

# **Return to Work and Employment Income After Stroke**

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## **ABSTRACT**

**Background:** Stroke is a leading cause of disability worldwide. Many people after stroke experience functional limitations and have difficulty returning to work. Returning to work after stroke is important for financial reasons, but also for mental health and life satisfaction. Health professionals may assume that many stroke rehabilitation patients do not expect to return to work and decide to retire. This may be a false assumption. Knowing the proportion of stroke rehabilitation patients who intend to return to work can help rehabilitation providers to better understand their patients' plans and to initiate discussion about return to work needs. Furthermore, healthcare and social service providers have limited information regarding the proportion of stroke survivors who do return to work. Estimates of return to work poststroke widely vary in the literature, and it is not clear how operational definitions have affected these estimates. Finally, Ontario healthcare and social service providers and planners could benefit from population-based estimates of return to work and poststroke employment income.

**Purpose and Objectives:** The overall purpose of my thesis research was to investigate return to work after stroke. The specific objectives were to: 1) estimate the proportion of stroke rehabilitation inpatients intending to return to work; 2) examine operational definitions of return to work, and more precisely estimate the proportion of stroke survivors returning to work; and 3) determine the relative effects of stroke on the probability of reporting employment income over 3 years, and estimate the changes in annual employment income attributable to stroke.

**Methods:** To meet these objectives, I conducted three studies: 1) a cross-sectional study using hospital data from the Canadian Institute for Health Information National Rehabilitation Reporting System; 2) a systematic review and meta-analysis; and 3) a retrospective cohort study using hospital data from the Canadian Institute for Health Information Discharge Abstract Database linked with personal income tax data from Statistics Canada.

**Results:** Study 1, the cross-sectional study, showed that in Ontario 43.7% of stroke rehabilitation inpatients who worked prestroke, including 36.2% of those over the traditional retirement age of 65 years, intended to return to work. The finding adds to our understanding of the potential return to work service needs of stroke rehabilitation inpatients in Ontario.

Study 2, the systematic review, found that almost all operational definitions of return to work were based on full-time or part-time paid employment (46 of 47 studies). Follow-up time differed across studies, from less than 1 month to 18 years poststroke. Meta-analyses using data from studies with similar lengths of follow-up revealed that the proportions of people returning to work poststroke were 55.7% at 1 year (95% CI; 51.3-60.0) and 67.4% at 2 years (95% CI; 60.4-74.4). These estimates can serve as benchmarks to monitor the effects of future improvements in programs and social services on return to work.

Study 3, the retrospective cohort study, demonstrated that in Ontario the percentages of people working in the year prestroke reporting employment income poststroke were 74.8% at 1 year (95% CI; 73.1-76.5), 68.1% at 2 years (95% CI; 66.3-69.9), and 63.4% at 3 years (95% CI; 61.6-65.3). Stroke survivors were less likely to report any employment income compared to people without stroke of similar demographic characteristics, incidence rate ratios 0.87 at 1 year (95% CI; 0.85-0.88), 0.82 at 2 years (95% CI; 0.81-0.84) and 0.81 at 3 years (95% CI; 0.79-0.82). Relative changes in annual employment income attributable to stroke varied from a decrease of 13.8% (95% CI; 8.7-18.9) at the 75th income percentile to a decrease of 43.1% (95% CI; 18.7-67.6) at the 25th income percentile.

**Conclusions:** Providers should initiate early discussions about return to work with stroke rehabilitation inpatients. It should not be assumed that older patients will be retiring, or that returning to work is not a priority. To help address return to work and the consequences of loss of income, rehabilitation providers should connect stroke survivors with employment and social services, especially those in low-income situations. While Ontario estimates of return to work after stroke are higher than international

averages, there is a troubling trend of employment decreasing over time, rather than increasing over time, as seen in the international data. Rehabilitation providers should make effort to start early and to follow up with stroke survivors who return to work to ensure employment is maintained.

## **ACKNOWLEDGEMENTS**

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# CHAPTER 1: INTRODUCTION

## Introduction

Globally, over 12 million people experience a stroke each year. It is estimated that a quarter of people over the age of 25 will have a stroke during their life (World Stroke Organization, 2022). While stroke is more common with older age, incidence in the younger populations has been gradually increasing (Pearce et al., 2023). Each year, 62% of strokes occur in people under the age of 70, and 16% of strokes occur in people between the ages of 15-49. The incidence of stroke, which has almost doubled in the last three decades, has been attributed to risk factors including high blood pressure, poor diet, obesity, smoking, air pollution, and sedentary lifestyle (World Stroke Organization, 2022).

Worldwide, over 100 million people are living with the effects of stroke (World Stroke Organization, 2022). Stroke is one of the leading causes of disability contributing to a significant economic burden in direct health care and indirect costs in decreased productivity (Rochmah et al., 2021; Strilciuc et al., 2021). Many people after stroke experience functional limitations and have difficulty working. Fatigue, weakness, difficulty concentrating, communication problems, and depression are commonly reported issues that make it challenging for stroke survivors to return to work. This can negatively impact psychological wellbeing and lead to financial issues. Returning to work can be a valued goal for stroke survivors for their overall quality of life and is a key aspect of community re-engagement (Martin et al., 2023; Moore et al., 2024; Wassenius et al., 2023).

## Thesis Overview

This is an article-based thesis of three studies (**Table 1.1**).

**Table 1.1.** Thesis overview

|                                                                                                                                                                                                                                                                                                                                                                            |                                       |                                     |                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Study 1</b>                                                                                                                                                                                                                                                                                                                                                             | Intention to return to work           | Cross-sectional study               | Estimate the proportion of stroke rehabilitation inpatients intending to return                                                                                                      |
| Duong, P. K., Egan, M. Y., Meyer, M. J., & Morrison, T. L. (2020). Intention to Return to Work after Stroke Following Rehabilitation in Ontario. <i>Canadian Journal of Occupational Therapy</i> , 87(3), 221–226.<br><a href="https://doi.org/10.1177/0008417420905706">https://doi.org/10.1177/0008417420905706</a>                                                      |                                       |                                     |                                                                                                                                                                                      |
| <b>Study 2</b>                                                                                                                                                                                                                                                                                                                                                             | Estimates of return work              | Systematic review and meta-analysis | Examine operational definitions of return to work, and more precisely estimate the proportion of stroke survivors returning to work                                                  |
| Duong, P., Sauvé-Schenk, K., Egan, M. Y., Meyer, M. J., & Morrison, T. (2019). Operational Definitions and Estimates of Return to Work Poststroke: A Systematic Review and Meta-Analysis. <i>Archives of Physical Medicine and Rehabilitation</i> , 100(6), 1140–1152. <a href="https://doi.org/10.1016/j.apmr.2018.09.121">https://doi.org/10.1016/j.apmr.2018.09.121</a> |                                       |                                     |                                                                                                                                                                                      |
| <b>Study 3</b>                                                                                                                                                                                                                                                                                                                                                             | Impact of stroke on employment income | Retrospective cohort study          | Determine the relative effects of stroke on the probability of reporting employment income over 3 years, and estimate the changes in annual employment income attributable to stroke |
| Duong, P., Egan, M., Meyer, M., Morrison, T., & Sauvé-Schenk, K. (2024). The impact of stroke on employment income: A cohort study using hospital and income tax data in Ontario, Canada. <i>Clinical Rehabilitation</i> , 2692155241249345. Advance online publication. <a href="https://doi.org/10.1177/02692155241249345">https://doi.org/10.1177/02692155241249345</a> |                                       |                                     |                                                                                                                                                                                      |

## Overview

- **Chapter 1** is an introduction presenting a review of the literature, rationale, and objectives of the studies;
- **Chapters 2-4** are the three studies in manuscript format; and
- **Chapter 5** is an integrated discussion of the key findings, implications for clinical practice, policy, and future research, and limitations and strengths

## **Contributions**

I (PD) acknowledge the following people who made contributions to my thesis:

Mary Egan (ME), PhD\*

*Professor, University of Ottawa, School of Rehabilitation Sciences*

Matthew Meyer (MM), PhD\*

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\*Thesis advisory committee members

Katrine Sauvé-Schenk (KSS), PhD

*Assistant Professor, University of Ottawa, School of Rehabilitation Sciences*

## **Study 1 - Intention to return to work (cross-sectional study)**

PD and ME designed the study. PD collected and analyzed the data and drafted the manuscript with input from all authors (PD, ME, MM, TM). All authors contributed to the interpretation of the findings, revised the manuscript for critically important intellectual content, and approved the final version for publication.

**Study 2 – Estimates of return to work (systematic review and meta-analysis)**

PD and ME designed the study. PD, KSS, and ME assessed articles for eligibility. PD extracted and analyzed the data and drafted the manuscript with input from all authors (PD, KSS, ME, MM, TM). All authors contributed to the interpretation of the findings, revised the manuscript for critically important intellectual content, and approved the final version for publication.

**Study 3 - Impact of stroke on employment income (retrospective cohort study)**

PD and ME designed the study. PD collected and analyzed the data and drafted the manuscript with input from all authors (PD, ME, MM, TM, KSS). All authors contributed to the interpretation of the findings, revised the manuscript for critically important intellectual content, and approved the final version for publication.

## **Review of the Literature**

### **Stroke**

A stroke occurs when blood flow is interrupted resulting in damage to the brain, lasting more than 24 hours, from the loss of oxygen and nutrients (Canadian Institute for Health Information, 2018). Ischemic stroke is the most common type of stroke and occurs when there is a blockage that obstructs blood flow. Hemorrhagic stroke, the less common type of stroke but typically more severe, occurs when there is bleeding within the brain from a ruptured blood vessel (Hui et al., 2024; Unnithan et al., 2024).

### **Impact of stroke**

In Canada, there are over 100,000 strokes each year (Holodinsky et al., 2023) and 878,500 people living with the effects of stroke (Public Health Agency of Canada, 2022). Impairments from stroke can include physical, cognitive, and psychological problems that contribute to activity limitations and reduced societal participation (Orange et al., 2024; Palstam et al., 2019). Approximately half of people living with stroke have difficulties with daily activities (Heart and Stroke Foundation of Canada, 2017). Working is an important daily activity that can be difficult, even for people with mild strokes. People after stroke may need to stop working altogether (Scott et al., 2019; Westerlind et al., 2020). Not working can have consequences for stroke survivors and their families, leading to decreased life satisfaction and financial problems (Chen et al., 2019; Coutts & Cooper, 2023; Gurková et al., 2023; Pan et al., 2023; Scott et al., 2019). Gurkova et al. (2023) conducted a scoping review of studies of young stroke survivors between the ages of 18-65 years. This review found that young stroke survivors were often concerned about their ability to work, and that unemployment was associated with lower health-related quality of life. Other studies have reported that stroke survivors who were not able to work often had mental health issues. Stroke survivors frequently experienced a loss of self-esteem and identity. They were also more likely to develop mood disorders, social isolation, and depression (Brouns

et al., 2019; Gurková et al., 2023; Guzik et al., 2020; La Torre et al., 2022; Radford et al., 2020; Turner et al., 2022; Westerlind et al., 2020).

### **Benefits of work**

Work plays a crucial role in various aspects of an individual's life. Beyond providing a source of income, work is a determinant of physical and mental health. According to Palstram et al. (2019) and Morris et al. (2011), work fosters a social context and helps in maintaining and developing one's identity. As well, Scott et al. (2017), note that employment is vital for learning and personal growth. Work provides structure to daily life and social interaction, which are essential for a sense of belonging (Saar et al., 2023; SWOSN, 2017). Employment opportunities also link individuals to broader goals and purposes, contributing to social status and personal fulfillment (Skarpaas, 2019). For individuals recovering from stroke, involvement in work has been shown to be a significant factor in feeling productive (Guzik et al., 2020). The benefits of employment extend to overall quality of life, with employed individuals reporting better health outcomes and less reliance on health services compared to unemployed people (van der Kemp et al., 2019).

### **Return to work after stroke**

Stroke survivors returning to work report higher subjective wellbeing than stroke survivors who do not return to work (La Torre et al., 2022; SWOSN, 2017; Wassenius et al., 2023). They also experience improved social reintegration in their community (Palstam et al., 2019; SWOSN, 2017). Additionally, returning to work boosts self-esteem, confidence, and offers a sense of regaining the pre-stroke identity (Coutts & Cooper, 2023; La Torre et al., 2022; SWOSN, 2017; Wassenius et al., 2023). Stroke survivors emphasize the importance of work and social life in their recovery narratives. They view gradually returning to work as confirmation that they are getting better (Edwards et al., 2018; Wassenius et al., 2023). Stroke survivors returning to work report lower rates of depression and better emotional status

and functional recovery than stroke survivors who do not return to work (Arwert et al., 2017; Han et al., 2019; Orange et al., 2024; Volz et al., 2023). Therefore, return to work is important not only for financial reasons, but also for community participation and health-related quality of life (Hartke & Trierweiler, 2015; Moore et al., 2024).

### **Barriers to return to work**

Stroke survivors often encounter challenges returning to work. The likelihood of returning to work can be influenced by the severity of the stroke and the resulting physical and cognitive impairments. These may be physical impairments such as mobility issues and weakness, cognitive deficits such as memory problems and loss of concentration, and communication disorders, namely aphasia (Aarnio et al., 2018; Coutts & Cooper, 2023; Martin et al., 2023; Orange et al., 2024; Pan et al., 2023; Pearce et al., 2023; Radford et al., 2020; Saar et al., 2023; SWOSN, 2017). Other common issues include chronic fatigue and pain which can significantly impact job performance (Moore et al., 2024; Radford et al., 2020; Saar et al., 2023; SWOSN, 2017). The ability to process and respond to information quickly is necessary for many work environments, and deficits in attention, speech, or multitasking can hinder successful return to work (Coutts & Cooper, 2023; SWOSN, 2017).

Return to work can also be influenced by macro factors. Individuals of lower socioeconomic status experience greater difficulty returning to work (Ashley et al., 2019; La Torre et al., 2022; Palstam et al., 2019; SWOSN, 2017). The lack of accessible transportation and workplaces can be major barriers to return to work (SWOSN, 2017). As well, negative attitudes from employers and stereotypes against people with disabilities can further complicate the difficulties stroke survivors face. While some of these barriers could be addressed through efforts such as workplace accommodations and peer support, others, like economic disparities and negative attitudes, pose more significant challenges that would require social change to overcome (Ashley et al., 2019; Martin et al., 2023; Scott et al., 2019).



## **Facilitators to return to work**

A number of factors may facilitate return to work after a stroke. These factors include characteristics and occupational factors such as younger age, male gender, white-collar work (non-manual), lower stroke severity, and functional independence (Ashley et al., 2019; Carcel et al., 2019; Coutts & Cooper, 2023; Edwards et al., 2018; Green et al., 2021; Guzik et al., 2020; La Torre et al., 2022; Orange et al., 2024; Palstam et al., 2019; Phillips et al., 2019; Saar et al., 2023; van der Kemp et al., 2017; Wang et al., 2014; Wei et al., 2016; Westerlind et al., 2017).

A recent systematic review and meta-analysis by Orange et al. (2024) estimated the pooled effects of various factors on return to work after stroke. In this review, 34 out of 39 total studies included estimates of return to work by age, and three studies could be pooled using the same age grouping. It was shown that people under the age of 50 years had 58% higher odds of return to work (OR 1.58; 95% CI, 1.41-1.77; n=3) compared to people above the age of 50 years. Men had 26% higher odds of returning to work (OR 1.26; 95% CI, 1.14-1.40; n=30). Stroke survivors employed in white-collar jobs had 84% higher odds of returning to work compared to blue-collar jobs (OR 1.84; 95% CI, 1.64-2.06; n=16). For every 1-point decrease in the measure of stroke severity (using the National Institutes of Health Stroke Scale), the odds of returning to work was higher by 23% (OR 1.23; 95% CI, 1.08-1.39; n=6). Stroke survivors who were functionally independent had a 317% higher odds of returning to work (OR 4.17; 95% CI, 2.40-7.26; n=20).

Socioeconomic factors can also positively influence return to work. Individuals with post-secondary education are more likely to return to work as they more often have professional jobs and earn greater income than people with lower levels of education, who tend to have more physically demanding manual jobs (Aarnio et al., 2018; Ashley et al., 2019; Bonner et al., 2016; Brey & Wolf, 2015; Chang et al., 2016; Glader et al., 2017; Van Patten et al., 2016). Other considerations are the person's living situation and interactions with coworkers and their workplace environments (Coutts & Cooper,

2023; Edwards et al., 2018; Jarvis et al., 2019; Orange et al., 2024; Schwarz et al., 2018; Skarpaas, 2019; SWOSN, 2017). Qualitative studies have found that living with supportive family members, receiving support from coworkers, and having accommodations from employers is favourable for return to work (Brannigan et al., 2017; Schwarz et al., 2018). According to expert opinion, receiving rehabilitation and services to assist with employment (e.g. vocational rehabilitation and counseling) may also be beneficial (Ashley et al., 2019; Brannigan et al., 2017; Brouns et al., 2019; Coutts & Cooper, 2023; La Torre et al., 2022; Moore et al., 2024; Pearce et al., 2023; Schwarz et al., 2018; Scott et al., 2019).

### **Intention to return to work**

People after stroke often experience uncertainty with return to work. Some stroke survivors are anxious to get back to working as soon as possible for financial or psychological reasons, while others may be more comfortable waiting (Brannigan et al., 2017; Martin et al., 2023; Wassenius et al., 2023). Wassenius et al. (2023) explains that stroke survivors struggle with the decision to return to work because they are unsure of their recovery and ability to work. Currently, little is known on stroke survivors' intentions to return to work. Rehabilitation providers may feel that return to work is a long-term rather than an immediate goal of recovery for their patients, and therefore may not see discussion of return to work as part of their role (Coutts & Cooper, 2023; Martin et al., 2023; Sauvé-Schenk et al., 2024; SWOSN, 2017). However, returning to work may still be a priority in the minds of their patients. Knowing the proportion of stroke rehabilitation patients who intend to return to work may help rehabilitation providers to better understand their patient's plans and to initiate discussion about return to work needs.

Therefore, **the objective of Study 1 was to investigate the proportion of stroke rehabilitation inpatients intending to return to work.** Study 1 was a cross-sectional study using province-wide hospital data in Ontario from The Canadian Institute for Health Information (CIHI) National Rehabilitation Reporting System (NRS) (Canadian Institute for Health Information, 2024b). Data collection for the NRS

includes employment status prior to admission (prestroke) and actual or expected employment status upon discharge from inpatient rehabilitation. This information was recorded in patient records and was used to determine the proportion intending to return to work. Study 1 contributes to our understanding of the potential return to work service needs of stroke rehabilitation inpatients in Ontario.

### **Estimates of return to work**

There is large variation in estimates of return to work after stroke. A 2018 systematic review of 29 studies revealed estimates ranging from 7.3% to 74.5% (Edwards et al., 2018). This variation could be due to operational definitions of return to work (Ashley et al., 2019; Brouns et al., 2019; Edwards et al., 2018; Schulz et al., 2017; Van Patten et al., 2016). How to define return to work has not been clearly established. Return to work can involve various activities, for example, resuming a previous paid job full-time or regular part-time work, casual work, or studying or training (Schulz et al., 2017). A detailed look at operational definitions of return to work could help to better understand the differences and similarities in definitions. Finding a common operational definition of return to work after stroke is important so that estimates can be more comparable across studies (Ashley et al., 2019; Van Patten et al., 2016).

Estimates of return to work could also vary due the study population and location. There are differences across countries in employment opportunities, policies and benefits, and the quality and access to healthcare and community services. These socioeconomic conditions can influence the likelihood of people returning to work after stroke (Ashley et al., 2019; Brouns et al., 2019; Chang et al., 2016; Edwards et al., 2018; Van Patten et al., 2016). Another reason for variation in estimates could be the length of follow-up. The systematic review by Edwards et al. (2018) found that follow-up varied from less than 1 month up to a mean of 11.9 years poststroke. Studies with longer periods of follow-up after stroke generally reported higher estimates of return to work (Ashley et al., 2019; Brouns et al., 2019; Edwards et al., 2018; Van Patten et al., 2016).

Estimates of return to work can be one indication of the effectiveness of medical treatment and rehabilitation. As well, a more precise estimate of return to work can aid in planning services to support stroke survivors with return to work. To date, no reviews have attempted to refine these estimates through meta-analysis.

Therefore, **the objectives of Study 2 were to conduct a systematic review to examine operational definitions of return to work, and to more precisely estimate the proportion of stroke survivors returning to work through meta-analysis.** Study 2 included quantitative studies on return to work outcomes for people employed prior to stroke. It aimed to provide more precise estimates of return to work by pooling studies with similar lengths of follow-up. The pooled estimates of return to work across similar length of follow-up time contribute to the literature by providing current benchmarks for health and social service providers. These benchmarks can be used for monitoring the impact of future changes in programs and services on return to work after stroke.

### **Impact of stroke on employment income**

Stroke has a substantial economic impact. In Canada, the indirect costs from decreased productivity and lost wages total approximately \$3.6 billion a year (Heart and Stroke Foundation of Canada, 2019). Stroke survivors have average hourly wages that are 17.5% lower than the general population. As well, 53.3% of stroke survivors have annual incomes of \$20,000 or less, whereas it is 27.8% for the general population (Vyas et al., 2016). The loss of employment can be detrimental to stroke survivors and their family's health and wellbeing (Martin et al., 2023; Wassenius et al., 2023). Population-level estimates of the percentage of stroke survivors reporting employment income would be valuable in understanding current rates and trends in employment after stroke. It would also be useful to know what changes in annual employment income are attributable to stroke.

Therefore, **the objectives of Study 3 were to determine the relative effects of stroke on the probability of reporting employment income over 3 years poststroke, and to estimate the changes in annual employment income attributable to stroke.** Study 3 was a retrospective cohort study using hospital data in Ontario from the Canadian Institute for Health Information Discharge Abstract Database (DAD) (Canadian Institute for Health Information, 2024a). The hospital data was linked with personal income tax data (Statistics Canada, 2023a). The study compared employment income reported by stroke survivors to people who did not have a stroke, while adjusting for characteristics influencing employment, such as age. Study 3 demonstrated the adverse impact that stroke has on employment income over time and highlighted the more drastic decline among low-income people.

## CHAPTER 2: INTENTION TO RETURN TO WORK (STUDY 1)

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The manuscript has been prepared in accordance with the journal requirements, but the numbering of the tables and figures has been modified for the thesis.

## Intention to Return to Work after Stroke Following Rehabilitation in Ontario

### Abstract

**Background:** Returning to work is important for many people following stroke. An estimate of the prevalence of people intending to return to work post-stroke would be helpful in planning services supporting work reintegration.

**Purpose:** This study examined the prevalence of intention to return work after discharge among stroke rehabilitation inpatients.

**Methods:** We performed secondary analysis of National Rehabilitation Reporting System data for all stroke rehabilitation inpatients across Ontario (2012-2017). Intention to return to work was examined by gender, age, and level of disability.

**Findings:** Among 25,691 stroke rehabilitation inpatients, 4,668 (18.2%) were employed pre-stroke and 2,039 (43.7%) of them intended to return to work. Intention to return to work was somewhat higher among younger and middle-aged stroke survivors and those with mild disability.

**Implications:** Providers and planners should be aware that almost half of previously employed stroke rehabilitation inpatients may be seeking services to assist with return to work.

**Key words:** Employment; Rehabilitation, Vocational; Neurology; Occupational therapy

## Introduction

Approximately 60,000 Canadians experience a stroke each year and over 400,000 Canadians are living with disability following stroke (Heart and Stroke Foundation of Canada, 2019). Engaging in meaningful productive work provides a sense of identity and fosters inclusion in social roles. However, stroke-related impairments can adversely affect the ability to work, which can result in decreased psychosocial wellbeing (Daniel, Wolfe, Busch, & McKeivitt, 2009; Morris, 2011; Wolfenden & Grace, 2015). Furthermore, loss of work can lead to personal financial hardship and difficulties in maintaining housing, affording transportation, and accessing other services necessary for participating in valued occupations (Sauvé-Schenk, Egan, Dubouloz-Wilner, & Kristjansson, 2019). A recent Canadian cohort study found that employment rates at three years post-stroke were 19.8% less among people who had experienced stroke, and earnings were 31.2% less than those of people of similar age and gender (Garland et al., 2019).

Return to work after stroke contributes to a higher quality of life (Arwert et al., 2017; Matérne, Strandberg, & Lundqvist, 2018; Sen et al., 2019). Canadian best practice recommendations for stroke rehabilitation advise that pursuing vocational interests should be encouraged, and employment and vocational rehabilitation services should be offered (Hebert et al., 2016). Occupational therapists play a key role in the provision of employment and vocational rehabilitation services to help people with disabilities reintegrate in the workplace (Brannigan et al., 2017; Scott & Bondoc, 2018). For effective planning and advocacy of these services, it is important to know how many people intend to return to work following a stroke. However, to date this information has not been well documented in a Canadian context. A population-level investigation of pre-stroke employment and intention to return to work among stroke survivors would be valuable.

The Canadian Institute for Health Information (CIHI) National Rehabilitation Reporting System (NRS) has population-based data on employment for people who have received inpatient stroke



rehabilitation (Canadian Institute for Health Information, 2019). Two data elements on employment status are contained in this database – the employment status prior to admission (pre-stroke) and the actual or expected employment status upon discharge from inpatient rehabilitation (post-discharge). Together, these data elements provide a better picture of the potential return to work service needs of stroke rehabilitation inpatients.

The objective of this study was to examine the prevalence of intention to return to work of stroke rehabilitation inpatients in Ontario. Specifically, we addressed the following research questions: 1) how many stroke survivors receiving inpatient rehabilitation were in paid employment pre-stroke; 2) what proportion of these stroke survivors intended to return to work after discharge; and 3) how do these proportions differ by gender, age, and level of disability?

## **Methods**

### **Design and data set**

This cross-sectional study involved secondary analysis of individual record-level CIHI NRS data for the time period January 1, 2012 to August 16, 2017. The collection of NRS data is mandated by the Ontario Ministry of Health and Long-Term Care from all facilities across the province with designated adult inpatient rehabilitation beds. This includes general rehabilitation units that are part of a hospital offering multiple levels of care and specialty rehabilitation units that are within a hospital or are a free-standing facility. From 2012 to 2017, there were between 69 and 72 facilities that submitted data to the NRS (Canadian Institute for Health Information, 2018a). Variation in the number of facilities submitting data is due to opening and closing of rehabilitation units, or facilities merging and splitting.

## **Participants and selection**

The study population was stroke survivors who received inpatient rehabilitation in Ontario and were discharged between January 1, 2012 to August 16, 2017. All patient records with stroke coded as the "most responsible health condition" for admission were included. Diagnoses included under stroke were subarachnoid hemorrhage, intracerebral hemorrhage, cerebral infarction, and stroke not specified as hemorrhage or infarction (ICD-10-CA I60, I61, I63, and I64, respectively) (Canadian Institute for Health Information, 2018b). Records of patients admitted with a diagnosis of transient ischemic attack were excluded.

## **Data collection**

NRS data elements used in this study, in addition to the most responsible health condition, included employment (vocational status), age, sex, and Functional Independence Measure (FIM) scores. These data elements had been collected at inpatient admission and discharge by facility administrative staff. Data were coded and inputted into electronic forms submitted to CIHI on a routine basis. Additional details on NRS data elements collected at admission and discharge are publicly available online (Canadian Institute for Health Information, 2019).

For each person, data on pre-stroke employment and post-discharge employment was coded as either paid employment (full-time, part-time, adjusted/modified work), unpaid employment, student, unemployed, retired, or unknown. Pre-stroke employment was defined as the "vocational status prior to admission to the rehabilitation facility". Post-discharge employment was defined as the "actual or expected vocational status upon discharge from the rehabilitation facility" (Canadian Institute for Health Information, 2018b). Return to work was defined as the "resumption of any paid work full-time or part-time, inclusive of self-employment, in a regular or modified capacity" (Duong, Sauvé-Schenk, Egan, Meyer, & Morrison, 2019). Stroke survivors were considered to be intending to return to work if they

were coded as being in "paid employment" prior to stroke, and their actual or expected vocational status upon discharge was coded as "paid employment".

### **Data analysis**

Pre-stroke employment and intention to return to work were reported as proportions. To test for differences in proportions intending to return to work, stroke survivors were stratified by gender, age, and level of disability. For age, stroke survivors were stratified into 10-year subgroups (<35 years, 35-44 years, 45-54 years, 55-64 years, and 65+ years). This allowed for meaningful comparisons between younger and older stroke survivors. For level of disability, stroke survivors were stratified by total FIM scores at discharge, FIM > 80 categorized as mild disability and FIM ≤ 80 categorized as moderate-severe disability. These cut-offs for the level of disability have been described by Teasell, Pereira, and Cotoi (2016). Chi-square tests  $\chi^2$  (or Fisher's exact tests) were used to assess whether there were statistically significant differences in proportions intending to return to work by gender, age, and level of disability (95% confidence interval, significance  $p < 0.05$ ). Bonferroni correction was applied for post hoc multiple comparisons of age subgroups. Analyses were conducted in SQL Server (Microsoft, 2019) and RStudio (RStudio Inc., 2018).

### **Ethics Approval**

This study was approved by the University of Ottawa Research Ethics Board.

## Results

Over the time period of the data set, January 1, 2012 to August 16, 2017, a total of 25,691 stroke survivors had received inpatient rehabilitation. In all, 4,668 (18.2%) were in paid employment pre-stroke (**Table 2.1**). Among the 4,668 stroke survivors in paid employment pre-stroke, 2,039 (43.7%) intended to return to work post-discharge, 59 (1.3%) were in unpaid employment, 13 (0.3%) were students, 254 (5.4%) were unemployed, and 1,394 (29.9%) were retired. Intention to return to work was unknown for the remaining 909 (19.5%) stroke survivors. Post hoc analysis showed no significant differences in terms of age, gender, or disability level between those with known and unknown data on intention to return to work.

**Table 2.1.** Intention to Return to Work

|                            |      | Intend to return to work, n (%) |           |                   |
|----------------------------|------|---------------------------------|-----------|-------------------|
| Employed pre-stroke, n (%) |      | Full-time                       | Part-time | Adjusted/modified |
| Men                        |      |                                 |           |                   |
| Age, years                 |      |                                 |           |                   |
| <35                        | 80   | 20 (25.0)                       | 3 (3.8)   | 14 (17.5)         |
| 35-44                      | 219  | 54 (24.7)                       | 3 (1.4)   | 57 (26.0)         |
| 45-54                      | 842  | 198 (23.5)                      | 19 (2.3)  | 184 (21.9)        |
| 55-64                      | 1371 | 292 (21.3)                      | 48 (3.5)  | 252 (18.4)        |
| ≥65                        | 736  | 100 (13.6)                      | 87 (11.8) | 84 (11.4)         |
| All Ages                   | 3248 | 664 (20.4)                      | 160 (4.9) | 591 (18.2)        |
| Women                      |      |                                 |           |                   |
| Age, years                 |      |                                 |           |                   |
| <35                        | 87   | 30 (34.5)                       | 5 (5.7)   | 15 (17.2)         |
| 35-44                      | 128  | 40 (31.3)                       | 7 (5.5)   | 25 (19.5)         |
| 45-54                      | 432  | 102 (23.6)                      | 18 (4.2)  | 77 (17.8)         |
| 55-64                      | 543  | 108 (19.9)                      | 36 (6.6)  | 82 (15.1)         |
| ≥65                        | 230  | 31 (13.5)                       | 25 (10.9) | 23 (10.0)         |
| All Ages                   | 1420 | 311 (21.9)                      | 91 (6.4)  | 222 (15.6)        |

Differences in intention to return to work by gender, age, and level disability are presented in **Table 2.2**. There were no significant differences in the proportions of men and women intending to return to work. There were also no significant differences between men and women among those with mild disability ( $\chi^2 = 0.43$ ,  $p = 0.51$ ) and moderate-severe disability ( $\chi^2 = 2.10$ ,  $p = 0.15$ ). There were significant differences in intention to return to work by age ( $\chi^2 = 46.77$ ,  $p < 0.001$ ). Post hoc comparisons revealed that the proportions were significantly higher among those less than 35 years ( $\chi^2 = 15.12$ ,  $p < 0.001$ ), 35 to 44 years ( $\chi^2 = 31.89$ ,  $p < 0.001$ ), 45 to 54 years ( $\chi^2 = 25.80$ ,  $p < 0.001$ ), and 55 to 64 years ( $\chi^2 = 11.27$ ,  $p < 0.001$ ), compared with people 65 years of age and older. There were significant differences in intention to return to work by level of disability. The proportions were significantly higher among stroke survivors with mild disability compared to stroke survivors with moderate-severe disability for all age subgroups, except for 35 to 44 years.

**Table 2.2.** Differences in Intention to Return to Work

|            | Men, n (%)             | Women, n (%)                      | 95% CI         | $\chi^2$ | <i>p</i> |
|------------|------------------------|-----------------------------------|----------------|----------|----------|
| Age, years |                        |                                   |                |          |          |
| <35        | 37 (46.3)              | 50 (57.5)                         | [-26.30, 3.85] | 2.10     | 0.147    |
| 35-44      | 114 (52.1)             | 72 (56.3)                         | [-15.04, 6.65] | 0.57     | 0.450    |
| 45-54      | 401 (47.6)             | 197 (45.6)                        | [-3.76, 7.81]  | 0.47     | 0.493    |
| 55-64      | 592 (43.2)             | 226 (41.6)                        | [-3.35, 6.47]  | 0.39     | 0.534    |
| ≥65        | 271 (36.8)             | 79 (34.3)                         | [-4.58, 9.53]  | 0.46     | 0.496    |
| All Ages   | 1415 (43.6)            | 624 (43.9)                        | [-3.47, 2.72]  | 0.06     | 0.811    |
|            | Mild disability, n (%) | Moderate-severe disability, n (%) | 95% CI         | $\chi^2$ | <i>p</i> |
| Age, years |                        |                                   |                |          |          |
| <35        | 83 (54.6)              | 2 (18.2)                          | [12.30, 60.55] | 5.45     | 0.020    |
| 35-44      | 174 (55.8)             | 9 (36.0)                          | [0.16, 39.38]  | 3.65     | 0.056    |
| 45-54      | 557 (49.8)             | 37 (27.4)                         | [14.34, 30.49] | 24.27    | <0.001   |
| 55-64      | 750 (46.0)             | 58 (24.0)                         | [16.18, 27.97] | 41.84    | <0.001   |
| ≥65        | 321 (40.1)             | 27 (19.7)                         | [12.89, 27.84] | 20.80    | <0.001   |
| All Ages   | 1885 (47.0)            | 133 (24.2)                        | [18.90, 26.70] | 101.95   | <0.001   |

## Discussion

Work is a meaningful, valued occupation that contributes to social wellbeing and quality of life. Whether out of desire to work or the need to earn, return to work is an important goal for many stroke survivors. The present study examined population-level Ontario data on intention to return to work among stroke survivors receiving inpatient rehabilitation.

Our findings showed that almost half of stroke survivors working prior to their stroke intended to return to work after discharge from inpatient rehabilitation. This has implications for the provision of rehabilitation and community employment services. Services such as access to career resource centers, job preparation and counseling, education, training, job leads, and transitional work placements can assist stroke survivors with returning to work (Donker-Cools, Daams, Wind, & Frings-Dresen, 2016; Treger, Shames, Giaquinto, & Ring, 2007). System leaders and funders involved in planning should be aware that there is a fairly large number of stroke survivors intending to return to work who may need these services. In Ontario, employment services are available through the Ontario Disability Employment Support Program and Ontario Works for eligible individuals, that is, those enrolled in social assistance programs with long-term disability (Ministry of Children Community and Social Services, 2019). Publicly funded services to assist in return to work for people with disabilities are also offered by the Canada Pension Plan Disability Vocational Rehabilitation Program (Government of Canada, 2017), March of Dimes Canada Employment Services Program (March of Dimes Canada, 2017), and local hospital-based vocational rehabilitation programs and community career centres. It is unclear, however, the extent to which these services are accessible to stroke survivors who want to return to work (Brannigan et al., 2017; Grigorovich et al., 2017; Sauvé-Schenk et al., 2019; Scott & Bondoc, 2018).

This study also investigated differences in intention to return to work with respect to gender, age, and level of disability. We did not find significant differences in intention to return to work by

gender. Employment services and vocational rehabilitation should be equally directed at promoting return to work for both men and women following stroke.

In terms of age, intention to return to work was found to be higher among stroke survivors aged 55 to 64 years and under compared to those over the age of 65 years. This could be explained by younger and middle-aged stroke survivors usually facing greater demands to work because of financial need and not yet in a position to be able to retire (Hartke, Trierweiler, & Bode, 2011; Morris, 2011). Furthermore, while it may be assumed that older stroke survivors will not be returning to work, our findings showed that over one third (36.2%) of people aged 65 and older still intended to return to work. Many older stroke survivors may need to work beyond the usual retirement age, or perhaps desire to work for personal or social reasons (Vestling, Ramel, & Iwarsson, 2013). Accordingly, service providers should be attentive to the vocational needs of both younger and older stroke survivors. As people aged 65 and older may not qualify for publicly funded employment assistance, this group may be in particular need of occupational therapy services to help them return to work.

Regarding level of disability, intention to return to work was found to be higher among stroke survivors with mild disability. The reason for this could be that people with mild disability perceive return to work to be a more attainable goal (Norstedt, 2017; Schwarz, Claros-Salinas, & Streibelt, 2017). Higher functional ability at discharge is an enabling factor for meeting the physical, cognitive, and psychosocial occupational demands for return to work (Brannigan et al., 2017; Edwards, Kapoor, Linkewich, & Swartz, 2018; van Velzen, van Bennekom, van Dormolen, Sluiter, & Frings-Dresen, 2011). Although a greater proportion of stroke survivors intending to return to work had mild disability, it should be noted that there was also a considerable amount of stroke survivors intending to return to work who had moderate-severe disability (24.2%). It is therefore important that employment and vocational rehabilitation service providers recognize that stroke survivors have varying levels of disability. Support should be tailored to individual functional capacity for achieving the goal of return to

work (Coole, Radford, Grant, & Terry, 2013; Culler, Wang, Byers, & Trierweiler, 2011; Schwarz et al., 2017).

A potential limitation to consider in this study is missing data. Intention to return to work was unknown for 19.5% of stroke survivors. However, post hoc analysis did not reveal that there were systematic differences in age, gender, or level of disability between those whom intention to return to work was known and unknown. Another limitation of this study is that only stroke survivors who had received inpatient rehabilitation in Ontario were included; therefore, the findings do not reflect all people who have experienced stroke. Despite this issue, the main strength of this study was the coverage. CIHI NRS data is the most comprehensive rehabilitation data currently available and includes patient-records of stroke survivors from all facilities across the province.

Future research should investigate follow-up employment among all stroke survivors intending to return to work. Linkage of CIHI data with government or tax data would offer the opportunity to explore more accurately with a longitudinal design questions of return to work using existing data sources. In addition, future studies should look into the accessibility of services and whether stroke survivors intending to return to work are informed of and can access these resources. Lastly, as low-income status can be detrimental to participation outcomes (Egan et al., 2015; Sauvé-Schenk et al., 2019), it would be useful to conduct studies on socioeconomic differences and return to work trajectories in sustained employment, particularly for stroke survivors with low income and precarious work (Brey & Wolf, 2015; Glader, Jonsson, Norrving, & Eriksson, 2017; Trygged, Ahacic, & Kareholt, 2011; Vyas, Hackam, Silver, Laporte, & Kapral, 2016).



## **Conclusion**

This Ontario-wide study raises awareness that there are many people with stroke intending to return to work after discharge from inpatient rehabilitation. Younger and middle-aged stroke survivors and those with mild disability have high intention to return to work, although many who are over the age of 65, and who have moderate-severe disability, intend to return to work as well. Clinicians should refrain from making early assumptions about a person's expectations of returning to work. Ideally, clinicians should engage with stroke survivors at all stages of rehabilitation in conversations about work. Stroke survivors can benefit from employment and vocational rehabilitation services to facilitate successful return to work.

## **Key Messages**

- Knowledge of stroke survivors' intention to return to work can inform service planning.
- Almost half of previously employed stroke survivors intend to return to work after discharge from inpatient rehabilitation and may benefit from services to aid with employment.

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## **Conflicts of Interest**

The authors declare that there are no conflicts of interest.

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### CHAPTER 3: ESTIMATES OF RETURN TO WORK (STUDY 2)

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The manuscript has been prepared in accordance with the journal requirements, but the numbering of the tables and figures has been modified for the thesis.

## **Operational Definitions and Estimates of Return-to-Work after Stroke: A Systematic Review and Meta-Analysis**

### **Abstract**

**Objective:** To examine operational definitions of return-to-work (RTW) after stroke and provide more precise estimates of RTW through meta-analysis.

**Data Sources:** A systematic search was conducted using MEDLINE, CINAHL, PsycINFO, and SCOPUS (2005 to March 26, 2018). The search strategy involved expansion of medical subjective headings using terms related to 'stroke' and 'work'. The reference lists of review articles and included studies were checked for additional relevant studies.

**Study Selection:** Studies were included if they 1) quantitatively analyzed RTW outcomes or factors associated with RTW, 2) reported RTW outcomes for participants employed prior to stroke, and 3) were written in English or French. Two reviewers independently screened titles and abstracts. Of 7265 articles initially identified, 55 studies were included.

**Data Extraction:** Data was extracted and study quality was assessed by one reviewer and verified by a second reviewer.

**Data Synthesis:** Explicit and implicit operational definitions of RTW were determined and categorized. Ranges of RTW estimates were presented for study and participant characteristics. Pooled summary estimates were calculated for comparable studies by follow-up time post-stroke: 55.7% at one year (95% CI, 51.3% to 60.0%) and 67.4% at two years (95% CI, 60.4% to 74.4%). Similar summary estimates were noted when only population-based studies were considered: 56.7% at one year (95% CI, 48.3% to 65.1%) and 66.7% at two years (95% CI, 60.2% to 73.2%).



**Conclusions:** Operational definitions varied across studies and were often not explicitly reported. To promote comparability of RTW outcomes in future studies, we recommend working towards a universal operational definition and consistent follow-up times. The more precise estimates calculated in this review could be used as benchmarks for healthcare and social service providers.

**Key words:** stroke; acquired brain injury; return-to-work; employment; occupation; functional outcomes; daily activities

**List of abbreviations:** CI, confidence interval; RTW, return-to-work

## Introduction

Many stroke survivors experience challenges with working due to impairments and social-environmental barriers. Return-to-work (RTW) after stroke is often a valued patient-centered goal for financial and social reasons, and RTW promotes psychological wellbeing.<sup>1-4</sup> The inability to RTW has adverse effects on quality of life and contributes to loss of economic productivity.<sup>1,2,4</sup> In the United States, indirect costs of stroke from morbidity, including lost work days, has been projected at \$7.5 billion (2018), in addition to \$67.1 billion for direct medical costs and premature mortality.<sup>5</sup>

Given the importance of work for stroke survivors, an increasing number of studies have been conducted to examine factors associated with RTW.<sup>6-8</sup> However, it is difficult to interpret and compare their findings due to differences in how RTW is operationalized, that is, how it is defined as an outcome.<sup>8-11</sup> RTW can be defined in various ways as there are many activities that can be considered 'work'. Operational definitions of RTW can include activities such as part-time employment, casual work, self-employment, and being in training or a student. Definitions may also include modified work, accommodations such as reduced work schedules or changes in job tasks, to help stroke survivors resume employment in light of illness or disability.<sup>10-13</sup> A detailed review of operational definitions of RTW after stroke would bring greater awareness of the differences and similarities in definitions across studies. Clearly reporting and reaching consensus on a common definition of RTW would be important so that RTW estimates may be more comparable in future studies.

Furthermore, RTW estimates provide one indication of the success of medical treatment and rehabilitation, and can be useful for the planning of social services. Recent systematic reviews have documented the large range of current RTW estimates,<sup>8,9</sup> but no reviews to date have attempted to develop more precise estimates through meta-analysis.

The objectives of this systematic review were to (1) examine operational definitions of RTW after stroke and (2) provide more precise estimates of RTW through meta-analysis.

## Methods

### Search and study selection

A systematic search of online published literature was conducted using the databases MEDLINE, CINAHL, PsycINFO, and SCOPUS (2005 to March 26, 2018). The search strategy involved expansion of medical subjective headings and title and abstracts searching using terms related to 'stroke' and 'work'. The complete search strategy was reviewed by a health sciences librarian and is available in the supplementary material. The reference lists of review articles identified during the search, as well as the studies included in this review, were scanned for additional relevant studies. This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.<sup>14</sup>

Two reviewers (P.D. and K.S.S.) independently screened titles and abstracts, and then assessed articles in full-text for eligibility. A third reviewer (M.Y.E.) was consulted to resolve any disagreements regarding eligibility. Studies were included if they 1) quantitatively analyzed RTW outcomes or factors associated with RTW as a study objective, 2) reported RTW outcomes for participants who were employed prior to their stroke, and 3) were written in English or French. Stroke was defined according to the World Health Organization definition,<sup>15</sup> inclusive of subarachnoid and intracerebral hemorrhage, cerebral infarction, and strokes not specified as hemorrhage or infarction (ICD-10 I60, I61, I63, I64). Intervention studies, case studies, and studies that measured RTW within a broader outcome measure were excluded.

## Data collection and analysis

Data was extracted by one reviewer (P.D.) and was verified by a second reviewer (M.Y.E.). Discrepancies in data extraction were resolved through discussion. Data were extracted on the study objectives, setting, follow-up time, geographic location, sampling frame, age, sex, marital status, occupation (type of work), stroke type, disabilities, rehabilitation, operational definition of RTW, and RTW estimates.

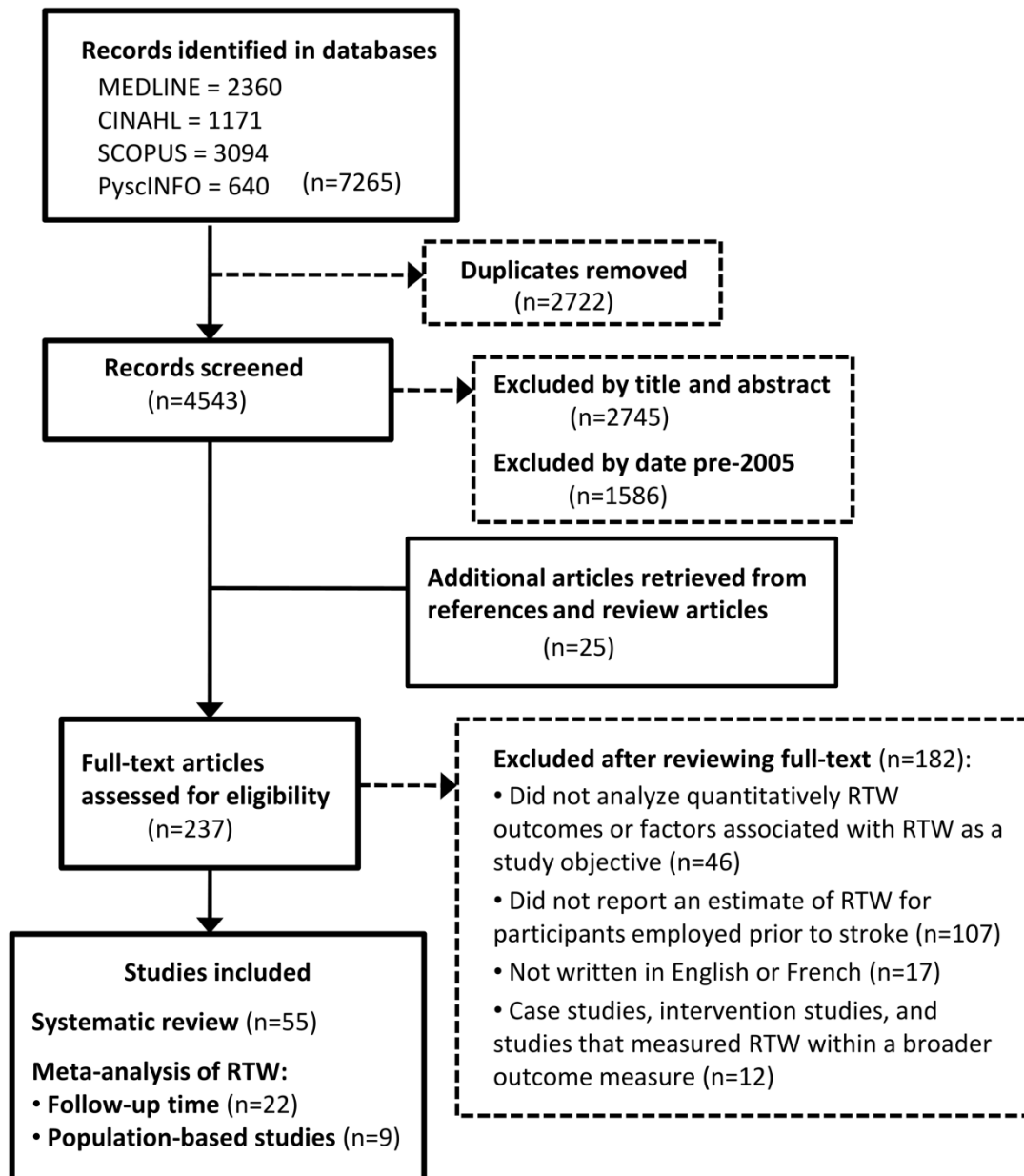
When an explicit operational definition was not reported, an implicit operational definition was determined through detailed examination of the methods and findings. Operational definitions were categorized based on similarity. Ranges of RTW estimates were presented for studies with the following similar characteristics: follow-up time post-stroke, geographic location, and type of sampling (population-based or not). Ranges of RTW estimates were also presented for the following participant characteristics: sex, marital status, occupation type (blue-collar worker or white-collar worker), type of stroke (ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, or aneurysmal subarachnoid hemorrhage), presence of aphasia or hemiplegia, and whether rehabilitation was received. The ranges of RTW estimates for age and severity of disability were not presented because the measurement and stratification for these characteristics differed between studies, which precluded aggregating this data.

RTW estimates were pooled for sufficiently comparable studies. Summary estimates (with 95% confidence intervals, CIs, and statistics for heterogeneity, tau-squared and I-squared) were calculated using a random-effects model with the Der Simonian-Laird estimator (R package 'Metafor').

Study quality was assessed by one reviewer (P.D.) and was verified by a second reviewer (M.Y.E.), using the Joanna Briggs Institute critical appraisal instrument for studies reporting prevalence data.<sup>16</sup> This included assessing the appropriateness of study sampling and setting, outcome measurement, statistical analyses, and response rate.

## Results

The study selection process is shown in **Figure 3.1**. The database search retrieved 7265 records, of which 237 full-text articles were assessed for eligibility. In total, 55 studies were included in this review.<sup>17–71</sup>



**Figure 3.1.** Flow diagram of study selection. RTW indicates return-to-work

Operational definitions of RTW after stroke

An operational definition of RTW was explicitly stated in 33 of 55 studies. A complete list and summary of operational definitions are available in the supplementary material (Table 3.2-3.3). Two main types of operational definitions were identified. Definitions were based on employment classification, or income/benefit status (Figure 3.2).

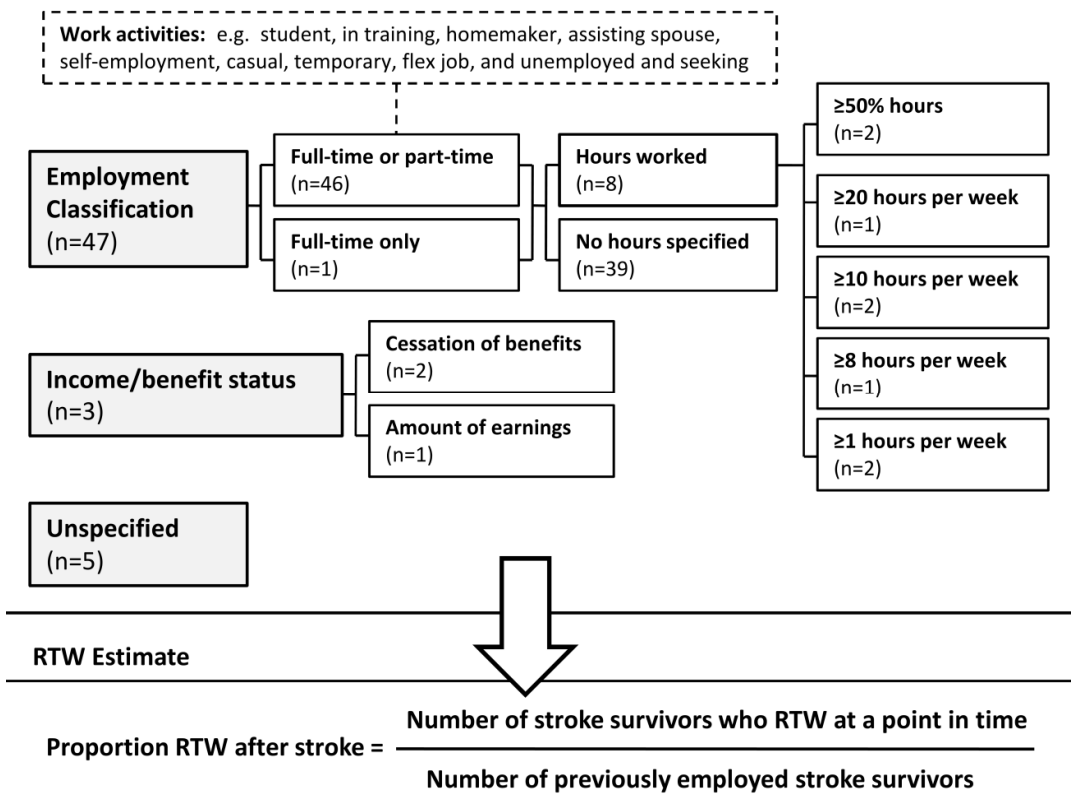


Figure 3.2. Operational definitions of RTW after stroke (n=55). RTW indicates return-to-work

The most common operational definitions of RTW were based on the classification of employment status. With the exception of one study categorizing only full-time work as RTW,<sup>62</sup> 46 studies considered the resumption of full-time or part-time work as a successful RTW outcome.<sup>19–28,30–</sup>

<sup>33,36–45,47–53,55,56,58–68,70,71</sup> Eight of these studies also required a minimum number of hours worked, which varied from one to 20 hours per week, or 50% or more of previous work schedule.<sup>31,41,44,53,61,63,69,71</sup>

Specific work activities that constituted RTW differed across studies. Being a student or 'in training'

explicitly qualified as RTW in eight studies,<sup>33,39,44,53,61,63,69,71</sup> but was explicitly excluded in 14 other studies.<sup>21,31,37,42,43,45,48,49,51,56,65,66,68,70</sup> Homemaking explicitly counted as RTW in one study,<sup>65</sup> and was explicitly excluded in nine other studies.<sup>21,26,31,37,39,48,51,56,66,68</sup> 'Assisting spouse' was explicitly considered RTW in four studies,<sup>41,42,45,49</sup> as was self-employment in 11 studies.<sup>21,27,33,38,41,42,45,49,51,55,59</sup> Other work activities qualifying as RTW included casual work,<sup>41,61</sup> temporary work,<sup>41</sup> flex job,<sup>44</sup> and 'unemployed and seeking work'.<sup>33,56,63,71</sup>

One study defined RTW in terms of work income.<sup>46</sup> In this study from Sweden, earnings of at least €6,600 (approximately \$9,000 USD as of 2011) were required to be considered RTW. Two studies defined RTW using a system-based approach that depended on benefits status. The first study, from Spain, defined RTW as the "finalization of sickness absence due to improvement of symptoms and functioning."<sup>34</sup> The second study, from Sweden, defined RTW as "no longer being registered on sickness compensation or sickness benefit (neither full time nor part time)."<sup>18</sup>

Five studies did not report sufficient information to determine how RTW was defined.<sup>17,29,35,54,57</sup>

### **Estimates of RTW after stroke**

The methodological quality of individual studies was judged to be adequate overall according to the Joanna Briggs Institute criteria. However, reporting with respect to follow-up time was unclear or not described in some studies. RTW estimates were reported as a time period (e.g. two to five years) in seven studies,<sup>19,27,36,38,52,55,65</sup> as a minimum time post-stroke (e.g. at least 3 years) in six studies,<sup>21,33,38,40,43,57</sup> and as an average time post-stroke in two studies.<sup>20,54</sup> Follow-up time was not specified in three studies.<sup>60,66,67</sup> The sampling frame was not clearly described in three studies,<sup>39,40,57</sup> and the participant inclusion and exclusion was unclear in five studies.<sup>32,53,54,60,66</sup> There were discrepancies in the reported data in three studies; estimates from those studies were excluded from the results.<sup>25,32,69</sup>

RTW estimates and the characteristics of included studies are presented in **Table 3.1**. The majority of estimates were from single-centre (n=26) or multi-centre (n=15) studies that recruited

people who had been hospitalized following stroke. The remaining estimates were from studies that sampled across a larger region, using workers' compensation, benefits, or insurance records (n=4), and population-based studies aimed at capturing all stroke cases in a predefined area, using multiple data sources including stroke registers or databases (n=9)

Across all studies, RTW ranged from 4.0% to 90.9%. Over half of the studies were European and a large range of estimates was seen among these studies, 7.3% to 89.5% (n=28).<sup>18–20,22,23,30,33,34,39,42–49,53–59,63,65,67,71</sup> RTW was relatively high in Denmark, 47.8% to 72.3% (n=5),<sup>20,42,44,45,49</sup> and in the Netherlands, 39.1% to 78.9% (n=5).<sup>19,23,48,57,65</sup> RTW in studies from the United States also had a large range from 16.4% to 63.3% (n=8).<sup>17,24,29,31,36,52,66,70</sup>

Reporting of stratified results differed between studies. Stratified participant characteristics included sex, relationship status, occupation type, stroke type, presence of aphasia or hemiplegia, and whether rehabilitation was received. RTW for men was 20.0% to 76.0% (n=26), and for women, 25.0% to 72.5% (n=26).<sup>18,19,22,23,26–29,31,35–38,41,43,44,46,49,50,55,56,59,62,67,70,71</sup> For stroke survivors who were married or in a relationship, RTW was 40.0% to 73.9% (n=9).<sup>23,26,27,31,36,38,41,43,70</sup> RTW for blue-collar workers (manual labour and jobs with basic skill requirement) was 23.5% to 71.9% (n=9) and for white-collar workers (desk job, clerical, manager, official, professional, technician, and associate professional), 35.0% to 87.5% (n=12). RTW after ischemic stroke was 26.9% to 83.7% (n=21),<sup>18,19,22,23,26–28,34,35,37,39,41,43,46,49,50,55,56,59,62,64</sup> intracerebral hemorrhage, 14.3% to 77.0% (n=12),<sup>18,22,28,34,37,41,46,49,50,56,59,62</sup> subarachnoid hemorrhage, 29.0% to 78.5% (n=7),<sup>28,37,46,49,50,59,62</sup> and aneurysmal subarachnoid hemorrhage, 44.2% to 74.2% (n=7).<sup>29,30,36,40,48,65,70</sup> In the presence of aphasia, RTW was 14.5% to 54.5% (n=4),<sup>27,37,44,50</sup> and in the presence of hemiplegia, 18.2% to 60.2% (n=4).<sup>37,50,59,61</sup> There was a large range in RTW for stroke survivors who received inpatient or outpatient rehabilitation, 7.3% to 90.9% (n=14).<sup>17,20,23,26,27,33,38,43,53,56,62–64,67</sup>



**Table 3.1.** Estimates of RTW after stroke by follow-up time (66 estimates, n=52 studies)

| First Author                               | RTW, % | Sample size | Follow-up time | Age (range), years* | Stroke type  | Location      | Sampling and setting/data source                                         |
|--------------------------------------------|--------|-------------|----------------|---------------------|--------------|---------------|--------------------------------------------------------------------------|
| Follow-up: specific time point post-stroke |        |             |                |                     |              |               |                                                                          |
| Skolarus, 2016                             | 40.0   | 125         | 3 months       | n/s (≥45)           | n/s          | United States | Population-based (county); Register/database (stroke)                    |
| Crago, 2016                                | 44.2   | 52          | 3 months       | 50.4 (21-75)        | aSAH         | United States | Single-centre (hospital); Intensive care unit                            |
| McAllister, 2013                           | 45.1   | 82          | 3 months‡      | 55.0 (18-64)        | n/s          | New Zealand   | Regional (districts); Register/database (compensation, benefits)         |
| Fride, 2015                                | 69.9   | 163         | 3 months       | 63.8 (50-89)        | IS           | Israel        | Single-centre (hospital); Emergency department                           |
| Kauranen, 2013                             | 41.4   | 140         | 6 months       | 52.0 (18-65)        | IS           | Finland       | Multi-centre (2 hospitals)                                               |
| Al Yassin, 2017                            | 49.2   | 130         | 6 months       | n/s                 | aSAH         | United States | Single-centre (hospital)                                                 |
| Glozier, 2008                              | 53.3   | 210         | 6 months       | 55.0 (≥15)          | IS, ICH, SAH | New Zealand   | Population-based (city); Multiple data sources                           |
| Van Patten, 2016                           | 59.4   | 244         | 6 months       | n/s (25-87)         | n/s          | United States | Multi-centre (2 hospitals, rehab centre); Register/database (stroke)     |
| Chang, 2016                                | 60.0   | 933         | 6 months       | 57.0 (≥19)          | IS, HEM      | Korea         | Multi-centre (9 hospitals); Inpatient                                    |
| Hofgren, 2010                              | 10.4   | 48          | 12 months      | 53.0 (29-62)        | n/s          | Sweden        | Single-centre (hospital); Inpatient rehab                                |
| Gabriele, 2009                             | 26.7   | 60          | 12 months      | 52.4 (30-65)        | IS, ICH      | Germany       | Multi-centre (4 rehab centres); Inpatient rehab, neurological clinic     |
| Busch, 2009                                | 35.3   | 266         | 12 months      | 53.8 (n/s)          | IS, ICH, SAH | England       | Population-based (city); Register/database (stroke)                      |
| Westerlind, 2017                           | 48.3   | 174         | 12 months      | 53.0 (21-63)†       | IS, ICH      | Sweden        | Single-centre (hospital); Stroke unit, neurosurgery, intensive care unit |
| McAllister, 2013                           | 48.8   | 82          | 12 months      | 55.0 (18-64)        | n/s          | New Zealand   | Regional (districts); Register/database (compensation, benefits)         |

| First Author       | RTW,<br>% | Sample<br>size | Follow-up<br>time | Age (range),<br>years*    | Stroke<br>type | Location      | Sampling and setting/data<br>source                                             |
|--------------------|-----------|----------------|-------------------|---------------------------|----------------|---------------|---------------------------------------------------------------------------------|
| Crago, 2016        | 51.9      | 52             | 12 months         | 50.4 (21-75)              | aSAH           | United States | Single-centre (hospital); Intensive care unit                                   |
| Wallmark, 2016     | 52.0      | 50             | 12 months         | 58.0 (≥19)                | aSAH           | Sweden        | Single-centre (hospital); Neurosurgery department                               |
| Andersen, 2012     | 53.0      | 83             | 12 months         | 53.8 (n/s) <sup>†</sup>   | n/s            | Denmark       | Single-centre (hospital); Stroke unit                                           |
| Hommel, 2009       | 54.4      | 68             | 12 months         | 43.5 (n/s)                | IS, HEM        | France        | Single-centre (hospital); Stroke unit                                           |
| Lindgren, 2017     | 54.8      | 62             | 12 months         | 41.5 (29-51) <sup>†</sup> | CVT            | Sweden        | Single-centre (hospital); Register/database (institutional)                     |
| Hannerz, 2011      | 71.3      | 19,903         | 12 months         | n/s (20-54)               | IS, ICH, SAH   | Denmark       | Population-based (nationwide); Register/database (occupational hospitalization) |
| van der Kemp, 2017 | 71.9      | 121            | 12 months         | 56.3 (≥18)                | IS, HEM        | Netherlands   | Multi-centre (6 hospitals); Stroke unit                                         |
| Glader, 2017       | 74.0      | 2539           | 12 months         | n/s (25-55)               | IS, ICH        | Sweden        | Population-based (nationwide); Register/database (stroke)                       |
| Hackett, 2012      | 74.5      | 271            | 12 months         | 51.0 (18-64)              | IS, ICH, SAH   | Australia     | Multi-centre (20 hospitals); Stroke network                                     |
| Alfieri, 2011      | 89.5      | 38             | 12 months         | 44.3 (18-80)              | naSAH          | Italy         | Single-centre (hospital)                                                        |
| Tanaka, 2014       | 51.2      | 250            | 18 months         | 55.3 (21-64)              | IS, ICH, SAH   | Japan         | Multi-centre (21 hospitals)                                                     |
| Saeki, 2010        | 54.5      | 253            | 18 months         | 55.1 (15-64)              | IS, ICH, SAH   | Japan         | Multi-centre (21 hospitals)                                                     |
| Andersen, 2012     | 57.8      | 83             | 2 years           | 53.8 (n/s) <sup>†</sup>   | n/s            | Denmark       | Single-centre (hospital); Stroke unit                                           |
| Hannerz, 2011      | 62.2      | 19,903         | 2 years           | n/s (20-54)               | IS, ICH, SAH   | Denmark       | Population-based (nationwide); Register/database (occupational hospitalization) |
| Hannerz, 2012      | 65.7      | 12,106         | 2 years           | 47.6 (21-57)              | IS, ICH, SAH   | Denmark       | Population-based (nationwide); Register/database (occupational hospitalization) |
| Hannerz, 2012      | 72.3      | 1,797          | 2 years           | n/s (20-57)               | IS, ICH, SAH   | Denmark       | Population-based (nationwide); Register/database (occupational hospitalization) |

| First Author                        | RTW,<br>% | Sample<br>size | Follow-up<br>time | Age (range),<br>years* | Stroke<br>type  | Location         | Sampling and setting/data<br>source                                                   |
|-------------------------------------|-----------|----------------|-------------------|------------------------|-----------------|------------------|---------------------------------------------------------------------------------------|
| Alfieri, 2011                       | 81.6      | 38             | 2 years           | 44.3 (18-80)           | naSAH           | Italy            | Single-centre (hospital)                                                              |
| Hannerz, 2011                       | 60.8      | 19,903         | 3 years           | n/s (20-54)            | IS, ICH,<br>SAH | Denmark          | Population-based (nationwide);<br>Register/database (occupational<br>hospitalization) |
| Passier, 2011                       | 61.4      | 88             | 3 years           | 51.4 (n/s)             | aSAH            | Netherlands      | Single-centre (hospital)                                                              |
| Hannerz, 2011                       | 58.5      | 19,903         | 4 years           | n/s (20-54)            | IS, ICH,<br>SAH | Denmark          | Population-based (nationwide);<br>Register/database (occupational<br>hospitalization) |
| Hannerz, 2011                       | 56.3      | 19,903         | 5 years           | n/s (20-54)            | IS, ICH,<br>SAH | Denmark          | Population-based (nationwide);<br>Register/database (occupational<br>hospitalization) |
| Alfieri, 2011                       | 81.6      | 38             | 5 years           | 44.3 (18-80)           | naSAH           | Italy            | Single-centre (hospital)                                                              |
| Westerlind,<br>2017                 | 74.7      | 174            | 6 years           | 53.0 (21-63)†          | IS, ICH         | Sweden           | Single-centre (hospital); Stroke<br>unit, neurosurgery, intensive care<br>unit        |
| Alfieri, 2011                       | 76.3      | 38             | 7 years           | 44.3 (18-80)           | naSAH           | Italy            | Single-centre (hospital)                                                              |
| Follow-up: time period post-stroke  |           |                |                   |                        |                 |                  |                                                                                       |
| Peters, 2013                        | 42.1      | 101            | 3-12 months       | 47.2 (24-90)           | n/s             | Nigeria          | Multi-centre (7 hospitals);<br>Outpatient physiotherapy                               |
| Bonner, 2016                        | 52.5      | 141            | 3-24 months       | 48.0 (≥18)             | IS,<br>HEM      | India            | Multi-centre (2 hospitals); Stroke<br>clinic                                          |
| O'brien, 2010                       | 63.3      | 98             | 6-18 months       | 52.0 (30-65)           | n/s             | United<br>States | Single-centre (hospital);<br>Register/database (institutional)                        |
| Lindström,<br>2009                  | 65.5      | 818            | 8-30 months       | n/s (18-55)            | IS,<br>HEM      | Sweden           | Population-based (nationwide);<br>Register/database (stroke)                          |
| Harris, 2014                        | 56.0      | 134            | 12-24 months      | 52.2 (25-65)           | aSAH            | United<br>States | Single-centre (hospital)                                                              |
| Peters, 2013                        | 58.8      | 101            | 13-24 months      | 47.2 (24-90)           | n/s             | Nigeria          | Multi-centre (7 hospitals);<br>Outpatient physiotherapy                               |
| Peters, 2013                        | 90.9      | 101            | 25-36 months      | 47.2 (24-90)           | n/s             | Nigeria          | Multi-centre (7 hospitals);<br>Outpatient physiotherapy                               |
| Arwert, 2016                        | 39.1      | 46             | 2-5 years         | 47.7 (20-90)           | IS,<br>HEM      | Netherlands      | Single-centre (hospital);<br>Register/database (institutional)                        |
| Wermer, 2007                        | 74.2      | 565            | 2.3-18.8 years    | 53.4 (24-70)           | aSAH            | Netherlands      | Multi-centre (2 hospitals)                                                            |
| Follow-up: minimum time post-stroke |           |                |                   |                        |                 |                  |                                                                                       |

| First Author                                                    | RTW,<br>% | Sample<br>size | Follow-up<br>time                                      | Age (range),<br>years* | Stroke<br>type  | Location         | Sampling and setting/data<br>source                                                          |
|-----------------------------------------------------------------|-----------|----------------|--------------------------------------------------------|------------------------|-----------------|------------------|----------------------------------------------------------------------------------------------|
| Huang, 2017                                                     | 4.0       | 2963           | at least 6<br>months                                   | n/s (<60)              | n/s             | Taiwan           | Regional (nationwide);<br>Register/database (long-term<br>disability)                        |
| Schweizer,<br>2012                                              | 60.0      | 25             | at least 6<br>months                                   | 55.2 (n/s)             | aSAH            | Canada           | Single-centre (hospital);<br>Register/database (institutional,<br>research)                  |
| Koopman,<br>2009                                                | 78.9      | 38             | at least 12<br>months                                  | 31.0 (16-68)†          | CVT             | Netherlands      | Single-centre (hospital);<br>Register/database (institutional)                               |
| Autret, 2015                                                    | 64.3      | 28             | at least 2 years                                       | 43.7 (18-60)           | IS,<br>HEM      | France           | Single-centre (rehab centre);<br>Professional reintegration unit<br>(vocational)             |
| Doucet, 2012                                                    | 32.1      | 56             | at least 3 years                                       | 48.3 (18-65)           | IS,<br>HEM      | France           | Single-centre (hospital); Rehab                                                              |
| Peters, 2013                                                    | 75.0      | 101            | at least 3 years                                       | 47.2 (24-90)           | n/s             | Nigeria          | Multi-centre (7 hospitals);<br>Outpatient physiotherapy                                      |
| Follow-up: specific time point after discharge or another event |           |                |                                                        |                        |                 |                  |                                                                                              |
| Tanaka, 2011                                                    | 30.0      | 335            | 1 month after<br>discharge from<br>hospital            | 55.2 (15-64)           | IS, ICH         | Japan            | Multi-centre (21 hospitals)                                                                  |
| Schulz, 2017                                                    | 16.4      | 73             | 12 months<br>after discharge<br>from hospital          | n/s (40-86)            | IS,<br>HEM      | United<br>States | Multi-centre (5 hospitals);<br>Inpatient rehab                                               |
| Trygged, 2011                                                   | 68.7      | 7081           | 4 years after<br>discharge from<br>hospital            | n/s (40-59)            | IS, ICH,<br>SAH | Sweden           | Population-based (nationwide);<br>Register/database (inpatient)                              |
| McLean, 2007                                                    | 45.7      | 46             | 6 months<br>discharge from<br>rehabilitation           | n/s (21-65)            | IS,<br>HEM      | Singapore        | Single-centre (hospital); Inpatient<br>rehab                                                 |
| Hofgren, 2007                                                   | 7.3       | 55             | 12 months<br>after discharge<br>from<br>rehabilitation | 52.0 (28-64)           | IS, ICH         | Sweden           | Single-centre, hospital; Inpatient<br>rehab, vocational rehab                                |
| Ownsworth,<br>2008                                              | 37.0      | 27             | 12 months<br>follow-up<br>since<br>rehabilitation      | 47.3 (24-62)           | IS, ICH,<br>SAH | Australia        | Multi-centre (2 hospitals, rehab<br>centre); Outpatient rehab,<br>community vocational rehab |

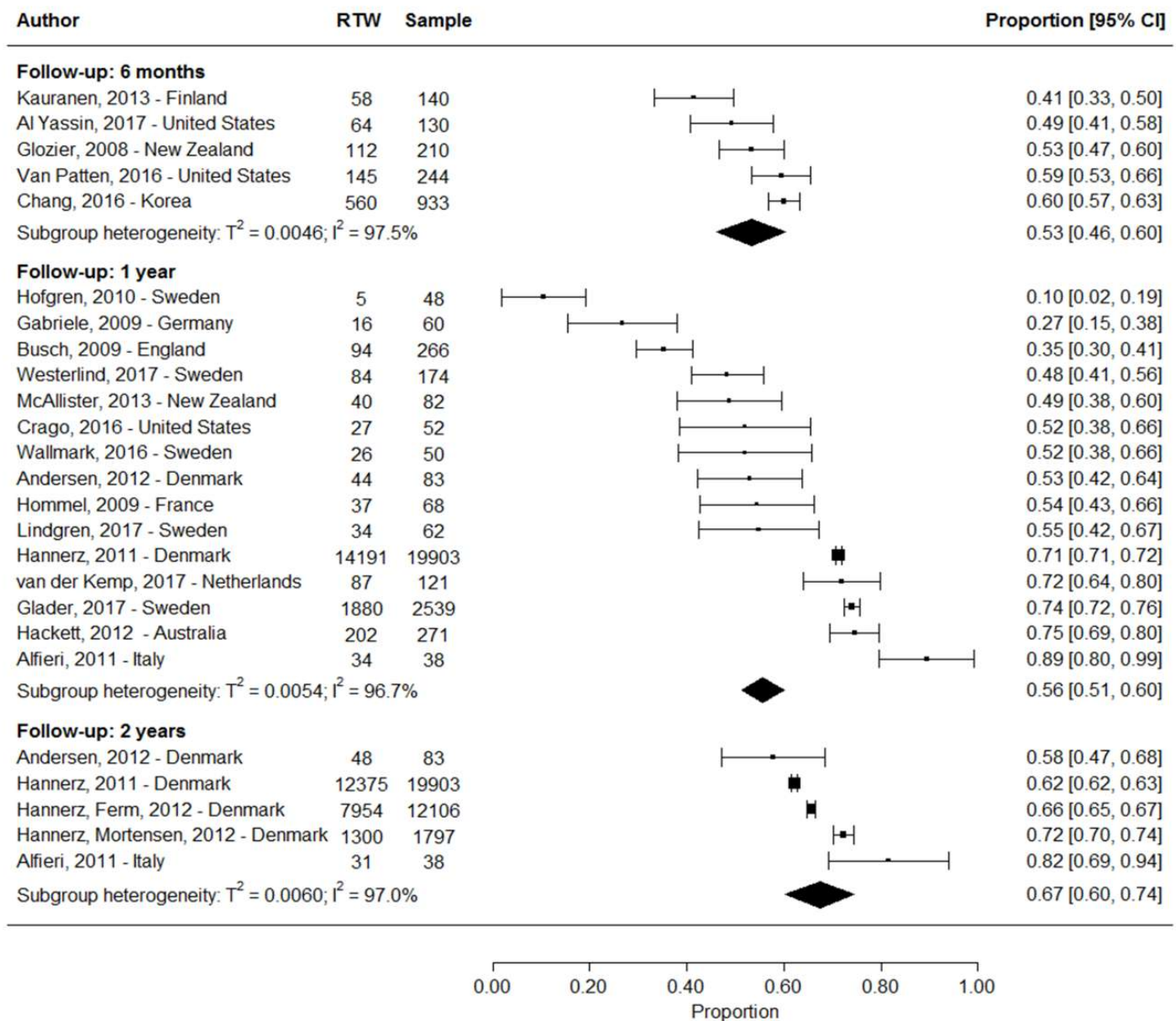
| First Author             | RTW,<br>% | Sample<br>size | Follow-up<br>time                                        | Age (range),<br>years*          | Stroke<br>type  | Location         | Sampling and setting/data<br>source                                                                         |
|--------------------------|-----------|----------------|----------------------------------------------------------|---------------------------------|-----------------|------------------|-------------------------------------------------------------------------------------------------------------|
| Catalina-Romero, 2015    | 66.4      | 232            | at end of<br>sickness<br>absence                         | n/s                             | IS,<br>HEM      | Spain            | Regional (nationwide);<br>Register/database (sickness<br>absence, benefits)                                 |
| Endo, 2016               | 74.5      | 380            | 12 months<br>after initial<br>day of sickness<br>absence | 52.7 (n/s)                      | IS, ICH,<br>SAH | Japan            | Single-centre (private<br>occupational health centre);<br>Register/database (sickness<br>absence, benefits) |
| Follow-up: not specified |           |                |                                                          |                                 |                 |                  |                                                                                                             |
| Chan, 2008               | 55.2      | 29             | n/s                                                      | n/s                             | n/s             | Singapore        | Single-centre, community centre;<br>Vocational assessment centre                                            |
| Vestling, 2005           | 35.4      | 65             | n/s                                                      | 54.0 ( $\leq 65$ ) <sup>†</sup> | IS,<br>HEM      | Sweden           | Single-centre (hospital); Rehab                                                                             |
| Beseoglu, 2010           | 42.9      | 14             | n/s, mean 32.7<br>months after<br>stroke                 | n/s (31-74)                     | naSAH           | Germany          | Single-centre (hospital);<br>Neurosurgery department                                                        |
| Menemeyer, 2006          | 22.3      | 121            | n/s                                                      | n/s                             | n/s             | United<br>States | Single-centre (hospital);<br>Outpatient rehab                                                               |
| Larsson-Lund, 2017       | 47.8      | 67             | n/s, mean 6<br>years after<br>stroke                     | n/s (23-65)                     | n/s             | Denmark          | Single-centre (hospital);<br>Registry/database (institutional,<br>inpatient rehab)                          |

n/s indicates not specified; IS, ischemic stroke; HEM, hemorrhagic ICH, intracerebral hemorrhage; SAH, subarachnoid hemorrhage; aSAH, aneurysmal subarachnoid hemorrhage; naSAH, nonaneurysmal subarachnoid hemorrhage; CVT, cerebral venous thrombosis

\*mean age, unless otherwise indicated, (†) median age

‡(McAllister, 2013) follow-up approximately 3.5 months after stroke

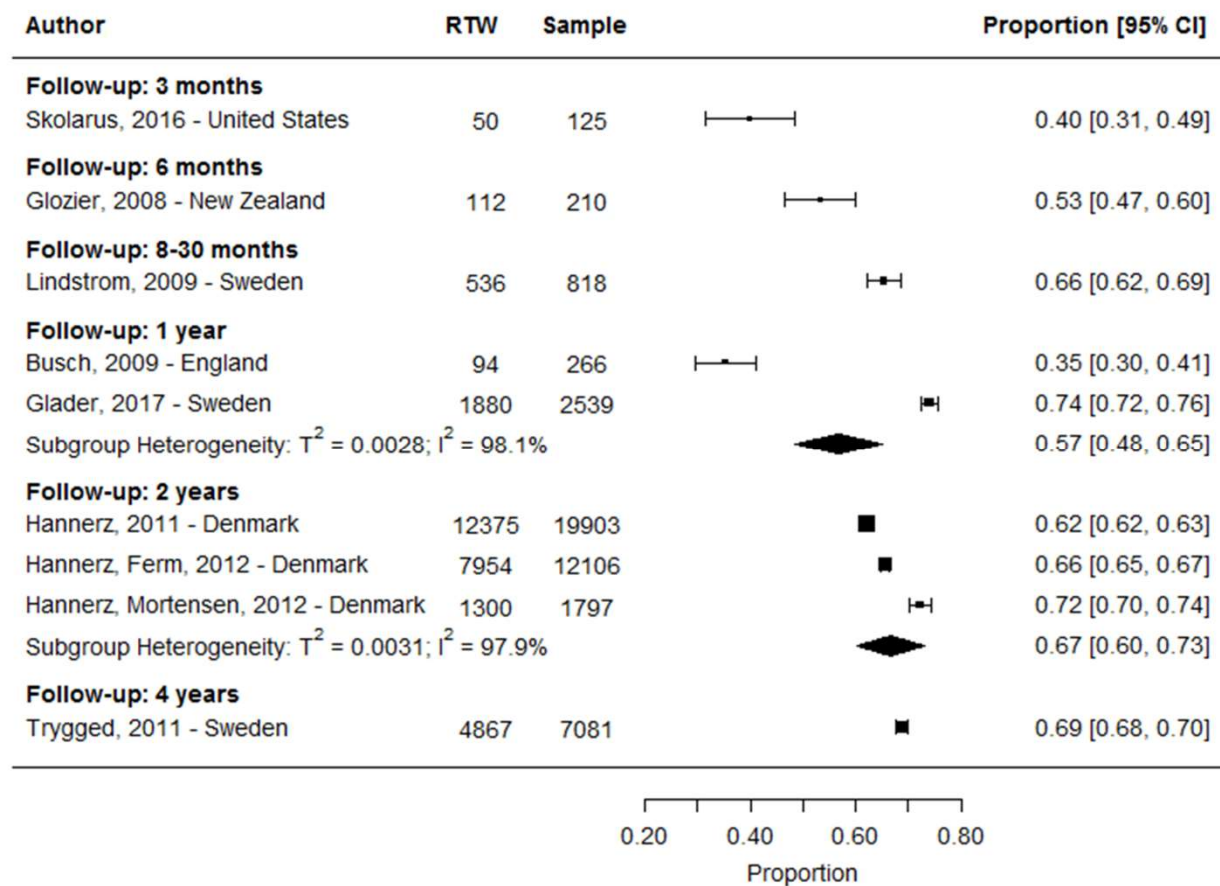
Pooled summary estimates could be calculated for follow-up time at six months, one year, and two years post-stroke (**Figure 3.3**). RTW appeared to increase with greater follow-up time: 53.2% at six months (95% CI, 46.2% to 60.3%; n=5),<sup>26,31,39,62,70</sup> 55.7% at one year (95% CI, 51.3% to 60.0%; n=15),<sup>18,22,23,29,30,41,44,47,49,53,56,58,59,68,71</sup> and 67.4% at two years (95% CI, 60.4% to 74.4%; n=5).<sup>42,44,45,47,49</sup>



**Figure 3.3.** Forest plot of RTW estimates for follow-up time post-stroke. RTW indicates return-to-work; CI, confidence interval

Summary estimates were similar when only population-based studies were considered (**Figure 3.4**):

56.7% at one year (95% CI, 48.3% to 65.1%;  $n=2$ )<sup>22,59</sup> and 66.7% at two years (95% CI, 60.2% to 73.2%;  $n=3$ ).<sup>42,45,49</sup>



**Figure 3.4.** Forest plot of RTW estimates for population-based studies. RTW indicates return-to-work; CI, confidence interval

Additional details on population-based studies are available in the supplementary material (**Table 3.4**).

## Discussion

The first objective of this systematic review was to examine operational definitions of RTW. Determining operational definitions was complicated by a number of issues. Many studies (22 of 55) did not explicitly report an operational definition, and the implicit operational definition used in the study could be determined only through careful examination of the data. As well, other studies reported definitions that were subject to interpretation,<sup>22,30,31,55,67</sup> for example, "returned to work was defined as having returned to work to at least some extent."<sup>30</sup> The findings of this review substantiate previous studies that had raised concerns about how RTW after stroke has been inconsistently defined and measured.<sup>8-12,72</sup> Additionally, while operational definitions were primarily based on the classification of employment status, specifically full-time or part-time work, there was variation in which activities qualified as work (e.g. being in studies and homemaking). The minimum required number of working hours per week also varied and was often not specified. There were no remarkable patterns or differences in operational definitions across studies conducted in different countries. Even less ideal were operational definitions using proxy measures, such as income or the cessation of benefit status. These measures could lead to invalid estimates. For instance, a stroke survivor who ceased receiving benefits may not have returned to work if the cessation of benefits resulted from surpassing the maximum duration of benefits, rather than work resumption. Although data regarding benefit status may be more readily available, it may lead to overestimation of RTW.

The variation and ambiguity in definitions of RTW suggests the need to develop a clear universal operational definition. As a starting point, based on the findings from our review, we recommend that this definition include paid full-time and part-time employment since almost all studies (46 of 47) had considered this type of work. The universal operational definition should also include self-employment, regular, and modified work since conceptually and practically it would be reasonable for these to be considered within the definition of RTW (and no studies had explicitly excluded these work activities).



Unpaid activities, such as studying or homemaking, should be explicitly added to the definition or excluded if the focus is only on return to paid work. In addition, the definition should specify a committed average number of hours of work each week so as to include seasonal work and self-employment, but exclude odd jobs or irregular work. There was no agreement among studies on the required number of hours for RTW. Accordingly, we propose the following preliminary universal operational definition: *the resumption of any paid work full-time or part-time, inclusive of self-employment, in a regular or modified capacity, for a committed average number of hours of work each week*. This definition could be further supplemented depending on the context since RTW is influenced by socio-political factors.<sup>72</sup> There may be reasons to add additional information to respect regional work and labour policies and to meet local data needs.<sup>18,25,46</sup> It would be beneficial for the future that an international group of researchers and other stakeholders, including patients, clinicians, public health professionals, and database administrators, discuss and arrive at consensus on this universal operational definition, including the committed average number of hours of work required for RTW.

There was broad international representation of studies in this review. RTW estimates were found to vary widely between studies conducted both within and between countries. While RTW estimates can be affected by operational definitions used in a particular study, estimates can also be influenced by regional differences in service provision and lifestyles.<sup>10,72</sup> It should be taken into consideration that almost all estimates were from economically developed countries, the majority from Europe, where stroke care and social benefits for people with disabilities may be more available compared to other countries. Notably, there were only two studies from less economically developed countries (India and Nigeria).<sup>27,38</sup> In both of these studies, the RTW estimates were relatively high, even though their operational definitions, which included full-time, part-time and self-employment, were similar to other studies from different parts of the world. The higher than expected RTW estimates might reflect survival bias – poorer survival among people with severe strokes who are then not

included in the study sample – or possibly a greater necessity to resume work in the absence of government sponsored income supports.

Previous studies have noted that the large range in RTW estimates can be attributed to variability in length of follow-up time across studies.<sup>8,9,11</sup> Most recently, a review in 2017 by Edwards et al., reported that RTW ranged from 7.3% to 74.5%, with follow-up varying from less than one month up to a mean of 11.9 years, across 29 studies.<sup>8</sup> Similarly, in our review, we found that RTW estimates ranged from 4.0% to 90.9%, with follow-up varying from less than one month to 18.8 years, across 52 studies. Length of follow-up seems to be an important determinant of RTW, and this is another potential area for international researchers to discuss and make recommendations for standardization in RTW studies. Ideally, RTW estimates should be measured and reported at the same follow-up time points for all participants across studies. We found that RTW was most commonly measured and reported at a follow-up of six months, one year, and two years post-stroke. Therefore, if future studies consistently used these follow-up time points, estimates would be more comparable. Moreover, researchers may wish to consider using time-to-event analysis for more precise estimates of RTW at specific follow-up time periods.<sup>12</sup> Only eight studies had analyzed RTW with this approach.<sup>18,25,28,37,41,51,69,71</sup>

The second objective of this review was to provide more precise estimates of RTW through meta-analysis. Prior to the present, the best summary estimates of RTW were, "41% between 0 and 6 months, 53% at 1 year, 56% at 1.5 years to 66% between 2 and 4 years post-stroke," from the aforementioned review in 2017 by Edwards et al.<sup>8</sup> However, these estimates were derived using medians that do not account for sample sizes, and the follow-up time intervals of 'zero to six month' and 'two to four years' were relatively variable. Our review provides more precise summary estimates of RTW at specific time points using meta-analysis.

In addition to RTW estimates by follow-up time, healthcare and social service providers may also be interested in RTW estimates by participant characteristics. However, it would only be possible to

provide meaningful summary estimates that take into consideration multiple participant characteristics (e.g. age, sex, and disability status) with multivariate analyses using individual patient-level data, which is unlikely to be feasible. In light of this, our meta-analysis of population-based studies provided the most precise RTW summary estimates from studies with larger, representative samples that best reflect the overall stroke population. These estimates begin to provide a defensible baseline for evaluation of interventions and policies that aim to help people RTW following stroke.

### **Limitations**

In terms of limitations, while we carried out a thorough search of the published literature, potentially relevant research from the grey literature may have been missed. As well, we did not formally assess publication bias. However, we consider the possibility of publication bias to be minimal since it is not foreseen that unpublished studies would be systematically different, in terms of the operational definitions or estimates of RTW, than the studies included in our review.

### **Conclusions**

This review examined operational definitions of RTW after stroke. Operational definitions were often not explicitly reported and varied across studies. To facilitate comparison of RTW outcomes in future studies, operational definitions should be clearly reported. Furthermore, we recommend that international researchers and stakeholders discuss and establish consensus on a universal operational definition and the average number of hours of work per week required for RTW.

This review also sought to determine more precise estimates of RTW through meta-analysis. While there is large variability in the range of RTW estimates across individual studies, pooling of studies with the same follow-up time provided more precise summary estimates. These summary estimates can be useful as current benchmarks for healthcare and social service providers striving to improve this

outcome. To further improve comparability across studies, researchers should discuss and make recommendations on consistently measuring and reporting RTW at common follow-up time points such as six months, one year, and two years post-stroke.

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**Conflicts of Interest**

The authors declare that there are no conflicts of interest.

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## Supplementary Material

### Supplementary material – search strategy

#### MEDLINE (via OVID)

1. exp stroke/ or exp brain ischemia/ or exp basal ganglia cerebrovascular disease/ or exp carotid artery diseases/ or exp cerebral small vessel diseases/ or exp cerebrovascular trauma/ or exp intracranial arterial diseases/ or exp "intracranial embolism and thrombosis"/ or exp intracranial hemorrhages/
2. (stroke\$ or poststroke or CVA\$ or brain attack\$ or acquired brain).tw.
3. ((cerebrovascular or cerebral) adj5 (accident\$ or trauma\$ or disorder\$ or isch?emi\$ or infarct\$ or insufficienc\$ or insult\$ or occlus\$ or anoxi\$ or hypoxi\$ or h?emorrhag\$ or bleed\$ or h?ematoma\$ or emboli\$ or thromb\$ or apople\$)).tw.
4. ((brain or left hemisphere or right hemisphere or intracranial or intracerebral or basal gangli\$ or brainstem or subcortical or vertebrobasilar or basilar or cerebellar or lacunar) adj5 (isch?emi\$ or infarct\$ or insufficienc\$ or insult\$ or occlus\$ or anoxi\$ or hypoxi\$ or h?emorrhag\$ or bleed\$ or h?ematoma\$ or emboli\$ or thromb\$ or apople\$)).tw.
5. ((epidural or extradural or extra-dural or subdural or sub-dural or subarachnoid) adj3 (h?emorrhag\$ or bleed\$ or h?ematoma\$)).tw.
6. (TIA or transient cerebr\$ or transient isch?emi\$).tw.
7. 1 or 2 or 3 or 4 or 5 or 6
8. exp supported employment/ or exp return to work/ or exp unemployment/ or exp workplace/
9. exp rehabilitation, vocational/ or exp vocational guidance/ or exp absenteeism/ or exp job satisfaction/
10. exp occupational health/ or exp occupational health services/ or exp occupational medicine/
11. (work\$ or job\$ or employ\$ or occupation\$ or vocation\$) adj5 (return\$ or resum\$ or re-entry or outcome\$ or status\$ or previous\$ or former\$).tw.
12. ((work\$ or job\$ or employ\$ or duties) adj1 (disabilit\$ or loss or capacit\$ or abilit\$ or adapt\$ or adjust\$ or modifi\$ or accommodat\$ or support\$)).tw.
13. (RTW or re-employ\$ or reemploy\$).tw.
14. 8 or 9 or 10 or 11 or 12 or 13
15. 7 and 14

#### CINAHL (via EBSCOhost)

1. (MH "Basal Ganglia Cerebrovascular Disease+") or (MH "Carotid Artery Diseases+") or (MH "Cerebral Ischemia+") or (MH "Cerebral Small Vessel Diseases+") or (MH "Intracranial Arterial Diseases+") or (MH "Intracranial Embolism and Thrombosis+") or (MH "Intracranial Hemorrhage+") or (MH "Stroke+")
2. TI (stroke\* or poststroke or CVA\* or "brain attack\*" or "acquired brain") or AB (stroke\* or poststroke or CVA\* or "brain attack\*" or "acquired brain")
3. TI ((cerebrovascular or cerebral) N5 (accident\* or trauma\* or disorder\* or isch#emi\* or infarct\* or insufficienc\* or insult\* or occlus\* or anoxi\* or hypoxi\* or h#emorrhag\* or bleed\* or h#ematoma\* or emboli\* or thromb\* or apople\*)) or AB ((cerebrovascular or cerebral) N5 (accident\* or trauma\* or disorder\* or isch#emi\* or infarct\* or insufficienc\* or insult\* or occlus\* or anoxi\* or hypoxi\* or h#emorrhag\* or bleed\* or h#ematoma\* or emboli\* or thromb\* or apople\*))

4. TI ((brain or "left hemisphere" or "right hemisphere" or intracranial or intracerebral or "basal gangli\*" or brainstem or subcortical or vertebrobasilar or basilar or cerebellar or lacunar) N5 (isch#emi\* or infarct\* or insufficienc\* or insult\* or occlus\* or anoxi\* or hypoxi\* or h#emorrhag\* or bleed\* or h#ematoma\* or emboli\* or thromb\* or apople\*)) or AB ((brain or "left hemisphere" or "right hemisphere" or intracranial or intracerebral or "basal gangli\*" or brainstem or subcortical or vertebrobasilar or basilar or cerebellar or lacunar) N5 (isch#emi\* or infarct\* or insufficienc\* or insult\* or occlus\* or anoxi\* or hypoxi\* or h#emorrhag\* or bleed\* or h#ematoma\* or emboli\* or thromb\* or apople\*))
5. TI ((epidural or extradural or extra-dural or subdural or sub-dural or subarachnoid) N3 (h#emorrhag\* or bleed\* or h#ematoma\*)) or AB ((epidural or extradural or extra-dural or subdural or sub-dural or subarachnoid) N3 (h#emorrhag\* or bleed\* or h#ematoma\*))
6. TI (TIA or "transient cerebr\*" or "transient isch#emi\*") or AB (TIA or "transient cerebr\*" or "transient isch#emi\*")
7. 1 or 2 or 3 or 4 or 5 or 6
8. (MH "Employment of Disabled+") or (MM "Employment of Older Workers") or (MM "Employment Status") or (MM "Employment Termination")
9. (MM "Job Re-Entry") or (MM "Work Redesign") or (MH "Rehabilitation, Vocational+") or (MM "Employment, Supported")
10. (MM "Adaptation, Occupational") or (MM "Absenteeism") or (MM "Impairment, Health Professional") or (MH "Job Satisfaction+") or (MM "Presenteeism") or (MM "Productivity") or (MM "Vocational Guidance")
11. (MH "Occupational Health Services+") or (MM "Disability Management") or (MM "Employee Assistance Programs") or (MH "Occupational Health+") or (MM "Occupational Medicine") or (MM "Psychology, Occupational")
12. TI ((work\* or job\* or employ\* or occupation\* or vocation\*) N5 (return\* or resum\* or re-entry or outcome\* or status\* or previous\* or former\*)) or AB ((work\* or job\* or employ\* or occupation\* or vocation\*) N5 (return\* or resum\* or re-entry or outcome\* or status\* or previous\* or former\*))
13. TI ((work\* or job\* or employ\* or duties) N1 (disabilit\* or loss or capacit\* or abilit\* or adapt\* or adjust\* or modifi\* or accommodat\* or support\*)) or AB ((work\* or job\* or employ\* or duties) N1 (disabilit\* or loss or capacit\* or abilit\* or adapt\* or adjust\* or modifi\* or accommodat\* or support\*))
14. TI (RTW or re-employ\* or reemploy\*) or AB (RTW or re-employ\* or reemploy\*)
15. 8 or 9 or 10 or 11 or 12 or 13 or 14
16. 7 and 15

## SCOPUS

1. TITLE-ABS(stroke\* or poststroke\* or CVA\* or "brain attack\*" or "acquired brain")
2. TITLE-ABS((cerebrovascular or cerebral) W/5 (accident\* or trauma\* or disorder\* or isch\*emi\* or infarct\* or insufficienc\* or insult\* or occlus\* or anoxi\* or hypoxi\* or h\*emorrhag\* or bleed\* or h\*ematoma\* or emboli\* or thromb\* or apople\*))
3. TITLE-ABS((brain or "left hemisphere" or "right hemisphere" or intracranial or intracerebral or "basal gangli\*" or brainstem or subcortical or vertebrobasilar or basilar or cerebellar or lacunar) W/5 (isch\*emi\* or infarct\* or insufficienc\* or insult\* or occlus\* or anoxi\* or hypoxi\* or h\*emorrhag\* or bleed\* or h\*ematoma\* or emboli\* or thromb\* or apople\*))

4. TITLE-ABS ((epidural or extradural or extra-dural or subdural or sub-dural or subarachnoid) W/3 (h\*emorrhag\* or bleed\* or h\*ematoma\*))
5. TITLE-ABS(TIA or "transient cerebr\*" or "transient isch\*emi\*")
6. 1 or 2 or 3 or 4 or 5
7. TITLE-ABS((work\* or job\* or employ\* or occupation\* or vocation\*) W/5 (return\* or resum\* or re-entry or outcome\* or status\* or previous\* or former\*))
8. TITLE-ABS((work\* or job\* or employ\* or duties) W/1 (disabilit\* or loss or capacit\* or abilit\* or adapt\* or adjust\* or modifi\* or accommodat\* or support\*))
9. TITLE-ABS(RTW or re-employ\* or reemploy\*)
10. 7 or 8 or 9
11. 6 and 10

#### **PsycINFO (via OVID)**

1. exp cerebrovascular accidents/ or exp cerebral ischemia/ or exp cerebral hemorrhage/ or exp cerebral small vessel disease/ or exp subarachnoid hemorrhage/ or exp cerebral arteriosclerosis/
2. (stroke\$ or poststroke or CVA\$ or brain attack\$ or acquired brain).tw.
3. ((cerebrovascular or cerebral) adj5 (accident\$ or trauma\$ or disorder\$ or isch?emi\$ or infarct\$ or insufficienc\$ or insult\$ or occlus\$ or anoxi\$ or hypoxi\$ or h?emorrhag\$ or bleed\$ or h?ematoma\$ or emboli\$ or thromb\$ or apople\$)).tw.
4. ((brain or left hemisphere or right hemisphere or intracranial or intracerebral or basal gangli\$ or brainstem or subcortical or vertebrobasilar or basilar or cerebellar or lacunar) adj5 (isch?emi\$ or infarct\$ or insufficienc\$ or insult\$ or occlus\$ or anoxi\$ or hypoxi\$ or h?emorrhag\$ or bleed\$ or h?ematoma\$ or emboli\$ or thromb\$ or apople\$)).tw.
5. ((epidural or extradural or extra-dural or subdural or sub-dural or subarachnoid) adj3 (h?emorrhag\$ or bleed\$ or h?ematoma\$)).tw.
6. (TIA or transient cerebr\$ or transient isch?emi\$).tw.
7. 1 or 2 or 3 or 4 or 5 or 6
8. exp supported employment/ or exp employment history/ or exp reemployment/ or exp unemployment/ or exp disabled personnel/
9. exp employee retention/ or exp "quality of work life"/ or exp role satisfaction/ or exp occupational health/ or exp person environment fit/ or exp employee absenteeism/
10. exp vocational rehabilitation/ or exp work adjustment training/ or exp disability management/ or exp occupational adjustment/ or exp work adjustment training/
11. (work\$ or job\$ or employ\$ or occupation\$ or vocation\$) adj5 (return\$ or resum\$ or re-entry or outcome\$ or status\$ or previous\$ or former\$).tw.
12. ((work\$ or job\$ or employ\$ or duties) adj1 (disabilit\$ or loss or capacit\$ or abilit\$ or adapt\$ or adjust\$ or modifi\$ or accommodat\$ or support\$)).tw.
13. (RTW or re-employ\$ or reemploy\$).tw.
14. 8 or 9 or 10 or 11 or 12 or 13
15. 7 and 14



## Supplementary material – operational definitions

**Table 3.2.** Supplementary material – operational definitions of RTW after stroke (n=33)

| First Author                    | Location  | Operational Definition                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hackett, 2012 <sup>1</sup>      | Australia | "Paid work was defined as any type of work in the month before stroke, including casual or temporary, for one hour or more for which some form of payment was received." (p2)                                                                                                                                                                                                    |
| Owensworth, 2008 <sup>2</sup>   | Australia | "Individuals were classified as 'employed' if they were participating in permanent full-time paid work or study, permanent part-time paid work or study or regular casual paid work of at least 8 hours per week. In terms of study, individuals were classified as 'employed' if they were undertaking either a part-time or full-time course at an academic institute." (p534) |
| Schweizer, 2012 <sup>3</sup>    | Canada    | "Current work status was classified as full-time, part-time, unemployed, or retired." (p138)                                                                                                                                                                                                                                                                                     |
| Andersen, 2012 <sup>4</sup>     | Denmark   | "We chose the following definition of return to paid work: Working (or studying) at least 10 h. per week (25% of full-time work) at a workplace on the open market." (p249)                                                                                                                                                                                                      |
| Hannerz, 2011 <sup>5</sup>      | Denmark   | "In the regression analysis, we looked at the odds of having a socio-economic code, which indicates gainful occupation in year 2 after stroke. The outcome variable was set to 1 if the person was self-employed, assisting a spouse or an employee in that particular year." (p3)                                                                                               |
| Hannerz, 2012 <sup>6</sup>      | Denmark   | "The end point of the analysis, were the odds of having a socio-economic code, which indicates gainful occupation in year 2 after stroke. The outcome variable was set to 1 if the person was self-employed, assisting spouse or employee in that particular year." (p457)                                                                                                       |
| Hannerz, 2012 <sup>7</sup>      | Denmark   | "In the regression analysis, we will look at the odds of having a socio-economic code, which indicates gainful occupation in year 2 after stroke. The outcome variable is set to 1 if the person is self-employed, assisting spouse or employee in that particular year." (p2, from Hannerz 2010 <sup>8</sup> )                                                                  |
| Larsson-Lund, 2017 <sup>9</sup> | Denmark   | "Participants were divided into four groups/levels of vocational status; (1) those who worked full-time or part-time, (2) those who worked part-time combined with a sickness benefit or disability pension, (3) those who had a long-term full-time sickness benefit and (4) those who                                                                                          |

| First Author                     | Location    | Operational Definition                                                                                                                                                                                                                                                                   |
|----------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                  |             | had a full-time disability pension." (p1620, from Larsson-Lund, 2014 <sup>10</sup> )                                                                                                                                                                                                     |
| Busch, 2009 <sup>11</sup>        | England     | "Self-reported employment status was classified into full-time (>30 hours per week) or part-time (≤30 hours per week) employed (including self-employed), unemployed and looking for work, carer for family or dependents, unable to work due to ill health, retired, and unknown." (p4) |
| Hiltunen, 2016 <sup>12</sup>     | Finland     | "We categorized those working part-time but over 50% of standard working hours and students as employed" (p478)                                                                                                                                                                          |
| Kauranen, 2013 <sup>13</sup>     | Finland     | "The main dependent variable, the inability to return to work, was defined as not returning to paid employment outside the house, either full or part time." (p317)                                                                                                                      |
| Bonner, 2016 <sup>14</sup>       | India       | "Work was defined as any self-reported paid employment whether it was part-time, full-time or self-employed. Furthermore, return to work was defined as resuming any sort of paid employment whether it was old or new employment." (p549)                                               |
| Saeki, 2010 <sup>15</sup>        | Japan       | "The outcome was RTW after stroke, which was defined as active employment at the former or at a new occupation (full-time or part-time competitive employment, or self-employment)." (p255)                                                                                              |
| Tanaka, 2011 <sup>16</sup>       | Japan       | "We adopted the definition of work as formal paid employment on a full-time or part-time basis." (p744)                                                                                                                                                                                  |
| Tanaka, 2014 <sup>17</sup>       | Japan       | "The outcome was return to work after stroke, which was defined as active employment in formal paid work on a full-time or part-time basis" (p446)                                                                                                                                       |
| Passier, 2011 <sup>18</sup>      | Netherlands | "Employment status was evaluated as a nominal variable comprising 3 categories: having no paid work either before or after SAH, having paid work before but not after SAH, and having paid work both before and after SAH." (p325)                                                       |
| van der Kemp, 2017 <sup>19</sup> | Netherlands | "The course of returning to work throughout the first-year post-stroke was evaluated by determining the frequencies of the four different subgroups (0 h, 1–16 h, 17–35 h, and >35 h) of return to work, at stroke onset and one-year post-stroke." (p5)                                 |
| Glozier, 2008 <sup>20</sup>      | New         | "Employment status was determined using the questions "During the month before your stroke were you in full-time or part-time paid                                                                                                                                                       |

| First Author                        | Location  | Operational Definition                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     | Zealand   | work?" at baseline, and "In the last 6 months before your stroke how often did you undertake gainful (paid) work?" during follow-up, cross referenced with the type of work recorded." (p1527)                                                                                                                                                                                                                                                                    |
| Peters, 2013 <sup>21</sup>          | Nigeria   | "Work was defined as paid full time, part-time or self-employment." (p456)                                                                                                                                                                                                                                                                                                                                                                                        |
| Budimkic, 2016 <sup>22</sup>        | Serbia    | "The self-reported employment status was classified as follows: (1) full-time employee (>30 h per week) or part time employee (<30 h per week) at the same working position or a new working position; (2) job loss after the stroke (lost their jobs after stroke without getting compensation; unemployed and looking for a job or unable to work due to a poststroke disability; (3) retired due to the stroke related problems." (p115)                       |
| McLean, 2007 <sup>23</sup>          | Singapore | "Return to work was defined as being employed, whether in a new position or pre-hospitalisation job, part-time or full-time at 6 months post-discharge." (p19)                                                                                                                                                                                                                                                                                                    |
| Catalina-Romero, 2015 <sup>24</sup> | Spain     | "The main dependent variable of the study was RTW (yes/no), as defined by finalization of sickness absence due to improvement of symptoms and functioning. Two situations were possible after recovering work ability – the worker either returning to his or her job or becoming unemployed." (p1221)                                                                                                                                                            |
| Glader, 2017 <sup>25</sup>          | Sweden    | "The primary outcome variable was whether the patient had resumed working 1 year after stroke, based on the Riksstroke follow-up question "Have you been able to return to work" with the response alternatives "Yes, to the same extent as before stroke," "Yes, but to a less extent than before stroke," "No, but planning to do so," "No," and "Do not know." Patients answering any of the first two alternatives were defined to have resumed work." (p609) |
| Hofgren, 2007 <sup>26</sup>         | Sweden    | "The patient was considered to be at work if he/she worked or studied at least 10 h/week (25% of full-time work) at a workplace on the open labor market." (p74)                                                                                                                                                                                                                                                                                                  |
| Hofgren, 2010 <sup>27</sup>         | Sweden    | "Return to work was defined as being at work (employability in the open labour market) or studying for at least 20 hours per week (half time)." (p433)                                                                                                                                                                                                                                                                                                            |
| Lindgren, 2017 <sup>28</sup>        | Sweden    | "Primary outcome measure was RTW within the study period spanning from onset of CVT symptoms to the follow-up date, defined as ≥50% of                                                                                                                                                                                                                                                                                                                            |

| First Author                   | Location      | Operational Definition                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                |               | gainful work or equivalent activity." (p2)                                                                                                                                                                                                                                                                                                                               |
| Lindström, 2009 <sup>29</sup>  | Sweden        | "Paid employment was considered as work irrespective of number of working hours per day." (p715)                                                                                                                                                                                                                                                                         |
| Trygged, 2011 <sup>30</sup>    | Sweden        | "The dependent variable, return to work, was measured in terms of patients' income from work after discharge from hospital. The lowest amount of income accepted was the same as the lowest amount accepted prior to the stroke (approximately €6,600). Return to work implies returning to any paid job and represents a documented indicator of work capability." (p2) |
| Vestling, 2005 <sup>31</sup>   | Sweden        | "Work was explicitly defined as continuing occupation in the production of supplies and services for payment." (p89)                                                                                                                                                                                                                                                     |
| Wallmark, 2016 <sup>32</sup>   | Sweden        | "Having returned to work was defined as having returned to work to at least some extent." (p234)                                                                                                                                                                                                                                                                         |
| Westerlind, 2017 <sup>33</sup> | Sweden        | "RTW was defined as no longer being registered on sickness compensation or sickness benefit (neither full time nor part time) in the Swedish Health Insurance Office and not leaving it within a year from turning 65 years old (old-age retirement in Sweden) or within a month from dying." (p3)                                                                       |
| Harris, 2014 <sup>34</sup>     | United States | "RTW was determined by asking the following questions: which of the following statements best describes your work situation now? (a) Full-time; (b) part-time; or (c) unemployed, unable, or retired?" (p209)                                                                                                                                                            |
| Van Patten, 2016 <sup>35</sup> | United States | "The outcome variable was a yes/no query pertaining to whether the patient self-reported that he or she had returned to work at 6 months after the stroke." (p2062)                                                                                                                                                                                                      |

## Supplementary material – operational definitions criteria

**Table 3.3.** Supplementary material – operational definitions of RTW after stroke based on employment

classification – criteria for work (n=47)

| First Author                    | Location  | Full-time or part-time | Full-time only | Student or in-training | Homemaker | Casual | Flex-job | Temporary | Assisting spouse | Self-employed | Unemployed and seeking | Minimum hours required                       |
|---------------------------------|-----------|------------------------|----------------|------------------------|-----------|--------|----------|-----------|------------------|---------------|------------------------|----------------------------------------------|
| Hackett, 2012 <sup>1</sup>      | Australia | yes                    |                |                        |           | yes    |          | yes       | yes              | yes           |                        | ≥1 h/week                                    |
| Owensworth, 2008 <sup>2</sup>   | Australia | yes                    |                | yes                    |           | yes    |          |           |                  |               |                        | ≥8 h/week                                    |
| Schweizer, 2012 <sup>3</sup>    | Canada    | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| Andersen, 2012 <sup>4</sup>     | Denmark   | yes                    |                | yes                    |           |        | yes      |           |                  |               |                        | ≥10 h/week                                   |
| Hannerz, 2011 <sup>5</sup>      | Denmark   | yes                    |                | no                     |           |        |          |           | yes              | yes           |                        |                                              |
| Hannerz, 2012 <sup>6</sup>      | Denmark   | yes                    |                | no                     |           |        |          |           | yes              | yes           |                        |                                              |
| Hannerz, 2012 <sup>7</sup>      | Denmark   | yes                    |                | no                     |           |        |          |           | yes              | yes           |                        |                                              |
| Larsson-Lund, 2017 <sup>9</sup> | Denmark   | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| Busch, 2009 <sup>11</sup>       | England   | yes                    |                |                        |           |        |          |           |                  | yes           |                        | Full-time >30 h/week<br>Part-time ≤30 h/week |
| Hiltunen, 2016 <sup>12</sup>    | Finland   | yes                    |                | yes                    |           |        |          |           |                  |               |                        | >50% hours                                   |
| Kauranen, 2013 <sup>13</sup>    | Finland   | yes                    |                | yes                    | no        |        |          |           |                  |               |                        |                                              |
| Autret, 2015 <sup>36</sup>      | France    | yes                    |                | yes                    |           |        |          |           |                  | yes           | yes                    |                                              |
| Doucet, 2012 <sup>37</sup>      | France    | yes                    |                | no                     |           |        |          |           |                  |               |                        |                                              |

| First Author                     | Location    | Full-time or part-time | Full-time only | Student or in-training | Homemaker | Casual | Flex-job | Temporary | Assisting spouse | Self-employed | Unemployed and seeking | Minimum hours required                       |
|----------------------------------|-------------|------------------------|----------------|------------------------|-----------|--------|----------|-----------|------------------|---------------|------------------------|----------------------------------------------|
| Hommel, 2009 <sup>38</sup>       | France      | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| Gabriele, 2009 <sup>39</sup>     | Germany     | yes                    |                | no                     | no        |        |          |           |                  |               | yes                    |                                              |
| Bonner, 2016 <sup>14</sup>       | India       | yes                    |                |                        |           |        |          |           |                  | yes           |                        |                                              |
| Alfieri, 2011 <sup>40</sup>      | Italy       | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| Endo, 2016 <sup>41</sup>         | Japan       | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| Saeki, 2010 <sup>15</sup>        | Japan       | yes                    |                | no                     | no        |        |          |           |                  | yes           |                        |                                              |
| Tanaka, 2011 <sup>16</sup>       | Japan       | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| Tanaka, 2014 <sup>17</sup>       | Japan       | yes                    |                | no                     | no        |        |          |           |                  |               |                        |                                              |
| Chang, 2016 <sup>42</sup>        | Korea       | yes                    |                |                        | no        |        |          |           |                  |               |                        |                                              |
| Arwert, 2016 <sup>43</sup>       | Netherlands | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| Passier, 2011 <sup>18</sup>      | Netherlands | yes                    |                | no                     | no        |        |          |           |                  |               |                        |                                              |
| van der Kemp, 2017 <sup>19</sup> | Netherlands | yes                    |                |                        |           |        |          |           |                  |               |                        | ≥1 h/week                                    |
| Wermer, 2007 <sup>44</sup>       | Netherlands | yes                    |                | no                     | yes       |        |          |           |                  |               |                        |                                              |
| Glozier, 2008 <sup>20</sup>      | New Zealand |                        | yes            |                        |           |        |          |           |                  |               |                        |                                              |
| McAllister, 2013 <sup>45</sup>   | New Zealand | yes                    |                | no                     | no        |        |          |           |                  |               |                        |                                              |
| Peters, 2013 <sup>21</sup>       | Nigeria     | yes                    |                |                        |           |        |          |           |                  | yes           |                        |                                              |
| Budimkic, 2016 <sup>22</sup>     | Serbia      | yes                    |                |                        |           |        |          |           |                  |               |                        | Full-time >30 h/week<br>Part-time <30 h/week |
| Chan, 2008 <sup>46</sup>         | Singapore   | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |
| McLean, 2007 <sup>23</sup>       | Singapore   | yes                    |                |                        |           |        |          |           |                  |               |                        |                                              |

| First Author                   | Location      | Full-time or part-time | Full-time only | Student or in-training | Homemaker | Casual | Flex-job | Temporary | Assisting spouse | Self-employed | Unemployed and seeking | Minimum hours required |
|--------------------------------|---------------|------------------------|----------------|------------------------|-----------|--------|----------|-----------|------------------|---------------|------------------------|------------------------|
| Glader, 2017 <sup>25</sup>     | Sweden        | yes                    |                |                        |           |        |          |           |                  |               |                        |                        |
| Hofgren, 2007 <sup>26</sup>    | Sweden        | yes                    |                | yes                    |           |        |          |           |                  |               | yes                    | ≥10 h/week             |
| Hofgren, 2010 <sup>27</sup>    | Sweden        | yes                    |                | yes                    |           |        |          |           |                  |               |                        | ≥20 h/week             |
| Lindgren 2017 <sup>28</sup>    | Sweden        | yes                    |                | yes                    |           |        |          |           |                  |               | yes                    | ≥50% hours             |
| Lindström, 2009 <sup>29</sup>  | Sweden        | yes                    |                |                        |           |        |          |           |                  | yes           |                        |                        |
| Vestling, 2005 <sup>31</sup>   | Sweden        | yes                    |                |                        |           |        |          |           |                  |               |                        |                        |
| Wallmark, 2016 <sup>32</sup>   | Sweden        | yes                    |                |                        |           |        |          |           |                  |               |                        |                        |
| Huang, 2017 <sup>47</sup>      | Taiwan        | yes                    |                | no                     | no        |        |          |           |                  | yes           |                        |                        |
| Al Yassin 2017 <sup>48</sup>   | United States | yes                    |                | no                     |           |        |          |           |                  |               |                        |                        |
| Harris, 2014 <sup>34</sup>     | United States | yes                    |                |                        |           |        |          |           |                  |               |                        |                        |
| Hartke, 2015 <sup>49</sup>     | United States | yes                    |                |                        |           |        |          |           |                  |               |                        |                        |
| Mennemeyer, 2006 <sup>50</sup> | United States | yes                    |                | no                     | no        |        |          |           |                  |               |                        |                        |
| O'brien, 2010 <sup>51</sup>    | United States | yes                    |                |                        |           |        |          |           |                  |               |                        |                        |
| Skolarus, 2016 <sup>52</sup>   | United States | yes                    |                |                        |           |        |          |           |                  |               |                        |                        |
| Van Patten, 2016 <sup>35</sup> | United States | yes                    |                | no                     | no        |        |          |           |                  |               |                        |                        |

## Supplementary material – estimates of RTW from population-based studies

**Table 3.4.** Supplementary material – estimates of RTW after stroke from population-based studies (13

estimates, n=9 studies)

| First Author                  | RTW, % | Sample size | Follow-up   | Location      | Description and data source                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------|--------|-------------|-------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Skolarus, 2016 <sup>52</sup>  | 40.0   | 125         | 3 months    | United States | Brain Attack Surveillance in Corpus Christi project (BASIC) – includes all stroke cases, in people aged 45 and older, in Nueces County, South Texas. Data from active surveillance, including hospital emergency department and intensive care units, passive review of hospital listings of discharge codes for stroke, and out-of-hospital surveillance program<br><br>Aug 2011 to Dec 2013 |
| Glozier, 2008 <sup>20</sup>   | 53.3   | 210         | 6 months    | New Zealand   | Auckland Regional Community Stroke Study (ARCOS) – includes all stroke events, in people aged 15 and older, who were residents of Auckland. Data from active surveillance including hospitals, local community services, general practitioners, residential care facilities, and national mortality and hospital morbidity data<br><br>2002 to 2003                                           |
| Lindström, 2009 <sup>29</sup> | 65.5   | 818         | 8-30 months | Sweden        | Riksstroke – Nationwide stroke register. Data from all hospitals in the country that admit acute stroke patients<br><br>July 2001 to Dec 2002                                                                                                                                                                                                                                                 |
| Busch, 2009 <sup>11</sup>     | 35.3   | 266         | 1 year      | England       | South London Stroke Register (SLSR) – includes all first-ever strokes, in people of all age groups, within a defined area in London. Data from hospitals, primary care, community services, and local health authorities<br><br>Jan 1995 to Dec 2004                                                                                                                                          |
| Glader, 2017 <sup>25</sup>    | 74.0   | 2539        | 1 year      | Sweden        | Riksstroke – Nationwide stroke register. Data from all hospitals in the country that admit acute stroke patients, linked with the Longitudinal Integration Database for Health Insurance, provided by Statistics Sweden<br><br>2008 to 2011                                                                                                                                                   |



| First Author                | RTW, % | Sample size | Follow-up                             | Location | Description and data source                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------|--------|-------------|---------------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hannerz, 2011 <sup>5</sup>  | 71.3   | 19,903      | 1 year                                | Denmark  | Danish Occupational Hospitalization Register – Record-linkage of the central person register, the national hospital patient register, and employment classification module, which includes all economically active inhabitants in the country. The national hospital patient register includes inpatient, outpatient, and emergency ward visits<br><br>1996 to 2006                                                 |
|                             | 62.2*  |             | 2 years*                              |          |                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                             | 60.8   |             | 3 years                               |          |                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                             | 58.5   |             | 4 years                               |          |                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                             | 56.3   |             | 5 years                               |          |                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Hannerz, 2012 <sup>6</sup>  | 65.7   | 12,106      | 2 years                               | Denmark  | Dataset from Statistics Denmark merged with the Danish Occupational Hospitalization Register – Record-linkage of the central person register, the national hospital patient register, and employment classification module, which includes all economically active inhabitants in the country. The national hospital patient register includes inpatient, outpatient, and emergency ward visits<br><br>2000 to 2006 |
| Hannerz, 2012 <sup>7</sup>  | 72.3   | 1,797       | 2 years                               | Denmark  | Danish Occupational Hospitalization Register – Record-linkage of the central person register, the national hospital patient register, and employment classification module, which includes all economically active inhabitants in the country. The national hospital patient register includes inpatient, outpatient, and emergency ward visits<br><br>1996 to 2006 (RTW estimate for the 2006 onset year)          |
| Trygged, 2011 <sup>30</sup> | 68.7   | 7081        | 4 years after discharge from hospital | Sweden   | Dataset from Statistics Sweden linked with an inpatient care population register from the Swedish National Board of Health and Welfare – Includes all first time stroke patients in the country, in people aged 40 to 49, who were discharged from a hospital<br><br>1996 to 2000                                                                                                                                   |

\*Hannerz, 2011 – follow-up at 2 years was used in meta-analysis as complete data was reported for this time point and the RTW proportion was more precise. Estimates at follow-up of 1, 3, 4, and 5 years were less precise due to the reporting of significant digits and rounding

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## CHAPTER 4: IMPACT OF STROKE ON EMPLOYMENT INCOME (STUDY 3)

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The manuscript has been prepared in accordance with the journal requirements, but the numbering of the tables and figures has been modified for the thesis.

# **The Impact of Stroke on Employment Income: A Cohort Study Using Hospital and Income Tax Data in Ontario, Canada**

## **Abstract**

**Objective:** To document the impact of stroke on employment income among people employed at the time of stroke.

**Design:** Population-based cohort study.

**Participants:** People hospitalized for stroke in Ontario, Canada (2010-2014) and people without stroke matched on demographic characteristics.

**Main Measures:** Robust Poisson regression to estimate the effects of stroke on the probability of reporting employment income on tax returns over three years. Quantile regression difference-in-differences to estimate the changes in annual employment income attributable to stroke.

**Results:** Stroke survivors were increasingly less likely to report any employment income poststroke, incidence rate ratios (IRR) 0.87 at 1-year (95% CI; 0.85-0.88), 0.82 at 2-years (95% CI; 0.81-0.84), and 0.81 at 3-years (95% CI; 0.79-0.82). IRR for reporting at least 50% of prestroke income levels were 0.76 at 1-year (95% CI; 0.75-0.78), 0.75 at 2-years (95% CI; 0.73-0.77), and 0.73 at 3-years (95% CI; 0.71-0.75). IRR for reporting at least 90% of prestroke income levels were 0.72 at 1-year (95% CI; 0.70-0.74), 0.66 at 2-years (95% CI; 0.64-0.68), and again 0.66 at 3-years (95% CI; 0.64-0.68). Relative changes in annual employment income attributable to stroke varied from a decrease of 13.8% (95% CI; 8.7-18.9) at the 75th income percentile to a decrease of 43.1% (95% CI; 18.7-67.6) at the 25th income percentile.

**Conclusions:** It is important for healthcare and service providers to recognize the impact of stroke on return to prestroke levels of employment income. Low-income stroke survivors experience a more drastic loss in employment income and may need additional social support.

## Introduction

Being employed is important for financial reasons and for psychosocial wellbeing.<sup>1,2</sup> Chronic impairments after stroke, such as cognitive and physical limitations, can result in difficulty returning to employment.<sup>3-5</sup> Following stroke, people may be working at reduced capacities or retire earlier than planned. This can lead to loss of income and financial stress, which adversely affects quality of life.<sup>6,7</sup>

The percentage of stroke survivors returning to employment is not precisely known. Estimates widely vary but are likely close to 55.7% at 1 year and 67.4% at 2 years poststroke.<sup>8</sup> Estimates vary depending on the operational definitions of employment and length of follow-up poststroke.<sup>3,8,9</sup> Return to employment can be influenced by characteristics such as age, gender, area of residence, marital status, and having children. Stroke survivors of younger age and men are more likely to return to employment.<sup>3,9-12</sup> As well, stroke survivors who are living in more populated areas, are single, or have children, are more likely to return to employment.<sup>3,9,10,12</sup> Adjusted population-level estimates of the percentage of stroke survivors returning to employment would be useful to better understand current rates and trends in return to employment.

Furthermore, there has been little information on the impact of stroke on employment income over time. We aimed to document this impact by comparing stroke survivors who were employed at the time of stroke with people of similar characteristics who did not have a stroke. We adjusted for characteristics that influence employment, particularly age, since stroke survivors are mostly older people who are likely to be working less over time approaching retirement.<sup>13</sup>

Our first objective was to estimate the relative effects of stroke on the probability of reporting employment income over 3 years poststroke. Our second objective was to estimate the changes in annual employment income attributable to stroke.

## Methods

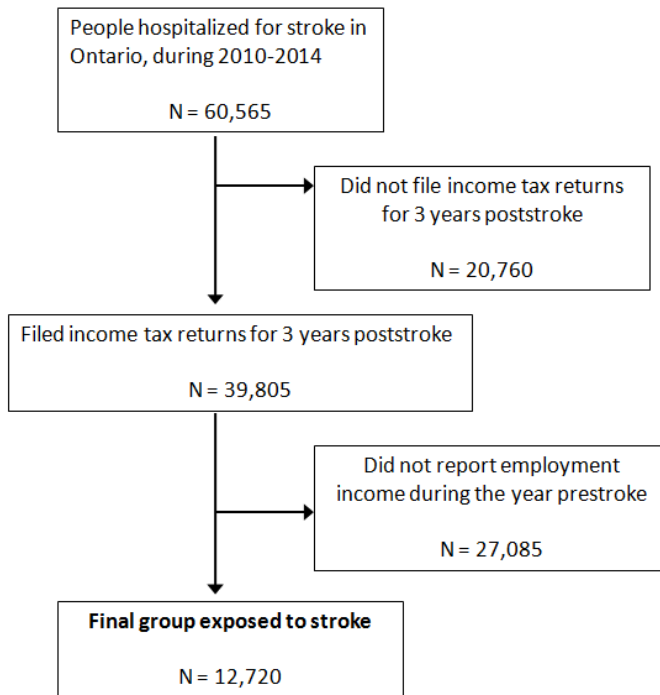
We conducted a provincewide retrospective cohort study using hospital and tax data in Ontario, the most populous province in Canada. We used patient record-level data from all hospitals (approximately 167 across Ontario as of 2014) from the Canadian Institute for Health Information Discharge Abstract Database.<sup>14</sup> The hospital data were linked by Statistics Canada to personal income tax returns of the annual T1 Family File collected by the Canada Revenue Agency (**Supplementary Material Table 4.4**).<sup>15</sup>

### Sample and cohort

Our sample was people hospitalized for stroke between 2010-2014 in Ontario. We included all stroke survivors who filed income tax returns for 3 years poststroke, and reported any employment income during the year prestroke, that is, stroke survivors who were employed prior to their stroke (**Figure 4.1**). For each unique individual, the index date is the year the stroke occurred. Pre-index refers to the time period prestroke, and post-index refers to the time period poststroke. We set 2014 as the limit to allow for 3 years of post-index follow-up until 2017, the latest year with available data.

We defined stroke as a brain infarct or a cerebrovascular accident lasting more than 24 hours (Canadian Coding Standards for the International Statistical Classification of Diseases, Tenth Revision).<sup>16</sup> We included the diagnostic codes subarachnoid hemorrhage (I60.X), intracerebral hemorrhage (I61.X), ischemic stroke or cerebral infarction (I63.X), and unspecified stroke (I64). These diagnostic codes have been reported to have high positive predictive value.<sup>17,18</sup> We excluded transient ischemic attack (G45.X), defined as a similar neurological deficit lasting less than 24 hours.<sup>16</sup>

**Figure 4.1.** Flow diagram



## Matching

We selected people who did not have a stroke from among all people in Ontario who had filed income tax returns during the same index date 2010-2014, had reported employment income during the year pre-index, and did not have any record of hospitalization during the 3 years pre-index and post-index. We used coarsened exact matching<sup>19,20</sup> to select a 10:1 ratio match with stroke survivors on the following characteristics: index date, age, sex, area of residence (urban area with population 15,000+ or rural area with population <15,000), marital status (married or common law, single, separated, divorced, widowed), at least one child under the age of 18 (yes or no), low-income household (yes or no), employment income pre-index, and total income pre-index. We defined low-income household according to the Statistics Canada definition of earning less than the low-income measure thresholds.<sup>21</sup> The low-income measure thresholds depend on the year and the household size. For example, in 2017, a one-person household would be considered low-income if the person earned less than \$25,397 Canadian dollars (CADs) (£15,200 British pound sterling).<sup>22,23</sup>

## Outcomes

Our main outcome was employment income, defined according to the Statistics Canada definition, "wages and salaries, commissions from employment, training allowances, tips and gratuities and self-employment income (net income from business, profession, farming, fishing and commissions), Indian exempt employment income, and Indian exempt self-employment income."<sup>24</sup> We inflated employment income to 2017 Canadian dollars with the Canadian Consumer price,<sup>25</sup> where 1 Canadian dollars =0.60 British pound sterling (October, 2023).<sup>26</sup>

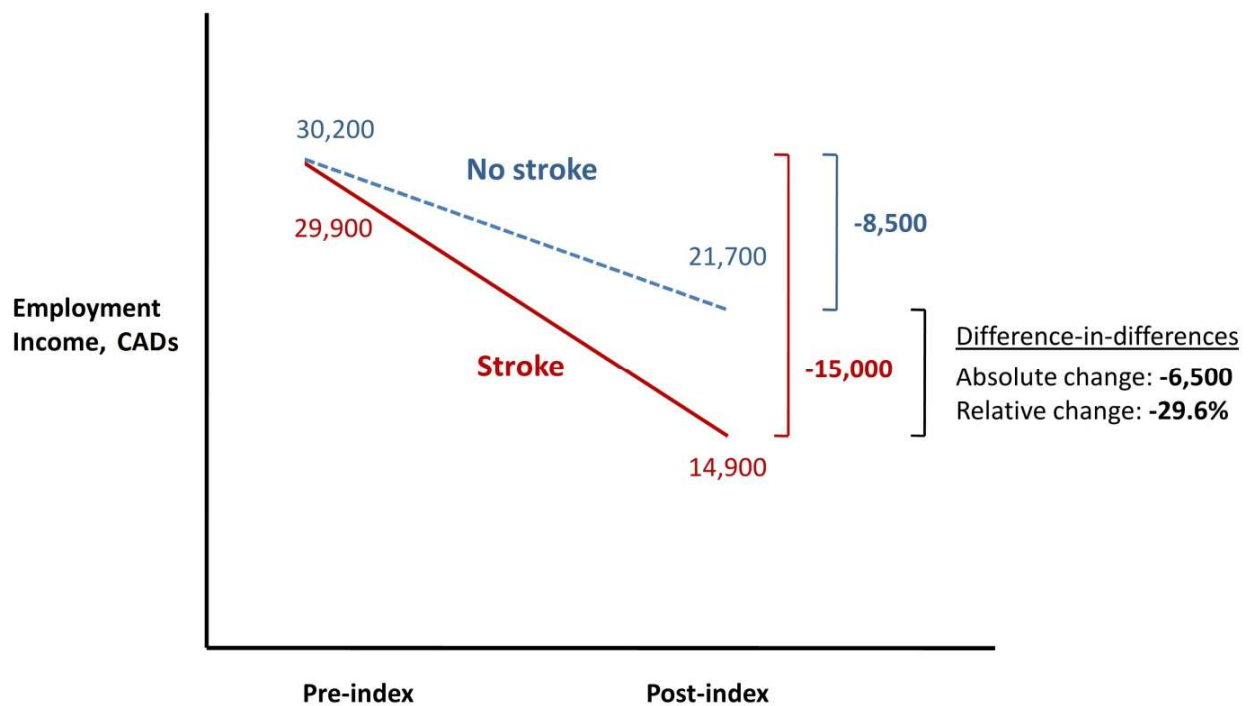
## Analysis

For our first objective, we estimated the percentage of people reporting employment income at 3 levels: 1) any employment income, 2) at least 50% of their pre-index employment income, and 3) at least 90% of their pre-index employment income. We used robust Poisson regression to estimate the relative effects of stroke on the probability of reporting employment income for each of those levels. We presented the incidence rate ratios (IRR) comparing stroke survivors and the people who did not have a stroke at 1, 2, and 3 years post-index. In addition, we performed stratified analyses by the following subgroups: low-income household (low-income stroke survivors versus low-income people who did not have a stroke), stroke type (ischemic versus hemorrhagic versus unspecified stroke), Charlson Comorbidity Index (0 versus 1-2 versus 3+), and total hospital length of stay (LOS; short  $\leq 4$  days versus medium 5-9 days versus long  $\geq 10$  days).<sup>14</sup>

For our second objective, we used quantile regression with difference-in-differences to estimate the changes in annual employment income attributable to stroke. This involved calculating the differences in pre-index and post-index annual employment income between stroke survivors and the people who did not have a stroke (example illustrated in **Figure 4.2**). To compare changes between lower and higher earners, we performed these analyses in 5 percentile increments from the 25th to the

75th pre-index employment income percentiles. We estimated the absolute changes and the relative changes in annual employment income (3-year average).

**Figure 4.2.** Difference-in-differences change in annual employment income (3-year average) at the 50th (median) pre-index employment income percentile



CADs, Canadian dollars

We adjusted our estimates by including the following variables in our regressions: index date, age, gender, area of residence, marital status, at least one child under the age of 18, low-income household. We reported estimates with 95% confidence intervals (CI) and statistical tests with  $p$  values less than 0.05 considered significant. We conducted analyses using SAS 9.4<sup>27</sup> and STATA 16.<sup>28</sup> We were granted access to the datasets for this study by Statistics Canada. We weighted estimates in conformity with the Statistics Canada policies on disclosure control of confidential microdata. We rounded counts to base 5, income values above 1,000 to base 100, and income values below 1,000 to base 10.<sup>15</sup> We obtained ethics approval for this study from the University of Ottawa Research Ethics board.

## Results

The cohort comprised 12,720 stroke survivors and 125,315 people of similar characteristics who did not have a stroke (**Table 4.1**).



**Table 4.1.** Characteristics of the cohort

| <b>Characteristics</b>                             | <b>Stroke<br/>(n = 12,720)</b> | <b>No stroke<br/>(n = 125,315)</b> |
|----------------------------------------------------|--------------------------------|------------------------------------|
| Age, mean $\pm$ SD, years                          | 61.5 $\pm$ 13.4                | 61.2 $\pm$ 13.3                    |
| Age group, n (%)                                   |                                |                                    |
| <45 years                                          | 1,220 (9.6)                    | 12,335 (9.8)                       |
| 45-64 years                                        | 6,410 (50.4)                   | 63,835 (50.9)                      |
| $\geq$ 65 years                                    | 5,090 (40.0)                   | 49,145 (39.2)                      |
| Female, n (%)                                      | 4,485 (35.3)                   | 44,335 (35.4)                      |
| Area of residence: urban population 15,000+, n (%) | 10,700 (84.1)                  | 106,000 (84.6)                     |
| Marital status, n (%)                              |                                |                                    |
| Married or common-law                              | 8,790 (69.1)                   | 86,820 (69.3)                      |
| Single, separated, divorced, or widowed            | 3,930 (30.9)                   | 38,495 (30.7)                      |
| Has at least one child under the age of 18, n (%)  | 2,265 (17.8)                   | 22,815 (18.2)                      |
| Employment income pre-index date, CADs             |                                |                                    |
| Mean $\pm$ SD                                      | 40,200 $\pm$ 42,100            | 41,000 $\pm$ 42,000                |
| Median (IQR)                                       | 28,100 (5,500-61,500)          | 28,900 (6,000-61,700)              |
| Total income pre-index date, CADs                  |                                |                                    |
| Mean $\pm$ SD                                      | 45,300 $\pm$ 40,200            | 44,800 $\pm$ 40,500                |
| Median (IQR)                                       | 32,900 (21,200-56,600)         | 32,400 (20,800-56,200)             |
| Low-income household, n (%)                        | 880 (6.9)                      | 8,540 (6.8)                        |
| Stroke type, n (%)                                 |                                |                                    |
| Ischemic                                           | 9,095 (71.5)                   |                                    |
| Hemorrhagic                                        | 2,705 (21.3)                   |                                    |
| Unspecified                                        | 925 (7.3)                      |                                    |
| Total hospital length of stay, mean $\pm$ SD, days | 10.4 $\pm$ 16.1                |                                    |
| Total hospital length of stay, terciles            |                                |                                    |
| Short, $\leq$ 4 days, n (%)                        | 4,625 (36.4)                   |                                    |
| Medium, 5-9 days, n (%)                            | 4,220 (33.2)                   |                                    |
| Long, $\geq$ 10 days, n (%)                        | 3,875 (30.5)                   |                                    |
| Charlson comorbidity index, n (%)                  |                                |                                    |
| 0                                                  | 8,630 (67.8)                   |                                    |
| 1-2                                                | 2,750 (21.6)                   |                                    |
| 3+                                                 | 1,340 (10.5)                   |                                    |

SD, standard deviation; IQR, interquartile range; CADs, Canadian dollars

## Relative effects of stroke on the probability of reporting employment income

The percentage of people reporting employment income decreased over time. The decrease was greater among stroke survivors (**Table 4.2**). Stroke survivors had a significantly lower probability of reporting any employment income compared to people who did not have a stroke. Stroke survivors also had a significantly lower probability of reporting at least 50% pre-index employment income and at least 90% pre-index employment income.

**Table 4.2.** Percentages of people reporting employment income and incidence ratio ratios (IRR) comparing stroke survivors and people who did not have a stroke\*

|                                                   | Percentage reporting employment income, % [95% CI] |                       | IRR [95% CI]†     |
|---------------------------------------------------|----------------------------------------------------|-----------------------|-------------------|
| Post-index date                                   | Stroke (n=12,700)                                  | No Stroke (n=125,315) |                   |
| Reported any employment income                    |                                                    |                       |                   |
| 1 year                                            | 74.8 [73.1, 76.5]                                  | 86.4 [85.9, 86.8]     | 0.87 [0.85, 0.88] |
| 2 years                                           | 68.1 [66.3, 69.9]                                  | 82.6 [82.1, 83.1]     | 0.82 [0.81, 0.84] |
| 3 years                                           | 63.4 [61.6, 65.3]                                  | 78.7 [78.2, 79.3]     | 0.81 [0.79, 0.82] |
| Reported at least 50% pre-index employment income |                                                    |                       |                   |
| 1 year                                            | 56.2 [54.4, 58.2]                                  | 73.5 [73.0, 74.1]     | 0.76 [0.75, 0.78] |
| 2 years                                           | 51.1 [49.2, 53.0]                                  | 68.4 [67.8, 69.0]     | 0.75 [0.73, 0.77] |
| 3 years                                           | 46.1 [44.2, 48.1]                                  | 63.6 [63.0, 64.2]     | 0.73 [0.71, 0.75] |
| Reported at least 90% pre-index employment income |                                                    |                       |                   |
| 1 year                                            | 38.4 [36.6, 40.4]                                  | 53.6 [53.0, 54.3]     | 0.72 [0.70, 0.74] |
| 2 years                                           | 31.6 [29.9, 33.4]                                  | 47.7 [47.1, 48.4]     | 0.66 [0.64, 0.68] |
| 3 years                                           | 28.9 [27.2, 30.7]                                  | 43.6 [43.0, 44.3]     | 0.66 [0.64, 0.68] |

CI, confidence interval; IRR, incidence rate ratio

\*Adjusted for index date, age, gender, area of residence, marital status, has at least one child under the age of 18, low-income household

†p < 0.05 for all comparisons

Additional results for stratified analyses by low-income household, stroke type, Charlson Comorbidity Index, and hospital length of stay are available in the supplementary material (**Tables 4.5-4.8**). Low-income household stroke survivors had significantly lower probabilities of reporting employment income compared to low-income household people who did not have a stroke. The different stroke types (ischemic, hemorrhagic, and unspecified stroke) had comparable probabilities. Stroke survivors with Charlson Comorbidity Index of 0 had significantly higher probabilities of reporting employment income compared to stroke survivors with Charlson Comorbidity Index of 3+. Stroke survivors with short hospital length of stay ( $\leq 4$  days) had significantly higher probabilities of reporting employment income compared to stroke survivors with long hospital length of stay ( $\geq 10$  days).

#### **Changes in annual employment income attributable to stroke**

The pre-index and post-index changes in annual employment income (3-year average) are shown in **Table 4.3**. For stroke survivors at the 50th percentile (median), pre-index employment income was \$29,900 and post-index employment income was \$14,900. The change in annual employment income attributable to stroke was -\$6,400 (-29.6%). The relative changes were larger at lower employment income percentiles (**Supplementary Material Figure 4.3**). The largest relative change was -52.2% at the 30th percentile and the smallest relative change was -13.8% at the 75th percentile.

**Table 4.3.** Pre-index and post-index changes in annual employment income (3-year average)\*

| Pre-index<br>employment<br>income<br>percentile | Employment income, CADs |                |                            |                |                                                                     |                                |
|-------------------------------------------------|-------------------------|----------------|----------------------------|----------------|---------------------------------------------------------------------|--------------------------------|
|                                                 | Stroke<br>(n = 12,700)  |                | No stroke<br>(n = 125,315) |                | Difference-in-differences                                           |                                |
|                                                 | Pre-<br>index           | Post-<br>index | Pre-<br>index              | Post-<br>index | Changes in annual employment income†<br>Absolute change<br>[95% CI] | Relative change, %<br>[95% CI] |
| 25th                                            | 4,300                   | 490            | 4,700                      | 1,500          | -650 [-1,000, -280]                                                 | -43.1 [-67.6, -18.7]           |
| 30th                                            | 8,400                   | 1,100          | 9,200                      | 4,000          | -2,100 [-2,800, -1,400]                                             | -52.2 [-69.4, -34.7]           |
| 35th                                            | 12,800                  | 2,800          | 13,900                     | 7,500          | -3,600 [-5,000, -2,300]                                             | -48.5 [-66.1, -30.8]           |
| 40th                                            | 18,600                  | 5,400          | 19,300                     | 11,800         | -5,700 [-7,600, -3,800]                                             | -48.2 [-64.2, -32.4]           |
| 45th                                            | 23,700                  | 8,600          | 24,400                     | 16,500         | -7,200 [-9,100, -5,300]                                             | -43.6 [-55.1, -32.2]           |
| 50th (median)                                   | 29,900                  | 14,900         | 30,200                     | 21,700         | -6,400 [-9,000, -3,800]                                             | -29.6 [-41.5, -17.7]           |
| 55th                                            | 35,200                  | 19,900         | 36,200                     | 27,000         | -6,200 [-8,500, -3,900]                                             | -23.0 [-31.6, -14.5]           |
| 60th                                            | 41,700                  | 25,800         | 42,700                     | 33,500         | -6,700 [-9,300, -4,200]                                             | -20.1 [-27.6, -12.6]           |
| 65th                                            | 46,600                  | 31,000         | 49,200                     | 40,400         | -6,700 [-9,500, -3,900]                                             | -16.5 [-23.5, -9.5]            |
| 70th                                            | 54,900                  | 38,800         | 56,200                     | 47,300         | -7,200 [-10,400, -4,100]                                            | -15.3 [-21.9, -8.6]            |
| 75th                                            | 63,500                  | 46,500         | 64,400                     | 55,000         | -7,600 [-10,400, -4,800]                                            | -13.8 [-18.9, -8.7]            |

\*Adjusted for index date, age, gender, area of residence, marital status, has at least one child under the age of 18, low-income household.

CI, confidence interval; CADs, Canadian dollars

†p < 0.05 for all comparisons

## Discussion

In this cohort study, we used hospital and tax data to examine the impact of stroke on employment income. To this end, we examined the income that stroke survivors reported on their tax returns during the time periods before and after stroke, and we compared this to the income reported by people of similar characteristics who did not have a stroke during the same time periods.

Our results showed that the percentage of people reporting employment income decreased over time. Among the people who did not have a stroke, this decrease most likely reflects the age-related decline in employment due to transition to retirement. The relative differences, between stroke survivors and people who did not have a stroke, indicate that stroke had negative effects on the probability of reporting employment income, as could be seen with the IRR that decreased each year. These findings suggest that stroke survivors experience increasingly more difficulty maintaining employment and earning prestroke levels of income over time. Offering interventions to assist stroke survivors early could be beneficial, such as modifying work duties and reducing work hours to part-time before gradually increasing to full-time.<sup>10,29–31</sup>

In our stratified analyses, we found that low-income household stroke survivors were less likely to report employment income than low-income household subjects who did not have a stroke. Low-income stroke survivors face unique challenges that may be linked to the type of employment at the time of stroke. People who experience stroke are more likely to be self-employed, doing part-time or contract work with no benefits, and are more likely to be employed in manual labour with demands that are more difficult to meet after stroke.<sup>32–35</sup> We did not find significant differences between ischemic, hemorrhagic, and unspecified stroke. The stroke type did not have a large effect after adjusting for other variables. Other studies have reported mixed findings on whether people with ischemic stroke or hemorrhagic stroke are more likely to return to employment.<sup>9,36</sup> We found differences when stratified by Charlson Comorbidity Index and total hospital length of stay. Stroke survivors with lower comorbidity

and shorter hospital length of stay were more likely to report employment income. Lower comorbidity and shorter hospital length of stay have been associated with better functional outcomes and more favourable return to employment.<sup>9,10,36</sup>

Regarding changes in annual employment income attributable to stroke, we observed larger relative changes at lower prestroke employment income percentiles. The largest relative change was a decrease of 52.2% at the 30th percentile. This highlights a disparity, that people earning less employment income prestroke further experience a disproportionately greater loss of employment income poststroke. This can result in difficulty meeting basic expenses, such as housing, food, medication, and accessible transportation, which in turn can lead to poor health outcomes.<sup>32,34,35,37,38</sup>

The findings of our study compliment another Canadian cohort study by Garland et al.<sup>12</sup> These authors found that the percentage of stroke survivors employed at 3 years had decreased by 19.8%, and the mean annual loss in employment income attributed to stroke was \$13,278. While our study had similar methods to Garland et al.,<sup>12</sup> an important difference was that they included people between the ages of 40-61 years. The mean age of their cohort was 53 years. Our study did not have an age restriction and therefore represented people employed across all ages. The mean age of our cohort was 61 years, and 40% were aged 65 years and older. In Canada, more people are delaying retirement and the proportion of people employed that are older than 65 years has been on the rise.<sup>39</sup> In a recent Danish cohort study, Skajaa et al.<sup>40</sup> examined employment poststroke using nationwide stroke registry data. They reported similar proportions of people employed at 1 and 2 years poststroke. Employment was highest at 2 years, but gradually decreased over 5 years poststroke, as more people began receiving disability pensions or retired early. It was also noted that stroke survivors at lower income levels were less likely to be employed after stroke.

Given these findings, further research is needed with special attention to people with low income. It is concerning that these people are less likely to be employed poststroke while also

confronted with more substantial relative loss of income. Low-income stroke survivors in particular may be less able to navigate community resources and have greater difficulty accessing employment and income support programs<sup>32</sup>. Future studies should investigate what proportion of low income versus higher income stroke survivors receive income supports, what amounts they are receiving, and what challenges they face with accessing income supports and programs designed to help them return to work. While considering regional socioeconomic differences, this research would be an important first step in better understanding whether the social support system is effectively providing assistance to stroke survivors in need and could help shape future policy on improving the provision of those services.

The main strength of our study was the large, population-based sample. This together with the multiple years of data allowed for more precise estimation of the impact of stroke on employment income over time. There were limitations to consider. We strived for a population-based sample of stroke survivors who were employed in Ontario. Our sample included all people hospitalized for stroke but did not include people who were not admitted to hospital following assessment in the emergency department (approximately 14%).<sup>41</sup> It may be reasonably assumed that these people had mild strokes that would not largely impact their ability to work. Since they were not included in our sample, we may have slightly underestimated poststroke employment and income. As well, our sample did not include people who did not file their income tax returns. However, it may be assumed that these people were not earning employment income. Lastly, we were not able to adjust for other variables that could have potentially influenced employment, such as education, type of occupation, years of employment, functional level, and social support,<sup>3,9,10,33,36</sup> as these variables were not available in our datasets.

## **Conclusions**

This population-based study showed that stroke has a considerable negative impact on employment income. Stroke survivors were increasingly less likely to report earning prestroke levels of employment income over three years. As well, stroke survivors with lower prestroke employment income were seen to have greater relative losses in poststroke employment income. Low income stroke survivors may be more financially disadvantaged and most in need of assistance.

## **Clinical Messages**

- Stroke survivors are increasingly less likely over 3 years to report earning prestroke levels of employment income. Providing interventions early to assist with returning and maintaining employment could be beneficial.
- Low-income stroke survivors may need additional social support because they experience a greater relative loss in employment income.

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**Declaration of conflicting interests**

Access to the datasets for this study was approved through the Statistics Canada Microdata Access Portal. The data were accessed at a university-based Research Data Centre. Although the research and analysis are based on data from Statistics Canada, the opinions expressed do not represent the views of Statistics Canada.

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## Supplementary Material

### Supplementary material – variables, definition, and data sources

**Table 4.4.** Supplementary material – variables, definitions, and data sources

| Variable                                   | Type        | Definitions and categories                                                                                                                                                                                                                                                                                                                                                               | Data source           |
|--------------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Stroke                                     | Categorical | Brain infarct or a cerebrovascular accident lasting more than 24 hours (Canadian Coding Standards for the International Statistical Classification of Diseases, Tenth Revision) in the main diagnostic field<br>3 categories:<br>- Subarachnoid hemorrhage (I60.X) or Intracerebral hemorrhage (I61.X)<br>- Ischemic stroke or cerebral infarction (I63.X)<br>- Unspecified stroke (I64) | Hospital database DAD |
| Index date                                 | Discrete    | Year the stroke occurred                                                                                                                                                                                                                                                                                                                                                                 | Hospital database DAD |
| Age                                        | Discrete    | Based on date of birth                                                                                                                                                                                                                                                                                                                                                                   | Tax database T1FF     |
| Sex                                        | Dichotomous | Women or men                                                                                                                                                                                                                                                                                                                                                                             | Tax database T1FF     |
| Area of residence                          | Dichotomous | Urban area with population 15,000+ or rural area with population <15,000                                                                                                                                                                                                                                                                                                                 | Tax database T1FF     |
| Marital status                             | Dichotomous | Married or common law<br>or<br>Single, separated, divorced, widowed                                                                                                                                                                                                                                                                                                                      | Tax database T1FF     |
| Has at least one child under the age of 18 | Dichotomous | Yes or no                                                                                                                                                                                                                                                                                                                                                                                | Tax database T1FF     |
| Employment income                          | Continuous  | Wages and salaries, commissions from employment, training allowances, tips and gratuities and self-employment income (net income from business, profession, farming, fishing and commissions), Indian exempt employment income, and Indian exempt self-employment income                                                                                                                 | Tax database T1FF     |

|                               |                            |                                                                                                                                                                                              |                       |
|-------------------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Total income                  | Continuous                 | Sum of all income sources including employment, investment, retirement, pensions, and benefits                                                                                               | Tax database T1FF     |
| Low-income household          | Dichotomous                | Yes or no, according to the Statistics Canada definition of earning less than the low-income measure thresholds. The low-income measure thresholds depend on the year and the household size | Tax database T1FF     |
| Total hospital length of stay | Continuous and categorical | Number of days between hospital admission and discharge<br>3 categories:<br>Short, $\leq 4$ days<br>Medium, 5-9 days<br>Long, $\geq 10$ days                                                 | Hospital database DAD |
| Charlson Comorbidity Index    | Discrete and categorical   | Measure of various comorbidities<br>3 categories:<br>0, 1-2, 3+                                                                                                                              | Hospital database DAD |

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Hospital database DAD – Canadian Institute for Health Information, Discharge Abstract Database

Tax database T1FF – Statistics Canada T1 Family File, Longitudinal Administrative Databank



## Supplementary material – stratified analyses

**Table 4.5.** Supplementary material – stratified analysis by low income household, percentages of people reporting employment income and incidence ratio ratios (IRR) comparing stroke survivors and people who did not have a stroke\*

|                                                   | Percentage reporting employment income, % [95% CI] |                                                   | IRR [95% CI]†     |
|---------------------------------------------------|----------------------------------------------------|---------------------------------------------------|-------------------|
| Post-index date                                   | Low income household<br>Stroke<br>(n = 880)        | Low income household<br>No stroke<br>(n = 11,840) |                   |
| Reported any employment income                    |                                                    |                                                   |                   |
| 1 year                                            | 48.1 [41.0, 56.5]                                  | 78.3 [76.4, 80.3]                                 | 0.61 [0.56, 0.68] |
| 2 years                                           | 43.1 [36.2, 51.2]                                  | 71.8 [69.7, 74.0]                                 | 0.60 [0.54, 0.66] |
| 3 years                                           | 37.1 [30.4, 45.2]                                  | 66.7 [64.4, 69.1]                                 | 0.56 [0.50, 0.62] |
| Reported at least 50% pre-index employment income |                                                    |                                                   |                   |
| 1 year                                            | 34.6 [28.0, 42.8]                                  | 66.2 [64.0, 68.5]                                 | 0.52 [0.47, 0.59] |
| 2 years                                           | 32.6 [26.3, 40.5]                                  | 60.2 [57.9, 62.6]                                 | 0.54 [0.48, 0.61] |
| 3 years                                           | 31.4 [25.1, 39.2]                                  | 55.3 [52.8, 57.8]                                 | 0.57 [0.50, 0.64] |
| Reported at least 90% pre-index employment income |                                                    |                                                   |                   |
| 1 year                                            | 26.8 [20.8, 34.5]                                  | 49.3 [46.9, 51.7]                                 | 0.54 [0.48, 0.62] |
| 2 years                                           | 22.0 [16.7, 29.0]                                  | 43.4 [41.1, 45.9]                                 | 0.51 [0.44, 0.58] |
| 3 years                                           | 21.4 [16.2, 28.4]                                  | 41.0 [38.6, 43.6]                                 | 0.52 [0.45, 0.60] |

CI, confidence interval; IRR, incidence rate ratio

\*Adjusted for index date, age, gender, area of residence, marital status, has at least one child under the age of 18

†p < 0.05 for all comparisons

**Table 4.6.** Supplementary material – stratified analyses by stroke type - percentages of stroke survivors reporting employment income and incidence ratio ratios (IRR)\*

| Post-index date                                   | Percentage reporting employment income, % [95% CI] |                                |                              | IRR [95% CI]†                   |                                 |                                 |
|---------------------------------------------------|----------------------------------------------------|--------------------------------|------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                                                   | Ischemic Stroke (n = 9,095)                        | Hemorrhagic Stroke (n = 2,705) | Unspecified Stroke (n = 925) | Ischemic vs Hemorrhagic         | Ischemic vs Unspecified         | Hemorrhagic vs Unspecified      |
| Reported any employment income                    |                                                    |                                |                              |                                 |                                 |                                 |
| 1 year                                            | 71.1 [68.5, 73.9]                                  | 70.7 [66.8, 74.9]              | 72.9 [67.0, 79.3]            | 1.01 [0.96, 1.06] <sup>ns</sup> | 0.98 [0.90, 1.06] <sup>ns</sup> | 0.97 [0.89, 1.06] <sup>ns</sup> |
| 2 years                                           | 63.1 [60.2, 66.2]                                  | 62.4 [58.3, 66.8]              | 65.2 [59.2, 71.7]            | 1.01 [0.96, 1.07] <sup>ns</sup> | 0.97 [0.89, 1.05] <sup>ns</sup> | 0.96 [0.87, 1.05] <sup>ns</sup> |
| 3 years                                           | 58.0 [55.0, 61.2]                                  | 57.3 [53.1, 61.9]              | 60.2 [54.1, 67.0]            | 1.01 [0.96, 1.07] <sup>ns</sup> | 0.96 [0.88, 1.05] <sup>ns</sup> | 0.95 [0.86, 1.05] <sup>ns</sup> |
| Reported at least 50% pre-index employment income |                                                    |                                |                              |                                 |                                 |                                 |
| 1 year                                            | 51.6 [48.7, 54.6]                                  | 51.7 [47.6, 56.2]              | 56.0 [49.9, 62.9]            | 1.00 [0.94, 1.06] <sup>ns</sup> | 0.92 [0.84, 1.01] <sup>ns</sup> | 0.92 [0.84, 1.02] <sup>ns</sup> |
| 2 years                                           | 45.4 [42.4, 48.6]                                  | 44.5 [40.5, 48.9]              | 48.8 [42.6, 55.8]            | 1.02 [0.96, 1.09] <sup>ns</sup> | 0.93 [0.84, 1.03] <sup>ns</sup> | 0.91 [0.82, 1.02] <sup>ns</sup> |
| 3 years                                           | 41.4 [38.4, 44.7]                                  | 40.4 [36.3, 44.9]              | 44.3 [38.1, 51.6]            | 1.03 [0.96, 1.10] <sup>ns</sup> | 0.94 [0.84, 1.04] <sup>ns</sup> | 0.91 [0.81, 1.02] <sup>ns</sup> |
| Reported at least 90% pre-index employment income |                                                    |                                |                              |                                 |                                 |                                 |
| 1 year                                            | 36.5 [33.7, 39.5]                                  | 37.1 [33.0, 41.7]              | 42.1 [35.6, 49.7]            | 0.98 [0.92, 1.06] <sup>ns</sup> | 0.87 [0.78, 0.96]               | 0.88 [0.78, 0.99]               |
| 2 years                                           | 29.2 [26.5, 32.2]                                  | 28.9 [25.2, 33.1]              | 32.7 [26.6, 40.2]            | 1.01 [0.93, 1.09] <sup>ns</sup> | 0.89 [0.79, 1.01] <sup>ns</sup> | 0.88 [0.77, 1.01] <sup>ns</sup> |
| 3 years                                           | 27.3 [24.6, 30.3]                                  | 24.4 [20.8, 28.5]              | 24.7 [19.3, 31.6]            | 1.12 [1.03, 1.22]               | 1.10 [0.96, 1.26] <sup>ns</sup> | 0.99 [0.85, 1.15] <sup>ns</sup> |

CI, confidence interval; IRR, incidence rate ratio; LOS, length of stay

\*Adjusted for index date, age, gender, area of residence, marital status, has at least one child under the age of 18, low income household, Charlson Comorbidity Index, and hospital LOS

†p < 0.05 for comparisons, unless noted ns (not significant)

**Table 4.7.** Supplementary material – stratified analyses by Charlson Comorbidity Index - percentages of stroke survivors reporting employment income and incidence ratio ratios (IRR)\*

| Post-index date                                          | Percentage reporting employment income, % [95% CI] |                                               |                                              | IRR [95% CI]†                   |                   |                                 |
|----------------------------------------------------------|----------------------------------------------------|-----------------------------------------------|----------------------------------------------|---------------------------------|-------------------|---------------------------------|
|                                                          | Charlson Comorbidity Index 0<br>(n = 8,630)        | Charlson Comorbidity Index 1-2<br>(n = 2,750) | Charlson Comorbidity Index 3+<br>(n = 1,340) | 0 vs 1-2                        | 0 vs 3+           | 1-2 vs 3+                       |
| <b>Reported any employment income</b>                    |                                                    |                                               |                                              |                                 |                   |                                 |
| 1 year                                                   | 75.3 [72.6, 78.1]                                  | 71.0 [66.8, 75.5]                             | 68.5 [62.6, 74.9]                            | 1.06 [1.01, 1.12]               | 1.10 [1.03, 1.18] | 1.04 [0.94, 1.15] <sup>ns</sup> |
| 2 years                                                  | 68.1 [65.2, 71.1]                                  | 62.3 [58.0, 66.9]                             | 60.5 [54.1, 67.7]                            | 1.09 [1.04, 1.15]               | 1.12 [1.04, 1.21] | 1.03 [0.91, 1.17] <sup>ns</sup> |
| 3 years                                                  | 63.0 [60.0, 66.2]                                  | 56.0 [51.6, 60.8]                             | 56.7 [50.2, 64.2]                            | 1.13 [1.06, 1.19]               | 1.11 [1.03, 1.20] | 0.99 [0.86, 1.14] <sup>ns</sup> |
| <b>Reported at least 50% pre-index employment income</b> |                                                    |                                               |                                              |                                 |                   |                                 |
| 1 year                                                   | 55.0 [52.0, 58.1]                                  | 54.7 [50.1, 59.3]                             | 49.7 [42.7, 56.6]                            | 1.01 [0.95, 1.07] <sup>ns</sup> | 1.11 [1.02, 1.20] | 1.10 [1.00, 1.21]               |
| 2 years                                                  | 50.4 [47.3, 53.6]                                  | 44.2 [39.6, 48.8]                             | 44.2 [37.4, 51.0]                            | 1.14 [1.07, 1.21]               | 1.14 [1.05, 1.24] | 1.00 [0.91, 1.10] <sup>ns</sup> |
| 3 years                                                  | 45.2 [42.1, 48.5]                                  | 41.5 [36.8, 46.1]                             | 39.5 [32.5, 46.6]                            | 1.09 [1.02, 1.16]               | 1.14 [1.04, 1.25] | 1.05 [0.95, 1.16] <sup>ns</sup> |
| <b>Reported at least 90% pre-index employment income</b> |                                                    |                                               |                                              |                                 |                   |                                 |
| 1 year                                                   | 44.0 [41.0, 46.9]                                  | 36.2 [31.6, 40.8]                             | 35.8 [28.4, 43.2]                            | 1.21 [1.13, 1.30]               | 1.23 [1.12, 1.35] | 1.01 [0.91, 1.13] <sup>ns</sup> |
| 2 years                                                  | 33.8 [30.9, 36.7]                                  | 29.1 [24.8, 33.3]                             | 28.1 [21.3, 35.0]                            | 1.16 [1.08, 1.26]               | 1.20 [1.08, 1.34] | 1.03 [0.91, 1.17] <sup>ns</sup> |
| 3 years                                                  | 27.4 [24.5, 30.3]                                  | 25.8 [21.8, 29.8]                             | 23.2 [16.8, 29.5]                            | 1.06 [0.98, 1.16] <sup>ns</sup> | 1.18 [1.05, 1.33] | 1.11 [0.97, 1.27] <sup>ns</sup> |

CI, confidence interval; IRR, incidence rate ratio; LOS, length of stay

\*Adjusted for index date, age, gender, area of residence, marital status, has at least one child under the age of 18, low income household, stroke type, and hospital LOS

†p < 0.05 for comparisons, unless noted ns (not significant)

**Table 4.8.** Supplementary material – stratified analyses by total hospital length of stay - percentages of stroke survivors reporting employment income and incidence ratio ratios (IRR)\*

| Post-index date                                          | Percentage reporting employment income, % [95% CI] |                                           |                                         | IRR [95% CI]†                   |                   |                   |
|----------------------------------------------------------|----------------------------------------------------|-------------------------------------------|-----------------------------------------|---------------------------------|-------------------|-------------------|
|                                                          | Hospital LOS Short, ≤4 days (n = 4,625)            | Hospital LOS Medium, 5-9 days (n = 4,220) | Hospital LOS Long, ≥10 days (n = 3,875) | Short vs Medium                 | Short vs Long     | Medium vs Long    |
| <b>Reported any employment income</b>                    |                                                    |                                           |                                         |                                 |                   |                   |
| 1 year                                                   | 74.2 [70.2, 78.5]                                  | 72.2 [68.2, 76.3]                         | 68.4 [64.8, 72.1]                       | 1.03 [0.98, 1.08] <sup>ns</sup> | 1.09 [1.03, 1.14] | 1.06 [1.00, 1.11] |
| 2 years                                                  | 68.7 [64.4, 73.2]                                  | 64.4 [60.2, 68.8]                         | 58.1 [54.4, 62.0]                       | 1.07 [1.01, 1.12]               | 1.18 [1.12, 1.25] | 1.11 [1.05, 1.17] |
| 3 years                                                  | 64.5 [60.0, 69.3]                                  | 59.2 [55.0, 63.8]                         | 52.5 [48.7, 56.5]                       | 1.09 [1.03, 1.15]               | 1.23 [1.16, 1.30] | 1.13 [1.07, 1.20] |
| <b>Reported at least 50% pre-index employment income</b> |                                                    |                                           |                                         |                                 |                   |                   |
| 1 year                                                   | 61.5 [56.8, 66.5]                                  | 53.7 [49.4, 58.3]                         | 45.3 [41.6, 49.2]                       | 1.15 [1.08, 1.21]               | 1.36 [1.28, 1.44] | 1.19 [1.11, 1.26] |
| 2 years                                                  | 51.4 [46.9, 56.3]                                  | 47.5 [43.3, 52.2]                         | 40.3 [36.7, 44.3]                       | 1.08 [1.02, 1.15]               | 1.28 [1.20, 1.36] | 1.18 [1.10, 1.26] |
| 3 years                                                  | 49.1 [44.4, 54.4]                                  | 41.7 [37.4, 46.5]                         | 36.2 [32.6, 40.2]                       | 1.18 [1.11, 1.25]               | 1.36 [1.27, 1.45] | 1.15 [1.07, 1.24] |
| <b>Reported at least 90% pre-index employment income</b> |                                                    |                                           |                                         |                                 |                   |                   |
| 1 year                                                   | 47.3 [42.4, 52.8]                                  | 39.6 [35.3, 44.5]                         | 30.4 [27.0, 34.2]                       | 1.19 [1.12, 1.27]               | 1.56 [1.45, 1.67] | 1.30 [1.21, 1.40] |
| 2 years                                                  | 35.4 [31.0, 40.5]                                  | 31.8 [27.7, 36.6]                         | 24.5 [21.3, 28.2]                       | 1.11 [1.03, 1.20]               | 1.44 [1.33, 1.56] | 1.30 [1.19, 1.41] |
| 3 years                                                  | 29.5 [25.4, 34.4]                                  | 26.6 [22.7, 31.2]                         | 20.9 [17.9, 24.3]                       | 1.11 [1.02, 1.20]               | 1.42 [1.30, 1.54] | 1.28 [1.17, 1.40] |

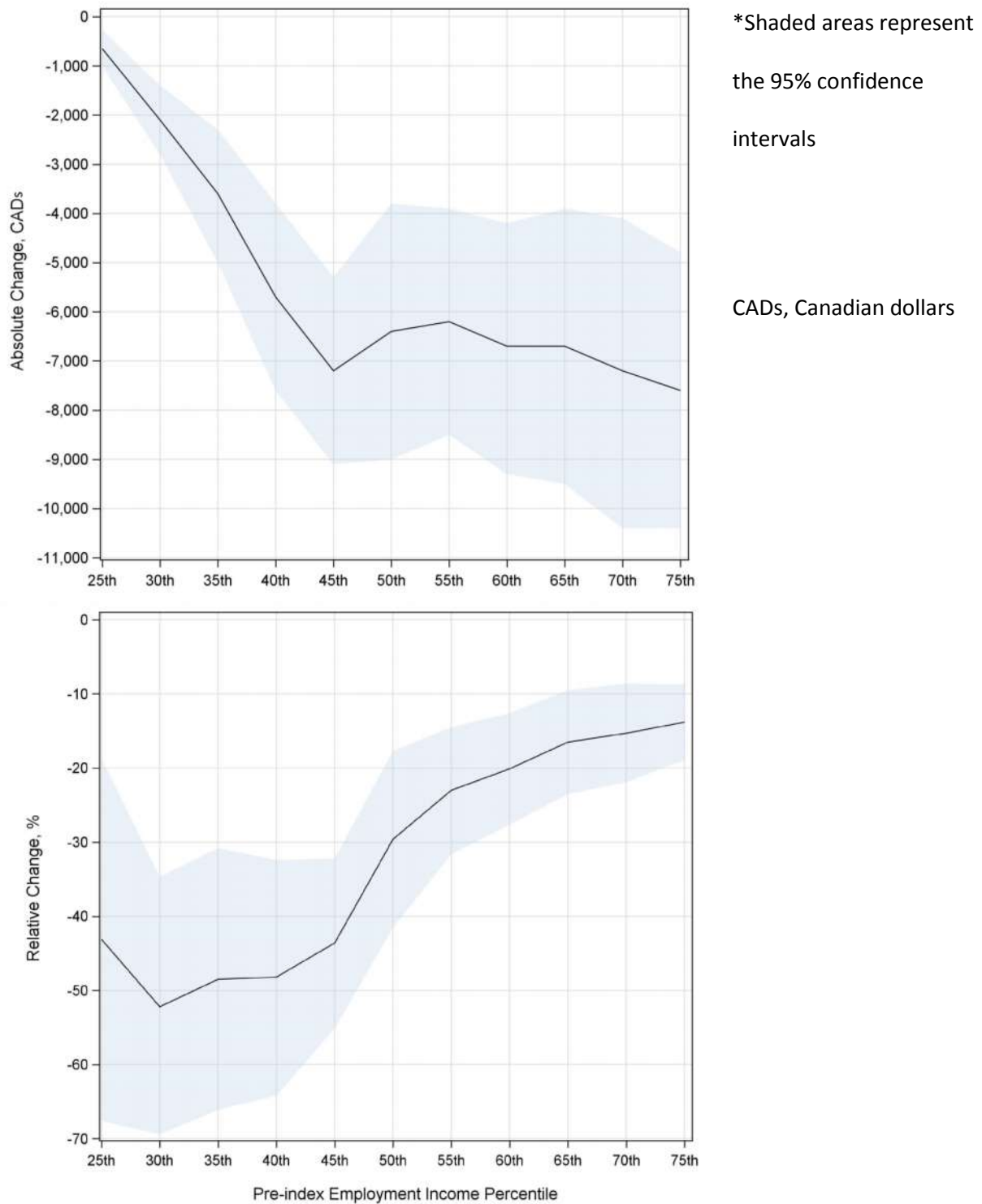
CI, confidence interval; IRR, incidence rate ratio; LOS, length of stay

\*Adjusted for index date, age, gender, area of residence, marital status, has at least one child under the age of 18, low income household, Charlson Comorbidity Index, and hospital LOS

†p < 0.05 for comparisons, unless noted ns (not significant)

## Supplementary material – changes in employment income

**Figure 4.3.** Supplementary material – pre-index and post-index absolute and relative changes in annual employment (3-year average)\*



## CHAPTER 5: INTEGRATED DISCUSSION

In this chapter, I provide a brief summary linking together the key findings from each study:

- Intention to return to work (Study 1)
- Estimates of return to work (Study 2)
- Impact of stroke on employment income (Study 3)

I then discuss the implications for clinical practice and policy. Next, I make suggestions for future research directions. Finally, I describe the strengths and limitations of my research.

*"Everyone has been made for some particular work, and the desire for that work has been put in every heart."*

– Rumi

## **Summary of Findings**

### **Intention to return to work**

Returning to work after stroke is important for financial and psychological reasons. Working provides income for meeting basic needs, enjoying a certain standard of living, and saving for the future. Additionally, being employed gives a sense of purpose and opportunities for social interaction in the workplace (Coutts & Cooper, 2023; Guzik et al., 2020; Martin et al., 2023; Palstam et al., 2019; Scott et al., 2019; Wassenius et al., 2023). Returning to work after stroke can be a complex process that takes time. People are unsure of how long it will take to recover and how their ability to work might change (Martin et al., 2023; Pan et al., 2023; Scott et al., 2019; Wassenius et al., 2023). For these reasons, they are undecided about returning to work early on but may have many questions they are interested in discussing with rehabilitation providers (Wassenius et al., 2023). It is likely that rehabilitation providers assume that older stroke survivors may decide to retire from the workplace. Less is known on stroke survivors' intentions to return to work.

The first article of my thesis (Study 1) investigated the intention to return to work among stroke rehabilitation inpatients who were employed prestroke. I conducted a population-based, cross-sectional study of Ontario using CIHI data from the National Rehabilitation Reporting System (NRS) (Canadian Institute for Health Information, 2024c). I examined hospital records of stroke survivors' employment status prior to admission (prestroke) and their actual or expected employment status (intention to return to work) at discharge from inpatient rehabilitation.

This study showed that almost one-fifth (18.2%) of stroke rehabilitation inpatients were employed in paid work prestroke, and 43.7% of 18.2% intended to return to work. When stroke rehabilitation inpatients aged 65 and older were considered separately, over one third (36.2%) of those working prestroke intended to return to work. These findings indicate that returning to work is a desired

goal for a fairly large proportion of stroke rehabilitation inpatients, including older people intending to work beyond the traditional retirement age.

### **Estimates of return to work**

The proportion of stroke survivors returning to work is not precisely known as there is large variation in estimates (Edwards et al., 2018). I wondered if this was due to variability in the way return to work was defined across studies and I performed a systematic review of these definitions (Study 2). I first examined operational definitions of return to work. I sought to determine whether some studies included non-paid productive activities, such as education or homemaking, in addition to paid employment. However, I found that almost all operational definitions were based on full-time or part-time paid employment (46 of 47 studies). From this, I recommended a preliminary universal operational definition that may help unify and facilitate comparison of return to work outcomes in future studies.

In Study 2, I found that estimates of return to work ranged from 4% to 90.0% across studies. Importantly, the length of follow-up varied considerably, from 3 months to 18 years poststroke. This has a substantial impact on the estimates. Studies with longer follow-up usually report higher estimates given that stroke survivors have more time to recover and return to work (Ashley et al., 2019; Brouns et al., 2019; Edwards et al., 2018; Van Patten et al., 2016). I performed a meta-analysis to provide more precise summary estimates of return to work by pooling studies with similar follow-up time. I used 6 months, 1 year, and 2 years poststroke as these were the most frequently reported time points. The meta-analysis showed higher summary estimates with longer follow-up. Approximately half (53.2%) of stroke survivors returned to paid work at 6 months poststroke. This increased slightly to 55.7% at 1 year poststroke, but there was a larger increase to 67.4% at 2 years poststroke. The meta-analysis of only population-based studies showed similar summary estimates, 56.7% at 1 year and 66.7% at 2 years. These findings indicate that a relatively large proportion of people return to work one year after stroke, but there are still people who return to work two years later. It may be that stroke survivors experience



less difficulty returning to work during the second year after stroke, or that over time, there is increasing need or desire to return to work (for example, after savings or benefits have been exhausted).

I found that the pooled estimates had high statistical heterogeneity ( $I^2 > 90\%$ ). This indicates that there was greater variability in the study estimates than could be expected due to sampling variability. The heterogeneity could be in part explained by differences among study sample characteristics (Higgins et al., 2024). It was curious that across countries, both moderate and extreme estimates were found. That is, the heterogeneity did not seem driven by geographic region.

### **Impact of stroke on employment income**

Following a stroke, people may retire earlier than planned or return to work in a limited capacity. Either outcome may result in loss of employment income that adversely affects the financial situation and wellbeing of the family (Pearce et al., 2023; Turner et al., 2022; Wassenius et al., 2023; Westerlind et al., 2020). In Study 3, I determined the effects of stroke on the probability of reporting employment income over 3 years. I conducted a population-based, retrospective cohort study using CIHI data from the Discharge Abstract Database (DAD) (Canadian Institute for Health Information, 2024a) linked with income tax data from Statistics Canada (Statistics Canada, 2023a). I compared employment income for people hospitalized in Ontario for stroke with a comparison group of similar characteristics.

Study 3 revealed that, among people employed before stroke, stroke survivors were less likely (13% less likely at 1 year, 18% at 2 years, and 19% at 3 years) to report employment income than people of similar characteristics that did not have a stroke. As well, the percentage of stroke survivors reporting employment income decreased over 3 years (74.8% at 1 year, 68.1% at 2 years, and 63.4% at 3 years). These findings suggest that over time stroke survivors may be experiencing more difficulty maintaining paid employment and may be working less. This is concerning because it could mean that stroke survivors are not receiving enough support once they return to work.

It was interesting to note that in Study 3, the percentage of stroke survivors reporting employment income decreased over time. Whereas in study 2, the combined estimates from across the world showed that the number of people returning to work increased over time. This discrepancy probably reflects the differences in socioeconomic situation in Ontario compared to other regions. In Study 2, many estimates were from countries in Europe, and Scandinavia in particular, which have high employment opportunities and strong health and social care programs, leading to higher poststroke employment (Glader et al., 2017; Hannerz et al., 2011; Palstam et al., 2019).

In Study 3, in addition to estimating the proportion of stroke survivors who returned to work, I also determined the changes in annual employment income attributable to stroke. The results showed that stroke survivors had a relative decrease in annual employment income varying between 13.8% (at the 75th prestroke employment income percentile) to 43.1% (at the 25th prestroke employment income percentile). That is, those with low incomes prior to stroke became even more financially disadvantaged after stroke. This important finding may be evidence of a disparity in our social service system. People in low-income situations may have greater difficulty accessing financial supports (Sauvé-Schenk et al., 2020). If this is the case, low-income stroke survivors require extra help to return to work or access social benefits.

The findings of Study 3 compliment those of another Canadian cohort study by Garland et al. (2019). These authors found that at 3 years poststroke, there was a decrease in the percentage of stroke survivors employed by 19.8% and a decrease in annual employment income by 31.2%. An important difference in Garland et al. (2019) was that they only included people between the ages of 40 and 61 years. The mean age of their cohort was 53 years. However, my Study 3 included employed people of all ages. The mean age of the cohort was 61 years, and 40% were aged 65 years and older. Study 3 was representative of the current demographic in Canada as an increasing number of people older than 65 years are staying employed and delaying retirement (Hazel, 2018; Statistics Canada, 2024b). Including all

adult age groups in return to work studies can be important since over a third of Ontario stroke rehabilitation inpatients aged 65 and older working prestroke intend to return to work (Study 1).

## **Implications**

### **Clinical practice**

Return to work after stroke is important for general health and financial stability (Pearce et al., 2023; Turner et al., 2022; Wassenius et al., 2023; Westerlind et al., 2020). The findings from Study 1 revealed that 43.7% of 18.2% of stroke rehabilitation inpatients working prestroke intend to return to work. As well, Study 3 showed that stroke survivors returning to work experience a substantial decrease in employment income. This suggests that people in Ontario need support with return to work after stroke. It appears that stroke survivors may not be receiving enough assistance with return to work from healthcare providers (Coutts & Cooper, 2023). Stroke survivors have expressed that at discharge they did not feel adequately informed about how stroke might affect their employment, as well as where to access services and financial assistance for returning to work (Sauvé-Schenk et al., 2020). Stroke survivors have also reported feeling discouraged when rehabilitation providers were less involved in the process of returning to work (Martin et al., 2023).

There may be several issues contributing to health care providers not addressing return to work after stroke. Firstly, stroke is more common among older individuals, which might lead to the assumption that most stroke survivors are retired or will want to retire. But it should not be presumed that employment is not a priority for older adults. In fact, as shown in Study 1, return to work is still a goal for many stroke rehabilitation inpatients older than 65 years.

Secondly, some rehabilitation providers consider it premature to discuss return to work due to difficulty predicting long-term functional status (Martin et al., 2023; Norstedt, 2017). However, almost half of people in inpatient rehabilitation programs who had been working at the time of their stroke intend to return to work. These patients are thinking about work and it makes sense to begin to address

their concerns. At this early stage, discussion of available resources could be reassuring. As well, it may be reasonable to include simulations of work tasks to help therapists and stroke survivors identify areas of focus for rehabilitation in preparation for return to work (Coutts & Cooper, 2023; Pearce et al., 2023; Scott et al., 2019).

Thirdly, another reason why return to work after stroke may not be receiving enough attention in clinical practice is that some rehabilitation providers do not think they have the time or knowledge, or that it is not within their scope of professional practice, to talk about return to work (Sauvé-Schenk et al., 2024). Many rehabilitation providers believe that issues related to return to work will be handled by other professionals further along the continuum of care (e.g. outpatient rehabilitation or in the community), yet ultimately it goes unaddressed (Sauvé-Schenk et al., 2024). At the very least, rehabilitation providers could be instrumental in connecting people with other resources (Moore et al., 2024; Sauvé-Schenk et al., 2020; Wassenius et al., 2023).

Considering the importance of work, rehabilitation providers should initiate early discussions about return to work after stroke. Discussions should ideally commence during rehabilitation, and preferably even before discharge from acute care if possible (Moore et al., 2024; Scott et al., 2019; SWOSN, 2017). Providers should offer guidance with returning to work. Setting goals and early planning for return to work should be emphasized. In the early stages after a stroke, individuals may not fully grasp the extent of their changed abilities and specific timelines for recovery may not be known immediately. It is often only when they attempt to resume working that they become more aware of hidden challenges, such as fatigue, anxiety, and problems concentrating (Coutts & Cooper, 2023; Radford et al., 2020; Scott et al., 2019). Fostering transparent communication can help diminish stress related to uncertainties (Brannigan et al., 2017; Moore et al., 2024; Schwarz et al., 2018; Scott et al., 2019; SWOSN, 2017; Wassenius et al., 2023). This open communication and early engagement can provide hope in attaining work goals. It aids with normalizing the recovery process and maintaining

realistic expectations for overcoming anticipated challenges in the workplace (Scott et al., 2019; SWOSN, 2017; Wassenius et al., 2023). Stroke survivors are better able to find solutions when they discuss and have a better understanding of return to work options early on (Wassenius et al., 2023).

Early conversations about return to work can also help establish the need for referrals. It is important that healthcare providers connect stroke survivors with the appropriate services. There are a number of allied health professionals that can be involved with return to work, including vocational and employment counselors, occupational therapists, physical therapists, kinesiologists, psychologists, speech-language pathologists, and social workers (Scott et al., 2019). Vocational and employment counselors, as well as occupational therapists, can help by collaborating with employers and developing gradual return to work plans. Occupational therapist can also assist by performing workplace assessments and making suggestions for accommodations and assistive devices. Physical therapists and kinesiologists can give interventions to improve physical functioning for work tasks. Psychologists can help with managing mental health and emotional concerns related to stress, motivation, and depression. Speech language pathologists can aid with cognitive-communication difficulties. Social workers can provide advice on accessing community services and financial assistance. All professionals involved with return to work should collaborate, be adaptive, and share information about decision-making. The provision of support should be ongoing, since challenges returning to work can be unpredictable and stroke survivors are likely to have changing needs with time (Moore et al., 2024; SWOSN, 2017; Wassenius et al., 2023). Interventions and accommodations at the workplace should be progressively adjusted for gradual resumption of work tasks. Maintaining a client-centered approach with long-term follow-up are key to facilitating return to work (Brannigan et al., 2017; Schwarz et al., 2018; SWOSN, 2017).

## Policy

This research has implications for updating policy of the Canadian Stroke Best Practice Recommendations (CSBPR). The CSBPR are evidence-based recommendations for guiding healthcare professionals in stroke care. The most recent version of the CSBPR is the Sixth Edition, 2019 (Mountain et al., 2019). The module on Transitions and Community Participation (part 2), focuses on rehabilitation and participation in the community. It includes a section with recommendations for return to work after stroke. The recommendations in this section are currently based on level C evidence, writing group consensus supported by limited research evidence (Mountain et al., 2019, p. 37, section 4.4 Participation in Social and Life Roles Following Stroke: Vocational Roles). For the next version of the CSBPR, I recommend that the writing group consider reviewing the findings from my studies and updating their recommendations. Suggestions for revision are as follows:

1) Section 4.4.i. (Mountain et al., 2019, p. 37) recommends that "Following stroke, people may be considered for assessment of vocational interests (i.e., work, school, volunteering) and for their potential to return to their vocations...This initial screening may take place early in the rehabilitation phase and should be reassessed at transitions as appropriate [Evidence Level C]." Study 1 showed that a fairly large proportion of previously employed stroke survivors intend to return to work after stroke. For this reason, it would be suggested that the recommendation be revised as "Following stroke, people *should be asked their intentions to work and other vocational interest* (i.e. school, volunteering)..."

2) Section 4 Summary of the Evidence on Return to Work (Mountain et al., 2019, p. 42), report large variation in the rates of return to work across studies, from 7.3%1-74.5% up to 12 years after stroke (Edwards et al., 2018; Hackett et al., 2012; Hannerz et al., 2011; Trygged et al., 2011). The findings from Study 2 systematic review and meta-analysis provide more recent and precise summary estimates of return to work. In light of these more precise estimates, I recommend this section be revised with those estimates – 55.7% at 1 year and 67.4% at 2 years.

3) Section 4.4.vi. (Mountain et al., 2019, p. 37) recommends that healthcare providers "Review financial concerns, sustainability and benefit options during admission and/or prior to discharge, and later in follow-up assessments and transitions. [Evidence Level C]." Study 3 revealed that stroke has a substantial financial impact, which provides further support for the current recommendations. Additionally, I recommend in future revisions of the guidelines that a statement should be included directing providers to ensure low-income stroke survivors, in particular, are offered assistance to access income supports. This recommendation is made on the basis of Study 3, which provides strong evidence that people in low-income brackets prestroke are more drastically affected by loss of employment income poststroke.

### **Future research**

My studies provide further evidence that stroke survivors experience difficulty returning to work and a loss of income. Notably, Study 3 highlights that low-income stroke survivors are more disadvantaged. Considering these findings, further research is needed with special attention to low-income stroke survivors.

Stroke survivors in financial need may be eligible for benefits and income supports. Examples of government benefits include Employment Insurance, the Canadian Pension Plan, and Old Age Security (Government of Canada, 2024). In Ontario, there are also income supports through Ontario Works and the Ontario Disability Support Program (Ministry of Children Community and Social Services, 2024). However, a qualitative study in Ontario has found that low-income stroke survivors have difficulty navigating community resources. As well, low-income stroke survivors encounter challenges with accessing benefits and income supports programs (Sauvé-Schenk et al., 2020). Future research should explore what proportion of low-income versus higher income stroke survivors receive benefits and income supports, what amounts they are receiving, and what difficulties they face with accessing income supports and programs designed to help them return to work. It would be important for this

investigation to account for socioeconomic variation and the availability of services in different regions (Ashley et al., 2019; Brey & Wolf, 2015; Brouns et al., 2019; Glader et al., 2017). Such research would be an initial step in understanding the effectiveness of our social service system in providing financial assistance to stroke survivors. It could also inform future policy aimed at enhancing the delivery of these services. Future efforts should also examine the long-term financial impact of stroke on the family household. Stress and burnout are commonly reported among family caregivers of stroke survivors, which can negatively impact their health and their ability to work and earn income for the household (Heart and Stroke Foundation of Canada, 2021; Ostwald et al., 2009).

## **Limitations**

The main limitations of my research stem from the use of administrative databases. In Study 1, I used CIHI data from the National Rehabilitation Reporting System (Canadian Institute for Health Information, 2024c). This was secondary data, information collected by the hospital staff asking questions to patients. This information was inputted electronically into the database system and sent to CIHI. There is the possibility of incomplete data if patients were not asked, if patients did not respond, or if information was not correctly inputted into the system. CIHI implements data quality checks and has mandatory fields in their system to reduce the occurrence of incomplete data (Canadian Institute for Health Information, 2018). Information on intention to return to work was incomplete for 19.5% of stroke survivors. However, I performed post-hoc analyses and did not find any significant differences in age, gender, or disability level between stroke survivors who had information on intention to return to work and those who were unknown. For that reason, I do not think the missing information would largely affect the findings.

In Study 1, it should be taken into consideration that the CIHI data from the National Rehabilitation Reporting was representative of rehabilitation inpatients. This includes only a portion of



all stroke survivors. According to provincial hospital data, 86% of stroke survivors are hospitalized in acute care, and 29% of these people receive inpatient rehabilitation (Canadian Institute for Health Information, 2012). The 29% receiving inpatient rehabilitation tend to fit into the moderate to severe categories of stroke. Some people with mild strokes or very severe strokes are not referred or eligible for rehabilitation. Therefore, their intentions to return to work are not known from this study (Canadian Institute for Health Information, 2012).

In study 3, I used CIHI data from the Discharge Abstract Database (Canadian Institute for Health Information, 2024a) and income tax data from Statistics Canada (Statistics Canada, 2023). This data is collected primarily for administrative purposes, rather than for research. As with any study making use of administrative data, there are data elements of potential interest that were not available. For example, rehabilitation providers and policy makers may be interested in the impact of job characteristics (e.g. the type of occupation, work demands, and number of hours worked) on employment and income after stroke. This limitation in available data could be potentially addressed with linkage of multiple databases. Linkages can help provide more information that otherwise would not be available from a single source (Harron et al., 2017). The Canadian Research Data Centre Network (CRDCN), which manages the use of databases and linkages from Statistics Canada, works in partnership with researchers from universities across Canada (Canadian Research Data Centre Network, 2024). After I completed Study 3, the CRDCN asked me for feedback on linkages that would be useful for improving my research and future studies. I suggested to the CRDCN that employment information could be obtained with linkage to the Statistics Canada Labour Force Survey database (Statistics Canada, 2024a). The Labour Force Survey collects detailed information from workers on a monthly basis, such as the type of occupation, hours of work and work arrangements, and wages. Rehabilitation providers and policy makers may also be interested on the impact of impairment levels and other health variables on employment and income. I suggested to the CRDCN that information on function, health service use,

and income support service use, could be obtained with linkages to the Canadian Community Health Survey, the Ontario Health Study Survey, the Ontario Health Insurance Plan Claims Database, and the Ontario Stroke registry (Institute for Clinical Evaluative Sciences, 2024).

In Study 3, the sample was representative of all people hospitalized for stroke that have filed their income tax returns in Ontario. It did not include people assessed and diagnosed with stroke in the emergency department who were not admitted to the hospital (approximately 14% of people with stroke presenting to the emergency department) (Canadian Institute for Health Information, 2012). This was only a minor limitation as it may be reasonably assumed that these people had mild strokes that would not largely impact their ability to work. Although because these people were not included in the sample, the percentages of people reporting employment income may be slightly underestimated. This limitation could be addressed with linkage of emergency department data from the National Ambulatory Care Reporting System with hospital data from the Discharge Abstract Database (Canadian Institute for Health Information, 2024b).

### **Strengths**

The use of administrative data in my research also had strengths. In Study 1, using CIHI data from the National Rehabilitation Reporting System (Canadian Institute for Health Information, 2024c) permitted the first known study of intention to return to work after stroke. The coverage of the CIHI data was a strength as I was able to conduct a population-based study including all rehabilitation inpatients across Ontario. Furthermore, the completeness of the CIHI data is high because of a Ministry of Health and Long Term Care data collection mandate (Canadian Institute for Health Information, 2018). All hospitals in Ontario must collect this data and routinely report it to CIHI, meaning there was minimal missing data overall.

In Study 3, the coverage of the CIHI data and the Statistics Canada data was a strength. I was able to conduct a population-based study including all hospitalized stroke survivors across Ontario. I

obtained high quality estimates of the percentages of people reporting employment income. Over the 3 years of follow-up, there was very little missing data on employment income (less than 5%). When employment income was missing, it was considered zero as it may be assumed that those people did not have any employment income to report on their income tax returns. Use of the CIHI Discharge Abstract Database linked with Statistics Canada tax data also allowed the identification of a comparison group. This comparison group was selected from the general population that did not have stroke and was matched to the stroke survivors on similar characteristics, such as age, sex, and area of residence. The comparison group was important for accurately examining the relative differences in reported employment income, between the general population and stroke survivors, that could not be accounted for by individual or societal factors (for example, nearing retirement or changes in employment rates).

To summarize, use of administrative databases for my thesis research had limitations and strengths. The main strength was the coverage and mandatory reporting of CIHI data. This made it possible to conduct Study 1 and Study 3, both were population-based studies of Ontario with large sample sizes and high levels of data completeness. In terms of limitations, Study 1 was representative of stroke rehabilitation inpatients, keeping in mind that not all stroke survivors receive rehabilitation. Study 3 was representative of hospitalized stroke survivors, taken into account that not all people who have a stroke are admitted to the hospital. While administrative databases can be a rich source of information, there were limitations in available data on job characteristics, impairment levels, and other health variables. Some of these limitations can be potentially addressed in future research with linkage of multiple databases.

## Conclusions

Returning to work after stroke is important for financial reasons and psychological wellbeing. In Ontario, a fairly large proportion (43.7%) of stroke rehabilitation inpatients who worked pre-stroke, including over one third (36.2%) of those over the usual retirement age of 65 years, intended to return to work. It should not be presumed that employment is not a priority after stroke, and rehabilitation providers should initiate early discussions with stroke survivors about their intentions to return to work.

Globally, it is estimated that slightly more than half (55.7%) of people return to work at 1 year poststroke, increasing to around two-thirds (67.2%) at 2 years poststroke. Although it should be taken into consideration that regional differences in socioeconomic situation may contribute to higher estimates of return to work.

In Ontario, the percentage of hospitalized stroke survivors employed prestroke reporting employment income poststroke was reasonably high (74.8% at 1 year, 68.1% at 2 years, and 63.4% at 3 years). These percentages are higher than the previously mentioned global estimates of return to work, although the trend over time is downward. It could be beneficial for healthcare providers to offer more guidance early on and to follow up with stroke survivors who return to work to ensure employment is maintained. People after stroke experience a decline in their employment income. Rehabilitation providers should connect stroke survivors with employment and social services. This seems especially important to people in low-income situations as they have a greater relative loss in their employment income after stroke.

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