ORIGINAL ARTICLE


# The Impact of Stroke Public Awareness Campaigns Differs Between Sociodemographic Groups

*Bastien Rioux, Vincent Brissette, Francine Forget Marin, Patrice Lindsay, Mark R. Keezer, Alexandre Y. Poppe*

**ABSTRACT:** ***Background:*** Prehospital delays are a major obstacle to timely reperfusion therapy in acute ischemic stroke. Stroke sign recognition, however, remains poor in the community. We present an analysis of repeated surveys to assess the impact of Face, Arm, Speech, Time (FAST) public awareness campaigns on stroke knowledge. ***Methods:*** Four cross-sectional surveys were conducted between July 2016 and January 2019 in the province of Quebec, Canada (n = 2,451). Knowledge of FAST stroke signs (face drooping, arm weakness and speech difficulties) was assessed with open-ended questions. A bilingual English/French FAST public awareness campaign preceded survey waves 1–3 and two campaigns preceded wave 4. We used multivariable ordinal regression models weighted for age and sex to assess FAST stroke sign knowledge. ***Results:*** We observed an overall significant improvement of 26% in FAST stroke sign knowledge between survey waves 1 and 4 (odds ratio [OR] = 1.26; 95% CI: 1.02, 1.55; p = 0.035). After the last campaign, however, 30.5% (95% CI: 27.5, 33.6) of people were still unable to name a single FAST sign. Factors associated with worse performance were male sex (OR = 0.68; 95% CI: 0.53, 0.86; p = 0.002) and retirement (OR = 0.54; 95% CI: 0.35, 0.83; p = 0.005). People with lower household income and education had a tendency towards worse stroke sign knowledge and were significantly less aware of the FAST campaigns. ***Conclusions:*** Knowledge of FAST stroke signs in the general population improved after multiple public awareness campaigns, although it remained low overall. Future FAST campaigns should especially target men, retired people and individuals with a lower socioeconomic status.

**RÉSUMÉ : L'impact de campagnes de sensibilisation du public à l'accident vasculaire cérébral varie par groupe sociodémographique.** ***Contexte :*** Les délais préhospitaliers constituent un obstacle majeur à la thérapie de reperfusion précoce en accident vasculaire cérébral (AVC) ischémique aigu. La reconnaissance des signes d'AVC demeure toutefois faible dans la population générale. Nous présentons une analyse d'enquêtes répétées visant à évaluer l'impact de campagnes successives de sensibilisation VITE (Visage [affaissé], Incapacité [à lever les bras], Trouble de la parole, Extrême urgence) sur la connaissance des signes d'AVC dans la population générale. ***Méthode :*** Quatre enquêtes transversales ont été effectuées au Québec entre juillet 2016 et janvier 2019 (n = 2451). Elles visaient à évaluer par des questions ouvertes la connaissance des signes VITE de l'AVC. Les trois premières enquêtes ont été précédées d'une seule campagne VITE bilingue (français-anglais) de sensibilisation du public à l'AVC, alors que la dernière enquête a été précédée de deux campagnes. Nous avons analysé la connaissance des signes VITE par régression ordinale pondérée pour l'âge et le sexe. ***Résultats :*** Nous avons observé une amélioration globale significative de 26 % pour la connaissance des signes VITE de l'AVC entre la première et la quatrième enquête (rapport de cotes [RC] : 1,26; IC à 95 % : 1,02-1,55; p = 0,035). Toutefois, après la dernière campagne, 30,5% des individus (IC à 95%: 27,5-33,6) demeuraient incapables de nommer au moins un signe VITE. Les principaux facteurs associés à une moins bonne connaissance des signes VITE étaient le sexe masculin (RC : 0,68; IC à 95 % : 0,53-0,86; p = 0,002) et la retraite (RC : 0,54; IC à 95 % : 0,35-0,83; p = 0,005). Les individus ayant un revenu de ménage et une éducation inférieurs avaient tendance à moins connaitre les signes VITE et étaient significativement moins au courant des précédentes campagnes de sensibilisation VITE. ***Conclusions :*** La connaissance des signes VITE s'est améliorée après une série de campagnes de sensibilisation du public à l'AVC, bien qu'elle demeure globalement faible. Les prochaines campagnes VITE devraient particulièrement cibler les hommes, les retraités ainsi que les individus à faible statut socioéconomique.

**Keywords:** FAST, Educational campaigns, Stroke awareness, Sociodemographic factors, Sex differences, Prehospital triage, Stroke signs

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## Introduction

Prehospital delays are a major obstacle to timely reperfusion therapy in acute ischemic stroke and predict worse outcomes regardless of treatment.[1] Median onset-to-door times still exceed three hours and cause the largest delays from stroke onset to reperfusion therapy in most published data.[2] Despite reductions

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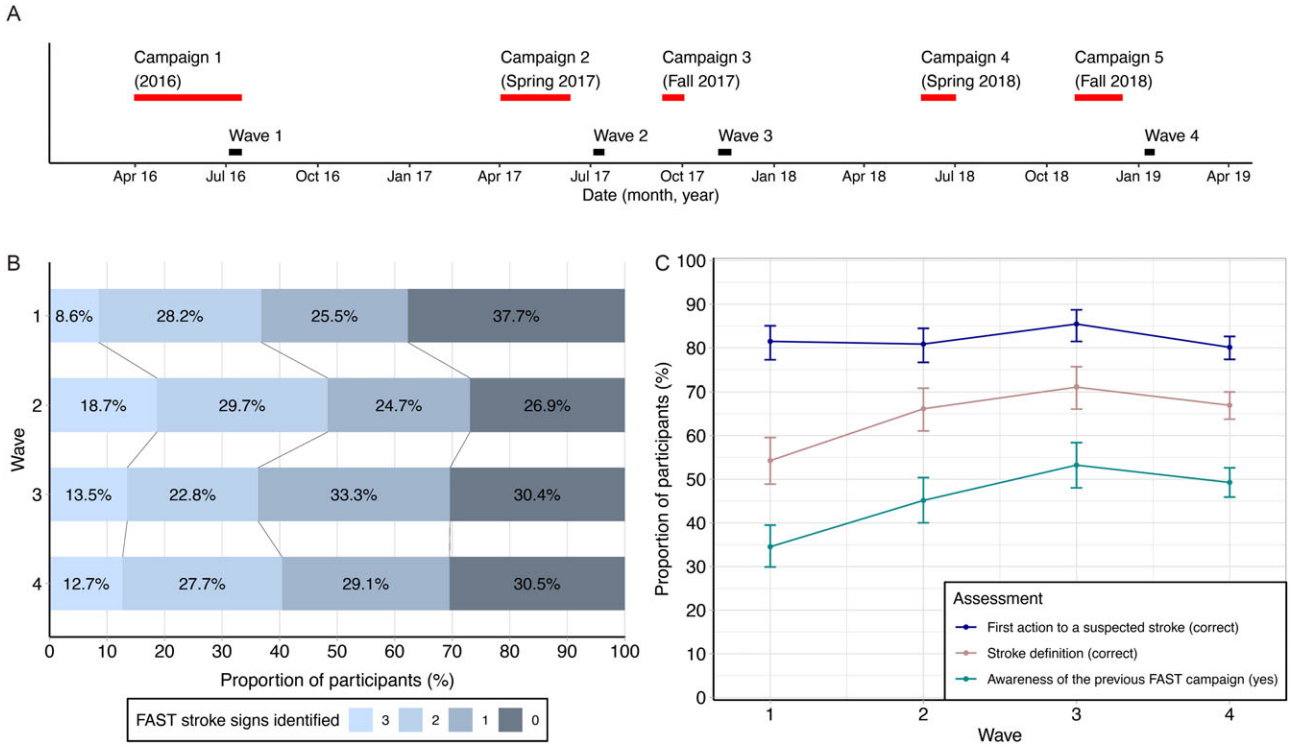


***Figure 1:*** *Stroke awareness by survey wave following FAST campaigns.* ***Panel A****: Timeline of FAST public awareness campaigns and survey waves.* ***Panel B****: FAST stroke signs identified per survey wave.* ***Panel C****: Correct first action to a suspected stroke, stroke definition and awareness of the previous FAST campaign per survey wave.*

in door-to-needle times, onset-to-door times have largely stagnated over the last 30 years.[3] The inability to recognise stroke signs and activate emergency medical services are modifiable factors consistently associated with delayed presentation in acute stroke.[4] Recognition and perception of urgency in the event of a stroke, however, remain poor in the general population.[5] Novel strategies that target stroke recognition and prompt activation of emergency medical services in the community are needed to reduce prehospital delays and improve stroke outcomes.

Prior stroke awareness campaigns have been associated with little change in the perception of urgency, whereas the improvement in stroke sign recognition declines after a few months.[6] The Face, Arm, Speech, Time (FAST; in French: *Visage*, *Incapacité*, *Trouble de la parole*, *Extrême urgence* or VITE) mnemonic is increasingly used in stroke awareness campaigns for its simplicity and good sensitivity for stroke.[7] Conflicting results, however, have emerged on the impact of recent FAST campaigns on stroke knowledge, while any effect modification by sociodemographic factors remains unclear.[8-11] In addition, the impact of a translated version of the FAST mnemonic on stroke knowledge and its application in a bilingual English-French campaign remain unknown.[12]

The Heart and Stroke Foundation of Canada launched in 2014 the FAST-VITE campaigns, a nationwide multi-platform advertisement program dedicated to stroke education in English and French. We used repeated cross-sectional survey data to assess the impact of successive FAST-VITE public awareness campaigns on stroke knowledge in the province of Quebec, Canada, and to identify sociodemographic factors associated with this performance.

## Methods

We conducted our research and report our findings according to the Template for Intervention, Description and Replication checklist applied to Population Health and Policy interventions (TIDieR-PHP)[13] and the good practice in the conduct and reporting of survey research guideline.[14] Our local institutional review board waived the need for ethics approval of this secondary use of anonymised data. We confirm that all supporting data are available within the article and its online supplementary file.

### FAST Stroke Public Awareness Campaigns

The Heart and Stroke Foundation of Canada conducted five public awareness campaigns in Quebec (population in 2016: 8,164,361)[15] between 2016 and 2018 (Figure 1A; Supplemental Table SI for details). Advertisements were purchased in multiple traditional (newspapers, radio and television) and new mass media (webpages, social networks) for a mean investment per campaign of CAD $226,887 (range: CAD $134,703 to 390,700; note: CAD $-purchasing power parity 2016 value is US $0.84). The value of public service announcements (i.e., donated ad time or space) ranged from CAD $212,090 to >1,300,000 and a mean of 12.1 million impressions (i.e., prints and screen displays) were generated per campaign (range: 2.3 to 20.3 million). The spring



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2017 campaign was distinct for the involvement of a new celebrity couple as spokespeople, a higher number of interviews and coverage (75 versus a range of 7 to 43), inclusion of English promotions (25% of budget) and the longest duration of the four most recent campaigns (70 versus a range of 22 to 48 d). The fall 2017 campaign was the shortest (22 versus a range of 35 to 108 d) and had the lowest budget proportion for the French component (59%).

### Repeated Cross-sectional Surveys

The Heart and Stroke Foundation of Canada mandated a marketing company (Environics Research Group Ltd)[16] partnered with an experienced call centre (Elemental Data Collection Inc)[17] to conduct four survey waves in the province of Quebec between 2016 and 2019. Quota samplings with predetermined response volumes were used to ensure a sufficient sample size per wave and generalisable results to the population.[18] Surveys were launched from 13 d before (wave 1) to 34 d after (wave 3) the end of the previous campaign except for the spring 2018 campaign which was not assessed (Figure 1A). All interviewers received training dedicated to the Heart and Stroke Foundation of Canada survey and were supervised. The quality of collected data was ensured by random selection and revision of surveys once interviewers had completed 10% of their assigned workload. Respondents were contacted using random digit dialling of landline and cellphone numbers weeknights 5–9 pm and weekends 10 am–8 pm. A maximum of eight call attempts were allowed per record and interviews were completed in the respondents' preferred language (English or French). Inclusion criteria were age ≥18 years and residency in the province of Quebec. Independent samples were collected at each wave. Informed consent was obtained verbally from each respondent following the survey introduction.

Surveys were administered with short, standardised questionnaires using computer-assisted telephone interviews. Interviewers collected sociodemographic data with categorical response levels on sex, age, highest level of education (highest degree), marital status, occupation, gross household income in the last year and main spoken language. Participants were asked open-ended questions on stroke definition, their first action in the event of a stroke, the main signs that a person is having a stroke and whether they recalled the preceding FAST campaign. Interviewers encouraged respondents to name multiple stroke signs and definitions. Stroke signs were recorded through a pre-coded list of 23 correct and incorrect items derived from the experience of the Heart and Stroke Foundation of Canada and the partner marketing company in stroke surveys.

### Statistical Analyses

We conducted an analysis of repeated cross-sectional survey data divided in four waves. We introduced post-stratification weights for age and sex in our analyses to better reflect their distribution in the province of Quebec with data from the 2016 Canadian census.[15] We pooled two response levels with few participants for marital status (divorced and separated) and occupation (unemployed and homemaker). We defined correct stroke definitions as any first answer referring to stroke signs (e.g., paralysis), organ involved (e.g., brain problem), or vascular disease (e.g., blood clot, vessel occlusion, or rupture). Incorrect stroke definitions included heart attack, heart problem and unable to answer. We tested the null hypothesis of independent distribution by survey waves for sociodemographic factors, contact method, FAST stroke signs, awareness of stroke campaign, stroke definition and first response to a suspected stroke, using chi-squared independence tests.

We modelled ordinal regressions to assess the distribution of FAST stroke signs by wave based on published guidance.[19] We defined the number of FAST stroke signs identified per respondent as the dependent variable and used an ordinal response (4 levels: 0, 1, 2, 3). We compared each new survey wave to the previous and compared the first and last waves to assess the overall change. For each inter-wave comparison, we built a family of three models, two of which were predetermined (model 1: simple non-adjusted, model 2: adjusted for sex and age). For the third model, we a priori defined five combinations of sociodemographic factors screened with causal graphs to select one using the Akaike information criterion.[20] We confirmed the absence of deviation from the proportional odds assumption by comparing overall and level-specific odds ratios (OR) and by nominal tests.[21]

For the fourth wave only, we identified variables associated with stroke sign knowledge using ordinal regression models, as well as variables associated with awareness of the preceding campaign using logistic regression models. We included individual variables in univariable models and all variables in multivariable models. We defined statistical significance as a p-value <0.05 and conducted our analyses with R Studio (v.1.2).[22]

## Results

### Characteristics of Surveyed Populations

A total of 2,451 respondents completed the surveys (Table 1). The overall surveyed population included slightly more women (51.5%; 95% CI: 49.3, 53.7) and people with a household income CAD $≥80,000 (34.4%; 95% CI: 32.2, 36.7). Most people were aged ≥55 (34.0%; 95% CI: 32.2, 35.9) or 35–54 years (33.8%; 95% CI: 31.8, 35.8) and had a university (34.7%; 95% CI: 32.6, 36.8) or a college degree (29.8%; 95% CI: 27.7, 31.9). The majority of people were married or living common-law (52.3%; 95% CI: 50.0, 54.5), were active workers (63.4%; 95% CI: 61.3, 65.5) and mostly spoke French (88.6%; 95% CI: 87.0, 90.0). The proportion of people contacted through cellphone increased from wave 1 (34.4%; 95% CI: 29.2, 40.0) to wave 4 (50.6%; 95% CI: 47.2, 53.9; $p < 0.001$). Data to calculate refusal rates were not available, although a similar stroke survey led in 2020 by the partner marketing company had a refusal rate of 77%.

### Identification of FAST Stroke Signs

Respondents gave a median of two stroke signs (interquartile range: 1, 3) and two stroke definitions (interquartile range: 1, 3). The number of FAST stroke signs identified changed overall from wave 1 through 4 ($p < 0.001$; Table 2; Figure 1B). We observed an overall significant improvement of 26% in FAST stroke sign awareness between survey waves 1 and 4 on the ordinal scale (OR = 1.26; 95% CI: 1.02, 1.55; $p = 0.035$; Table 3). The spring 2017 campaign was associated with the strongest improvement in FAST stroke sign recognition after adjustments for sex, age, household income, occupation, education and language (OR = 1.64; 95% CI: 1.26, 2.13; $p < 0.001$). After the fall 2017 campaign, however, the number of FAST stroke signs



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**Table 1: Population characteristics by survey wave**

| Wave | 1 | 2 | 3 | 4 | TOTAL |
|---|---|---|---|---|---|
| Unweighted sample size (n) | 450 | 451 | 450 | 1,100 | 2,451 |
| Sex | | | | | |
| Female | 54.8 (49.5, 59.9) | 49.3 (44.2, 54.5) | 49.1 (44.0, 54.3) | 51.9 (48.6, 55.2) | 51.5 (49.3, 53.7) |
| Age (years) | | | | | |
| 18–24 | 16.6 (11.8, 22.9) | 11.5 (7.5, 17.1) | 11.6 (7.7, 17.1) | 14.6 (11.7, 18.2) | 13.9 (11.9, 16.2) |
| 25–34 | 17.5 (13.4, 22.6) | 15.8 (11.9, 20.8) | 20.5 (16.1, 25.6) | 18.8 (16.0, 21.9) | 18.3 (16.5, 20.4) |
| 35–54 | 33.0 (28.5, 37.9) | 33.4 (28.9, 38.2) | 31.4 (27.1, 36.1) | 35.1 (32.2, 38.2) | 33.8 (31.8, 35.8) |
| ≥55 | 32.8 (28.6, 37.3) | 39.3 (34.7, 44.0) | 36.5 (32.2, 41.1) | 31.5 (28.9, 34.2) | 34.0 (32.2, 35.9) |
| Education completed | | | | | |
| Elementary school | 14.5 (11.4, 18.3) | 12.2 (9.6, 15.5) | 11.7 (9.1, 15.1) | 12.8 (10.9, 15.0) | 12.8 (11.5, 14.2) |
| High school | 22.7 (18.5, 27.5) | 21.7 (17.7, 26.3) | 23.2 (18.9, 28.2) | 22.9 (20.3, 25.8) | 22.7 (20.9, 24.7) |
| College | 30.8 (25.9, 36.1) | 27.7 (23.2, 32.8) | 28.4 (23.9, 33.3) | 30.7 (27.6, 33.9) | 29.8 (27.7, 31.9) |
| University | 32.0 (27.4, 37.1) | 38.4 (33.5, 43.5) | 36.7 (31.9, 41.7) | 33.6 (30.5, 36.8) | 34.7 (32.6, 36.8) |
| Marital status | | | | | |
| Married/common-law | 57.1 (51.7, 62.3) | 51.1 (45.9, 56.2) | 54.5 (49.2, 59.6) | 49.8 (46.5, 53.2) | 52.3 (50.0, 54.5) |
| Single (never married) | 28.5 (23.5, 34.0) | 32.3 (27.2, 37.9) | 31.1 (26.0, 36.7) | 36.0 (32.7, 39.5) | 33.1 (30.8, 35.4) |
| Divorced/separated | 8.9 (6.5, 12.0) | 11.0 (8.5, 14.2) | 10.6 (8.2, 13.6) | 9.0 (7.5, 10.8) | 9.6 (8.6, 10.8) |
| Widowed | 5.6 (3.9, 7.8) | 5.6 (4.0, 7.7) | 3.9 (2.6, 5.8) | 5.1 (4.1, 6.4) | 5.1 (4.4, 5.9) |
| Occupation | | | | | |
| Working | 62.3 (57.2, 67.1) | 64.1 (59.1, 68.8) | 61.6 (56.5, 66.3) | 64.3 (61.1, 67.4) | 63.4 (61.3, 65.5) |
| Retired | 20.6 (17.3, 24.3) | 24.2 (20.6, 28.1) | 25.6 (22.0, 29.7) | 21.4 (19.2, 23.7) | 22.5 (21.0, 24.1) |
| Unemployed/homemaker | 11.1 (8.3, 14.7) | 6.1 (4.2, 9.0) | 3.6 (2.2, 5.6) | 7.4 (5.8, 9.3) | 7.1 (6.1, 8.4) |
| Student | 6.1 (3.5, 10.3) | 5.7 (3.0, 10.5) | 9.3 (6.0, 14.0) | 7.0 (5.0, 9.7) | 7.0 (5.6, 8.7) |
| Household income (CAD $) | | | | | |
| <40,000 | 38.3 (32.9, 44.1) | 28.2 (23.6, 33.3) | 31.9 (26.8, 37.4) | 33.6 (30.2, 37.3) | 33.2 (30.9, 35.6) |
| ≥40,000 to <80,000 | 29.6 (24.5, 35.2) | 36.8 (31.8, 42.2) | 32.6 (27.9, 37.7) | 31.6 (28.4, 35.1) | 32.3 (30.2, 34.6) |
| ≥80,000 | 32.1 (27.1, 37.7) | 35.0 (29.9, 40.5) | 35.5 (30.6, 40.8) | 34.7 (31.4, 38.2) | 34.4 (32.2, 36.7) |
| Language | | | | | |
| French | 89.1 (85.0, 92.1) | 89.3 (85.3, 92.3) | 85.5 (81.1, 89.0) | 89.3 (87.0, 91.2) | 88.6 (87.0, 90.0) |
| Contact method | | | | | |
| Cellphone | 34.4 (29.2, 40.0) | 34.4 (29.3, 39.9) | 32.9 (27.9, 38.3) | 50.6 (47.2, 53.9) | 41.5 (39.2, 43.8) |

Frequencies are presented in % weighted proportions (95% confidence interval) unless otherwise specified. Abbreviations: CAD $, Canadian dollars.

identified decreased significantly (OR = 0.66; 95% CI: 0.51, 0.85; p = 0.001). The two successive 2018 campaigns were not associated with a significant change in stroke sign knowledge (OR = 1.12; 95% CI: 0.91, 1.38; p = 0.300). At the end of the last stroke awareness campaign in 2018, 30.5% (95% CI: 27.5, 33.6) of people were still unable to name a single FAST stroke sign, 59.6% (95% CI: 56.3, 62.8) could not name more than one sign and only 12.7% (95% CI: 10.7, 15.1) could identify all three FAST stroke signs (Table 2). Speech difficulty was the most frequently reported sign (54.4%; 95% CI: 51.0, 57.8), followed by arm weakness (53.8%; 95% CI: 50.5, 57.2) and face drooping in the last survey (36.2%; 95% CI: 33.0, 39.5; Supplemental Tables SII and SIII).

In the univariable ordinal regression models of FAST stroke signs identified in the last survey wave, five respondents' characteristics were associated with worse performance: male sex (OR = 0.67; 95% CI: 0.55, 0.82; p < 0.001), completed education no higher than elementary school as compared to university (OR = 0.47; 95% CI: 0.33, 0.66; p < 0.001), widowed as compared to married/living common-law (OR = 0.62; 95% CI: 0.39, 0.98; p = 0.043), retired as compared to working (OR = 0.69; 95% CI: 0.53, 0.90; p = 0.005) and household income CAD $<40,000 as compared to CAD $≥80,000 (OR = 0.63; 95% CI: 0.48, 0.83; p < 0.001; Table 4). In the multivariable model, only male sex (OR = 0.68; 95% CI: 0.53, 0.86; p = 0.002) and retired as compared to working (OR = 0.54; 95% CI: 0.35, 0.83; p = 0.005) remained significant, although lower education (OR = 0.67; 95% CI: 0.44, 1.01; p = 0.055) and lower household income (OR = 0.72; 95% CI: 0.51, 1.01; p = 0.058) were close to statistical significance (Supplemental Figure S1). Age 25–34 as



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**Table 2: Stroke knowledge and campaign awareness by wave**

| Wave | 1 | 2 | 3 | 4 | TOTAL | P-VALUE |
|---|---|---|---|---|---|---|
| FAST stroke signs identified | | | | | | |
| 0 | 37.7 (32.6, 43.0) | 26.9 (22.5, 31.8) | 30.4 (25.8, 35.5) | 30.5 (27.5, 33.6) | 31.2 (29.1, 33.3) | **<0.001** |
| 1 | 25.5 (21.2, 30.3) | 24.7 (20.6, 29.4) | 33.3 (28.7, 38.3) | 29.1 (26.2, 32.3) | 28.4 (26.5, 30.5) | |
| 2 | 28.2 (23.9, 33.1) | 29.7 (25.3, 34.5) | 22.8 (18.8, 27.3) | 27.7 (24.9, 30.7) | 27.3 (25.4, 29.2) | |
| 3 | 8.6 (6.2, 11.7) | 18.7 (14.9, 23.1) | 13.5 (10.3, 17.5) | 12.7 (10.7, 15.1) | 13.1 (11.7, 14.7) | |
| Awareness of the previous FAST campaign | | | | | | |
| Yes | 34.5 (29.9, 39.5) | 45.1 (40.0, 50.4) | 53.2 (48.0, 58.4) | 49.3 (45.9, 52.6) | 46.5 (44.3, 48.7) | **<0.001** |
| No | 65.5 (60.5, 70.1) | 54.9 (49.6, 60.0) | 46.8 (41.6, 52.0) | 50.7 (47.4, 54.1) | 53.5 (51.3, 55.7) | |
| Stroke definition | | | | | | |
| Correct | 54.3 (48.9, 59.6) | 66.1 (61.1, 70.9) | 71.1 (66.1, 75.7) | 67.0 (63.8, 70.0) | 65.2 (63.0, 67.3) | **<0.001** |
| Incorrect | 45.7 (40.4, 51.1) | 33.9 (29.1, 38.9) | 28.9 (24.3, 33.9) | 33.0 (30.0, 36.2) | 34.8 (32.7, 37.0) | |
| First response to a suspected stroke | | | | | | |
| Call EMS/911/Ambulance | 81.5 (77.3, 85.1) | 80.9 (76.7, 84.5) | 85.5 (81.5, 88.7) | 80.1 (77.4, 82.6) | 81.5 (79.7, 83.1) | 0.158 |
| Other | 18.5 (14.9, 22.7) | 19.1 (15.5, 23.3) | 14.5 (11.3, 18.5) | 19.9 (17.4, 22.6) | 18.5 (16.9, 20.3) | |

Frequencies are presented in % weighted proportions (95% confidence interval) unless otherwise specified. P-values for Chi-squared tests are presented. Abbreviations: EMS, emergency medical services; FAST, 'Face, Arm, Speech, Time' mnemonic.

**Table 3: Ordinal regression models for FAST stroke signs identified by wave**

| Comparison | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | OR (95% CI) | p-value | OR (95% CI) | p-value | OR (95% CI) | p-value |
| Wave 2 vs 1 (reference: 1) | **1.73 (1.37, 2.18)** | **<0.001** | **1.73 (1.36, 2.19)** | **<0.001** | **1.64 (1.26, 2.13)** | **<0.001** |
| Wave 3 vs 2 (reference: 2) | **0.70 (0.56, 0.89)** | **0.003** | **0.70 (0.55, 0.88)** | **0.002** | **0.66 (0.51, 0.85)** | **0.001** |
| Wave 4 vs 3 (reference: 3) | 1.07 (0.88, 1.29) | 0.509 | 1.05 (0.87, 1.28) | 0.610 | 1.12 (0.91, 1.38) | 0.300 |
| Wave 4 vs 1 (reference: 1) | **1.30 (1.08, 1.58)** | **0.007** | **1.29 (1.06, 1.57)** | **0.010** | **1.26 (1.02, 1.55)** | **0.035** |

All models are weighted. Model 1 is unadjusted. Model 2 is adjusted for sex and age. Model 3 is adjusted for sex, age, household income, occupation, education and language. Abbreviations: CI, confidence interval; FAST, 'Face, Arm, Speech, Time' mnemonic; OR, odds ratio.

compared to ≥55 years was significantly associated with worse performance in the multivariable analysis only (OR = 0.46; 95% CI: 0.29, 0.73; p = 0.001). Language was not associated with stroke sign identification in both models (multivariable: OR = 0.71; 95% CI: 0.48, 1.06; p = 0.098). Stroke sign knowledge was better in people who had completed college as compared to university (multivariable: OR = 1.56; 95% CI: 1.17, 2.07; p = 0.002).

### Awareness of FAST Campaigns

The most frequent methods by which respondents became aware of FAST campaigns were television (80.1%; 95% CI: 77.3, 82.7) and social media (13.3%; 95% CI: 11.1, 15.7; Supplemental Table SIV). Respondents' awareness of the previous FAST campaign increased from wave 1 (34.5%; 95% CI: 29.9, 39.5) to wave 4 (49.3%; 95% CI: 45.9, 52.6; p < 0.001; Table 2; Figure 1C). In the last survey wave, awareness of the previous FAST campaign was associated with a significant increase in FAST stroke sign knowledge after adjustments for sex, age, household income, occupation, education and language (OR = 5.33; 95% CI: 4.10, 6.93; p < 0.001).

In multivariable logistic regression models, four factors were negatively associated with awareness of the prior FAST campaign: male sex (OR = 0.66; 95% CI: 0.49, 0.88; p = 0.006), age 18–24 as compared to ≥55 years (OR = 0.33; 95% CI: 0.16, 0.66; p = 0.002), completed education no higher than elementary school (OR = 0.45; 95% CI: 0.26, 0.75; p = 0.002) and household income CAD $<40,000 as compared to CAD $≥80,000 (OR = 0.52; 95% CI: 0.34, 0.80; p = 0.003; Supplemental Table SV).

### Stroke Definition and First Response to a Suspected Stroke

The proportion of people who defined stroke correctly increased significantly between wave 1 (54.3%; 95% CI: 48.9, 59.6) and wave 4 (67.0%; 95% CI: 63.8, 70.0; p < 0.001; Table 2; Figure 1C). In the last survey, respondents most commonly defined stroke as a blockage of blood circulation to the brain (35.3%; 95% CI: 21.1, 38.6), followed by a heart problem (28.8%; 95% CI: 25.8, 31.9; Supplemental Table SVI). The



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**Table 4: Ordinal regression models for FAST stroke signs identified in wave 4**

| | Univariable model | | Multivariable model | |
|---|---|---|---|---|
| **Variables** | **OR (95% CI)** | **p-value** | **OR (95% CI)** | **p-value** |
| Male sex | **0.67 (0.55, 0.82)** | **<0.001** | **0.68 (0.53, 0.86)** | **0.002** |
| Age (reference: ≥55 years) | | | | |
| 18–24 | 0.99 (0.72, 1.37) | 0.968 | 0.64 (0.37, 1.10) | 0.104 |
| 25–34 | 0.77 (0.56, 1.04) | 0.085 | **0.46 (0.29, 0.73)** | **0.001** |
| 35–54 | **1.31 (1.01, 1.68)** | **0.038** | 0.72 (0.48, 1.06) | 0.097 |
| Education completed (reference: university) | | | | |
| Elementary school | **0.47 (0.33, 0.66)** | **<0.001** | 0.67 (0.44, 1.01) | 0.055 |
| High school | 0.82 (0.62, 1.09) | 0.177 | 0.92 (0.67, 1.27) | 0.615 |
| College | **1.44 (1.12, 1.86)** | **0.005** | **1.56 (1.17, 2.07)** | **0.002** |
| Marital status (reference: married/common-law) | | | | |
| Single (never married) | 0.88 (0.71, 1.11) | 0.287 | 1.20 (0.89, 1.62) | 0.221 |
| Divorced/separated | 0.74 (0.50, 1.08) | 0.123 | 0.81 (0.52, 1.26) | 0.359 |
| Widowed | **0.62 (0.39, 0.98)** | **0.043** | 0.86 (0.47, 1.55) | 0.610 |
| Occupation (reference: working) | | | | |
| Retired | **0.69 (0.53, 0.90)** | **0.005** | **0.54 (0.35, 0.83)** | **0.005** |
| Student | 0.76 (0.50, 1.15) | 0.195 | 0.65 (0.39, 1.09) | 0.103 |
| Unemployed | 0.75 (0.50, 1.12) | 0.162 | 0.84 (0.53, 1.33) | 0.457 |
| Household income (reference: CAD $≥80,000) | | | | |
| <40,000 | **0.63 (0.48, 0.83)** | **<0.001** | 0.72 (0.51, 1.01) | 0.058 |
| ≥40,000 to <80,000 | 0.96 (0.73, 1.26) | 0.747 | 1.00 (0.73, 1.35) | 0.976 |
| English language | 0.77 (0.56, 1.07) | 0.126 | 0.71 (0.48, 1.06) | 0.098 |
| Landline contact method | **1.25 (1.02, 1.54)** | **0.030** | 1.12 (0.85, 1.47) | 0.419 |

All models are weighted. Multivariable model includes all variables. Abbreviations: CAD $, Canadian dollars; CI, confidence interval; FAST, 'Face, Arm, Speech, Time' mnemonic; OR, odds ratio.

proportion of respondents who would first call emergency medical services in the event of a stroke did not change significantly between survey waves (p = 0.158; Table 2; Figure 1C; Supplemental Table SVII for details). One in five respondents (19.9%; 95% CI: 17.4, 22.6) did not know they should first call emergency medical services in the event of a stroke after the last FAST campaign.

## Discussion

In this analysis of four cross-sectional surveys conducted after five FAST stroke awareness campaigns, we observed an overall improvement of 26% on the ordinal scale in the identification of FAST stroke signs among the general population. Correct stroke definition and awareness of the previous campaign also improved throughout the study period. Adequate first response to a suspected stroke, however, did not improve, and an important proportion of respondents remained unable to name any (about 30%) or more than one (about 60%) FAST stroke sign. Male sex, retirement and age 25–34 years were associated with worse stroke sign knowledge, while lower household income and education had a tendency towards poorer stroke sign identification. Awareness of the previous FAST campaign was strongly associated with better stroke sign knowledge, although educational interventions were less effective to reach men, people aged 18–24 years, and people with lower household income and education. These observations will guide the Heart and Stroke Foundation of Canada and may help other stakeholders to adapt their campaigns to optimise outreach to populations for whom current campaigns seem less effective.

Recognition of stroke signs and early activation of emergency medical services in the event of a stroke were poor in our study and inferior to published data.[23,24] Delayed activation of emergency medical services in the event of a stroke in our study (19.9%) is almost triple the proportion found in a 2012 UK survey (7.2%).[23] The proportion of people unable to name a single FAST stroke sign in our study (30.5%) is more than three times higher as compared to a 2011 UK survey (8.8%).[24] Stroke knowledge improvements may reach a plateau after successive campaigns as overall stroke awareness increases.[12] A saturation of stroke knowledge, however, hardly explains the lack of improvement in our survey waves 3 and 4 given this poor performance. These differences in stroke knowledge may rather be explained by a lower reach of our FAST campaigns. Recall of the previous FAST campaign was low overall (46.5%) in our study and inferior to that observed in the 2011 UK survey



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(69.8%).[24] We also observed a strong association between prior campaign awareness and stroke sign knowledge, suggesting FAST educational programs are most effective in people who recall its core message.[25] These findings suggest that strategies aiming to increase the reach and recall of educational programs may help improve persisting gaps in stroke knowledge.

We found that those who had less recall of the previous FAST campaign also performed more poorly in stroke sign identification. These groups include men, retired people and individuals with a lower socioeconomic status, which are also all characteristics associated with a higher risk of stroke,[26-28] thus suggesting that key groups of higher-risk individuals may not be benefitting from adequately targeted stroke awareness messaging. In contrast with our results, male sex was the only factor negatively associated with recall in a prior US educational program study.[25] Retired people, despite frequent health-related concerns,[29] had poorer stroke sign recognition than those working. This might be explained by the greater decrease in stroke knowledge after the end of a campaign in the elderly.[12] The different health communication preferences displayed by men and women, especially in the elderly, may also explain the poorer performance of both men and retired people in our study.[30] These findings suggest that the yield of future interventions may be increased by tailored messages targeting men, retired people and individuals with a lower socioeconomic status. Such efforts might include advertising on social media platforms with audience targeting algorithms, inserts in magazines and newspapers with relevant readership demographics, campaign materials in spaces more often frequented by target populations (e.g., community and recreation centres, retirement homes) and partnerships with spokespeople or organisations that resonate with these populations.

We observed the greatest improvement in stroke knowledge after the spring 2017 campaign. This intervention was distinguished by a longer campaign duration as well as the introduction of a celebrity couple generating more interviews and media coverage. Few studies have compared different methods to improve stroke knowledge among the general public. A Canadian two-year mass media campaign study reported an improvement in the identification of stroke signs in communities exposed to television advertisements, but not in those receiving newspaper inserts.[18] A qualitative study on stroke patients and bystanders suggested that people who were able to relate to a FAST campaign may better apply its content.[31] The celebrity couple involved in our campaigns, composed of a stroke survivor and her husband, may have increased the ability of some people to relate to the FAST mnemonic. The fall 2017 campaign, in contrast, was about three times shorter than the spring 2017 campaign and may explain the decrease in stroke sign knowledge observed in the third survey. The spring 2017 campaign may thus serve as an effective model to inspire and design future stroke awareness campaigns.

Stroke sign knowledge and campaign awareness were not associated with respondents' main spoken language in our study. The FAST mnemonic has been adopted as a public awareness instrument in several majority English-speaking countries such as the UK, Australia and the USA.[32] The Heart and Stroke Foundation of Canada adopted the FAST mnemonic in 2014 along with its French-translated version (VITE). The components of the VITE acronym, however, may not be as intuitive and straightforward as the English version and to our knowledge, its impact has not been studied. Our results suggest that the translated mnemonic is not associated with a lower impact on stroke sign knowledge or a lower reach when used in large campaigns as compared to the original English-language FAST version.

### Strengths and Limitations

The strengths of our study include the use of sociodemographic data, which allowed us to identify their key role in the efficacy of FAST campaigns. We also analyzed stroke sign knowledge on the ordinal scale to better detect any valuable transition in stroke sign knowledge (e.g., from 0 to 1), in contrast with prior studies that only used dichotomous outcomes (e.g., $\geq 2$ versus $<2$ signs).[12,18] Our study, however, has limitations. First, the interval between the end of a campaign and the launch of a survey varied slightly between waves. A longer interval in wave 3 may have resulted in an underestimation of stroke knowledge at the end of the fall 2017 campaign as stroke awareness decreases after a few months of an intervention.[12] The impact on our results is likely small as wave 3 respondents had the highest awareness of the previous campaign (53%) despite this delay. Second, demographic characteristics of respondents were limited, and in particular, no information on race or ethnicity was available. Also, those people unable to speak either French or English were excluded from the survey. Health disparities related to race and ethnicity may, at least in part, be mediated by social determinants of health,[33] which we have partially captured with data on education level and household income. Third, people without a high school diploma or equivalent were slightly underrepresented in our sample as compared to the general population in Quebec (12.8% versus 19.9%), implying that stroke awareness in the general population may be slightly lower than observed in our study.[15] Other sociodemographic characteristics, however, were similar.[15]

## Conclusion

In this repeated cross-sectional survey analysis, we observed a 26% overall increase on the ordinal scale in FAST stroke sign knowledge following successive stroke educational campaigns. The proportion of people unable to name a single FAST stroke sign (one in three) or activate emergency medical services urgently in the event of a stroke (one in five) remained high despite educational interventions. Future FAST campaigns should especially target men, retired people and individuals with a lower socioeconomic status in order to increase overall uptake by the general population of this important public health messaging.

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## Statement of Authorship

BR wrote the first draft of the manuscript. BR, VB and MRK handled the data and did the analyses. All authors contributed to the interpretation of the data and revised the final version.

## Supplementary Material

To view supplementary material for this article, please visit https://doi.org/10.1017/cjn.2021.76.

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