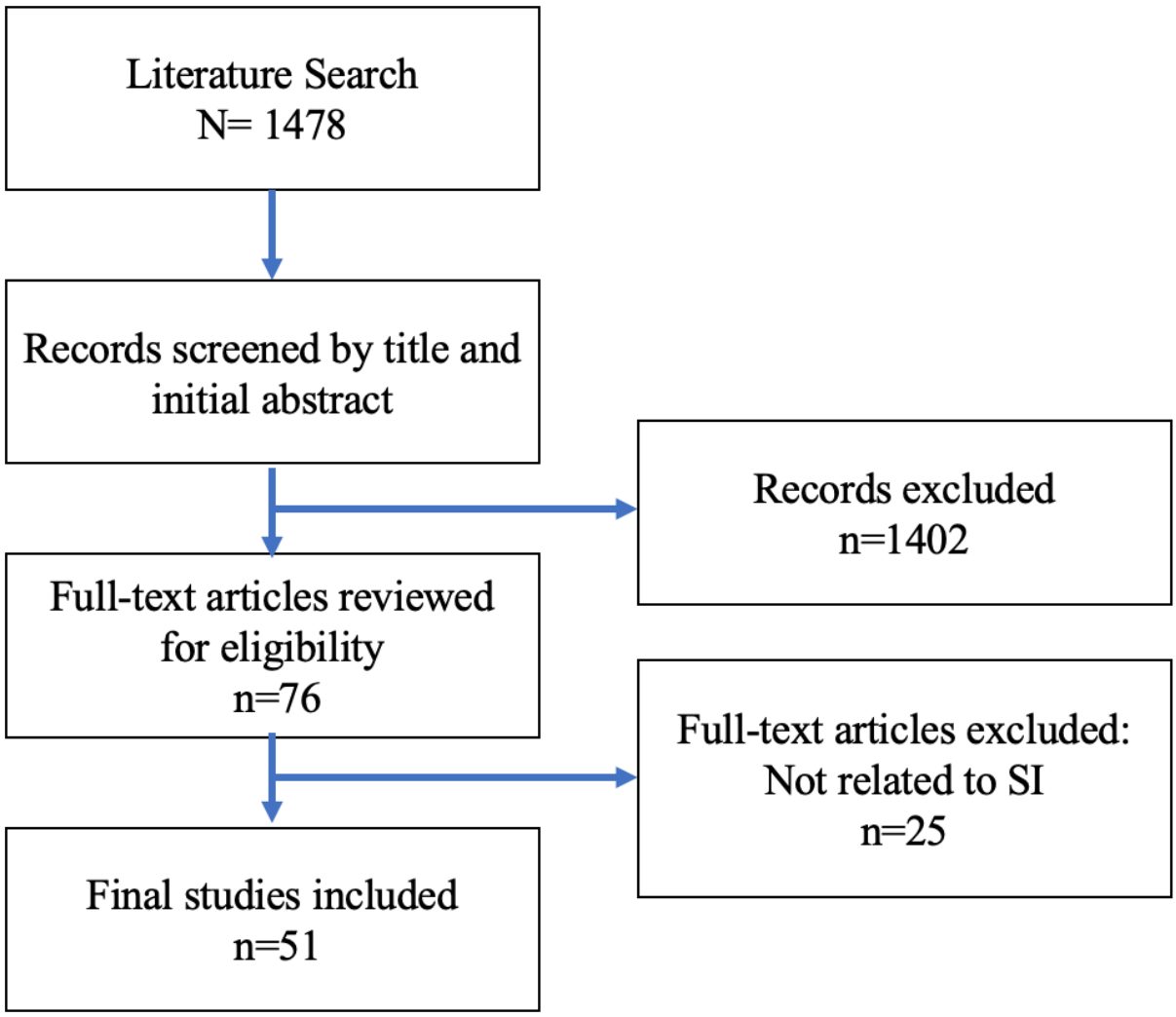
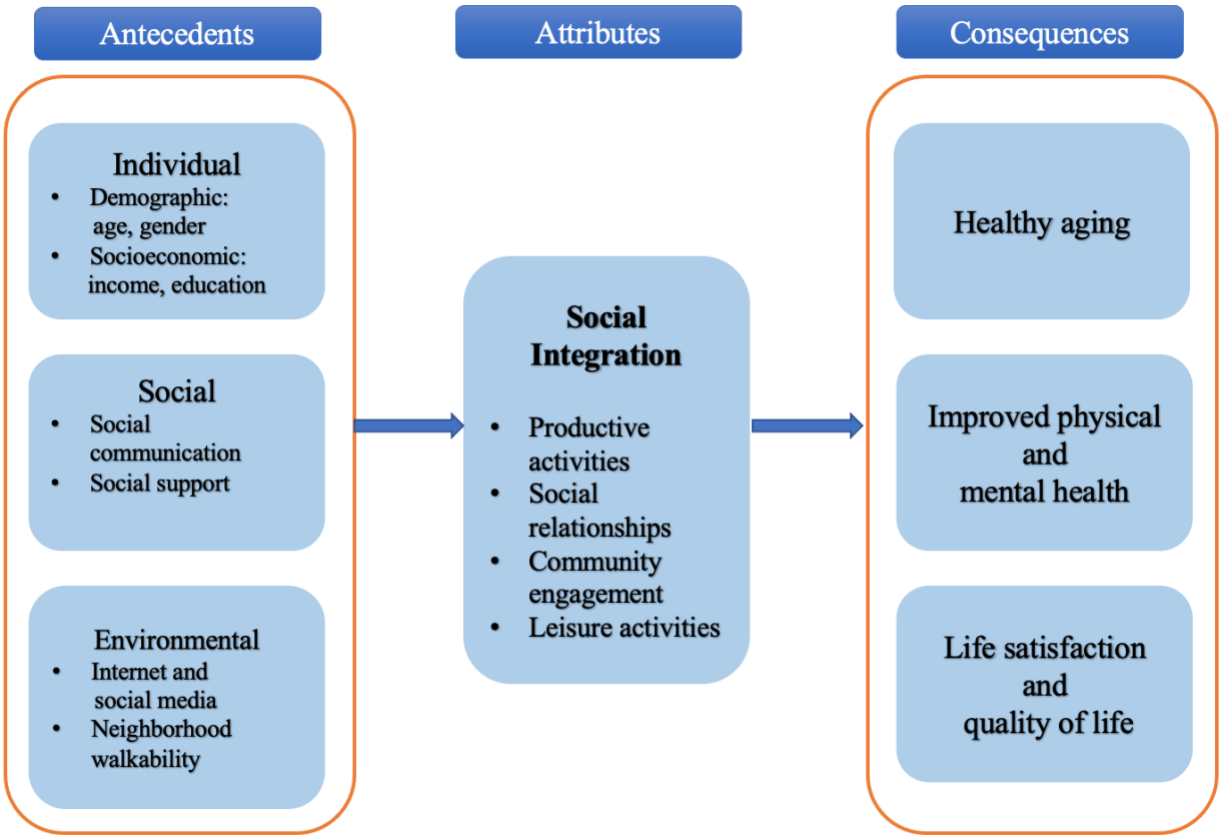


Figure 3. Concept framework of social integration



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Chapter 4.
The Mediating Role of Functional Outcome in the Relationship Between Social Integration and Cognition in Older Adults Following Traumatic Brain Injury

Abstract

The current study aimed 1) to examine interrelationships among social integration, functional outcome, and cognition in older adults at years 1, 2, and 5 post- traumatic brain injury (TBI) and 2) to examine if functional outcome mediates the concurrent and longitudinal relationships between social integration and cognitive function after TBI in older adults. A longitudinal mediation analysis was adopted using a sample of 1469 older adults aged 65 and over at injury. Data were obtained from Traumatic Brain Injury Model System National Database (TBI-NDB). The results revealed that social integration had a direct effect on functional outcome (Year 1: $\beta = .29$, $p < .001$; Year 2: $\beta = .08$, $p < .05$; Year 5: $\beta = .07$, $p < .001$) and cognition (Year 1: $\beta = .21$, $p < .001$; Year 2: $\beta = .08$, $p < .001$; Year 5: $\beta = .15$, $p < .001$) at each time point. Functional outcome also had a positive direct effect on concurrent cognition (Year 1: $\beta = .46$, $p < .001$; Year 2: $\beta = .15$, $p < .001$; Year 5: $\beta = .1$, $p < .05$). Regarding the mediating role of functional outcome, social integration and cognition were mediated by concurrent functional outcome. However, there was no significant mediating effect of concurrent functional outcome on concurrent social integration and later cognition. The findings suggest there are positive relationships between social integration, functional outcome, and cognition over time. Also, functional outcome mediates the concurrent relationships between social integration and cognition in older adults following TBI. With a better understanding of the interrelationships between social integration, functional outcome, and cognition, tailored interventions should be developed for older adults following TBI.

Key words: Traumatic Brain Injury Model Systems; Aged; Head Injury; Longitudinal Mediation Analyses

1 | Introduction

Maintaining cognitive health is an important aspect of healthy aging.[1] Cognition refers to complex brain activities including memory, reasoning, attention, learning, problem-solving, decision making, and planning.[2] As people get older, cognitive decline in conceptual reasoning, memory, and processing speed is expected as part of the normal aging process.[3] However, there are other factors that could impact older adults' cognitive health including family history,[4] education level, [5] alcohol use,[6] and central nervous system issues such as traumatic brain injury (TBI), [7] stroke, [8] and Parkinson's disease. [9] A risk factor for developing cognitive impairment or subsequent dementia is TBI during one's lifetime, to include incident TBI in older adulthood.[10,11]

TBI in older adults is globally recognized as a public health priority due to its high mortality and negative functional outcomes. Older adults are more likely to have limited ability to reintegrate into society due to slower recovery trajectories and worse physical and cognitive functioning following TBI. As a result, they may experience a lower quality of life compared to their younger brain-injured counterparts.[12,13]

Social integration is an essential part of healthy aging and quality of life. [14-16] Social integration refers to the coping and adaptation process that allows one to resume the full participation in life regardless of sequela after brain injury[17] and is the ultimate goal of neurorehabilitation.[18] There is evidence to suggest that a higher level of social integration is associated with better cognitive function in older adults.[19,20] For example, Ertel et al. found in a prospective longitudinal study that high levels of social integration delay memory loss over six years among community-dwelling older adults.[19] Also, Krueger et al. found that frequent participation in social activities and a higher level of social integration were associated with

better performance on cognitive tests in a cross-sectional study of older adults without clinical symptoms of dementia.[20] Social integration is closely related to other terms such as social networks, [21,22] social support, [23-25] and social engagement.[20] These concepts have also been associated with higher cognitive function later in life. While numerous studies report a positive association between social integration and cognitive function, relatively little is known about this association in older adults who have experienced a TBI.

In addition to the importance of social integration, better functional outcome (the capacity to perform independent living, social relationships, education, and work, and enjoy leisure activities) has been found to reduce the risk of cognition decline in previous studies.[26-28] Sabbagh et al. identified that functional declines were correlated with cognitive impairment among individuals with neurodegenerative disease.[27] Stavrinou et al. found that greater level of functional capacity was associated with not only superior cognitive performance, but also better quality of life in a cross-sectional study on older adults residing in long-term facilities.[28] Specific to TBI, cognitive function (i.e., performance on attention, memory, executive function, and information processing speed tests) was significantly lower in individuals with poor functional outcomes following TBI.[26]

Functional outcome and social integration have been found to be interrelated in previous studies. Baseman et al. found that functional status can be the predictor of social integration among stroke survivors.[29] Ditchman et al. suggested improving functional outcome may lead to better social integration after TBI.[30] In addition, prior research reported that high level of social integration was associated with better functional outcome in patients with lower extremity amputation.[31] As these findings come from cross sectional studies, there is at present no

indication of the direction and temporality of the association, which is a gap in the available literature.

Although functional outcome has been associated with social integration and cognitive health, few studies have investigated the relationship between social integration, functional outcome, and cognition after TBI in older adults. Moreover, the mediating role of functional outcome on the relationship between social integration and cognition remains unknown. In addition, there is still limited research on the long-term trajectories of cognitive function in geriatric TBI. According to previous studies, individuals with TBI experience cognitive decline in the first month to five years after injury.[32-34] Thus, well-designed longitudinal studies are needed to identify the long-term cognitive trajectories and understand the relationships among social integration, functional outcome, and cognitive function.

From the review of existing literature, social integration and functional outcome are essential factors to improve cognitive health in older adults following TBI. However, few studies have examined the mechanisms and indirect effects of functional outcome on the relationship between social integration and cognition after TBI in older adults. Understanding these mechanisms is important to determine which pathways should be targeted for intervention.

2 | Aims

This study aimed 1) to examine interrelationships among social integration, functional outcome, and cognition in older adults in years 1, 2, and 5 post-TBI and 2) to examine if functional outcome mediates the concurrent and longitudinal relationships between social integration and cognitive function after TBI in older adults. We hypothesize that 1) greater social

integration and higher functional outcome are associated with higher cognition in older adults after TBI at each time point (years 1, 2, and 5 post-injury) and 2) functional outcome from TBI will mediate concurrent and longitudinal relationships between social integration and recent and later cognitive function in older adults following TBI. This study tested the hypothesized model in Figure 1.

3 | Methods

3.1 | Study design and participants

This study is a longitudinal mediation analysis with data obtained from the Traumatic Brain Injury Model System National Database (TBIMS-NDB).[35] TBIMS-NDB is sponsored by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR), U.S. Department of Health and Human Services. The TBIMS-NDB is the largest multi-site longitudinal database for TBI in the world, with data collection from subjects at entry, 1, 2, and 5 years and every 5 years thereafter up to 35 years. Participants were recruited from inpatient rehabilitation admissions for moderate to severe TBI at study sites. Informed consent to participate was provided by the patient, family, or guardian. Repeated surveys of individuals post-injury at regular intervals were performed via telephone, in-person, or mail questionnaires. Data have been collected through patient examination, interviews, medical records, and family interviews by TBIMS-NDB research team members.[36] TBIMS-NDB has been used in various research to identify the functional, [37,38] psychosocial, [39] and neurobehavioral outcomes after TBI, and recovery trajectory in the years following TBI.[40,41]

For the current study, participants from the TBIMS were included if they 1) were aged 65 years and above at the time of injury, and 2) had data from two or more follow up time points (year 1-,2-, and/or 5). Individuals were excluded if they died within 5 years post-injury. The institutional review board (IRB) from the University of Washington Human Subjects Division determined this study was not human subjects research, and thus not required to have approval, given that data were deidentified.

3.2 | Measures

3.2.1 | Socio-demographic characteristics

Variables used in the analysis included socio-demographic factors at the time of injury (age, sex, race, education level, marital status, and employment). In the dataset, age is a continuous variable. Sex at birth is defined as: female, male and unknown. Self-reported racial identification includes 5 categories: “White”, “Black, African American”, “Asian”, “American Indian or Alaskan Native”, “Native Hawaiian or other Pacific Islander” and “Other”. Education level is a categorical variable defined as the highest grade of school completed at the time just prior to injury: “8^{th} Grade or Less; 9^{th}-11^{th} Grade; Higher Secondary/General Education Development; Trade; Some College; Associate; Bachelors; Masters; Doctorate; Other. Marital status is defined as marital status at the time just prior to injury including “single (never married)”, “married”, “divorced”. “separated”, and “widowed”. Finally, employment is a categorical variable defined as employment status at the time of injury: “full-time student”, “part-time student”, “employed”, “homemaker”, “unemployed”, and “volunteer”.

3.2.2 | Social Integration

Participation Assessment with Recombined Tools-Objective (PART-O)

PART-O is a 24-item questionnaire that assesses participation and societal functioning after TBI. Item contents offered for the number of hours, number of times on involvement in activities. PART-O consists of 3 subscales: (1) productivity, (2) social relations, (3) out and about in the community. Items are scored on 0 to 5 and the rating forms are included in the questionnaires. A total score is computed by averaging the scores of all items. Higher scores indicate more participation. TBIMS-NDB provides an averaged total score of PART-O, equating to the sum of the three subscale scores divided by three. The consistency of PART-O is adequate with a reliability of .99. [42]

3.2.3 | Functional outcome

Glasgow Outcome Scale-Extended (GOS-E)

Glasgow Outcome Scale (GOS) was originally developed by Teasdale and Jennett in 1975 for assessing the severity of the injury and predicting long-term outcomes among individuals following TBI. [43] GOS-E was developed in 1981 to address limitations of the original tool such as its lack of sensitivity and reliability.[44] The structured interview for GOS-E is composed of 7 subscales: (1) consciousness, (2) independence at home, (3) independence outside home, (4) work, (5) social and leisure activities, (6) family and friendships, and (7) return to normal life. [44] The GOS-E provides 8 outcome categories: death, vegetative state, lower severe disability, upper severe disability, lower moderate disability, upper moderate disability, lower good recovery, and upper good recovery. The consistency of GOS-E is adequate with a reliability of .95.[44]

3.2.4 | Cognition

Functional Independence Measure (FIM)

For this study, cognitive function is measured by the Cognitive FIM subscale. The FIM is a functional status instrument that assesses performance restriction and cognitive impairments. The FIM is reliable and valid for use in TBI patients (internal consistency Cronbach's alpha = .93).[45] The cognition subscale includes items on comprehension, expression, social interaction, problem-solving, and memory. Each item is scored on a 7-point ordinal scale (1= total assist to 7 = complete independence). The cognitive FIM score has a possible range between 5 and 35, with lower scores indicating more cognitive impairment.[45]

3.2.5 | Covariates

Based on prior literature,[46-48] covariates in this study included age, sex at birth, race, marital status, education level, and employment status.

4 | Statistical analyses

For the primary study objective, prior to performing any analysis related to the study aims, we assessed for missing data. Little's missing completely at random (MCAR) test [49] was performed using IBM SPSS version 29.0 (Armonk, NY).[50] The test results indicated that data were not MCAR with the $X^2(366) = 600.7$, $p < 0.05$. Then, we analyzed a pattern of missingness using SPSS. As shown in Figure 2, the pattern of missingness was not a systematic pattern. If data are missing not at random (MNAR), this would indicate a monotonicity or a systematic

pattern of missingness.[51] Therefore, it was assumed that the data for this study were missing at random (MAR). To address missing data, multiple imputation (MI) with regression methods in SPSS was used as it reduces bias and improves efficiency for analysis of MAR data.[52] Among variables, social integration at 5-year post-injury included the largest percentage of missing values (36.8%). Next, descriptive statistics and bivariate Pearson's correlation coefficients were performed. We summarized variables using means and standardized deviation (SD), respectively. We compared data using Student's t-tests for continuous variables, and X^2 or Fisher's exact tests for categorical variables, as appropriate. Finally, the longitudinal mediation analysis was conducted using bootstrapping procedures with 5000 samples and a 95% confidence interval in Mplus Version 8.0 (Los Angeles, CA).[53] Model fit was evaluated by nonsignificant X^2 test statistics of the exact fit hypothesis, root mean squared error of approximation (RMSEA), comparative fit index (CFI) and Tucker–Lewis index (TLI), and standardized root mean residual (SRMR). Fit indices such RMSEA below 0.06, CFI and TLI greater than 0.95, and SRMR below 0.08 were considered as good fits of the model to the data.[54]

5 | Results

5.1 | Sample Characteristics

At the baseline (at injury), a total of 3027 older adults were in the dataset. Among the original sample, 2265 (74.8%), 1999 (66.0%), and 1086 (35.9%) followed up at 1-,2-, and 5-year postinjury respectively. Those who had completed follow up were more likely to be younger (t=3.14, p= .04), married (x^2=13.10, p= .02), and unemployed (x^2=21.07, p= .02). Among 3027

participants, we included 1469 who completed follow-up data collection at least two-time points in the final analysis.

Table 1 provides a summary of demographic characteristics for the sample at time of injury. The sample was predominantly male (59.8%) and age ranged 65-99 years (mean 74.3). The majority of participants were White (n= 1136, 77.3 %), married (n=834, 56.8%), retired (n=991, 67.5%) and completed high school or less than a high school education (n=758, 51.5%).

5.2 | Path analyses

Table 2 presents the descriptive statistics and bivariate correlations among variables in this study. There were no indications of multicollinearity in the current study as correlation coefficients are below .85.[55,56] Overall, the model showed a good fit to the data with $X^2(8)$ = 23.74, p= .003, RMSEA= .037, CFI= .998, TLI= .991, and SRMR= .015.

5.2.1 | Direct effect

Figure 3 presents the interrelationship between social integration, functional outcome, and cognition. Social integration was positively associated with concurrent functional outcome (Year 1: β = .29, p <.001; Year 2: β = .08, p < .05; Year 5: β = .07, p < .001) and cognition (Year 1: β = .21, p <.001; Year 2: β = .08, p < .001; Year 5: β = .15, p < .001) following TBI in older adults. In addition, there was a significant positive association between functional outcome and cognition across the 1- 2- and 5-year assessments (Year 1: β = .46, p < .001; Year 2: β = .15, p < .001; Year 5: β = .1, p < .05).

5.2.2 | Mediating effect of functional outcome

As Figure 3 and Table 3 present, there were significant indirect effects from social integration to concurrent cognition working through concurrent functional outcome at each time point. However, controlling for socio-demographic characteristics, concurrent functional outcome did not mediate the longitudinal relationship between concurrent social integration and cognitive function at the next time point.

6 | Discussion

The aim of this study was to examine the cross-sectional and longitudinal relationships between social integration, functional outcome, and cognition in older adults following TBI. Follow-up assessments were conducted at 1-,2-, and 5-year post-injury. Two hypotheses were tested: 1) greater social integration and functional outcome will be associated with higher cognition in older adults at 1-,2-, and 5-year post-injury respectively. 2) concurrent functional outcome from TBI will mediate relationships between social integration and concurrent cognition and next timepoint of cognition in older adults following TBI.

In support of hypothesis 1, social integration had significant positive effects on functional outcome and cognition at each time point: 1-,2, and 5-year post-injury. These findings confirm the effect of social integration on concurrent functional outcome and cognition in older adults following TBI. This result is congruent with previous findings in which higher social integration was associated with better cognitive function. [19,20] In addition, some randomized, controlled trials suggest that greater integration in society is associated with improving cognitive function in older adults without TBI.[57,58] Galinha et al. found socialization to be a critical piece of their multidimensional intervention to improve cognition in older adults.[57] Mortimer et al. found that a

social interaction intervention increased total brain volume and cognitive performance over 10 months in older adults without dementia.[58] The positive association between social integration and functional outcome in the current study is also aligned with the previous literature. In addition, more active integration into society was associated with a reduced risk of developing disabilities in later life.[46,59,60]

Furthermore, in this study, good functional recovery was associated with a higher level of cognition as functional outcome had a significant positive effect on cognition at each time point to 5 years post-injury. Previous studies have also highlighted the importance of functional ability in the maintenance or improvement of cognitive health in older adults. For example, Ramnath et al. reported a higher level of functional ability was associated with higher cognitive performance in community-dwelling older adults.[61] Stavrinou et al. also found in a cross-sectional study that greater levels of functional capacity were associated with superior global cognition and executive cognitive performance in older adults.[28]

In partial support of hypothesis 2, our analyses demonstrated the mediating effect of concurrent functional outcome on the relationship between concurrent social integration and cognition at 1-,2-, and 5-year post-injury. This finding is in line with those reported by previous studies, which suggest that frequently engaging in social activities indirectly alleviates declines in cognitive function via effects on physical function in community-dwelling older adults.[47,48] In terms of the longitudinal effect, we did not find that concurrent social integration had an effect on later cognition via concurrent functional outcome. However, some other pathways showed significant indirect effects between concurrent social integration and later cognition. For example, the pathway from social integration at 1-year post-injury to cognition at 2-year post-injury was mediated by cognition at 1-year post-injury ($\beta = .15$, $p < .001$). Similarly, social

integration at 2-year post-injury was indirectly associated with cognition at 5-year post-injury via cognition at 2-year postinjury ($\beta = .03$, $p < .01$). Hence, this result indicates the importance of social integration to protect cognitive function over time. Several longitudinal studies previously identified that greater social integration is associated with less cognitive decline over time.[60,62-64]

From results of the path analysis, we found a causal relationship between social integration and cognition. Interestingly, while recent social integration predicted concurrent cognition, it did not predict later cognition at the next timepoint. On the other hand, recent cognition was directly associated with social integration at the next time point. In other words, the causal pathway relationship between social integration and cognition followed a step-by-step pattern. Greater social integration enhanced simultaneous cognitive function, then that relationship impacted social integration at the next time point. For instance, cognition at 1-year post-injury mediated the relationship between social integration at 1-year and 2-year post-injury ($\beta= .02$, $p < .001$). Then, social integration at 2-year post-injury was positively associated with cognition at 2-year post-injury ($\beta= .07$, $p < .001$). Therefore, in this study we confirmed that social integration and cognition were bi-directionally through path analysis. Based on this path analysis, social integration in the first-year post-injury plays an important role in maintaining cognitive health after TBI over time.

7 | Limitations and strengths

This study has some limitations. First, as this study was a secondary data analysis using TBIMS-NDB, we were limited to the available data. For cognitive function, FIM Cognitive subscale was only available to address cognition over time in this study. Future studies are

needed with other cognitive assessment tools or neuropsychological testing to investigate if there is a direct effect of social integration on more specific measures of cognitive function. Second, the generalizability of this study's findings to historically underrepresented groups in research is limited as minoritized individuals accounted for by less than 15% of the total sample. As a previous study suggested the patterns of social integration vary by race and ethnicity,[65] and there is a higher burden of TBI in historically underrepresented groups,[66] future studies in this area should endeavor to recruit a more diverse sample in a deliberative manner. This approach would allow for a further examination of interrelationships between social integration, functional outcome, and cognitive function in older adults following TBI.

Despite these limitations, this study presents several important strengths. Older adults are at increased risk for social isolation and loneliness due to the low frequency of social interactions and decreased functionality. [67] This study could contribute to awareness of the importance of social integration for better functional outcomes and cognition following TBI in older adults. Also, the findings of this study provided important information about the changes in social integration over time and the association with functional recovery and cognition. In addition, we identified causal relationships between social integration, functional outcome, and cognition through longitudinal mediation analysis.

8 | Clinical implications

Based on the findings from the current study, we should consider several clinical implications. First, social (re)integration should be included in patient care plans from the early stage of care in order to better understand of individual's cultural context and values. Second,

health providers should emphasize and encourage older adults' social integration during the first year of post-injury to maintain cognitive health or to prevent cognitive decline after TBI. Finally, we should consider developing multidisciplinary interventions focused on social integration to enhance functional outcomes and cognition after TBI. The potential interventions by a multidisciplinary team could consider some activities such as developing communication skills, meditation, rebuilding an individual's identity and acceptance of disabilities from injury, reinforcement of social relationships, and sport-based interventions.

9 | Conclusion

The results of this study showed concurrent direct effects between social integration, functional outcome, and cognition. Furthermore, functional outcome had a significant mediating effect on the relationship between concurrent social integration and cognition at 1-, 2-, and 5-year postinjury among older adults. This investigation clearly highlights the robust impact of social integration and functional outcome on cognitive health, concurrently and over time. With this understanding of the interrelationships between social integration, functional outcome, and cognition, it is important for clinicians and family members to encourage and support older adults' social integration after brain injury.

Table1. Baseline demographic characteristics of the sample population (N=1469)

Variables	Participants (%)
Age (year)	
65-74	824(56.1)
75-84	498(33.9)
≥85	147(10.0)
Sex	
Female	591(40.2)
Male	878(59.8)
Race/Ethnicity	
White	1136(77.3)
Black	142(9.7)
Asian/Pacific islander	62(4.2)
Native American	2(0.1)
Hispanic Origin	116(7.9)
Marital status	
Single (never married)	113(7.7)
Married	834(56.8)
Divorced	190(12.9)
Separated	24(1.6)
Widowed	308(21.0)
Education	
High school or less	758(51.5)
College	190(13.0)
Bachelors	263(17.9)
Masters	151(10.3)
Doctorate	107(7.3)
Employment	
Student	7(0.5)
Employed	363(24.7)
Retired	994(67.5)
Unemployed	70(4.8)
Volunteer	37(2.5)

Table 2. Descriptive statistics and correlations among variables included in the study.

	n	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.
1.SI1	1162	1.40	.63	1								
2.FO1	1370	5.80	1.97	.46**	1							
3.COG1	1366	30.47	5.40	.48**	.56**	1						
4.SI2	1208	1.39	0.65	.81**	.40**	.43**	1					
5.FO2	856	5.66	2.11	.46**	.77**	.53**	.47**	1				
6.COG2	1354	30.36	5.59	.45**	.50**	.74**	.48**	.58**	1			
7.SI5	845	1.26	.67	.72**	.34**	.37**	.76**	.40**	.42**	1		
8.FO5	1435	6.08	1.92	.45**	.53**	.44**	.47**	.64**	.50**	.55**	1	
9.COG5	852	29.62	6.95	.40**	.42**	.55**	.44**	.50**	.67**	.53**	.63**	1

Abbreviations: SI1, social integration at 1-year post-injury; FO1, Functional outcome at 1-year post-injury; COG1, cognition at 1-year post-injury; SI2, social integration at 2-year post-injury; FO2, Functional outcome at 2-year post-injury; COG2, cognition at 2-year post-injury; SI5, social integration at 5-year post-injury; FO5, Functional outcome at 5-year post-injury; COG5, cognition at 5-year post-injury; SD, standard deviation.
*p <.05; **p <.01; ***p <.001

Figure 1. Hypothesized model across five years.

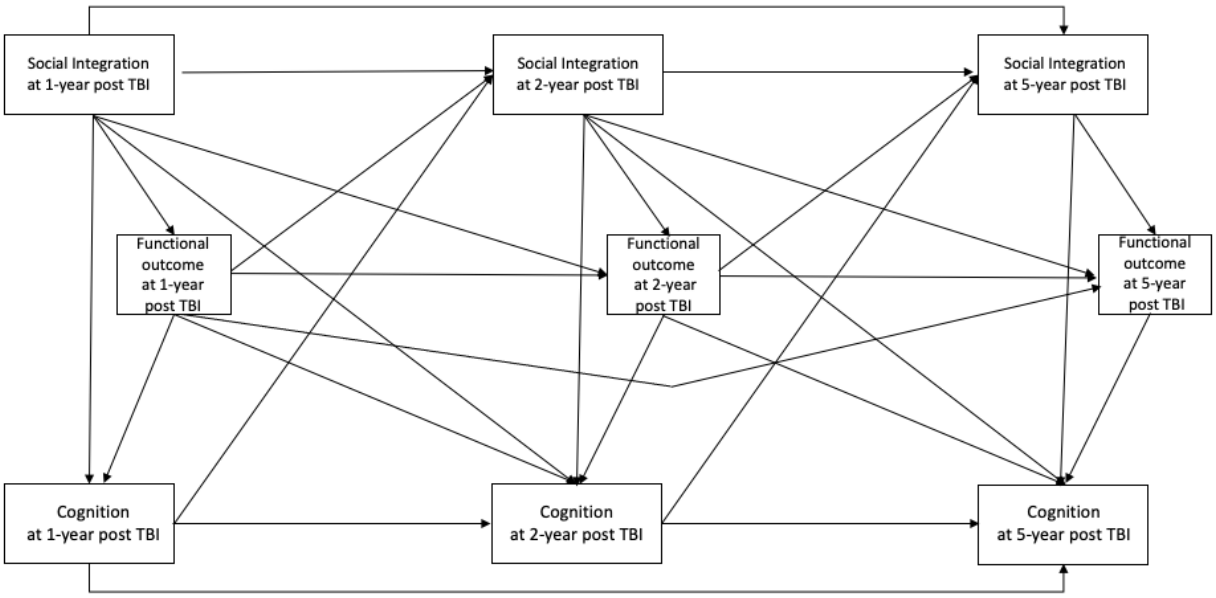


Figure2. Missing value patterns

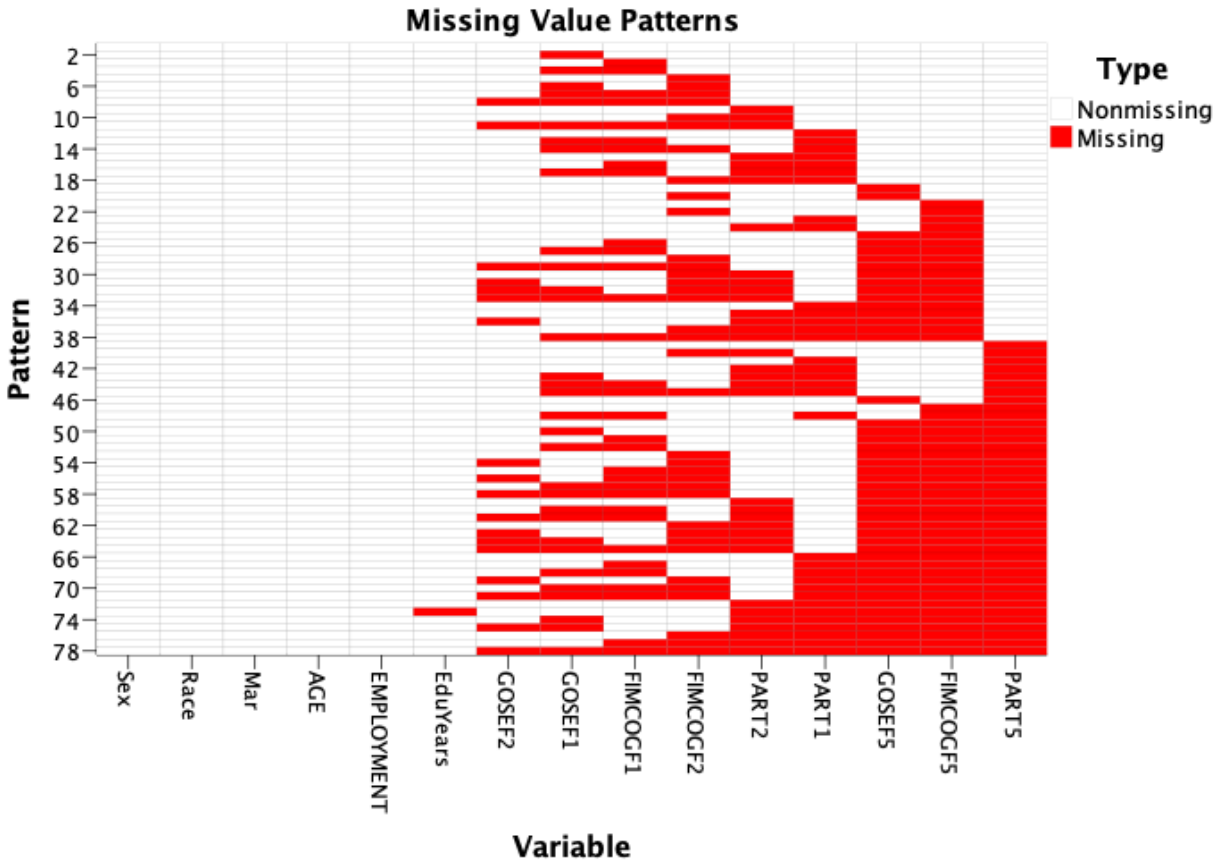
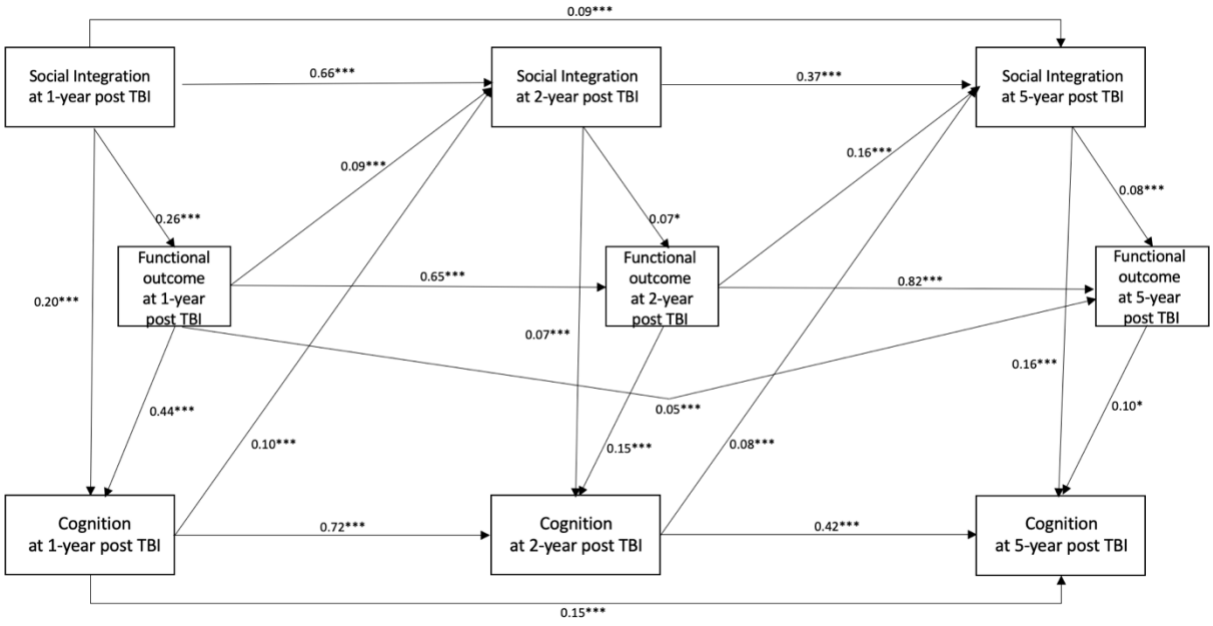


Figure 3. Path model with significant standardized coefficients.



*p <.05; **p <.01; ***p <.001

Table 3. Indirect(mediation) effects of functional outcome

Path	β	SE	95% CI	p-value
SI1 -> FO1->COG1	.12***	.01	.09, .14	<.001
SI2 -> FO2->COG2	.01*	.01	0, .02	.03
SI5 -> FO5->COG5	.01*	.004	0, .02	.02
SI1 -> FO1->COG2	-.01	.01	-.02, .001	.44
SI2 -> FO2->COG5	.002	.003	0, .01	.58

Abbreviations: SI1, social integration at 1-year post-injury; FO1, Functional outcome at 1-year post-injury; COG1, cognition at 1-year post-injury; SI2, social integration at 2-year post-injury; FO2, Functional outcome at 2-year post-injury; COG2, cognition at 2-year post-injury; SI5, social integration at 5-year post-injury; FO5, Functional outcome at 5-year post-injury; COG5, cognition at 5-year post-injury; β, standardized beta; SE, standard error; CI, confidence interval.

*p <.05; **p <.01; ***p <.001

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Chapter 5. Conclusion

Traumatic brain injury (TBI) has been defined as a "silent epidemic" [1] and the incidence of TBI in older adults is increasing. [2] With the "Baby Boom" generation entering into older adulthood, the population of older adults is expected to double by 2030. [3] With the rapid increase in the older adult population, the number of older adults sustaining TBI is growing. [4] For all individuals, life after TBI is generally not the same as prior to injury. While numerous studies focus on the prevention of TBI in older adults, [5-7] little is known about how older adults think about their injury and how they return to daily life after TBI. The overall purpose of this dissertation was to better understand older adults' lives after traumatic brain injury (TBI). Specifically, it sought to explore how older adults integrate the experience of injury into their lives and how social integration may influence this integration via cognitive functioning.

Chapter 2 was a longitudinal multiple-case study to explore the perceived meaning of TBI to older adults and to explore if and how the meanings change over the first-year post-injury. This study utilized secondary data from 13 older adults who were interviewed over 12 months post injury (n=57 interviews). I found five main themes regarding how individuals process and perceive meaning from their TBI: 1) gratitude, 2) vulnerability and dependence, 3) slowing down and being more careful, 4) a chance for reflecting on life, and 5) an unexpected event. The majority of participants did not change their perspective regarding their injury in the 12 months following it. They had either positive or negative illness perceptions about their injury. Only one participant changed the illness perception from negative to positive over one year following TBI. The findings demonstrate how older adults view their injury and generally do not change their beliefs in the first year following TBI.

Chapter 3 was a concept analysis to clarify the concept of social integration in human health research and to identify attributes, antecedents, and consequences of the concept of social

integration to enhance understanding of the concept. Eight steps of Walker and Avant's framework were used for this concept analysis. This study provided the proposed concept of social integration which is a process of incorporation and inclusion in society through productive activities, social relationships, community engagement, and leisure activities. The findings from this concept analysis suggest that social integration is affected by individual, social, and environmental factors. The analysis also found improved physical and mental health, healthy aging, and life satisfaction were consequences of better social integration.

Finally, in chapter 4 of this dissertation, a longitudinal mediation analysis was conducted to examine interrelationships among social integration, functional outcome, and cognition in older adults at years 1, 2, and 5 post-TBI and to investigate whether functional outcome mediates the concurrent and longitudinal relationships between social integration and cognitive function after TBI in older adults. This study included a sample of 1469 older adults aged 65 and over following TBI. Findings from this study indicated significant positive interrelationships between social integration and concurrent functional outcome and cognition at 1-,2-, and 5-year post-injury in older adults. On longitudinal mediation analysis, we found that functional outcome mediated the pathway between social integration and concurrent cognition over time.

Taken together, this dissertation work provides new insights into older adults' experiences following TBI using multiple methods. Older adults who had a positive perception of their brain injury related feelings of appreciation for their family members, friends, and health providers. In contrast, some older adults had a negative perception of TBI due to a sense of increased dependency and vulnerability following injury. They related these feelings to physical symptoms such as headache, diplopia as well as post-traumatic amnesia (PTA). PTA includes symptoms such as disorientation, confusion, and loss of memory that can occur immediately

following TBI.[8] PTA duration has been reported to be a factor associated with cognitive impairment in adults following TBI.[9] In this dissertation, I revealed greater social integration was associated with higher cognitive function in older adults following TBI. Findings from this dissertation suggest social relationships among attributes of social integration may play a significant role in having a positive illness perception of TBI in older adults, then greater social integration affects maintaining cognitive function or preventing cognitive decline after TBI.

Implications for future nursing research and practice

This series of studies in this dissertation contributes to understanding older adults' beliefs about their brain injury and the role of social integration in improving cognitive function following TBI. This dissertation's findings provide several important implications for future nursing research and practice.

This dissertation indicates several implications for future research. The first paper presented only one of 13 participants changed the perceived meaning of TBI across 12 months post-injury. Despite the small size of the sample, this study gave us a chance to hear their thoughts regarding TBI. Future studies may need to consider larger studies with more participants from diverse backgrounds. The second paper serves to define the concept of social integration. Social integration is complex and multidimensional. To date, few studies have considered cultural components of social integration in older adults following TBI. This is a gap in the present understanding identified from the concept analysis that should be considered in future studies. Next, given the association between social integration and cognitive function, future studies may consider other potential mediators on the pathway between social integration

and cognition for enhancing the mechanisms. Lastly, the results from three papers in this dissertation showed evidence that illness perception about TBI and social integration affect cognitive function after TBI in older adults. As part of understanding these interrelationships, future research needs to examine a pathway of illness perception about TBI, social integration, and cognitive function.

Several implications for clinical practice from the findings in this dissertation include: 1) including social (re)integration into patient care plans, with a solid understanding of the role of social functioning from a cultural context and individual values; 2) educating older adults with TBI and their caregivers about utilizing relevant formal and informal resources to support recovery following injury to include social (re)integration after discharge; 3) developing multidisciplinary interventions to enhance functional outcome and cognition that include formal and informal social activities in older adults following TBI.

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