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1 **Males Receive More Intense Inpatient Stroke Rehabilitation Than Females in Ontario,**
2 **Canada**

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49

50 **Abstract**

51

52 Increased rehabilitation intensity, the number of minutes of therapy per day, is associated with
53 improved outcomes; however, it is unclear whether males and females receive the same inpatient
54 stroke rehabilitation intensity. A sub-analysis of a retrospective population-based cohort study of
55 adults (5877 females, 6893 males) with stroke discharged to inpatient rehabilitation between
56 2017 and 2021 was conducted. Mean rehabilitation intensity was 75.86 mins/day for males and
57 73.33 mins/day for females ($p < .0001$). Males <80 years of age were more likely to receive
58 higher rehabilitation intensity than females. Future research should explore what factors account
59 for this sex difference.

60 Stroke is a leading cause of disability globally, but it affects males and females differently;
61 females have worse functional outcomes than males.^{1, 2} Although many of the sex differences in
62 stroke functional outcomes may be attributed to females being older at the time of stroke, having
63 more severe strokes, and being more dependent pre-stroke, these factors do not fully account for
64 the disparity in outcomes.^{1, 3} Therefore, it is important to identify any potentially modifiable
65 factors that may contribute to females' worse functional outcomes and to develop strategies to
66 mitigate their effects.

67

68 Increased rehabilitation intensity (RI), measured by the number of minutes per day of therapy, in
69 the inpatient rehabilitation setting is associated with several positive outcomes including
70 improved function (as measured by the FIM® Instrument), returning to one's pre-admission
71 setting, and a lower likelihood of being discharged to long-term care.⁴ However, it is currently
72 unclear if males and females receive similar RI.

73

74 The objective of this study was to determine if there are sex differences in the RI provided to
75 individuals admitted for inpatient rehabilitation after stroke.

76

77 This is a sub-analysis of a previous study; the study design and cohort have been described
78 elsewhere.⁴ In brief, we used a population-based cohort of community-dwelling adults in
79 Ontario, Canada who were discharged from acute care between 1 January 2017 and 31
80 December 2021 with a diagnosis of subarachnoid hemorrhage (International Classification of
81 Diseases (ICD) 10th version, code I60), intracerebral hemorrhage (ICD code I61), or ischemic
82 stroke (ICD codes I63 and I64) and who were subsequently admitted to inpatient stroke
83 rehabilitation.

84

85 The primary predictor was sex (male vs female). The primary outcome was RI, which was
86 defined as the number of minutes per day of direct therapy provided to a patient divided by
87 rehabilitation length of stay. Although there is currently debate in the literature as to how to
88 define rehabilitation intensity vs rehabilitation dosage,⁵ we used Ontario's current reporting
89 definition. In Ontario, it is mandatory for inpatient stroke rehabilitation programs to report RI (as

90 documented by frontline clinicians) for each patient to the National Rehabilitation Reporting
91 System (NRS).

92
93 Data from the Discharge Abstract Database, NRS, Registered Persons Database, National
94 Ambulatory Care Reporting System, Continuing Care Reporting System, and Postal Code
95 Conversion File held at ICES were linked using unique coded identifiers.

96
97 Sex differences in baseline characteristics were examined using Chi-square tests for categorical
98 variables and Student's t tests for continuous variables. The association between sex and RI was
99 examined using regression analyses, stratified by age. Regression analyses adjusted for the
100 following variables: treated on an acute stroke unit at any time during their inpatient stay (yes vs
101 no); Charlson co-morbidity index (CCI; low = 0–1 vs high = ≥ 2); rural (residing in a community
102 with a population $\leq 10,000$ – yes vs no); admission setting (home vs assisted living vs other);
103 living alone prior to admission (yes vs no); income quintile; acute LOS (days); and total
104 admission FIM (18 - 126). Rehabilitation institution was adjusted as a random effect. All
105 analyses were carried out using SAS version 9.4.

106
107 A total of 5877 females and 6893 males were included. Compared to males, females were older,
108 more likely to be living alone prior to their stroke, more likely to be in the bottom two income
109 quintiles, and had lower admission FIM scores. On the other hand, males were more likely to
110 have a CCI ≥ 2 , reside in a rural community, be admitted from home, or treated on an acute
111 stroke unit, compared to females (Table 1).

112
113 Mean (SD) RI was 75.86 mins/day (29.69) for males and 73.33 mins/day (29.76) for females (p
114 $<.0001$). For each age category, males received higher RI than females. After adjusting for
115 baseline factors, males <80 years of age continued to be more likely to receive higher RI than
116 females (Table 2).

117
118 This study examined sex differences in the provision of inpatient RI after stroke. Males <80
119 years of age were more likely to receive higher RI than females. Although this difference was
120 statistically significant, the clinical significance is unclear as the absolute difference was small.

121 However, there is potential that a combination of several factors, including RI, each with a
122 relatively small individual effect size, may account for the sex difference in stroke functional
123 outcomes reported by others, which was not explained by age, stroke severity, or pre-morbid
124 function.^{1, 3} Additionally, studies are limited in terms of the relationship between fatigue, pain,
125 and low mood and level of participation in rehabilitation. These conditions may be more
126 prevalent in females than males and several studies have demonstrated an association between
127 these factors and outcomes after stroke.⁶⁻¹⁰ Future studies should address whether these, or other
128 factors, account for the sex difference in the provision of inpatient stroke RI.

129

130 This analysis focused on the delivery of rehabilitation and not outcomes. Prior research has
131 generally focused on RI and outcomes or sex differences in outcomes, but not the intersection of
132 both. Additionally, much of the previous research is in the acute setting and information
133 regarding RI and sex differences in the rehabilitation setting is limited. Given the important role
134 inpatient rehabilitation plays in recovery post-stroke, more research should focus on potential sex
135 differences in access, delivery, and outcomes in this setting. A previous study performed in
136 Ontario demonstrated no difference in functional outcomes based on sex for those on an inpatient
137 stroke rehabilitation unit.¹¹ It is possible that the sex difference in RI is associated with
138 differences in other outcome measures not previously reported; however, it is anticipated that the
139 effect size of any findings would be small. Further research is warranted on the interaction
140 between RI and sex.

141

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146

147 **Statement of authorship**

148 SLM, EL, MB, JLF contributed to the study concept and design. IJ-HJ, JF conducted the
149 analyses. SLM prepared the initial draft of the manuscript. All authors contributed to the
150 interpretation of the data and critical revision of the manuscript for intellectual content.

151 **Disclosures**

152 This document used data adapted from the Statistics Canada Postal Code^{OM} Conversion File,
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154 Ontario Ministry of Health Postal Code Conversion File, which contains data copied under
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161
162 SLM has received institutional support to attend academic conferences. She chairs / co-chairs
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170 Institute.

Table 1. Sex differences in baseline characteristics.

Variable	Total N=12,770	Female N=5,877	Male N=6,893	P-Value
Age, mean (SD)	72.57 (13.37)	74.88 (13.42)	70.60 (13.01)	<.0001
Stroke inpatients treated on an acute care stroke unit, n (%)	8,928 (69.9%)	4,046 (68.8%)	4,882 (70.8%)	0.015
LOS (days) among stroke patients admitted to inpatient care, mean (SD)	29.50 (21.76)	29.44 (20.39)	29.56 (22.86)	0.761
Charlson co-morbidity index \geq 2, n (%)	7,856 (61.5%)	3,480 (59.2%)	4,376 (63.5%)	<.0001
Residing in a community with a population \leq 10,000, n (%)	1,258 (9.9%)	538 (9.2%)	720 (10.4%)	0.0147
Admitted from, n (%):				
Assisted living	645 (5.1%)	431 (7.3%)	214 (3.1%)	
Home	12,006 (94.0%)	5,411 (92.1%)	6,595 (95.7%)	
Other	119 (0.9%)	35 (0.6%)	84 (1.2%)	<.0001
Living Alone, n (%)	3,754 (29.4%)	2,119 (36.1%)	1,635 (23.7%)	<.0001
Income Quintile, n (%)				
1	3,249 (25.4%)	1,533 (26.1%)	1,716 (24.9%)	
2	2,771 (21.7%)	1,327 (22.6%)	1,444 (20.9%)	
3	2,546 (19.9%)	1,140 (19.4%)	1,406 (20.4%)	
4	2,205 (17.3%)	971 (16.5%)	1,234 (17.9%)	
5	1,999 (15.7%)	906 (15.4%)	1,093 (15.9%)	0.0251
Admission Motor FIM, mean (SD)	47.04 (18.28)	45.64 (17.63)	48.24 (18.73)	<.0001
Admission Cognitive FIM, mean (SD)	24.41 (6.29)	24.27 (6.32)	24.53 (6.26)	0.0175
Admission Total FIM, mean (SD)	71.45 (20.97)	69.91 (20.36)	72.77 (21.38)	<.0001

SD = standard deviation; LOS = length of stay

Table 2. Unadjusted and adjusted risk differences in rehabilitation intensity by sex, stratified by age

Age	Mean (SD) RI for males	Mean (SD) RI for females	Unadjusted Risk Difference (95% CI) - Male vs Female	p-value	Adjusted Risk Difference (95% CI) - Male vs Female	p-value
<60	79.25 (30.73)	77.97 (29.22)	2.33 (0.24 to 4.42)	0.03	3.34 (1.33 to 5.35)	0.001
60 – 79	76.41 (29.68)	74.67 (30.06)	1.29 (0.13 to 2.44)	0.03	1.37 (0.21 to 2.53)	0.02
≥80	72.41 (28.59)	70.52 (29.35)	1.86 (0.56 to 3.16)	0.005	1.15 (-0.23 to 2.53)	0.1

SD = standard deviation

References

1. Rexrode KM, Madsen TE, Yu AYZ, Carcel C, Lichtman JH, Miller EC. The impact of sex and gender on stroke. *Circ Res.* 2022;130:512-28.
2. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol.* 2021;20:795-820.
3. Phan HT, Blizzard CL, Reeves MJ, et al. Factors contributing to sex differences in functional outcomes and participation after stroke. *Neurology.* 2018;90:e1945-e53.
4. MacDonald SL, Linkewich E, Bayley M, Jeong IJ, Fang J, Fleet JL. The association between inpatient rehabilitation intensity and outcomes after stroke in Ontario, Canada. *Int J Stroke.* 2024;19:431-41.
5. Goikoetxea-Sotelo G, van Hedel HJA. Defining, quantifying, and reporting intensity, dose, and dosage of neurorehabilitative interventions focusing on motor outcomes. *Front Rehabil Sci.* 2023;4:1139251.
6. Ozkan H, Ambler G, Banerjee G, et al. Prevalence, patterns, and predictors of patient-reported non-motor outcomes at 30 days after acute stroke: prospective observational hospital cohort study. *Int J Stroke.* 2024;19:442-51.
7. Glader EL, Stegmayr B, Asplund K. Poststroke fatigue: a 2-year follow-up study of stroke patients in Sweden. *Stroke.* 2002;33:1327-33.
8. Westerlind E, Singh R, Persson HC, Sunnerhagen KS. Experienced pain after stroke: a cross-sectional 5-year follow-up study. *BMC Neurol.* 2020;20:4.
9. Kutlubaev MA, Hackett ML. Part II: predictors of depression after stroke and impact of depression on stroke outcome: an updated systematic review of observational studies. *Int J Stroke.* 2014;9:1026-36.
10. Poynter B, Shuman M, Diaz-Granados N, Kapral M, Grace SL, Stewart DE. Sex differences in the prevalence of post-stroke depression: a systematic review. *Psychosomatics.* 2009;50:563-9.
11. MacDonald SL, Hall RE, Bell CM, Cronin S, Jaglal SB. Sex differences in the outcomes of adults admitted to inpatient rehabilitation after stroke. *PM R.* 2021.