

Processes of Care and Associated Factors in Patients With Stroke by Immigration Status

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Background: Receiving evidence-based stroke care processes is associated with good clinical outcome. However, data on early stroke care among immigrants are scarce.

Objective: We investigated whether guideline-recommended acute stroke care and associated factors differ between immigrants and Danish-born residents.

Design: Patients admitted with ischemic and hemorrhagic stroke diagnoses (n = 129,724) between 2005 and 2018 were identified from the Danish Stroke Registry.

Results: We included 123,928 Danish-born residents and 5796 immigrants with stroke. Compared with Danish-born residents, immigrants were less likely to be admitted to a stroke unit within 24 hours after stroke onset (81.5% vs. 83.9%, $P < 0.001$) and had lower odds of early stroke care including dysphagia screening, physiotherapy, occupational therapy, and nutritional assessment. After adjustment for age, sex, clinical, and sociodemographic factors, immigrants had lower

odds of early stroke unit admission (odds ratio [OR]: 0.97; 95% CI, 0.94–0.99), early dysphagia screening (OR: 0.96; 95% CI, 0.93–0.98), early physiotherapy (OR: 0.96; 95% CI, 0.94–0.99), and early occupational therapy (OR: 0.96; 95% CI, 0.93–0.98) than Danish-born residents. Small absolute differences in overall quality of stroke care were found when comparing immigrants and Danish-born residents. Significant factors associated with greater likelihood of stroke care included high income, high education, and cohabitation.

Conclusions: Immigrants had lower chances of early stroke unit admission and received fewer individual early stroke care processes such as dysphagia screening, physiotherapy and occupational therapy than Danish-born residents. However, the absolute disparities were in general minor and largely influenced by socioeconomic status and cohabitation.

Key Words: immigration, ethnicity, processes of care, stroke

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Stroke is considered a leading cause of death and disability globally, with high individual, family, and societal costs.^{1,2} Evidence suggests that receiving guideline-recommended processes of stroke care such as early admission to stroke unit, early computed tomography/magnetic resonance imaging (CT/MR) scan, timely thrombolytic and/or endovascular therapy, early assessment and neuro-rehabilitation by physiotherapist and occupational therapist is associated with lower risk of medical complications and decreased mortality.^{3–6} Several studies conducted in the United States have shown disparities in receiving evidence-based stroke care processes in minorities such as African Americans relative to White Americans or Hispanic Americans.^{7–9} One study from Canada found no disparities in stroke care performance measures and is among the few studies up-to-date reporting data on immigrants.¹⁰ In Europe, disparities in stroke care may also be found.^{11,12} Hence, we have recently reported on prehospital delay, door-to-needle time, timely reperfusion therapy, and medical prophylaxis including antithrombotic, antihypertensive, and lipid-lowering therapy in immigrants with stroke in Denmark.^{11,12} Still, more comprehensive data on early stroke care including receiving CT/MR scan, dysphagia screening, timely mobilization, early assessment by physiotherapists, and occupational therapists among immigrants are scarce.

Disparities in the fulfilment of relevant care processes among ethnic minorities and immigrants may be attributed to

patient characteristics such as socioeconomic status, language barriers, health beliefs, and acculturation factors (social, psychological, and cultural change associated with adapting into a new cultural environment), and characteristics of health delivery system such as resource and organizational factors, as previously described in Andersen behavioral model.^{13–18} For example, a study in the United Kingdom found that socioeconomic deprivation is associated with poor fulfillment of stroke care processes and may be stronger in patients who are Black than White.¹⁵ In Denmark, lacking language proficiency and strong cultural norms have been reported to hinder the utilization of care among Turkish and Pakistani immigrants.^{17,18} However, it remains largely unknown to what extent social determinants of health affect immigrants' chances of receiving optimal stroke care.

Therefore, the present study sought to address this knowledge gap and investigated whether disparities in guideline-recommended acute stroke care exist between immigrants and Danish-born residents. Furthermore, we compared the processes of stroke care between immigrants and Danish-born residents by socioeconomic status, marital status, and duration of residence.

METHODS

Study Design and Population

The Danish health care system is primarily financed through taxation, allowing free access to hospital care and general practitioners for all residents including immigrants with residence permit. This nationwide register-based cohort study was conducted using data from the Danish Stroke Registry (DSR). Reporting to the DSR is mandatory for all hospitals in Denmark providing acute stroke care. The DSR provided patient-level data on stroke type, age, sex, marital status, lifestyle risk factors, comorbidities, admission date, hospital identification number, and processes of care.¹⁹ All diagnoses were identified in the DSR in accordance with World Health Organization's International Classification of Diseases (ICD) system, 10th revision (ICD 10). Included were patients aged 18 years or older admitted with ischemic stroke (ICD 10, I63) and hemorrhagic stroke (ICD 10, I61) starting from January 1, 2005, to December 31, 2018. Validation studies have reported a high sensitivity and positive predictive value of stroke diagnoses in the DSR.^{20,21}

The study population was linked with registers at Statistics Denmark containing information on immigration status (country of origin), date of birth, date of immigration, highest attained education, family income, and occupation by a unique personal identification number.^{22–24} Only immigrants with residence permit were included. This study was approved by the Danish Data Protection Agency, reference number 514–0457/20–3000 and adhered to the principles underlying the Declaration of Helsinki. In Denmark, no further approval is required regarding registry-based research.

Immigration Status

Immigration status was constructed based on the country of origin or birth in accordance with Statistics

Denmark.²⁵ The study population was classified as immigrants or Danish-born residents. Immigrants are defined as “persons born abroad whose parents are both (or one of them if there is no available information on the other parent) foreign citizens or were both born abroad.”²⁵ In addition, immigrants were categorized by region of origin: western and non-western immigrants. Western immigrants comprised all immigrants originating from 28 European Union countries and Andorra, Iceland, Liechtenstein, Monaco, Norway, San Marino, Switzerland, Vatican State, Australia, New Zealand, Canada, and the United States. Immigrants from other countries constituted the non-western group.²⁵ Immigrants originating from Turkey, Poland, Iraq, and Pakistan were presented as separate subgroups because of their large proportion among the population of immigrants in Denmark. Danish-born residents were regarded as a reference group. Descendants were excluded because of small numbers.

Outcome

The process measures included in the present study were defined by the multidisciplinary national expert committee of clinical stroke experts to reflect core elements of early hospital-based care for patients with acute stroke. The following in-hospital processes of stroke care (performance measures) were included as outcomes: (1) admission to a stroke unit within 24 hours of stroke onset, (2) receipt of CT/MR scan on the day of admission, (3) dysphagia screening (direct swallowing test) on the day of admission, (4) dysphagia screening (indirect swallowing test) on the day of admission, (5) mobilization on the day of admission, (6) assessment by physiotherapist, (7) occupational therapist, and (8) nutritional risk assessment within 2 days of admission, (9) CT angiography/ultrasound within 4 days of admission, (10) administration of antiplatelets if relevant within 2 days of admission, and (11) administration of anticoagulants if relevant within 14 days of admission. Stroke care processes were further assessed using the opportunity-based composite score and the all-or-none composite score, as previously used in quality of care assessment.²⁶ The opportunity-based composite score for each person was calculated by counting total number of care processes received (numerator), divided by total number of times that care processes were eligible for that person (denominator). The all-or-none composite score for a person was defined as 1 if all eligible care processes were received by the patient and 0 otherwise. Both composite scores were based on 11 care processes across all patients with acute stroke.

Covariates

Age, sex, hospital identification number, stroke type, stroke severity, smoking, diabetes, hypertension, atrial fibrillation, myocardial infarction, previous stroke or transient ischemic attack, marital status, education, income, occupation, and duration of residence (proxy for acculturation) were used as covariates to study association between immigration status (immigrants vs. Danish-born residents) and use of care processes among patients with stroke. Stroke severity was assessed at admission and classified as a continuous variable according to the Scandinavian Stroke Scale score. Lifestyle risk factors

and comorbidities collected at baseline were categorized as yes or no. Marital status was classified as cohabiting, living alone, or other. Income was grouped into low, middle, or high tertiles. Education was categorized as low (primary and lower secondary education), medium (upper secondary, postsecondary nontertiary, and short cycle tertiary education), or high (bachelor, master, and doctoral education) according to the International Standard Classification of Education. Moreover, occupation was classified as employed, pensioner/retired, or unemployed. Duration of residence was defined as time difference between date of entry in Denmark and date of admission to a stroke unit. The duration of residence was first handled as a continuous variable in years. When evaluating overall quality of stroke care, 3 levels of duration of residence for immigrants were created: <10 years of residence, 10–20 years of residence, >20 years of residence in Denmark and a separate category for Danish-born residents.

Statistical Analyses

Processes of care among immigrants with stroke compared with Danish-born residents were summarized using frequencies and percentages. We estimated the use of 11 processes of care between immigrants and Danish-born residents by fitting multivariable logistic regression models. Models were adjusted for age, sex, clinical factors (stroke severity, previous of stroke or transient ischemic attack, smoking, myocardial infarction, atrial fibrillation, diabetes, and hypertension), and sociodemographic factors (marital status, income, occupation, education, and duration of residence). In case of missing data, we included the maximum number of patients with information for a specific covariate in the multivariable analyses. The first model contained immigration status (2 levels): overall immigrants and Danish-born residents. The second model contained region of origin (3 levels): western, non-western immigrants, and Danish-born residents. The third model consisted of country of origin: Polish, Turkish, Iraqi, Pakistani, Others, and Danish-born residents. In all models, Danish-born residents were the reference group. We reported odds ratios (ORs) and their 95% CI as unadjusted and fully adjusted.

Furthermore, overall quality of stroke care was evaluated using opportunity-based and all-or-none composite score measures. We used a linear regression when computing mean absolute differences in composite scores comparing immigrants with Danish-born residents. We assessed whether quality of care in immigrants compared with Danish-born residents differed by stroke type in a stratified linear regression. Moreover, we performed subgroup analyses in which quality of stroke care was compared between immigrants and Danish-born residents based on (1) education (4 groups: immigrants high education level, Danish-born high education level, immigrants low education level vs. Danish-born low education level), (2) income (4 groups: immigrants high income, Danish-born high income, immigrants low income vs. Danish-born low income), (3) marital status (4 groups: immigrants cohabiting, Danish-born cohabiting, immigrants living alone vs. Danish-born living alone), and (4) duration of residence (4 groups: immigrants with <10 y of residence, immigrants with 10–20 y of residence, immigrants with >20 y of residence in Denmark

vs. Danish-born residents). Finally, an interaction term (hospital identifier and immigration status) was applied to assess quality of care between hospitals treating patients with acute stroke. We reported mean, mean absolute differences, and their 95% CI as percentages. Comparisons were made using Pearson χ^2 test for categorical variables and Kruskal-Wallis test for continuous variables. All analyses were performed in R statistical software (version 4.0.5 and 4.1.1).

RESULTS

Patient Characteristics

Between 2005 and 2018, 129,724 stroke cases were identified, of which 5796 (4.5%) were immigrants and 123,928 (95.5%) were Danish-born residents (Figure, Supplemental Digital Content 1, <http://links.lww.com/MLR/C555>). Compared with Danish-born residents, immigrants in particular those originating from non-western countries were in general younger at stroke diagnosis, more likely to have low income, more likely to be unemployed, and more likely to be cohabiting (Table, Supplemental Digital Content 2, <http://links.lww.com/MLR/C555>). Turkish were the most likely of all immigrant subgroups to have low educational level. Polish immigrants were the most likely of all immigrant subgroups to have low income. Diabetes was more prevalent in Pakistani, followed by Turkish and Iraqi than in Danish-born residents. The median Scandinavian Stroke Scale score was 49 for immigrants and Danish-born residents (Table 1).

Processes of Care

Compared with Danish-born residents, immigrants were less likely to be admitted to a stroke unit within 24 hours after stroke onset (81.5% vs. 83.9%, $P < 0.001$), with the lowest proportion seen in Iraqi. Immigrants less frequently received stroke care than Danish-born residents (70.6% vs. 73.8%, $P < 0.001$ for early direct swallowing test, 81.3% vs. 83.3%, $P = 0.003$ for early indirect swallowing test, 79.2% vs. 81.3%, $P = 0.001$ for early physiotherapy, 77.6% vs. 79.4%, $P = 0.004$ for early occupational therapy, 82.0% vs. 83.5%, $P = 0.011$ for early nutritional assessment; Table 2) (Table, Supplemental Digital Content 3, <http://links.lww.com/MLR/C555>). The lowest proportions of receiving early dysphagia screening (direct or indirect swallowing tests) and early physiotherapy and occupational therapy were found in Pakistani, Polish, and Turkish immigrants (Table 3). Compared with Danish-born residents, we observed lower unadjusted odds of receiving early dysphagia screening (OR: 0.97; 95% CI, 0.96–0.98), early physiotherapy (OR: 0.97; 95% CI, 0.96–0.99), early occupational therapy (OR: 0.98; 95% CI, 0.97–0.99), and early nutritional assessment (OR: 0.98; 95% CI, 0.97–0.99) among immigrants (Fig. 1) (Table, Supplemental Digital Content 4, <http://links.lww.com/MLR/C555>). After adjustment for age, sex, clinical, and sociodemographic factors, the odds ratio of early stroke unit admission (OR: 0.97; 95% CI, 0.94–0.99), early dysphagia screening (OR: 0.96; 95% CI, 0.93–0.98), early physiotherapy (OR: 0.96; 95% CI, 0.94–0.99), and early occupational therapy (OR: 0.96; 95% CI, 0.93–0.98) were significantly lower for immigrants than Danish-born residents (Fig. 1) (Table, Supplemental Digital

TABLE 1. Baseline Characteristics of Patients Admitted With Ischemic and Hemorrhagic Stroke Between 2005 and 2018

	Danish-born, N = 123,928	Immigrants, N = 5796	Polish, N = 254	Turkish, N = 360	Iraqi, N = 179	Pakistani, N = 258	Others,* N = 4745
Age at stroke diagnosis, y median (IQR)	73 (63–82)	68 (58–78)	68 (57–81)	63 (52–72)	63 (53–71)	64 (57–70)	69 (58–79)
Duration of residence, y median (IQR)	NA	22 (14–31)	25 (10–32)	30 (25–36)	16 (11–21)	31 (25–38)	22 (13–30)
Sex (female), n (%)	66,492 (53.7)	3053 (52.7)	117 (46.1)	206 (57.2)	123 (68.7)	168 (65.1)	2439 (51.4)
Ischemic stroke, n (%)	108,736 (87.7)	5039 (86.9)	227 (89.4)	324 (90.0)	157 (87.7)	232 (89.9)	4099 (86.4)
Hemorrhagic stroke, n (%)	15,192 (12.3)	757 (13.1)	27 (10.6)	36 (10.0)	22 (12.3)	26 (10.1)	646 (13.6)
SSS score, median (IQR)	49 (35–56)	49 (34–56)	49 (29–55)	52 (39–56)	52 (36–56)	53 (42–56)	49 (33–56)
Missing, n (%)	8496 (6.9)	546 (9.4)	27 (10.6)	31 (8.6)	20 (11.2)	38 (14.7)	430 (9.1)
Comorbidities, n (%)							
Current smoking	35,943 (29.0)	1545 (26.7)	67 (26.4)	112 (31.1)	47 (26.3)	61 (23.6)	1258 (26.5)
Missing	19,949 (16.1)	1057 (18.2)	55 (21.7)	54 (15.0)	27 (15.1)	42 (16.3)	879 (18.5)
Hypertension	66,493 (53.7)	3129 (54.0)	147 (57.9)	197 (54.7)	100 (55.9)	176 (68.2)	2509 (52.9)
Missing	4247 (3.4)	176 (3.0)	5 (2.0)	8 (2.2)	5 (2.8)	6 (2.3)	152 (3.2)
Diabetes	17,398 (14.0)	1366 (23.6)	51 (20.1)	140 (38.9)	57 (31.8)	153 (59.3)	965 (20.3)
Missing	3018 (2.4)	140 (2.4)	5 (2.0)	5 (1.4)	6 (3.4)	6 (2.3)	118 (2.5)
Myocardial infarction	10,558 (8.5)	507 (8.7)	17 (6.7)	39 (10.8)	18 (10.1)	46 (17.8)	387 (8.2)
Missing	4522 (3.6)	227 (3.9)	9 (3.5)	11 (3.1)	8 (4.5)	11 (4.3)	188 (3.9)
Atrial fibrillation	22,370 (18.1)	916 (15.8)	55 (21.7)	49 (13.6)	17 (9.5)	11 (4.3)	784 (16.5)
Missing	3319 (2.7)	160 (2.7)	5 (2.0)	15 (4.1)	8 (4.5)	8 (3.1)	124 (2.6)
Previous stroke or TIA	28,084 (22.7)	1228 (21.2)	59 (23.2)	66 (18.3)	34 (19.0)	59 (22.8)	1010 (21.3)
Missing	40,062 (32.3)	1723 (29.7)	60 (23.6)	128 (35.6)	58 (32.4)	63 (24.4)	1414 (29.8)
Education [†] , n (%)							
Low	52,452 (42.3)	1481 (25.5)	37 (14.6)	175 (48.6)	42 (23.5)	94 (36.5)	1133 (23.9)
Medium	13,790 (11.1)	1547 (26.7)	92 (36.2)	65 (18.1)	40 (22.3)	86 (33.3)	1264 (26.6)
High	14,614 (11.8)	880 (15.2)	40 (15.7)	9 (2.5)	35 (19.6)	22 (8.5)	774 (16.3)
Missing	43,072 (34.8)	1888 (32.6)	85 (33.5)	111 (30.8)	62 (34.6)	56 (21.7)	1574 (33.2)
Family income [‡] , n (%)							
Low	42,472 (34.2)	2512 (43.4)	140 (55.1)	164 (45.6)	72 (40.2)	95 (36.8)	2041 (43.0)
Middle	40,589 (32.8)	1781 (30.7)	58 (22.8)	106 (29.4)	73 (40.8)	94 (36.4)	1450 (30.6)
High	40,867 (33.0)	1503 (25.9)	56 (22.1)	90 (25.0)	34 (19.0)	69 (26.8)	1254 (26.4)
Occupation, n (%)							
Employed	33,182 (26.8)	1345 (23.2)	73 (28.7)	79 (22.0)	30 (16.8)	62 (24.0)	1101 (23.2)
Pensioner/retired	69,508 (56.1)	2686 (46.4)	112 (44.1)	148 (41.1)	51 (28.5)	100 (38.8)	2275 (47.9)
Unemployed	11,634 (9.4)	1179 (20.3)	35 (13.8)	116 (32.2)	88 (49.1)	87 (33.7)	853 (18.0)
Missing	9604 (7.7)	586 (10.1)	34 (13.4)	17 (4.7)	10 (5.6)	9 (3.5)	516 (10.9)
Marital status, n (%)							
Cohabiting	65,815 (53.1)	3378 (58.3)	114 (44.9)	289 (80.3)	133 (74.3)	206 (79.8)	2636 (55.6)
Living alone	50,990 (41.1)	2042 (35.2)	115 (45.3)	55 (15.3)	41 (22.9)	35 (13.6)	1796 (37.9)
Other	3904 (3.2)	179 (3.1)	13 (5.1)	7 (1.9)	5 (2.8)	8 (3.1)	148 (3.1)
Missing	3219 (2.6)	197 (3.4)	12 (4.7)	9 (2.5)	NA	9 (3.5)	165 (3.4)

TIA data were available from 2013 onward.

*Other immigrant groups excluding Polish, Turkish, Iraqi, and Pakistani.

[†]According to the International Standard Classification of Education.

[‡]Tertiles.

IQR indicates interquartile range; NA, not applicable; SSS, Scandinavian Stroke Scale; TIA, transient ischemic attack.

TABLE 2. Processes of Stroke Care by Immigration Status

Processes of care	Total		Danish-born		Immigrants		P
	Eligible, N	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)		
Admission to a stroke unit within 24 h	129,724	123,928	103,941 (83.9)	5796	4724 (81.5)	<0.001	
CT/MR scan on the day of admission	127,211	121,547	97,250 (80.0)	5664	4542 (80.2)	0.739	
Dysphagia screening on the day of admission (direct swallowing test)	86,528	82,643	61,004 (73.8)	3885	2741 (70.6)	<0.001	
Dysphagia screening on the day of admission (indirect swallowing test)	65,516	62,418	52,022 (83.3)	3098	2519 (81.3)	0.003	
Mobilization on the day of admission	67,619	64,336	50,258 (78.1)	3283	2531 (77.1)	0.166	
Physiotherapy within 2 d of admission	101,967	97,660	79,371 (81.3)	4307	3410 (79.2)	0.001	
Occupational therapy within 2 d of admission	103,148	98,775	78,424 (79.4)	4373	3393 (77.6)	0.004	
Nutritional risk assessment within 2 d of admission	101,939	97,473	81,358 (83.5)	4466	3663 (82.0)	0.011	
CT angiography/ultrasound within 4 d of admission	73,102	69,596	57,062 (82.0)	3506	2956 (84.3)	<0.001	
Antiplatelet therapy within 2 d of admission	85,310	81,472	74,272 (91.2)	3838	3522 (91.8)	0.197	
Anticoagulant therapy within 14 d of admission	12,446	11,952	10,118 (84.7)	494	409 (82.8)	0.261	
Opportunity-based composite score, reported as percentage, mean (95% CI)	129,724	123,928	79.9 (79.8–80.1)	5796	78.9 (78.2–79.6)	<0.001	
All-or-none score, reported as percentage, mean (95% CI)	129,724	123,928	45.7 (45.5–46.0)	5796	44.0 (42.7–45.3)	<0.001	

Content 5, <http://links.lww.com/MLR/C555>). The lower odds of early dysphagia screening, early physiotherapy, and occupational therapy were most evident in non-western immigrants. In the country-specific estimates, the lower odds of receiving the aforementioned stroke care processes were more pronounced for Turkish, Iraqi, and Pakistani immigrants than Danish-born residents. In contrast, immigrants were more likely to receive CT angiography/ultrasound and had a higher odds of receiving this care process than Danish-born residents in the unadjusted model (84.3% vs. 82.0%, $P < 0.001$ and OR: 1.02; 95% CI, 1.01–1.03); however, the association disappeared after adjustment for covariates. No evidence was found that other stroke care processes differed between immigrants and Danish-born residents.

The mean opportunity-based composite score was lower for immigrants than Danish-born residents (78.9% vs. 79.9%, $P < 0.001$). Similarly, immigrants had a lower mean all-or-none composite score than Danish-born residents (44.0% vs. 45.7%, $P < 0.001$). Immigrants with stroke were in general less likely to receive care (1.0% points less likely for stroke care using opportunity-based composite score and 1.7% points less likely for stroke care using all-or-none composite score) than Danish-born residents (−1.0%; 95% CI, −1.7% to −0.3% and −1.7%; 95% CI, −3.1% to −0.4%). No differences in stroke care were observed when comparing immigrant subgroups and Danish-born residents using both approaches (Table, Supplemental Digital Content 6, <http://links.lww.com/MLR/C555>). Analysis by stroke type showed that differences in care were only present in ischemic stroke. Figure 2 and Supplemental Digital Content 7, <http://links.lww.com/MLR/C555> illustrate opportunity-based composite score and all-or-none composite score by socioeconomic status, marital status, and duration of residence. Compared with Danish-born residents, immigrants who had resided in Denmark for <10 years were 2.5% and 4.7% less likely to receive stroke care using opportunity-based and all-or-none composite scores, respectively (−2.5%; 95% CI, −4.7% to −0.4% and −4.7%; 95% CI, −8.9% to −0.5%). We found that patients who were cohabiting versus living alone, those who had high educational level versus low

educational level, and those with high income versus low income were overall more likely to receive stroke care regardless of immigration status. Moreover, immigrants with low educational level were less likely to receive stroke care than Danish-born residents of a similar educational level. In general, we observed that quality of care was not different between hospitals treating patients with acute stroke when comparing immigrants with Danish-born residents (Supplemental Digital Content 8, <http://links.lww.com/MLR/C555>).

DISCUSSION

This nationwide register-based cohort study found that immigrants compared with Danish-born residents were less likely to be admitted to a stroke unit within 24 hours after stroke onset and had lower chances of receiving individual guideline-recommended acute stroke care such as dysphagia screening, physiotherapy, occupational therapy, and nutritional assessment. After adjustment for relevant confounders, immigrants had lower chances of early stroke unit admission, early dysphagia screening, early physiotherapy, and occupational therapy than Danish-born residents. The lower chances of receiving the mentioned stroke care processes were evident for non-western immigrants in particular Turkish, Iraqi, and Pakistani than Danish-born residents. However, when combining processes of care using opportunity-based and all-or-none composite scores, minor disparities in overall stroke care were observed between immigrants and Danish-born residents. Significant factors associated with greater likelihood of stroke care included high income, high education, and cohabitation.

Previous studies on minorities compared with the majority population have reported conflicting results regarding the receipt of evidence-based stroke care processes. For example, 1 study in the United States found that individuals who are African American more often than White Americans or Hispanic Americans received fewer stroke care processes such as intravenous thrombolysis and anti-coagulant therapy.⁷ Whereas the other study showed that African American patients with stroke were more likely to

TABLE 3. Processes of Stroke Care by Country of Origin

Processes of care	Danish-born		Polish		Turkish		Iraqi		Pakistani		Others*		P
	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	
Admission to a stroke unit within 24 h	123,928	103,941 (83.9)	254	203 (79.9)	360	298 (82.8)	179	138 (77.1)	258	206 (79.8)	4745	3879 (81.7)	<0.001
CT/MR scan on the day of admission	121,547	97,250 (80.0)	246	191 (77.6)	352	268 (76.1)	176	147 (83.5)	249	192 (77.1)	4641	3744 (80.7)	0.150
Dysphagia screening on the day of admission (direct swallowing test)	82,643	61,004 (73.8)	178	119 (66.9)	249	174 (69.9)	117	81 (69.2)	188	122 (64.9)	3153	2245 (71.2)	<0.001
Dysphagia screening on the day of admission (indirect swallowing test)	62,418	52,022 (83.3)	153	124 (81.0)	191	147 (77.0)	100	82 (82.0)	158	125 (79.1)	2496	2041 (81.8)	0.030
Mobilization on the day of admission	64,336	50,258 (78.1)	155	111 (71.6)	209	162 (77.5)	116	92 (79.3)	176	133 (75.6)	2627	2033 (77.4)	0.373
Physiotherapy within 2 d of admission	97,660	79,371 (81.3)	184	143 (77.7)	262	206 (78.6)	132	106 (80.3)	171	124 (72.5)	3558	2831 (79.6)	0.003
Occupational therapy within 2 d of admission	98,775	78,424 (79.4)	186	136 (73.1)	259	203 (78.4)	126	100 (79.4)	178	130 (73.0)	3624	2824 (77.9)	0.019
Nutritional risk assessment within 2 d of admission	97,473	81,358 (83.5)	190	156 (82.1)	284	229 (80.6)	128	108 (84.4)	194	166 (85.6)	3670	3004 (81.9)	0.101
CT angiography/ultrasound within 4 d of admission	69,596	57,062 (82.0)	164	143 (87.2)	241	207 (85.9)	117	103 (88.0)	191	166 (86.9)	2793	2337 (83.7)	0.005
Antiplatelet therapy within 2 d of admission	81,472	74,272 (91.2)	159	146 (91.8)	248	227 (91.5)	132	125 (94.7)	202	189 (93.6)	3097	2835 (91.5)	0.534
Anticoagulant therapy within 14 d of admission	11,952	10,118 (84.7)	31	26 (83.9)	30	25 (83.3)	†	†	†	†	424	349 (82.3)	0.550

(Continued)

TABLE 3. Processes of Stroke Care by Country of Origin (continued)

Processes of care	Danish-born		Polish		Turkish		Iraqi		Pakistani		Others*		
	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	Eligible, N	Received care, N (%)	
Opportunity-based composite score, reported as percentage, mean (95% CI)	123,928	79.9 (79.8–80.1)	254	77.6 (74.1–81.2)	360	78.2 (75.4–81.0)	179	80.3 (76.7–83.9)	258	77.0 (73.7–80.3)	4745	79.1 (78.3–79.8)	
All-or-none score, reported as percentage, mean (95% CI)	123,928	45.7 (45.5–46.0)	254	43.7 (37.5–49.8)	360	42.2 (37.0–47.3)	179	41.3 (34.0–48.6)	258	44.1 (38.0–50.2)	4745	44.2 (42.8–45.6)	
												P	
													0.081

*Other immigrant groups excluding Polish, Turkish, Iraqi, and Pakistani.
 †Number not presented in pursuance of Danish Data Protection Act.

receive dysphagia screening and physiotherapy than White Americans.⁹ Ideally, the racial groups are created based on the physical features such as skin color, hair type, and eye color, whereas ethnicity refers to a state of belonging to a certain social group based on shared cultural traditions and languages.²⁷ This distinction makes comparison of our findings with these previous studies conducted in the United States challenging, as there is a significant variation in the study population (immigrants vs. ethnic groups vs. racial groups). Although immigrants and ethnic minorities generally represent a vulnerable group, because they are often subject to social prejudice and poor living conditions. In contrast to our findings, a Canadian study found no difference in stroke care delivery including dysphagia screening, carotid imaging, and palliative care between immigrants and Canadian-born population.¹⁰ In Europe, studies reporting data on acute stroke care processes among immigrants or ethnic minorities are limited.

Utilization of care among immigrants admitted with stroke may be contributed by several factors related to characteristics of population at risk (including predisposing and enabling factors) and characteristics of health delivery system (including resource and organization) as presented by Andersen.¹³ First, we have recently reported that immigrants have a longer prehospital time delay than Danish-born residents,¹¹ which may partly explain the lower chance of early stroke unit admission seen in immigrants. Furthermore, predisposing factors such as low health literacy, strong sociocultural values and beliefs, and language barriers among immigrants may preclude this population chance of receiving early dysphagia screening, early physiotherapy, and occupational therapy.^{16–18} This may be the case for Turkish, Iraqi, and Pakistani immigrants, as these immigrant subgroups have been reported to underutilize care in Denmark because of the mentioned predisposing factors.^{17,18} Our study found a less likelihood of overall stroke care in immigrants with low educational level relative to their Danish-born counterpart. Turkish immigrants had the largest proportion of patients with low educational level and this may contribute to explaining why they had lower chances of receiving the mentioned early stroke care processes. We observed a greater likelihood of overall stroke care among patients with high income level than those with low income level, regardless of immigration status. Income in particular is considered as one of the enabling factors toward realized access to health care. Both income and education are classified as part of socioeconomic status and are reported to influence individual likelihood of stroke care in the general population.^{28–30} Therefore, much effort is still needed to reduce socioeconomic disparities in acute stroke care even in a setting that is considered to provide equal access to health care. Insurance coverage is another enabling factor, which has been shown to contribute to disparities in access to emergency medical care in minorities compared with the majority population in the United States.³¹ Because of the availability of universal health care system in Denmark, there is no reason to believe that insurance coverage could impact access to care since having a legal residence in the

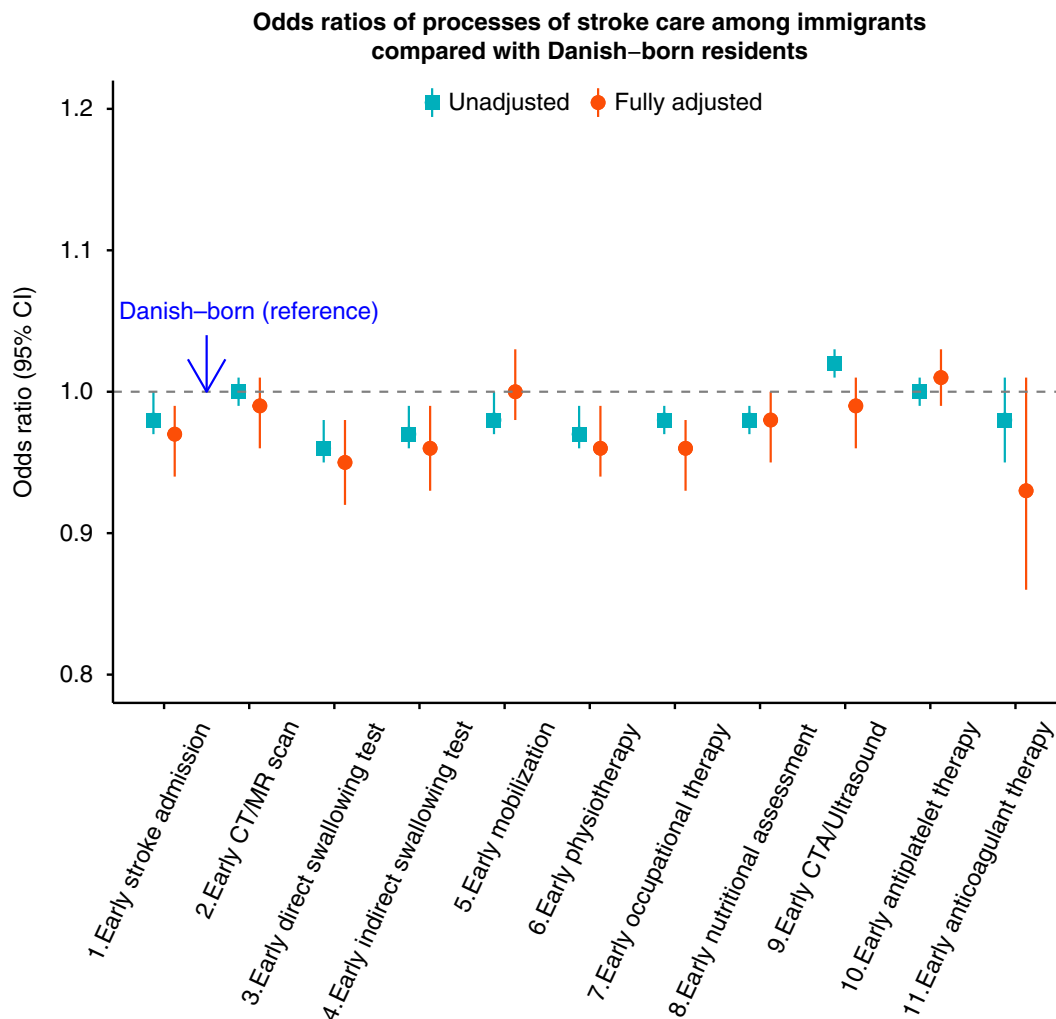


FIGURE 1. Unadjusted and fully adjusted odds ratio of processes of care among immigrants with stroke relative to Danish-born residents. The fully adjusted model comprised age, sex, stroke severity, previous stroke or transient ischemic attack, smoking, myocardial infarction, atrial fibrillation, diabetes, hypertension, income, occupation, education, marital status, and duration of residence. CTA indicates computed tomography angiography; CT/MR, computed tomography/magnetic resonance imaging.

country guarantees immigrants free access to health care like Danish citizens. Moreover, immigrants residing in Denmark for <10 years were found to have less likelihood of overall stroke care than Danish-born residents. This finding may be in part attributable to acculturation factors including sociocultural challenges associated with adjusting into new culture and navigating the health care system. The observed greater likelihood of stroke care in patients who were cohabiting relative to those living alone may be related to social support offered by a partner or spouse. It is important to highlight that providing dysphagia screening, physiotherapy and occupational therapy requires patient-provider engagement for maximizing optimal stroke care. Thus, disparities in observed stroke care processes may also arise from patient mistrust of health care system/attending physician, or prior negative health care experience, or patient refusal of care, or simply physician implicit bias toward immigrants.

Previous studies have demonstrated an inverse dose-response relationship between receiving processes of stroke care and clinical outcome, with increase in number of care processes received associated with lower risk of medical complications and reduced mortality.^{3,4} We found a slightly less likelihood of overall stroke care for immigrants than Danish-born residents in a composite score analysis. This minor difference in stroke care does not seem to play an important clinical role, as we have previously reported no difference in mortality risk between immigrants and Danish-born residents poststroke.³² Our findings suggest that more effort is needed to reduce disparities in in-hospital stroke care for patients with ischemic stroke. Compared with Danish-born residents, immigrants were not treated differently between hospitals providing acute stroke care in Denmark. This indicates that disparities found in stroke care are within hospitals. The observed lower proportion of immigrants with stroke (4.5%) reflects that immigrant population in Denmark is in general younger than local-born

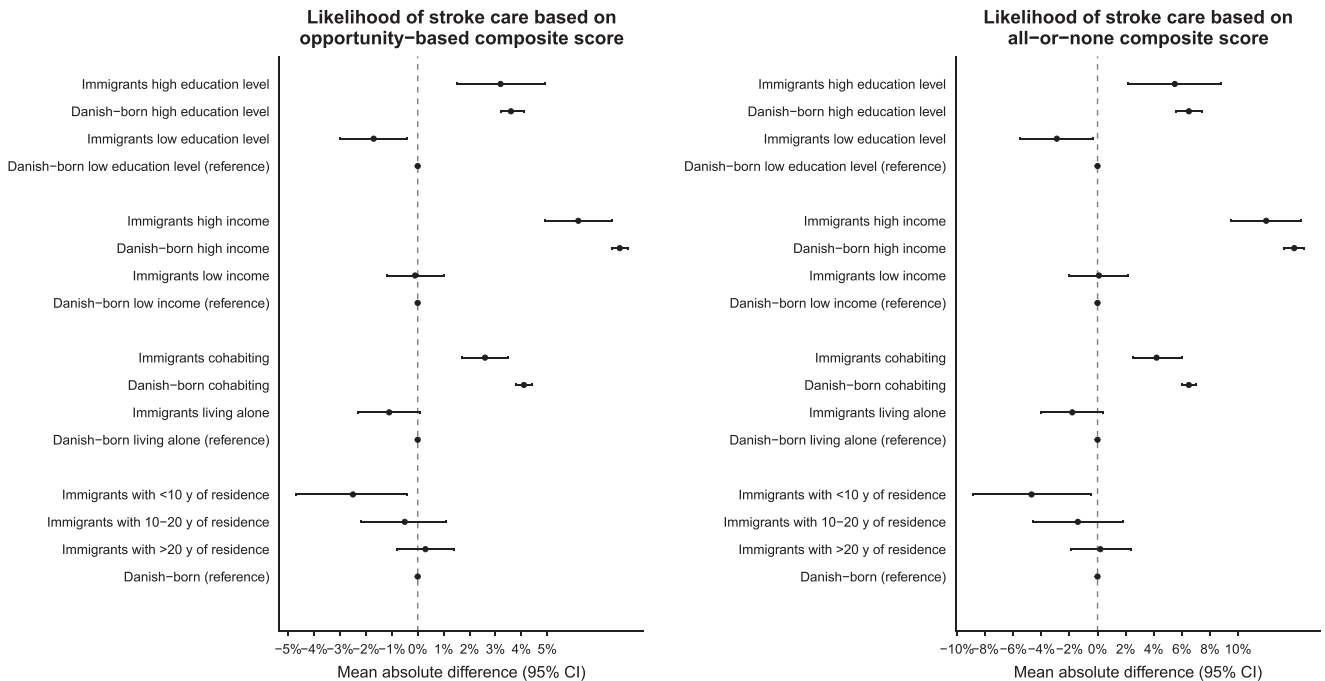


FIGURE 2. Opportunity-based composite score and all-or-none composite score by socioeconomic status, marital status, and duration of residence. The opportunity-based composite score for each person was calculated by counting total number of care processes received (numerator), divided by total number of times that care processes were eligible for that person (denominator). The all-or-none composite score for a person was defined as 1 if all eligible care processes were received by the patient and 0 otherwise. Both composite scores were based on 11 care processes across all patients with acute stroke.

population and some immigrants may return to their country of origin as they get older.

Strengths and Limitations

This study has several strengths including a nationwide sample, a broad range of clinical and sociodemographic factors, and few missing data among immigrants relative to Danish-born residents. This study contributes knowledge about disparities in guideline-recommended acute in-hospital stroke care processes among immigrants rather than racial groups. Composite score measures used in assessing the quality of stroke care in this study are increasingly being recognized in evaluating hospital performance and improving organization of health care services.²⁶ Our study has some limitations. We could not investigate the role of professional medical interpreters in the quality of acute stroke care delivery as such data were unavailable.³³ The proportion of immigrants was increasing over time and that we did not have a sufficient number in the early part of the study period to explore the temporal trends in stroke care processes. A caution should in general be advised when interpreting multivariable analyses of small samples particularly for immigrant subgroups. Lastly, there is a risk that some of our analyses might be over adjusted because of mediating factors, but we did not observe instability in the majority of multivariable models performed.

CONCLUSIONS

Compared with Danish-born residents, immigrants had lower chances of early stroke unit admission and received

fewer individual stroke care processes such as early dysphagia screening, early physiotherapy, and occupational therapy. However, the absolute disparities were in general minor and largely explained by differences in income, educational level, and cohabitation status.

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