Association Between Rehabilitation and Functional Outcomes of Stroke Survivors: A Population-Based Study

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ABSTRACT

Background:

There is little known about the provision of rehabilitation in the community settings for stroke survivors.

Purpose: To investigate the association between rehabilitation and functional outcomes of stroke-survivors.

Method: Data for this analysis was derived from the Canadian Community Health Survey (CCHS). The effect of physiotherapy (PT) and other allied health (AH) utilization on rate of assistance in activity of daily living (ADL) and injury due to fall (Inj-fall) was assessed in stroke survivors.

Results:

Overall, 3,773 (1.1%) patients with stroke (47% females, 71.1% >60 years) were included. Stroke survivors in 2013-14 had less PT and AH utilizations compared to 2015-16, consequently, the rate of assistance with ADL and Inj-Fall were significantly greater in 2013-14. PT or AH utilization were associated with less assistance in ADL and lower Inj-Fall.

Conclusion:

Results of this study reinforce the beneficial effect of rehabilitation on ADL and injury in stroke survivors.

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“The more I learn, the more I realize how much I don't know.”

- Albert Einstein

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ABBREVIATIONS

HUI: Health utility Index

PT: Physiotherapy

AH: Allied Health

ADL: Activity of Daily Living

Inj-Fall: Injury Due to Fall

CVD: Cerebrovascular diseases

CNS: Central Nervous System

INTRODUCTION

Stroke is a common cerebrovascular event which can lead to transient or permanent physical and psychosocial disability; affecting activities of daily living (ADL) and quality of life (QoL) (Fang et al., 2003; Kim, Kim, & Kim, 2014; Sturm et al., 2002). Recent improvements in the treatment and surveillance of acute stages of stroke, along with risk factor management has led to decreases in patterns of stroke-related deaths, and increases in morbidity and disability after a stroke event (Fang et al., 2003; Kim et al., 2014; Stewart et al., 2018; Sturm et al., 2002). Difficulty in performing ADLs can impact quality of life, interpersonal relationships, and psychosocial adjustment due to long-term disability, stress and tension (Gulick, 1997; Kim et al., 2014; Stewart et al., 2018). Falls and fall-related injuries are among the most common complications during all stages of stroke recovery as a consequence of failure to recuperate loss of balance after stroke (Jørgensen, Engstad, & Jacobsen, 2002; Watanabe, 2005). Falling is also an important predictor of worse functional recovery post discharge, which can be due to activity restrictions and fear of having another fall (Mansfield et al., 2017; Wong, Brooks, Inness, & Mansfield, 2016).

Rehabilitation (i.e. occupational therapy (OT), physiotherapy (PT), speech therapy, social services and psychotherapy) (Stewart et al., 2018)), especially in the early stages, have been shown to be effective in improving functional and psychological outcomes post stroke (Fang et al., 2003; Hyndman, Ashburn, & Stack, 2002; Kim et al., 2014; S. Paolucci et al., 2000). Few studies to date have studied predictors of falls in stroke patients and association between rehabilitation utilization on rate of falls– an important area of study to ensure independence and the preservation of patient functional status within the community setting (C. Clark et al., 2016;

C. E. Clark et al., 2018; Carina U Persson et al., 2018). To address this gap, this thesis will investigate the prevalence of PT and rehabilitative services utilization in the community setting, and the relationships between rehabilitation service use (i.e. physiotherapy and other allied health), falls and ADLs within the Canadian population.

REVIEW OF THE LITERATURE

Background

Cerebrovascular diseases (CVD) are a group of medical conditions involving blood vessels of the central nervous system (CNS) (Sacco et al., 2013; Truelsen, Begg, & Mathers, 2000). Stroke, which is one of the most common types of CVD, is characterized by an acute CNS injury that can lead to permanent or temporary disturbance of cerebral function due to disruption of cerebral blood circulation and cell death (Sacco et al., 2013; Truelsen et al., 2000). The two common sub-types of stroke are hemorrhagic strokes, which are primarily due to hypertensive disorders, coagulation disorders, vascular malformations, and ischemic stroke, which originates from systemic thromboembolism and atherosclerosis (Sacco et al., 2013; Truelsen et al., 2000). Collectively, stroke is a major cause of disability and mortality around the world (Sacco et al., 2013; Truelsen et al., 2000).

Epidemiology of Stroke

In Ontario, CVD affects approximately 1.9 to 2.5 per 100 people per year (Tourangeau et al., 2011), and accounts for an approximately 6,000 additional deaths annually (Stolee, Hillier, Webster, & O'Callaghan, 2006). Within the country as a whole, stroke (i.e. hemorrhagic, ischemic, and transient ischemic attack (TIA) strokes) is the fourth leading cause of death, costing approximately $2.7 billion (CDN) per year in 2006 (Lewis, Trypuc, Lindsay, O'Callaghan, & Dishaw, 2006). With a growing proportion of older adults, inflation and differences in treatments, these rates represent lower estimates of the ongoing impact of stroke in

the Ontario health care system (R Teasell, Meyer, Foley, Salter, & Willems, 2009; Tourangeau et al., 2011). Finally, over 300,000 people (1% of the Canadian population) experience a stroke each year, and over 60% of stroke survivors suffer from neurological disabilities (Bagg, Pombo, & Hopman, 2006; R Teasell et al., 2009; Tourangeau et al., 2011). These alarming statistics represent the high human and financial cost of this devastating condition.

Stroke Best Practice guidelines

Country-specific clinical practice guidelines have been developed as a means to provide guidance and raise awareness for evidence-based stroke-related care (Jolliffe, Lannin, Cadilhac, & Hoffmann, 2018). To date, approximately 90% of these guidelines have focused on five categories of rehabilitative services: i) caregiver support; ii) peer support; iii) multidisciplinary service delivery; iv) specialized rehabilitation wards, and; v) delivery and process of service. Most notably, multidisciplinary service delivery has been recommended in about 88% of the guidelines around the world (Jolliffe et al., 2018). About 95% of the guidelines also focus on rehabilitation therapies across 15 major categories, which commonly include: 'motor function', 'activities of daily living', 'cognition', 'upper limb management', 'patient/family education', 'communication' and 'psychosocial' elements (Jolliffe et al., 2018).

In Canada, the four most common guidelines endorsed for stroke rehabilitation are the Canadian Stroke Best Practice Recommendations, Acquired Brain Injury Knowledge Uptake Strategy (ABIKUS) guideline, *Ottawa Panel Evidence-Based Clinical Practice Guidelines for Post-stroke Rehabilitation (Panel, 2006),* and Nursing Best Practice Guideline (Stroke Assessment across the Continuum of Care) (Jolliffe et al., 2018). While all of the guidelines above include overlapping and complementary elements, *Canadian Stroke Best Practice*

Recommendations (CSBPR) (Hebert et al., 2016) provide a comprehensive guideline for all areas of stroke care including clinical care, interventions and rehabilitation. The rehabilitation guideline focuses on 12 key areas, inclusive of initial assessment, stroke rehabilitation units, inpatient rehabilitation, and outpatient and community-based rehabilitation as it relates to a range of deficits and special populations (e.g. arm and hand management, mobility, lower limb and balance, malnutrition and dysphagia, visual deficits, daily activities and life roles, and pediatric stroke rehabilitation). While different care providers may prefer occupation-specific guidelines, CSBPR is particularly beneficial for early assessment and the development of individualized rehabilitation plans (Hebert et al., 2016).

Injury due to fall post stroke:

Falls in early stages of post-stroke and during hospitalization or after discharge from inpatient services, are a leading cause of injury in stroke survivors. Stroke survivors experience twice the risk of falling compared to other older people without stroke (Batchelor, Mackintosh, Said, & Hill, 2012; Forster & Young, 1995; Jørgensen et al., 2002; Kerse et al., 2008; Mansfield et al., 2017; Carina U Persson et al., 2018; R. Teasell, McRae, Foley, & Bhardwaj, 2002; Watanabe, 2005). The incidence of falls during hospitalization has been reported between 14% to 22% post stroke (Czernuszenko & Członkowska, 2009; Davenport, Dennis, Wellwood, & Warlow, 1996; Nyström & Hellström, 2013; Carina U Persson et al., 2018; Tutuarima, van der Meulen, de Haan, van Straten, & Limburg, 1997). Previous studies have reported that half of stroke survivors experience at least 1 episode of fall within first year of acute stroke (Ashburn, Hyndman, Pickering, Yardley, & Harris, 2008; C. U. Persson, Hansson, & Sunnerhagen, 2011). Stroke-specific deficits (impaired posture control, visuospatial hemineglect and selfcare deficit)

(Campbell & Matthews, 2010), impaired balance (Olsson, Löfgren, Gustafson, & Nyberg, 2005), orthostatic blood pressure (C. E. Clark et al., 2018), male gender (Carina U Persson et al., 2018), SwePASS score (impaired postural control) (Carina U Persson et al., 2018), and use of a walking aid (Carina U Persson et al., 2018) are some of known risk factors for fall in stroke survivors. Older patients in community settings are also more prone to falling (Kerse et al., 2008; Carina U Persson et al., 2018), while younger patients in inpatient setting are more at risk of falling (Breisinger, Skidmore, Niyonkuru, Terhorst, & Campbell, 2014).

Stroke Rehabilitation

It is estimated that approximately 40% of stroke survivors will need assistance with daily activities, amongst whom, one-in-ten may require admission to a LTC facility (Stolee et al., 2006). After spinal injury and brain dysfunction, stroke recovery and rehabilitation has the third longest length of stay (Bagg et al., 2006) and is a vital component of patient care to help stroke survivors regain and maximize their abilities and function (Bagg et al., 2006; McArthur et al., 2015). Dependence in activities of daily living are inversely related to quality of life in stroke survivors, with the greatest impact seen in the need for assistance with mobility and social cognition (Kim et al., 2014).

Stroke rehabilitation is now a hallmark of care for stroke survivors and is credited with improving morbidity and mortality outcomes (Bagg et al., 2006; Stolee et al., 2006; R Teasell et al., 2009). Indeed, (Yagura, Miyai, Seike, Suzuki, & Yanagihara, 2003) 12 months of multidisciplinary rehabilitation post stroke is credited with improvements in walking ability and ADL (Yagura et al., 2003). Physiotherapy and physical therapy, a health discipline under the

scope of rehabilitation, helps patients restore and maintain maximal functional and movement capacity and helps with ADL and quality of life (Wojkowski, 2018). Early physiotherapy post-stroke alone (Hyndman et al., 2002; Stefano Paolucci et al., 2000), or with repetitive locomotor training, has been shown to improve ADLs (Pohl et al., 2007). Kwakkel et al (Kwakkel et al., 2004). A met-analysis of randomized trials reported the effectiveness of augmented exercise therapy time in ADL improvement of stroke survivors within the first 6 month of stroke (Kwakkel et al., 2004). This study demonstrated overall change of 4-5% with more therapy time following minimum of 16 hours of additional exercise therapy time (Kwakkel et al., 2004). While psychological therapies have also been recommended for patients with stroke complications, evidence to date is insufficient to support their use for stroke rehabilitation in older patients (Royal College of Physicians, 2016; Stewart et al., 2018).

Stroke rehabilitation in Canada:

While studies have shown the positive effect of rehabilitation on functional independence, daily activities, and all-cause mortality (Bagg et al., 2006; McArthur et al., 2015), implementation of stroke-related clinical practice guidelines remains suboptimal (Munce et al., 2017). Lack of accessibility due to transportation problems, costs, long wait times, and lack of awareness has been known as important factors of underutilization of rehabilitation in high income countries (Wojkowski, 2018). Older patients and women are more likely to discontinue rehabilitation prematurely (Wojkowski, 2018). Other predictors of poor rehabilitation outcomes include: age, location and severity of stroke, general health and comorbidities before stroke (Kwakkel, Kollen, & Wagenaar, 2002; Lieberman & Lieberman, 2005).

Lack of governmental coverage for rehabilitation along with other non-insured services (dental care, vision, prescribed medications, mental health) in Canada is one of the most important reasons for health disparities and unmet care in the population (Wojkowski, 2018). Of note, physiotherapy services in Canada are provided in different inpatient and outpatient facilities (Wojkowski, 2018). After the decision regarding closing and outsourcing publicly funded physiotherapy in 2007, physiotherapy services were removed from the Ontario Health Insurance Plan (OHIP), which left patients responsible for the entire cost of physiotherapy in private clinics (Gordon et al., 2007). While studies have shown underutilization and increased inpatient dependency following increased cost of similar ambulatory services (Trivedi, Moloo, & Mor, 2010), cost and unavailability of services are considered as the most common causes of physiotherapy underutilization in patients with chronic conditions in Canada (Easley & Miedema, 2012; Feldman et al., 2010; Miedema & Easley, 2012; Paul et al., 2008).

The increasing rate of stroke and its consequent disabilities have contributed to a growing proportion of stroke survivors requiring rehabilitation. Increasingly, the prevailing models of care have focused on multimodal rehabilitation intervention as a means to improve patient function, independence, and to decrease overall morbidity and mortality. According to the *2018 Ontario Stroke Evaluation Report (Hall et al., 2018)*, further research is needed to understand the provision of stroke-related care in community settings for the Canadian population. In particular, little is known about facilitators and barriers to Canadian Best Practice implementation at the staff and provider level, and how variance in stroke care implementation is related to patient-level outcomes (e.g. falls and activities of daily living, pain, mood, social status, and quality of life) for stroke recovery. This thesis will therefore i) provide preliminary insight into implementation efforts for stroke-related models of care within the community setting in Canada,

and; ii) compare variation in the provision of rehabilitative services to patients' complications at the Canadian population-level. Together, these exploratory analyses will help to inform future primary data collection efforts within the LTC sector and free-living populations, which will allow for a greater understanding of rehabilitation capacity in Canada.

OBJECTIVES

The objectives of this thesis are two-fold:

1. To estimate the prevalence of physiotherapy and rehabilitative service use in people who have experienced a stroke and living in community settings in Canada.
2. To estimate the association between physiotherapy and rehabilitative care use on fall prevention, activities of daily living, mood, and quality of life.

METHODS

Study Design

Data for this analysis were obtained from the Canadian Community Health Survey (CCHS) (StatCan) public use microdata file, a cross-sectional survey that collects information about health determinants of various regions in Canadian population. The goal of this survey is to improve health by collecting data in national, provincial, and intra-provincial levels to address issues related to population health. This survey began in 2001 and has been repeated every two years until 2005. Since 2007 data for CCHS has been collected annually with 65,000 respondent each year. CCHS covers data for various subjects including diseases and health conditions, health, health care services, lifestyle, social conditions, mental health and well-being. The survey is administered for individuals over the age of 12 in 10 provinces, and 3 territories. Excluded population are people living on reserves, and Aboriginal settlements in the provinces, full-time members of the Canadian forces; the institutionalized population, children aged 12-17 that are living in foster care, and people who live in the Quebec health regions of Région du Nunavik or Région des Terres-Cries-de-la-Baie-James. Collectively, these exclusions represent 3% of the Canadian population aged 12 and over.

Sample Selection

Inclusion Criteria

Data from CCHS cycle 2013-2014 and 2015-16 were used for this analysis. To account for the complex survey design (i.e. sampling frame, cluster, and primary sampling unit) of the CCHS, master survey weights for each cycle were used to ensure national representativeness of the population. A total of 109,659 participants from the cycle 2015-16 and 127,462 participants

from cycle 2013-14 were assessed for eligibility. Stroke was present in 1,696 ($Prevalence^{weighted}$=1.2%) participants in cycle 2015-16 and 2,077($Prevalence^{weighted}$=1.1%) participants in cycle 2013-14. In order to increase the power to detect a difference (between those accessing vs not accessing rehabilitation services), patients with self-reported stroke complications in the two cycles were then merged to create a pooled sample. After merging, a total of 3,773 CCHS participants (1.1% of 2013-2016 cycle) with stroke were included. Given the exploratory nature of this study, a case analysis (pairwise deletion) approach to missing data was taken to ensure sufficient statistical power for all primary analyses.

Statistical Analysis

Baseline characteristics of study participants were described by mean and standard deviation for continuous measures, and with frequency and % for categorical variables. Group-based differences in baseline characteristics were compared using an independent t-test for continuous variables and chi-square for categorical variables. Logistic regression models were developed to assess the association between rehabilitation utilization with patient activity of daily living and other health outcomes. All models were adjusted for age, sex, comorbidities, and disabilities regardless of their significance in the univariate model.

Survey design and appropriate survey sampling weights (survey package) were used for analysis of the data. In order to merge the two cycles, the original sampling weights were rescaled by the factor $\alpha i=1/k=0.5$ to represent the characteristics of the average population of interest. All statistical analysis was performed using RStudio (Version 1.2.5042) and R version (4.0.2) with two-sided statistical significance set at an alpha = 0.05.

Exposure:

In order to assess the effect of rehabilitation on patients with complications of stroke in the community setting, patients were classified into two categories: i) patients who sought physiotherapy or other allied health consults in the past 12 months within each cycle, and: ii) patients who did not. Other allied health included physiotherapist, chiropractors, social workers, audio/occupational therapists, psychologists, and dietitians.

Confounders

To account for possible confounding by factors related to social location, healthcare access, and stroke risk, characteristics of participants were compared between those with and without rehabilitation service use. Potential confounders included: age (<20 - >=80), sex, body mass index (BMI), marital status (single, divorced/widowed, common-law/married), education (<secondary, secondary, post-secondary), household income (low, medium, high), history of smoking (never, former, occasionally, daily), immigrant (yes, no), ethnicity/race (white, other), and history of comorbidities (including history of hypertension, diabetes, heart disease, arthritis, and cancer).

Outcomes

Primary endpoint:

Need for assistance in activity of daily living (ADL) was considered the primary endpoint of study. ADL is characterized according to two subtypes: i) personal care index, which includes washing, dressing or eating and moving inside the house, and; ii) home support, which consists

of meal preparation, shopping/errands, normal household chores and finances. For this purpose, we used all sub-categories to assess the association between rehabilitation and ADLs in patients with a continuing complication of stroke. This variable was collected in the survey using a question asking if the patient needed help in preparing meals, appointments/errands, doing housework, personal care, moving inside house, and personal finances in both 2013-14 and 2015-16 cycles. These scores were used to create instrumental activity of daily living index (personal care, home support) only in 2015-16 cycle, therefore we had to use only subcategories when merging 2 cycles. Response to these questions were "yes" and "No" in 2013-14, and "No, no difficulty", "Yes, difficulty, but do not require help of others", "Yes, difficulty, but can do it with the help of others", and "Cannot do it at all" in 2015-16. We then harmonized the last two categories where they needed help in doing task as "yes" and the first two as "No" to merge the data in both cycles. Our composite ADL outcome was coding as "yes" if the participant reported need for help in any of these variables and was coded as "no" otherwise.

Secondary endpoints:

Injury due to fall in the past 12 months and Health Utility Index (HUI) were also utilized as an outcome. Health utility index defines the health status of participants which considers vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain. The index ranges between -0.36 (severe health state) to 1 (perfect health state). A clinically significant change in this index is denoted by any change ≥ 0.03 (Edwards, Koehoorn, Boyd, & Levy, 2010). This score is usually grouped into three categories of Perfect/mild health state (0.89-1), Moderate health state (0.88-0.70), Severe health state (<0.70).

Ethics

This secondary analysis was approved by the Human Participants Research Committee of York University (certificate number: e2020-008).

RESULTS

Study Population

Baseline characteristics

Patients demographic information and comorbidities in each cycle are summarized in Tables 1 and 2 and merged cycles in Table 3.

CCHS cycle 2013-14

In this sample of 127,000 participants, 2,077 (Un-weighted prevalence: 1.6%, weighted prevalence: 1.1%) suffered from stroke complications. The majority of patients reporting complications of stroke (87%) were more than 50 years old compared to 42% in overall population (P<0.001), whereas the proportion of females and immigrants were similar in both groups. Stroke survivors had a greater BMI (26.9±5.2 vs 25.8±5.3, P<0.001), but lower level of education (P<0.001) and household income compared to the overall population (P<0.001). Overall, the majority of stroke survivors had medium or low income compared to the general population (66.8% vs 42.6%, P<0.001), and more than half had a secondary (or less than secondary) level education. Stroke survivors had a greater proportion of former smokers, while the overall population was more so comprised of never smokers. As expected, the prevalence of comorbidities (hypertension, diabetes, heart disease, arthritis, and cancer) was greater in stroke survivors compared to general population **(Table 1).**

CCHS cycle 2015-16

Overall, 109,000 people participated in 2015-16 cycle, from which 1,696 (1.5%, W-freq: 358,944 (1.2%)) had complications of stroke. More than 80% of stroke survivors were more than

50 years old (vs 43% in general population). The proportion of male vs female was greater in stroke survivors compared to overall population. Similar to the 2013-14 cycle, individuals reporting complications of stroke had higher average BMI, and a greater proportion of former smokers and comorbidities compared to general population (P<0.001). Stroke survivors also had mostly secondary or less than secondary education levels degree and low-to-medium household incomes **(Table 1).**

Outcomes:

In the final sample, only 0.2% and 1.6% of stroke survivors population in 2013-14 had consulted PT and other services, as compared to 9.1% and 21% in 2015-16 **(Table 2)**. At the same time, the need for supports related to ADLs and injury due to fall was significantly greater in the 2013-14 cycle, while there was no significant difference in Health Utility Index **(Table 2 and Figures 1-3).** Finally, the prevalence of injury due to fall in 2013-14 was 12.9%, while only 1.2% of stroke survivors experience fall injury in 2015-16 (P-value<0.001) **(Figure 3)**.

Access to physio and allied health:

As expected, based on the result of bivariate analysis **(Table 3)** age was a significant predictor of lower accessibility to physiotherapy (PT) (OR=0.66 (0.51-0.85)) or allied health services (OR=0.79 (0.66-0.93). In general, older patients received less physiotherapy or allied health consults. While no significant association between sex and access to PT or allied health was found (P=0.1), more than 86% of patients who didn't have PT or other allied health consults were older than 50 years old. Moreover, higher household income was associated with a two-fold

higher physiotherapy utilization (OR=2.11 (1.1-4.2)). Finally, being in the "other" racial group was associated with greater physiotherapy utilization compared to "white" ethnicity (OR=1.4 (1.2-13.6)).

The effect of physio and allied health in patient's outcome:

Due to the small number of stroke cases in the two CCHS cycles, analyses were not sufficiently powered for examination of the primary study exposure (i.e. physiotherapy or other allied health consultation) with most functional outcomes and complications in each cycle separately. As a result, data from both cycles were pooled to create a combined sample to allow for exploratory multivariable analysis.

Results from this pooled analysis found that physiotherapy or other allied health consultation was significantly associated with less need for assistance in ADLs (Meal: OR=0.3 (0.1-0.8), Errand: OR=0.15 (0.06-0.4), House work: OR=0.24 (0.1-0.6), Personal: OR=0.18 (0.05-0.6), Move: OR=5.1E-7 (3.5E-7-7.6E-7), and Finance: OR=0.01(0.002-0.1) and a lower risk of injury due to fall (OR=0.1 (0.02-0.6)), after adjustment for age, sex, and other comorbidities **(Table 4, 5, 6).**

DISCUSSIONS

Main Findings

In this study we showed the significant effect of rehabilitation on patients' activity of daily living and lower risk of falls. Lower use of rehabilitation, especially physiotherapy, in stroke survivors in 2013-14, was associated with a greater need for assistance in ADLs and a higher prevalence of injury due to fall compared to stroke survivors in 2015-16. In either case, the main predictors for underutilization of PT and other types of rehabilitation were non-modifiable (i.e. older age and income level) but suggest population-level differences in access to care.

Risk factors of rehabilitation underutilization:

Similar to our study, earlier studies have shown a strong correlation between age, sex, income and access to rehabilitation services (Stefano Paolucci et al., 2000; Wojkowski, 2018). In many studies, female sex and older age consistently predict the discontinuation of rehabilitation (Stefano Paolucci et al., 2000; Stewart et al., 2018; Wojkowski, 2018). For example, Nakaxama et al (Nakayama, Jørgensen, Raaschou, & Olsen, 1994), reported a 7% decrease in Barthel index score of ADL with every 10-year increase in age. In addition to crucial factors including severity and location of stroke, and patients comorbidities before stroke, age plays an important role in stroke rehabilitation outcomes (Kwakkel et al., 2002; Lieberman & Lieberman, 2005). Iversen et al (Iversen, Chhabriya, & Shadick, 2011), identified the association between lower education and lower use of PT. These studies suggest that social determinants of health play a key role in

health disparities and unmet care in the population which can be attributed to a lack of governmental coverage for rehabilitation in Canada (Wojkowski, 2018).

Our study demonstrated that other racial groups compared to white race were more likely to use rehabilitation. This was also observed in a study on Medicare data in 2011, where black stroke survivors were more likely to receive each type of rehabilitation therapy post stroke than white race stroke survivors (Skolarus, Feng, & Burke, 2017). This was also evident in a systematic review for examining racial/ethnic differences in rehabilitation utilization post stroke (Ellis, Breland, & Egede, 2008). Potential hypotheses for this finding include the possibility of more severe cases of stroke in minority groups (Schwamm et al., 2010), which led to an increased need for and use of rehabilitation services.

Fall and rehabilitation:

Balance problems and falls are important complications of stroke mostly during early stages of recovery (6-month post stroke) and post discharge from inpatient rehabilitation units (Jørgensen et al., 2002; Mansfield et al., 2017; Watanabe, 2005). Because falls often lead to additional injuries and can have a negative impact on patients' rehabilitation outcomes, fall prevention is a crucial part of current stroke guidelines (Holloway, Tuttle, Baird, & Skelton, 2007; Lee, Geller, & Strasser, 2013). To date, several interventions have been introduced to decrease rate of falling in stroke survivors (Mansfield et al., 2017). Among them, balance-training interventions are some of the most promising, which aim to improve balance control and reaction to instability during inpatient stroke rehabilitation and have been found to decrease the number of falls 6 months post discharge (Mansfield et al., 2017).

Activity of daily living and rehabilitation

A study by Fang et al (Fang et al., 2003), showed a decrease in the need for assistance in ADLs with additional physiotherapy post stroke, but no improvements in other functional outcomes. Two randomized trials by (Han, Wang, Meng, & Qi, 2013; Harris, Eng, Miller, & Dawson, 2009) demonstrated higher ADL scores in groups who received more intensive upper limb physiotherapy at 4 weeks than the conventional treatment group. In a single blinded randomized controlled trial (Werner & Kessler, 1996), there was a significant improvement in functional outcomes of stroke survivors with intensive outpatient therapy within at least 6 months post stroke. This effect was also shown in a systematic review of randomized trials, which revealed improvement in ADL and reduced risk of deterioration in ability by outpatient rehabilitation within 1-year post stroke (Trialists, 2004). Taken together, these studies suggest a significant effect of rehabilitation especially physiotherapy - on patients' activity of daily living, which was similar to the result of our study that showed a significant association between rehabilitation utilization and ADL at the population level.

Quality of life and rehabilitation:

Our study showed no significant difference in health status (HUI) as a measure of physical quality of life of stroke survivors post rehabilitation. However, studies regarding the effect of rehabilitation on QoL of patients are contradictory and limited (Stewart et al., 2018). In an observational, prospective study, Aprile et al. (Aprile et al., 2008), evaluated in-patients with chronic stroke before and after rehabilitation and demonstrated a significant improvement in physical components of quality of life and activities of daily living; however, this improvement was transitory and was no longer significant at follow-up.

The effect of different types of non-pharmacological interventions for rehabilitation has been assessed in the guideline as part of the Optimal Evidence-Based Non-Drug Therapies in Older Persons (ONTOP) project conducted by the Software Engine for the Assessment and Optimization of Drug and Non-Drug Therapies in Older Persons (SENATOR) (Stewart et al., 2018). This guideline did not recommend the use of acupuncture, caregiver training, constraint-induced movement therapy (CIMT), device assisted physiotherapy, music therapy, nerve stimulation, self-management education and video games since the evidence that was assessed by GRADE guidelines suggested low quality of the available literature. On the other hand, even if there are few high quality studies on use of additional occupational therapy, and physiotherapy, this guideline recommended these interventions, as the current evidence suggests improvements in quality of life for older stroke survivors (Stewart et al., 2018).

To date, few studies have assessed the added benefit of greater PT intensity or volume of for improving QoL in older stroke survivors. In one (Langhammer, Stanghelle, & Lindmark, 2008), showed a significant improvement in health-related quality of life (as measured by Nottingham Health Profile (NHP)) by exercise, and physical improvements within first year of stroke, with no evidence of a dose-response relationship. In this longitudinal randomized controlled trial, patients were divided into two groups of intensive exercise with scheduled intensive training within the first-year post stroke, and a regular exercise group who underwent self-initiated training. Patients in the regular exercise group showed better NHP sores compared to the intensive exercise group. Harris et al. (Harris et al., 2009) used the SF12 questionnaire to assess QoL in patients post stroke and revealed no differences between patients who underwent more intensive upper limb physiotherapy compared to conventional therapy. The same result was achieved in other trials that compared higher intensity PT compared to conventional treatments

(Cooke, Tallis, Clark, & Pomeroy, 2010; Group, 2004). While a higher dose may play an important role in a patient's outcome, we could not assess this effect because of different variables of physiotherapy frequency across the two CHHS cycles that prevented their merging.

LIMITATIONS:

As with other secondary analyses of survey data, these findings must be viewed in light of some limitations. One important limitation of this study was differences in response rate for the HUI variables in the two survey cycles, which may have led to reduced power to detect differences.

Due to the small number of stroke cases in the two CCHS cycles, analyses were not sufficiently powered for examination of the primary study exposure (i.e. physiotherapy or other allied health consultation) with most functional outcomes and complications in each cycle separately. As a result, despite major differences in the prevalence of outcomes of the two cycles, we had to pool the data from both cycles to create a combined sample and allow for interpretable outcomes. These results are exploratory therefore should be interpreted with caution.

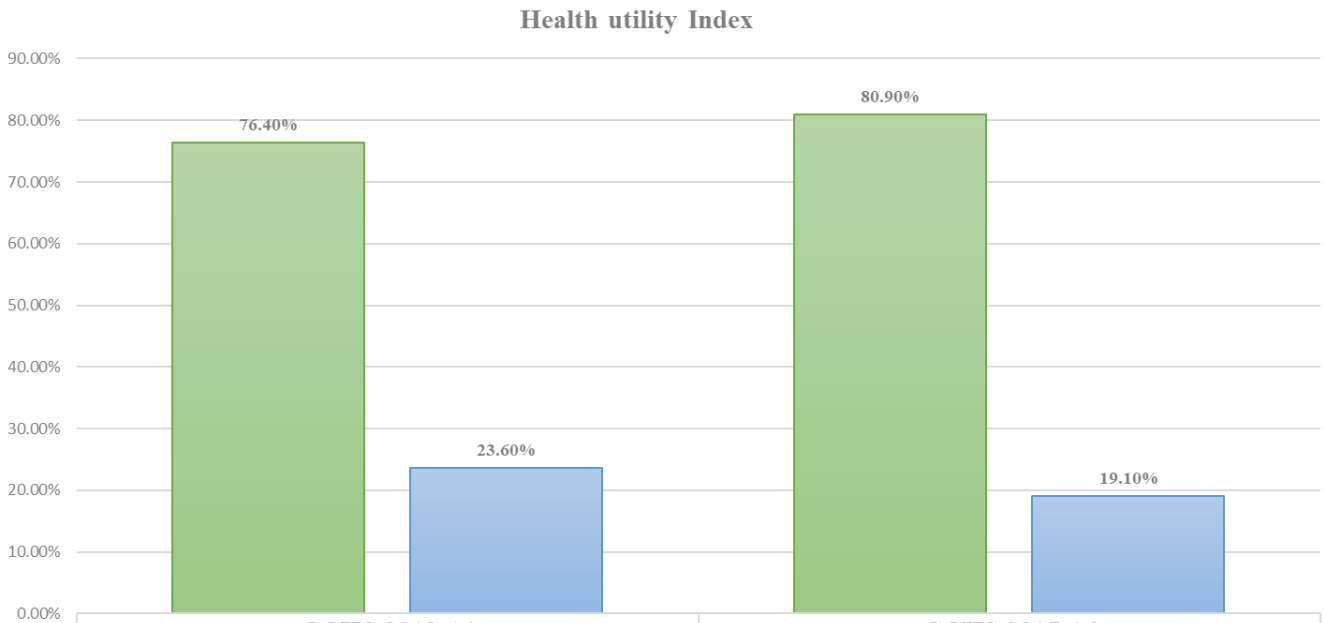
Moreover, differences in questions between the cycles led to loss of data through the harmonization process. Since the sample size for stroke survivors were not sufficient for ethnic-specific analyses (85% white), we could not assess these factors due to insufficient variability. Large-scale prospective studies are therefore required to evaluate intersectionality and better understand national variations in provision of rehabilitation in the community settings of Canadian population.

CONCLUSION

The most common reasons of underutilization of rehabilitation in Canada, especially physiotherapy, appear to be service affordability and patient age. Nonetheless, results of this study reinforce the beneficial effect of rehabilitation on ADL and injury in stroke survivors. Future longitudinal work is necessary to understand directionality of the relationship, and the impact of healthcare access, within varied healthcare systems and models of health delivery across Canada.

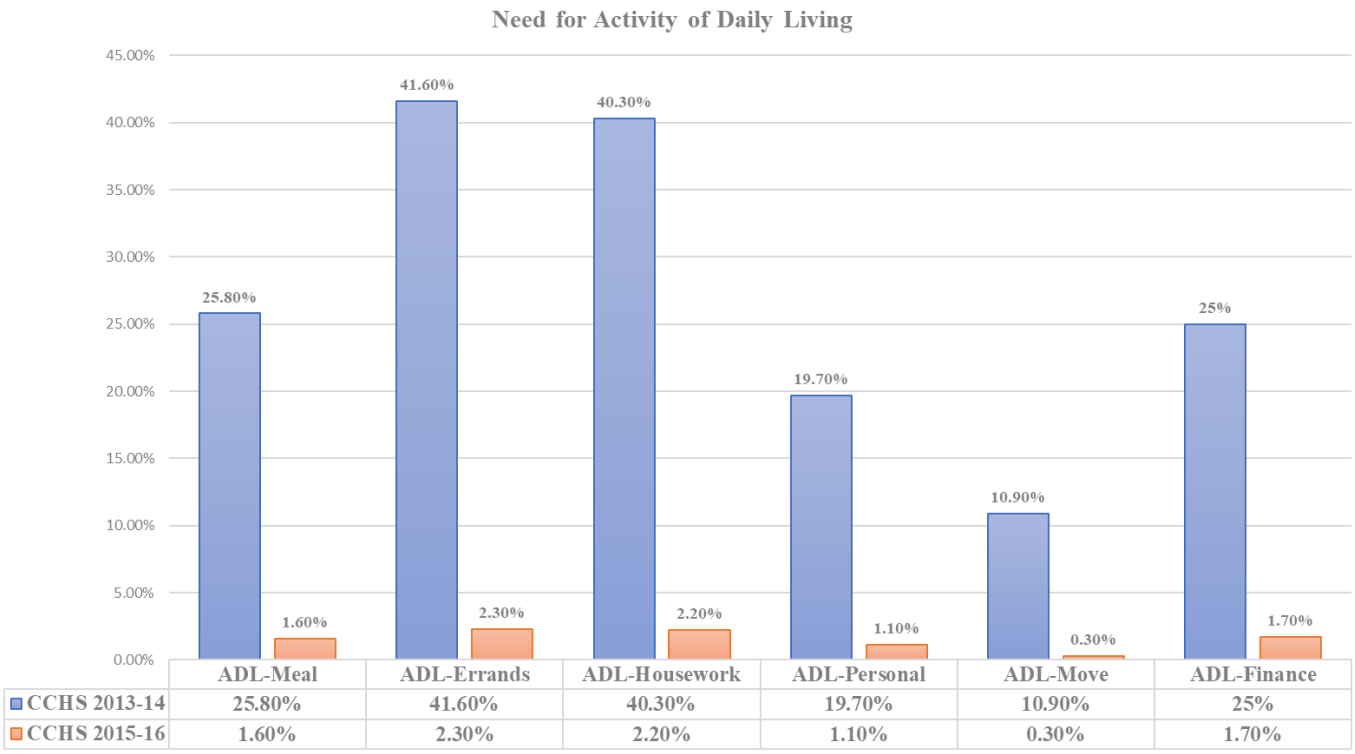
FIGURE AND TABLES

Figure 1: Proportion of Health Utility index of stroke survivors in 2 cycles



	CCHS 2013-14	CCHS 2015-16
<=0.88	76.40%	80.90%
0.89-1	23.60%	19.10%

Figure 2: Proportion of need for assistance in activity of daily living of stroke survivors in 2 cycles



	ADL-Meal	ADL-Errands	ADL-Housework	ADL-Personal	ADL-Move	ADL-Finance
CCHS 2013-14	25.80%	41.60%	40.30%	19.70%	10.90%	25%
CCHS 2015-16	1.60%	2.30%	2.20%	1.10%	0.30%	1.70%

Figure 3. Rate of injury due to fall of stroke survivors in 2 cycles

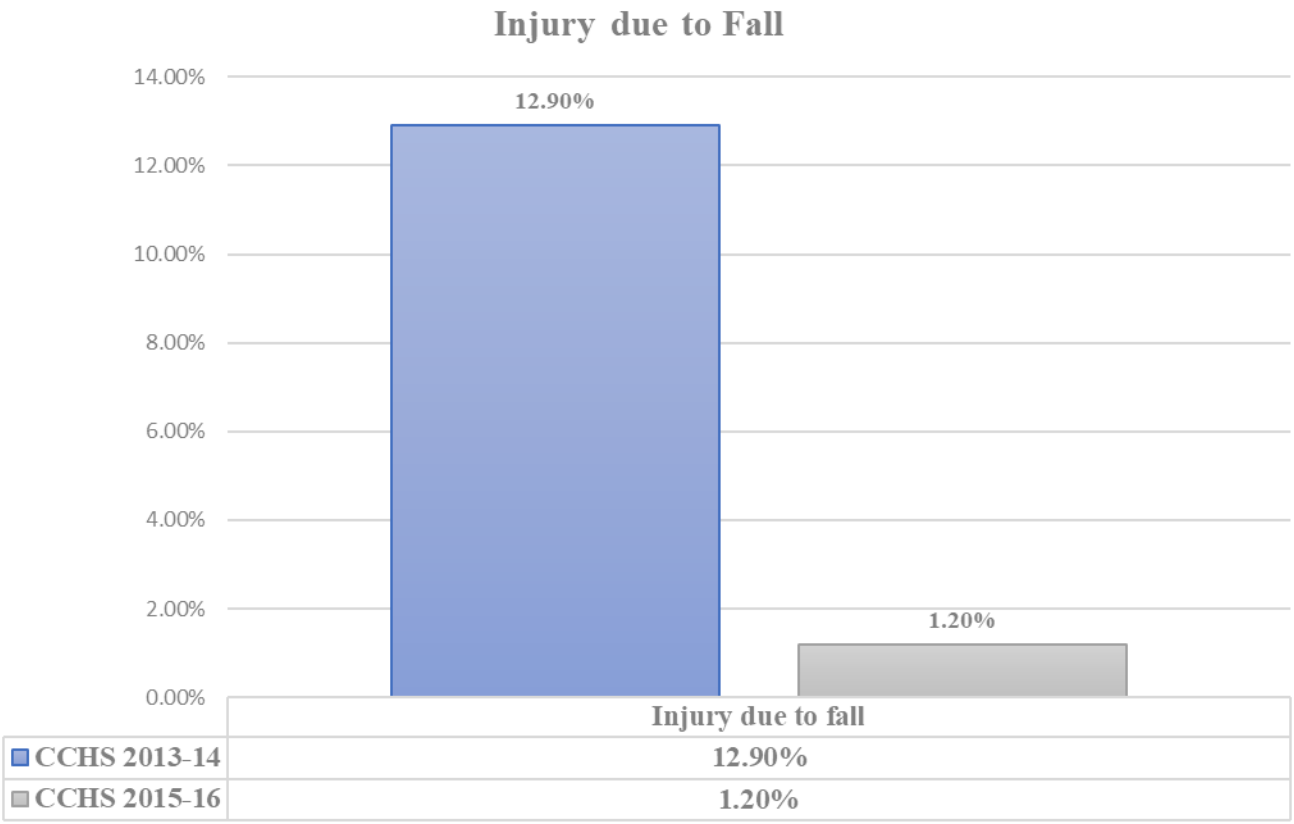


Table 1: Baseline characteristics of all respondent vs stroke survivors in each cycle

Baseline Characteristics, %	CCHS 2013-14			CCHS 2015-16		
	Overall	**Stroke+**	**P-Value**	**Overall**	**Stroke+**	**P-Value**
Age	N=30,002,817	N=333,109		**N=30,590,780**	**N=358,944**	
<20	10.6%	1.1%	<0.001	10.2%	1.1%	<0.001
20-29	16%	1.0%		14.9%	4.6%	
30-39	15.4%	2.4%		16.2%	2.7%	
40-49	15.8%	8.4%		15.8%	8%	
50-59	17.6%	15.8%		17.1%	12.6%	
60-69	13.3%	25.6%		14.2%	24%	
70-80	7.5%	24.2%		7.9%	26%	
>=80	3.8%	21.4%		3.8%	21%	
Sex	N=30,002,817	N=333,109		N=30,590,780	N=358,944	
Female	50.1%	50.7%	0.97	50.7%	45%	0.01
BMI						
	25.8±5.3	26.9±5.2	<0.001	25.9±5.1	27±5.3	<0.001
Marital Status	N=29,928,693	N=331,607		N=30,509,358	N=357,148	
Single	30%	10.2%	<0.001	30%	13.6%	<0.001
Divorced/widowed	12.3%	30%		12.2%	26.9%	
Common-law/married	57.7%	59.7%		57.8%	59.5%	
Education (respondent)	N=29,498,089	N=320,368		N=30,157,609	N=348,568	
<Secondary	19.7%	34.3%	<0.001	18.5%	29.2%	<0.001
Secondary	19.4%	17%		21.8%	25.9%	
Post-Secondary	60.9%	48.7%		59.7%	44.9%	
Household Income	N=29,985,412	N=333,061		N=30,568,549	N=358,800	
Low	7.5%	18%	<0.001	7.3%	13.5%	<0.001
Medium	35.1%	48.8%		30.2%	48.4%	
High	57.4%	33.2%		62.4%	38.11%	
Smoking	N=29,800,994	N=326,687		N=30,460,542	N=353,168	
Never	43.9%	33.2%	<0.001	45.1%	33.4%	<0.001
Former	37.4%	48.8%		37.5%	49.1%	
Occasionally	4.8%	2.7%		50%	32.4%	
Daily	13.9%	15.2%		12.4%	14.1%	
Immigrant	N=28,932,762	N=316,171		N=29,426,948	N=341,183	
	24.4%	26.2%	0.4	25.3%	25.7%	0.8
Race	N= 28,995,784	N= 314,677		N= 28,258,555	N= 323,256	
White	76.1%	83.4%	0.003	77.5%	86.1%	0.004
Other	23.9%	16.6%		22.5%	13.9%	
History of Hypertension	N=31,916,083	N=332,051		N=30,426,012	N=354,673	
	17.7%	61.2%	<0.001	17.3%	58.8%	<0.001
History of Diabetes	N=29,970,313	N=331,802		N=30,552,188	N=358,767	
	6.6%	23.1%	<0.001	6.9%	28.5%	<0.001
History of Heart Disease	N=29,948,102	N=330,273		N=30,508,599	N=352,980	
	4.9%	36.2%	<0.001	4.6%	34%	<0.001
History of Arthritis	N=28,846,802	N=328,119		N=30,085,936	N=356,819	
	16.2%	41.3%	<0.001	20%	49.8%	<0.001
History of Cancer	N=29,428,009	N=310,482		N=30,114,597	N=338,622	
	5%	13.1%	<0.001	5.7%	15.9	<0.001

Table 2: Rate of Rehabilitation utilization following health outcomes in overall respondent vs stroke survivors in each cycle.

Rehabilitation consult, %	CCHS 2013-14			CCHS 2015-16			
	Overall	**Stroke+**	**P-Value***	**Overall**	**Stroke+**	**P-Value**	**P-value****
Physiotherapy	N=30,002,597	N=333,109		N=29,986,136	N=345,833		
	0.1%	0.2%	0.2	5.7%	9.1%	0.04	<0.001
Allied health consult	N=30,002,817	N=333,109		N=29,986,136	N=345,833		
	1.5%	1.6%	0.7	16%	21%	0.01	<0.001
Health Outcomes, %	**CCHS 2013-14**			**CCHS 2015-16**			
	Overall	**Stroke+**	**P-Value**	**Overall**	**Stroke+**	**P-Value**	**P-value****
HUI	N=29,324,229	N=305,671		N=91,985	N=920		
	0.86±0.2	0.58±0.33	<0.001	0.84±0.2	0.5±0.34	<0.001	0.33
HUI	N=29,324,229	N=305,671		N=91,985	N=920		
<=0.88 0.89-1	31.4% 68.6%	76.4% 23.6%	<0.001	35.7% 64.3%	80.9% 19.1%	<0.001	0.65
ADL-Meal	N=29,983,476	N=332,242		N=30,589,238	N=358,844		
	3.2%	25.8%	<0.001	0.2%	1.6%	<0.001	<0.001
ADL-Errands	N=29,981,285	N=331,688		N=30,587,545	N=358,944		
	6%	41.6%	<0.001	0.4%	2.3%	<0.001	<0.001
ADL-Housework	N=29,977,422	N=331,159		N=30,587,601	N=358,944		
	6.2%	40.3%	<0.001	0.4%	2.2%	<0.001	<0.001
ADL-Personal	N=29,987,205	N=332,351		N=30,589,278	N=358,944		
	2%	19.7%	<0.001	0.1%	1.1%	<0.001	<0.001
ADL-Move	N=29,985,346	N=331,788		N=30,588,676	N=358,944		
	1.3%	10.9%	<0.001	0.07%	0.3%	<0.001	<0.001
ADL-Finance	N=29,949,674	N=331,994		N=30,585,175	N=358,850		
	3.1%	25%	<0.001	0.2%	1.7%	<0.001	<0.001
Injury past 12 months due to Fall	N=29,899,783	N=330,658		N=30,579,012	N=358,944		
	6.1%	12.9%	<0.001	0.8%	1.2%	0.1	<0.001
Overnight in hospital	N=29,989,524	N=332,677		N=29,931,069	N=344,645		
	8.1%	31%	<0.001	6.4%	27.6%	<0.001	0.25

***P-value of difference between stroke survivors and overall population**
****P-value of difference between stroke survivors in 2013-14 vs 2015-16**

Table 3: Baseline characteristics of stroke survivors in merged cycles (2013-2016) categorized by receiving physiotherapy or allied health consultations

Baseline Characteristics, %	Merged cycles CCHS 2013-16						
	Overall	Physio+	Physio-	P-Value	Allied+	Allied-	P-Value
Age	N=346,027	N=16,114	N=323,358		N=38,971	N=301,501	
<20	1.1%	4.6%	0.9%	0.01	3.7%	0.8%	0.02
20-29	2.9%	14.8%	2.3%		6.5%	2.4%	
30-39	2.5%	1.8%	2.6%		1.8%	2.7%	
40-49	8.2%	21.3%	7.7%		14.8%	7.5%	
50-59	14.2%	16.3%	14.1%		18.6%	13.6%	
60-69	24.8%	14.3%	25.5		21%	25.4%	
70-80	25.1%	17.3%	25.3%		17.2%	25.9%	
>=80	21.2%	9.7%	21.6%		16.4%	21.6%	
Sex	N=346,027	N=16,114	N=323,356		N=38,970	N=300,501	
Female	47.8%	33.6%	48.4%	0.1	44.9%	48%	0.5
BMI							
	26.9±5.2			0.1			0.9
Marital Status	N=344,378	N=16,114	N=321,708		N=38,877	N=298,945	
Single	11.9%	23.2%	11.4%	0.2	14.2%	11.7%	0.8
Divorced/widowed	28.4%	17.9%	29.0%		28.2%	28.5	
Common-law/married	59.6%	58.8%	59.6%		57.6%	59.8	
Education (respondent)	N=239,268	N=16,114	N=312,154		N=21,521	N=289,300	
<Secondary	31.6%	17.2%	32.7%	0.3	25%	32.9%	0.3
Secondary	21.6%	27.7%	20.9%		25.3%	20.7	
Post secondary	46.8%	55.1%	46.4%		49.7%	46.5%	
Household Income	N=345,932	N=16,094	N=329,838		N=38,950	N=300,426	
Low	15.6%	9.9%	16%	0.004	12.0%	16.2%	0.1
Medium	48.6%	29%	48.9%		42.5%	48.7%	
High	35.8%	61.1%	35.1%		45.5%	35.1%	
HX Smoking	N=339,928	N=16,028	N=317,344		N=38,106	N=295,266	
Never	33.3%	44%	32.3%	0.38	35.2%	32.5%	0.1
Former	49%	44.3	49.7%		48.8%	49.5%	
Occasionally	3%	3.6%	3%		5.6%	2.7%	
Daily	14.7%	8.2%	15%		10.4%	15.3%	
Immigrant	N=328,677	N=16,006	N=311,905		N=38,586	N=289,326	
	26%	30.5%	25.7%	0.7	21.1%	26.6%	0.4
Race	N= 318,967	N= 15,406	N= 302,971		N= 36,894	N= 281,482	
White	84.8%	60.3%	86.1%	0.01	78.5%	85.6%	0.31
Other	15.2%	39.7%	13.9%		21.4%	14.6%	
History of Hypertension	N=343,362	N=16,115	N=320,692		N=38,374	N=298,433	
	60%	32.4%	60.9%	0.001	45.4%	61.3%	0.004
History of Diabetes	N=345,285	N=16,115	N=322,614		N=38,970	N=299,759	
	25.9%	16%	26.3%	0.09	27.9%	25.5%	0.5
History of Heart Disease	N=341,626	N=15,867	N=319,203		N=38,182	N=296,888	
	35.1%	22.2%	35.8%	0.06	34%	35.3%	0.8
History of Arthritis	N=342,470	N=16,104	N=335,914		N=38,315	N=297,599	
	45.7%	33.9%	46.4%	0.1	50.7%	45.1%	0.3
History of Cancer	N=324,553	N=15,445	N=303,069		N=36,071	N=282,443	
	14.5%	11%	14.2%	0.4	14.9%	13.9%	0.7

Table 4: Health outcomes of stroke survivors in merged cycles (2013-2016) categorized by receiving physiotherapy or allied health consultations

Health Outcomes, %	Merged						
	Overall	Physio+	Physio-	P-Value	Allied +	Allied -	P-Value
HUI	N=153,296	N=440	N=152,856		N=2,458	N=150,838	
<=0.88 0.89-1	76.4% 23.6%	89.3% 10.7%	76.4% 23.6%	0.2	77.2% 22.8%	76.4% 23.6%	0.9
ADL-Meal	N=315,542	N=16,114	N=322,873		N=38,920	N=300,067	
	13.3%	3%	14%	<0.001	3.5%	14.8%	<0.001
ADL-Errands	N=345,316	N=16,115	N=322,647		N=38,970	N=299,790	
	21.2%	2.8%	22.5%	<0.001	4.8%	23.7%	<0.001
ADL-Housework	N=345,052	N=16,115	N=322,382		N=38,970	N=299,527	
	20.5%	4.1%	21.7%	<0.001	5.7%	22.8%	<0.001
ADL-Personal	N=345,648	N=16,115	N=322,977		N=38,970	N=300,122	
	10%	1.3%	10.7%	<0.001	2.2%	11.3%	<0.001
ADL-Move	N=345,366	N=16,114	N=322,696		N=38,970	N=299,840	
	5.4%	0%	5.8%	<0.001	0.9%	6.1%	<0.001
ADL-Finance	N=345,422	N=16,115	N=322,752		N=38,962	N=299,905	
	12.9%	0.1%	13.8%	<0.001	2.9%	14.5%	<0.001
Injury past 12 months due to Fall	N=344,801	N=16,114	N=322,131		N=38,971	N=299,275	
	6.8%	1.2%	7.2%	<0.001	0.7%	7.7%	<0.001
Overnight in hospital	N=338,661	N=16,115	N=321,781		N=38,934	N=298,961	
	29.3	41.5%	28.7%	0.2	36%	28.4%	0.1

Physio+ and -: Physiotherapy utilization in the past 12 months
Allied + and -: Allied health utilization including physiotherapist, chiropractors, social workers, audio/occupational therapists, psychologists, and dietitians in the past 12 months.

Table 5: Univariate and multivariable models for assessing relationship of activity of day living with rehabilitation intervention.

	Physiotherapy consult				Allied health consult		
ADL-Meal	**Model1**	**Model2**	**Model3**	**ADL-M**	**Model1**	**Model2**	**Model3**
Physio-consult	0.18 (0.13-0.19)	0.24 (0.08-0.70)	0.3 (0.1-0.8)	**Allied-consult**	0.2 (0.1-0.4)	0.23 (0.1-0.4)	0.3 (0.1-0.5)
Age		1.28 (1.1-1.5)	1.28 (1.1-1.6)	**Age**		1.3 (1.1-1.5)	1.3 (1-1.5)
Sex		1.37 (0.98-1)	1.43 (0.96-2.1)	**Sex**		1.4 (1-1.9)	1.5 (1-2.2)
DM			1.22 (0.8-1.8)	**DM**			1.3 (0.9-1.9)
HD			1.34 (1-1.8)	**HD**			1.4 (1-1.9)
HTN			1.11 (0.8-1.6)	**HTN**			1.1 (0.8-1.6)
CA			0.98 (0.7-1.4)	**CA**			1 (0.7-1.5)
AT			1.27 (0.8-1.9)	**AT**			1.3 (0.9-2)
ADL-Errand	**Model1**	**Model2**	**Model3**	**ADL-E**	**Model1**	**Model2**	**Model3**
Physio-consult	0.09 (0.03-0.26)	0.12 (0.04-0.3)	0.15 (0.06-0.4)	**Allied-consult**	0.16 (0.1-0.3)	0.17 (0.1-0.3)	0.16 (0.1-0.3)
Age		1.22 (1.1-1.4)	1.19 (1-1.4)	**Age**		1.22 (1.1-1.4)	1.18 (1-1.4)
Sex		1.9 (1.4-2.5)	2.03 (1.5-2.8)	**Sex**		1.94 (1.5-2.6)	2.08 (1.5-2.9)
DM			0.92 (0.7-1.3)	**DM**			1 (0.7-1.3)
HD			1.45 (1-2)	**HD**			1.5 (0.9-1.8)
HTN			1.26 (0.9-1.8)	**HTN**			1.25 (0.9-1.8)
CA			0.96 (0.7-1.3)	**CA**			1 (0.7-1.3)
AT			1.27 (0.9-1.78)	**AT**			1.32 (0.9-1.8)
ADL-House	**Model1**	**Model2**	**Model3**	**ADL-H**	**Model1**	**Model2**	**Model3**
Physio-consult	0.15 (0.06-0.4)	0.19 (0.08-0.5)	0.24 (0.1-0.6)	**Allied-consult**	0.2 (0.1-0.3)	0.22 (0.1-0.4)	0.21 (0.1-0.4)
Age		1.23 (1.1-1.4)	1.19 (1-1.4)	**Age**		1.22 (1.1-1.4)	1.18 (1-1.4)
Sex		1.81 (1.4-2.4)	1.9 (1.4-2.6)	**Sex**		1.85 (1.4-2.5)	1.9 (1.4-2.7)
DM			1.12 (0.8-1.5)	**DM**			1.18 (0.9-1.6)
HD			1.42 (1.1-1.9)	**HD**			1.43 (1.1-1.9)
HTN			1.24 (0.9-1.7)	**HTN**			1.23 (0.9-1.7)
CA			0.95 (0.7-1.3)	**CA**			0.98 (0.7-1.3)
AT			1.23 (0.9-1.7)	**AT**			1.28 (0.9-1.8)
ADL-Personal	**Model1**	**Model2**	**Model3**	**ADL-P**	**Model1**	**Model2**	**Model3**
Physio-consult	0.11 (0.03-0.4)	0.16 (0.04-0.6)	0.18 (0.05-0.6)	**Allied-consult**	0.17 (0.1-0.4)	0.2 (0.1-0.4)	0.2 (0.1-0.4)

Age		1.46 (1.2-1.7)	1.58 (1.4-1.8)	**Age**		1.5 (1.2-1.7)	1.56 (1.3-1.8)
Sex		1.82 (1.3-2.5)	1.93 (1.4-2.7)	**Sex**		1.84 (1.3-2.6)	1.9 (1.4-2.8)
DM			1.67 (1.2-2.4)	**DM**			1.76 (1.2-2.5)
HD			1.27 (0.9-1.7)	**HD**			1.28 (0.9-1.7)
HTN			0.73 (0.5-1)	**HTN**			0.7 (0.5-1)
CA			1.01 (0.7-1.2)	**CA**			1 (0.7-1.5)
AT			1.05 (0.7-1.5)	**AT**			1.1 (0.7-1.5)
ADL-Move	**Model1**	**Model2**	**Model3**	**ADL-Move**	**Model1**	**Model2**	**Model3**
Physio-consult	3.1E-7 (1.8E-7-5.15E-7)	4.2E-7 (2.8E-7-6.14E-7)	5.1E-7 (3.5E-7-7.6E-7)	**Allied-consult**	0.13 (0.03-0.4)	0.15 (0.04-0.5)	0.14 (0.03-0.6)
Age		1.41 (1.1-1.8)	1.43(1.1-1.8)	**Age**		1.4 (1.1-1.8)	1.4 (1.1-1.8)
Sex		1.58 (1-2.5)	1.68(1-2.8)	**Sex**		1.6 (1-2.5)	1.7 (1-2.8)
DM			2(1.2-3.4)	**DM**			2.1 (1.3-3.6)
HD			1.9(1.2-3)	**HD**			1.9 (1.2-3)
HTN			0.81(0.5-1.3)	**HTN**			0.8 (0.5-1.3)
CA			1.04(0.6-1.8)	**CA**			1.1 (0.6-1.8)
AT			0.9(0.5-1.5)	**AT**			1 (0.6-1.6)
ADL-Finance	**Model1**	**Model2**	**Model3**	**ADL-F**	**Model1**	**Model2**	**Model3**
Physio-consult	0.009 (0.001-0.06)	0.01 (0.001-0.1)	0.01(0.002-0.1)	**Allied-consult**	0.17 (0.1-0.4)	0.2 (0.1-0.4)	0.17 (0.08-0.3)
Age		1.48 (1.3-1.7)	1.59(1.4-1.8)	**Age**		1.5 (1.3-1.7)	1.6 (1.4-1.8)
Sex		1.67 (1.2-2.3)	1.8(1.3-2.5)	**Sex**		1.7 (1.2-2.3)	1.9 (1.3-2.6)
DM			1.23(0.9-1.7)	**DM**			1.3 (0.9-1.8)
HD			1.02(0.9-1.6)	**HD**			1.21 (0.9-1.6)
HTN			0.86(0.6-1.2)	**HTN**			0.8 (0.6-1.2)
CA			1.06(0.74-1.5)	**CA**			1.1 (0.8-1.5)
AT			0.91(0.7-1.3)	**AT**			0.9 (0.7-1.3)

Table 6: Univariate and multivariate models for assessing relationship of injury due to fall with rehabilitation intervention

	Physiotherapy consult				Allied health consult		
Injury Due to Fall	**Model1**	**Model2**	**Model3**	**Injury Due to Fall**	**Model1**	**Model2**	**Model3**
Physio-consult	0.15 (0.04-0.5)	0.18 (0.05-0.6)	0.1 (0.02-0.6)	**Allied-consult**	0.08 (0.03-0.2)	0.08 (0.03-0.22)	0.07 (0.02-0.2)
Age		1.1 (0.9-1.4)	1.1 (0.8-1.4)	**Age**		1.1 (0.9-1.4)	1.1 (0.8-1.4)
Sex		1.8 (1-3.4)	1.6 (0.8-3.3)	**Sex**		1.86 (1-3.4)	1.7 (0.8-3.4)
DM			0.8 (0.4-1.4)	**DM**			0.8 (0.4-1.5)
HD			1 (0.6-1.6)	**HD**			1 (0.6-1.6)
HTN			1.1 (0.5-2.1)	**HTN**			1.07 (0.5-2.2)
CA			0.59 (0.3-1.1)	**CA**			0.6 (0.3-1.1)
AT			1.6 (0.8-3.3)	**AT**			1.66 (0.8-3.4)

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