EM Advances

Socioeconomic status and the use of computed tomography in the emergency department

Rajesh Bhayana, BSc*; Marian J. Vermeulen, BScN, MHSc[†‡]; Qi Li, MSc[†]; Chelsea R. Hellings, MSc[†]; Carl Berdahl, MD[§]; Michael J. Schull, MD, MSc*[†‡¶]

ABSTRACT

Background: Low socioeconomic status (SES) is associated with adverse health outcomes. Possible explanations include differences in health status, access to health care, and care provided by clinicians. We sought to determine whether SES is associated with computed tomography (CT) use in the emergency department (ED).

Methods: A retrospective cohort study of all Ontario ED patients (April 1, 2009, to March 31, 2010) using administrative databases was conducted, and patients were stratified into SES quintiles based on median neighbourhood income. Using multivariate logistical regression, CT scan use within SES quintiles was compared for all patients and subgroups based on chief complaints: headache, abdominal pain, and complex abdominal pain (age ≥ 65 years, high acuity, and admittance to hospital).

Results: We analyzed 4,551,101 patient visits, of which 52% were female. Overall, 8.2% underwent CT scanning. In adjusted analyses, the lowest SES patients were less likely to undergo CT scanning overall and in all clinical subgroups, except for complex abdominal pain. Compared to the lowest SES quintile, the adjusted odds ratios of CT scanning in the highest SES quintile were 1.08 (95% CI 1.07–1.09), 1.28 (95% CI 1.22–1.34), and 1.24 (95% CI 1.21–1.27) for all patients, headache pain patients, and abdominal pain patients, respectively. For patients presenting with complex abdominal pain, no significant difference in CT use was observed.

Conclusion: Lowest SES ED patients were less likely to receive CT scans overall and in headache and abdominal pain subgroups. No difference was seen among complex abdominal pain patients, suggesting that as clinical indications for the test become more clearcut, use across SES quintiles differs less.

RÉSUMÉ

Contexte: Un faible statut socioéconomique (SSE) est associé à des résultats défavorables sur la santé. La situation peut s'expliquer par des différences quant à l'état de santé, à l'accès aux soins de santé et aux soins fournis par les cliniciens. L'étude visait à déterminer s'il y avait un lien entre le SSE et le recours à la tomodensitométrie (TDM) au service des urgences (SU).

Méthodes: Une étude de cohortes, rétrospective, a été menée, à l'aide de bases de données administratives, sur tous les patients ayant consulté dans un SU, en Ontario (1er avril 2009 au 31 mars 2010); puis ceux-ci ont été classés en quintiles de SSE selon le revenu médian du quartier. Nous avons ensuite comparé le recours à la TDM entre les différents quintiles de SSE, à l'aide d'une régression logistique multidimensionnelle, par rapport à l'ensemble de la population à l'étude ainsi que par rapport aux sous-groupes établis selon le principal motif de consultation, soit des céphalées, des douleurs abdominales ou des douleurs abdominales complexes (âge ≥ 65 ans, degré élevé de gravité et hospitalisation).

Résultats: Sur 4 551 101 consultations dénombrées, 52% ont été demandées par des femmes. Dans l'ensemble, 8.2% des patients ont subi une TDM. D'après les analyses rajustées, les patients se situant au niveau de SSE le plus bas étaient moins susceptibles de subir une TDM que les autres, que ce soit dans l'ensemble de la population à l'étude ou dans les sous-groupes cliniques, à l'exception de celui des douleurs abdominales complexes. Comparativement au quintile de SSE le plus bas, les risques relatifs approchés rajustés de subir une TDM dans le quintile le plus haut étaient de 1.08 (IC à 95%: 1.07–1.09), de 1.28 (IC à 95%: 1.22–1.34) et de 1.24 (IC à 95%: 1.21–1.27) par rapport, respectivement, à l'ensemble de la population à l'étude, au sous-groupe de céphalées et au sous-groupe de douleurs abdominales. Quant aux patients ayant des douleurs abdominales complexes, aucun écart important n'a été relevé en ce qui concerne le recours à la TDM.

Conclusion: Les patients au SU ayant le SSE le plus bas étaient moins susceptibles de subir une TDM que les autres, et ce, dans l'ensemble de la population à l'étude ainsi que dans les sous-groupes de céphalées et de douleurs abdominales. Par contre, aucun écart n'a été relevé en ce qui concerne les

From the *Department of Medicine, University of Toronto, Toronto, ON; †The Institute for Clinical Evaluative Sciences, Toronto, ON; and ‡Sunnybrook Research Institute, Toronto, ON; §Department of Medicine, Yale University, New Haven, CT; and ¶Institute of Health Policy, Management, and Evaluation, University of Toronto, Toronto, ON.

Correspondence to: Dr. Michael J. Schull, 2075 Bayview Avenue, G106, Toronto, ON M4N 3M5; mjs@ices.on.ca.

This article has been peer reviewed.

 CJEM 2014;16(4):288-295 DOI 10.2310/8000.2013.131102

douleurs abdominales complexes, ce qui donne à penser que plus les indications cliniques de l'examen sont claires, moins il y a d'écart entre les différents quintiles de SSE.

Keywords: health care disparities, health services accessibility, socioeconomic status

Lower socioeconomic status (SES) is considered one of the most important social determinants of health given its strong association with poor health outcomes.[1] This difference exists on a gradient, meaning that groups with progressively lower incomes have progressively poorer health outcomes.[1] This relationship is even observed in Canada despite its universal health care system.[2] Multiple factors may be contributing to this association, such as differences in health-related behaviours, access to health care workers and services, and health services provided by physicians.[2] A better understanding of the contributors to this association may help reduce this disparity.

There is good evidence to suggest that low SES patients receive fewer medical services than high SES patients.[3–10] There are many potential explanations for this association. First, low SES patients may be healthier as a population and therefore require fewer health services. This is unlikely as it has been widely demonstrated that lower SES patients have a greater burden of disease.[1] Second, patients of low SES may be accessing health services less often than high SES patients. This might be due to barriers, such as poor access to physician services, financial barriers, or a tendency for lower SES patients to choose not to access care. Lastly, these patients may also be systematically less likely to have health services offered or ordered for them by their physicians despite similar need.

Whether physician decisions are based in part on SES is especially of interest to emergency physicians. Emergency physicians frequently provide health care services to low SES patients given the role of the emergency department (ED) as a safety net for the uninsured in some health systems and the ease of access for low SES patients, who frequently lack a usual source of primary care.[11–14] Examining care provided to low SES patients in the ED is a useful model because it helps remove possible alternate explanations for differences in health service use between SES groups found in many other studies. First, we can control for illness severity and the need for care because all patients are acutely ill enough to present to an ED and factors such as chief complaint and triage acuity are known. Second, since study patients are present in the ED, they all have equivalent access to computed tomography (CT) if a scan is ordered because the CT scan is almost always done immediately and does not require a subsequent visit. Finally, the emergency physician's decision to order a CT scan is subject to judgment, occurs relatively frequently, and can be measured objectively. The objective of this study was to determine whether SES is associated with CT use for patients presenting to Ontario EDs. Given equivalent access and need, we hypothesized that there would be no difference in CT use between SES quintiles.

METHODS

We conducted a retrospective cohort study of patients presenting to EDs from April 1, 2009, to March 31, 2010, using administrative databases in Ontario: the National Ambulatory Care Reporting System (NACRS) and the Ontario Health Insurance Plan (OHIP) databases.

The NACRS database contains demographic, administrative, and clinical data surrounding visits to hospital- and community-based ambulatory care, such as day surgery, outpatient clinics, and EDs.[15] The data in the NACRS are collected and coded by trained nosologists from patient records, physician notes, and admission-discharge-transfer systems. The data are complete because submission to the NACRS is mandated for all Ontario hospitals. These data were linked with the OHIP database, which includes all claims made by physicians for insured services, including diagnostic imaging. OHIP data are presumed complete based on the strong financial incentive for physicians to bill accurately. The NACRS database gave access to information surrounding ED visits, including patient demographic data and clinical data, such as chief complaint and triage acuity. By linking this to the OHIP billing database, whether or not these patients received a CT scan was determined.

The study population included all patients presenting to Ontario EDs between April 1, 2009, and March 31, 2010. All patients needed to have an OHIP health card number to be included in the database. Exclusion

https://doi.org/10.2310/8000.2013.131102

criteria include patients over 99 and non-Ontario residents.

Postal codes were used to assign each patient to an income quintile. Using the Statistics Canada Postal Code Conversion File (PCCF), patients were linked to a corresponding dissemination area (DA). A DA is the smallest geographic area for which all census data are disseminated.[16] Based on 2006 census summary data, neighbourhood income data were assigned to each DA, which allowed stratification into income quintiles. The outcome of interest was the proportion of patients in each SES quintile receiving a CT scan. This was determined first for the entire cohort of patients presenting to the ED and subsequently for clinical subgroups defined by their presenting chief complaint: patients presenting with headache, patients presenting with abdominal pain, and a subgroup of complex abdominal pain patients (age ≥ 65 years, Canadian Triage and Acuity Scale [CTAS] 1–3, and admittance to hospital). The chief complaint was captured using ICD-10-CA codes, which were abstracted by trained coders at each ED. Headache and abdominal pain were chosen because they are among the most common reasons for ED visits and often warrant the use of diagnostic imaging.[17] The high-acuity abdominal pain subgroup represents a population with more severe illness, a greater probability of acute pathology, and a more clearcut indication for ordering a CT scan. We conducted a sensitivity analysis in which we restricted our study sample to only the first ED visit made by each patient to determine whether repeat ED use by patients might bias our results.

The proportion of patients receiving a CT scan in each income quintile was compared using multivariate logistical regression for all patients and the three clinical subgroups. *SAS* version 9.2 (SAS Institute, Cary, NC) was used for all analyses, and a two-tailed type 1 error rate of 0.05 was used as the threshold for statistical significance. Analysis adjusted for confounding variables: age group, sex, triage acuity (CTAS), day of the week, shift, hospital ED volume, hospital type (pediatric, small, teaching, community), residential area (urban, rural), and presenting chief complaint. These are variables that can independently affect the use of CT scans, and adjusting for them ensures that the results are not influenced by any differences between the SES quintiles that may exist with respect to these variables. This study was approved by the Research Ethics Board of Sunnybrook Health Sciences Centre.

RESULTS

During the study period, we identified 4,551,101 patient visits to Ontario EDs (Table 1). The majority of patients were female (52.3%) and age 40 to 64 years (30.1%) and presented on a weekday (71.9%) to community hospitals (71.9%) in urban areas (77.9%). The composition of each quintile was relatively similar. The following differences were noted between the lowest and highest SES quintiles: the lowest SES quintile had a greater number of patients presenting to the ED (1,081,104 versus 758,052), were younger (a lower proportion of patients over the age of 40 [48.7% versus 51.5%]), and had different chief complaints. The lowest income patients presented with less injury or trauma (27.2% versus 31.6%), more administrative issues (5.7% versus 4.6%), and more mental health problems (3.0% versus 2.0%).

Table 2 indicates the unadjusted rate of CT scan overall and for each SES quintile, which shows a gradual increase from the lowest (7.76%, 95% CI 7.71–8.81%) to the highest (8.58%, 95% CI 8.51–8.64%) SES group.

Adjusted odds ratios (aORs) for CT scanning by SES quintile are presented in Figure 1. SES quintiles are indicated from 1 (lowest) to 5 (highest). The figure demonstrates that SES quintile is associated with the likelihood of undergoing CT scanning overall and in all clinical subgroups with the exception of complex abdominal pain. Compared to the lowest SES quintile, the odds of undergoing CT scanning for the highest SES quintile were aOR 1.08 (95% CI 1.07–1.09), aOR 1.28 (95% CI 1.22–1.34), and aOR 1.24 (95% CI 1.21–1.27) for all patients, headache patients, and abdominal pain patients respectively. All higher income quintiles (2–5) were associated with significantly increased odds of undergoing CT scanning compared to the lowest income quintile (see Figure 1). For patients presenting with complex abdominal pain, no difference in CT use was observed between the highest and lowest SES quintiles (aOR 1.09, 95% CI 0.99–1.20). The results of our sensitivity analysis in which we restricted the study sample to only the first ED visit made by each patient during the study period revealed similar results with no meaningful differences in interpretation (results not shown).

https://doi.org/10.2310/8000.2013.131102

Table 1. Baseline characteristics of ED visits from April 1, 2009, to March 31, 2010, by SES income group, n (%)

	SES income quintile					
Variable (missing)	1 (n = 1,081,104)	2 (n = 939,727)	3 (n = 886,039)	4 (n = 864,535)	5 (highest) (n = 758,052)	Overall* (N = 4,551,101)
Sex (39)						
Female	578,819 (53.5)	493,849 (52.6)	462,300 (52.2)	447,176 (51.7)	388,424 (51.2)	2,381,579 (52.3)
Male	502,265 (46.5)	445,870 (47.4)	423,737 (47.8)	417,355 (48.3)	369,625 (48.8)	2,169,483 (47.7)
Age group, yr (0)						
< 1	40,910 (3.8)	32,066 (3.4)	30,346 (3.4)	30,074 (3.5)	22,052 (2.9)	156,639 (3.4)
1–4	52,992 (4.9)	45,337 (4.8)	45,069 (5.1)	46,091 (5.3)	36,261 (4.8)	226,604 (5.0)
5–9	45,894 (4.2)	41,444 (4.4)	42,472 (4.8)	43,531 (5.0)	37,532 (5.0)	211,690 (4.7)
10–17	76,240 (7.1)	73,088 (7.8)	75,592 (8.5)	78,080 (9.0)	73,497 (9.7)	377,943 (8.3)
18–39	338,886 (31.3)	282,110 (30.0)	257,810 (29.1)	242,897 (28.1)	198,688 (26.2)	1,327,720 (29.2)
40–64	327,097 (30.3)	280,363 (29.8)	264,136 (29.8)	258,547 (29.9)	232,778 (30.7)	1,369,579 (30.1)
65–74	82,161 (7.6)	75,927 (8.1)	69,957 (7.9)	68,923 (8.0)	65,086 (8.6)	363,496 (8.0)
75–99	116,924 (10.8)	109,392 (11.6)	100,657 (11.4)	96,392 (11.1)	92,158 (12.2)	517,430 (11.4)
Triage score (21,194)						
1 (lowest)	6,117 (0.6)	5,282 (0.6)	4,942 (0.6)	4,754 (0.5)	4,035 (0.5)	25,254 (0.6)
2	155,795 (14.4)	137,493 (14.6)	129,088 (14.6)	131,535 (15.2)	115,916 (15.3)	672,195 (14.8)
3	460,436 (42.6)	400,115 (42.6)	371,072 (41.9)	365,472 (42.3)	316,746 (41.8)	1,921,341 (42.2)
4	385,840 (35.7)	339,683 (36.1)	323,463 (36.5)	316,458 (36.6)	278,115 (36.7)	1,651,289 (36.3)
5 (highest)	67,781 (6.3)	54,323 (5.8)	51,598 (5.8)	43,891 (5.1)	40,709 (5.4)	259,828 (5.7)
Day of week (0)						
Weekday	783,831 (72.5)	678,206 (72.2)	637,269 (71.9)	618,680 (71.6)	539,659 (71.2)	3,273,581 (71.9)
Weekend/holiday	297,273 (27.5)	261,521 (27.8)	248,770 (28.1)	245,855 (28.4)	218,393 (28.8)	1,277,520 (28.1)
Shift (0)						
00:01–08:00	157,094 (14.5)	132,703 (14.1)	123,311 (13.9)	121,414 (14.0)	104,199 (13.7)	641,635 (14.1)
08:01–16:00	497,761 (46.0)	437,326 (46.5)	413,746 (46.7)	402,371 (46.5)	358,285 (47.3)	2,119,902 (46.6)
16:01–24:00	426,249 (39.4)	369,698 (39.3)	348,982 (39.4)	340,750 (39.4)	295,568 (39.0)	1,789,564 (39.3)
Hospital ED volume (0)						
< 20,000	152,029 (14.1)	144,505 (15.4)	138,335 (15.6)	132,206 (15.3)	124,136 (16.4)	698,524 (15.3)
20,000–< 40,000	260,053 (24.1)	225,569 (24.0)	223,520 (25.2)	222,714 (25.8)	174,686 (23.0)	1,109,468 (24.4)
40,000+	669,022 (61.9)	569,653 (60.6)	524,184 (59.2)	509,615 (58.9)	459,230 (60.6)	2,743,109 (60.3)
Hospital type (0)						
Community	759,772 (70.3)	673,826 (71.7)	649,249 (73.3)	638,236 (73.8)	541,040 (71.4)	3,273,768 (71.9)
Pediatrics	30,957 (2.9)	25,485 (2.7)	22,516 (2.5)	24,141 (2.8)	23,216 (3.1)	126,741 (2.8)
Small	128,027 (11.8)	117,766 (12.5)	114,047 (12.9)	110,501 (12.8)	88,820 (11.7)	565,029 (12.4)
Teaching	162,348 (15.0)	122,650 (13.1)	100,227 (11.3)	91,657 (10.6)	104,976 (13.8)	585,563 (12.9)
Urbal/rural (3,782)						
Urban	844,538 (78.1)	735,255 (78.2)	690,192 (77.9)	678,723 (78.5)	589,652 (77.8)	3,545,680 (77.9)
Rural	236,566 (21.9)	204,472 (21.8)	195,847 (22.1)	185,812 (21.5)	168,400 (22.2)	1,001,639 (22.0)
Chief complaint (0)						
Injury/trauma	294,179 (27.2)	270,607 (28.8)	261,281 (29.5)	262,821 (30.4)	239,368 (31.6)	1,333,973 (29.3)
GU/obstetric	44,213 (4.1)	38,349 (4.1)	36,094 (4.1)	35,826 (4.1)	30,082 (4.0)	185,473 (4.1)
Administrative issue	61,632 (5.7)	47,949 (5.1)	44,960 (5.1)	39,353 (4.6)	35,027 (4.6)	231,107 (5.1)
General signs and symptoms	57,452 (5.3)	48,512 (5.2)	44,195 (5.0)	42,195 (4.9)	37,786 (5.0)	231,382 (5.1)
Other	78,358 (7.2)	67,019 (7.1)	62,052 (7.0)	60,054 (6.9)	53,313 (7.0)	322,627 (7.1)
Mental health	32,556 (3.0)	22,294 (2.4)	18,780 (2.1)	17,022 (2.0)	15,042 (2.0)	106,491 (2.3)
Gastrointestinal problems	129,043 (11.9)	110,762 (11.8)	104,290 (11.8)	100,387 (11.6)	84,678 (11.2)	531,137 (11.7)
Chest pain	62,122 (5.7)	55,569 (5.9)	52,350 (5.9)	51,138 (5.9)	44,733 (5.9)	266,987 (5.9)
Shortness of breath/ asthma	50,208 (4.6)	41,937 (4.5)	38,552 (4.4)	36,934 (4.3)	31,009 (4.1)	199,474 (4.4)
URTI/otitis media	97,150 (9.0)	85,477 (9.1)	81,638 (9.2)	78,859 (9.1)	66,343 (8.8)	411,446 (9.0)

https://doi.org/10.2310/8000.2013.131102

Table 1. Continued

Variable (missing)	SES income quintile 1 (n = 1,081,104)	2 (n = 939,727)	3 (n = 886,039)	4 (n = 864,535)	5 (highest) (n = 758,052)	Overall* (N = 4,551,101)
Fever	43,433 (4.0)	38,011 (4.0)	37,014 (4.2)	37,065 (4.3)	29,473 (3.9)	185,746 (4.1)
Headache and other neurologic problems	79,213 (7.3)	69,046 (7.3)	63,238 (7.1)	62,277 (7.2)	55,961 (7.4)	331,048 (7.3)
Skin problems	51,545 (4.8)	44,195 (4.7)	41,595 (4.7)	40,604 (4.7)	35,237 (4.6)	214,210 (4.7)
Headache	26,658 (2.5)	22,809 (2.4)	20,850 (2.4)	20,187 (2.3)	17,470 (2.3)	108,397 (2.4)
Abdominal pain	94,797 (8.8)	83,177 (8.9)	78,530 (8.9)	76,270 (8.8)	65,187 (8.6)	399,427 (8.8)
High-acuity abdominal pain†	3,735 (0.3)	3,648 (0.4)	3,409 (0.4)	3,282 (0.4)	3,113 (0.4)	17,242 (0.4)

ED = emergency department; GU = genitourinary; SES = socioeconomic status; URTI = upper respiratory tract infection.
*Includes 21,644 patients with missing SES data.
†Subset of the abdominal pain group.

DISCUSSION

Among Ontario ED patients, we found that higher SES was associated with a statistically significantly higher likelihood of undergoing CT scanning compared to patients in the lowest SES quintile. The association was observed among all ED patients; however, a stronger association was seen for those presenting with headache and abdominal pain, chief complaints that are common and often investigated with the help of diagnostic imaging. However, the association was not found to be statistically significant in patients presenting with complex abdominal pain, a group that represents higher-acuity illness with a greater chance of having a clearcut indication for ordering CT. This may suggest that factors other than clinical appropriateness might be influencing the decision as to who gets a CT scan in the ED but that with greater clinical certainty regarding the indications for CT, the influence of SES on the decision to order a CT scan may be reduced.

Theoretically, SES should not affect access to or quality of care in Canada's universal health care system. The vast majority of Ontarians have a health card

Table 2. Rate of CT scan overall and stratified by SES income group

	SES income quintile 1	2	3	4	5 (highest)	Overall*
Total						
Number of patients	1,081,104	939,727	886,039	864,535	758,052	4,551,101
Proportion receiving CT (%)	7.76	8.25	8.13	8.24	8.58	8.15
95% CI	7.71–7.81	8.19–8.30	8.07–8.18	8.19–8.30	8.51–8.64	8.13–8.18
Headache						
Number of patients	26,658	22,809	20,850	20,187	17,470	108,397
Proportion receiving CT (%)	23.2	25.0	26.3	26.3	27.7	25.5
95% CI	22.7–23.7	24.5–25.6	25.7–26.9	25.7–26.9	27.1–28.4	25.2–25.7
Abdominal pain						
Number of patients	94,797	83,177	78,530	76,270	65,187	399,427
Proportion receiving CT (%)	18.4	20.7	20.7	21.6	22.6	20.6
95% CI	18.1–18.6	20.5–21.0	20.4–21.0	21.3–21.9	22.3–22.9	20.5–20.7
Complex abdominal pain						
Number of patients	3,735	3,648	3,409	3,282	3,113	17,242
Proportion receiving CT (%)	55.4	56.1	56.0	56.7	57.0	56.2
95% CI	53.8–57.0	54.4–57.7	54.3–57.7	55.0–58.4	55.2–58.7	55.5–56.9

CI = confidence interval; CT = computed tomography; SES = socioeconomic status.
*Includes patients with missing SES data.

https://doi.org/10.2310/8000.2013.131102

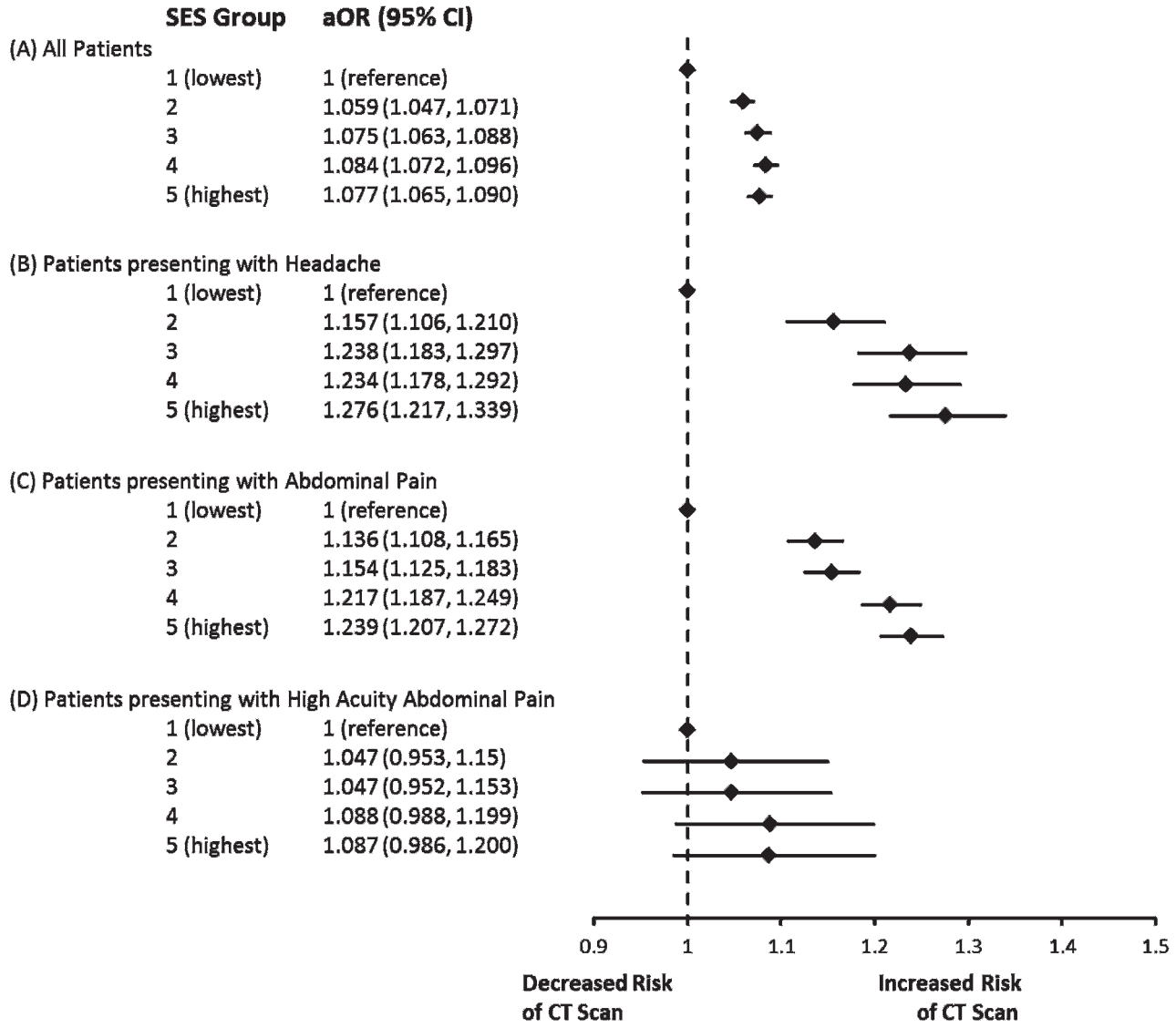

Figure 1. Adjusted odds ratios (aOR) (95% confidence intervals [95% CI]) for computed tomography (CT) scanning in (A) all patients admitted to Ontario emergency departments and patients presenting to Ontario emergency departments with a chief complaint of (B) headache, (C) abdominal pain, and (D) complex abdominal pain (age ≥ 65 years, Canadian Triage and Acuity Scale 1–3, admitted to hospital). Odds ratios adjusted for triage level, age group, sex, day of week, shift, hospital ED volume, hospital type (pediatrics, small, teaching, community), residential area (urban, rural), and presenting chief complaint. SES = socioeconomic status.

number, indicating that they are insured for medically necessary care and should receive medically necessary hospital and physician services regardless of age, race, or income. However, there is still evidence to suggest that lower SES patients receive fewer health services than higher SES patients in Canada and elsewhere.[4–7,9,10]

Studies of SES in settings relevant to EDs have found conflicting results. In the United States, low SES has been linked to reduced emergency surgery for appendicitis and other conditions.[3] In Ontario and Alberta, studies of acute myocardial infarction have found that low SES was associated with fewer invasive tests and greater 1-year mortality.[8,18] On the other hand, low SES was not associated with differential access to emergency surgery or trauma centre care in Canada.[3,19]

Various causes have been postulated for this difference in health service use. Access barriers, such as lack of transport, may play a role.[20] Physical and social barriers have been found to be among the primary reasons for noncompletion of specialist consultations.[21] We considered only patients already in the

https://doi.org/10.2310/8000.2013.131102

ED, where they theoretically have equal access to CT scanning, suggesting that our results reflect factors related to emergency physician decision making.

It is important to underline that our results do not indicate, and we do not suggest, that higher SES patients had more appropriate or better care than lower SES patients. Rather, they suggest that patients of different SES groups may be treated differently. Receiving a CT scan is not always an indication of appropriate treatment and may lead to harm through unnecessary radiation exposure[22] or through false positive scan results, leading to further unnecessary testing. The odds ratios we observed, where statistically significant, reflect small absolute differences in CT rates between the highest and the lowest SES quintiles. However, with an overall CT use rate of 20 to 25% for headache and abdominal pain patients, and with more than 500,000 Ontarians presenting each year to an ED with one of those two problems, even small absolute increases in rates still mean that substantial numbers of additional patients undergo CT scanning each year.

The limitations of our study merit emphasis. Although the association between CT use and SES may be due to physician decision making, there are alternative explanations. Although a multivariate logistical regression helped control for confounding variables, there may be residual confounding, such as differential illness severity among high and low SES patients or differences in clinical presentation. We attempted to adjust for this using the Canadian CTAS score, a validated triage score assigned by trained triage nurses to each patient based on perceived acuity of the presenting complaint,[23] and the chief complaint. Still, if lower SES patients presenting to the ED were found to be less sick after full examination by the emergency physician, they may have been less likely to receive a CT scan. Patients in the lowest income quintile had the highest number of ED visits; however, we found very similar results when we restricted our analysis to only the first ED visit for each patient. It is also possible that higher SES patients are more demanding of higher technology tests and that physicians are simply responding to this increased demand (which would nonetheless be potentially clinically inappropriate) or that low SES patients are more likely to refuse CT imaging (which is unlikely in our clinical experience). Individual physician CT ordering practices and beliefs surrounding CT risk may also confound results, but only if physicians less likely to order CTs were systematically more likely to encounter low SES patients. With respect to the complex abdominal pain analysis, although no significant association was found between SES and CT use, a trend toward greater CT use with higher SES was observed. The absence of a statistically significant association may be due to limited power as this clinical subgroup had a smaller population than the other groups examined. Lastly, SES encompasses more than just income and includes factors such as education and occupation. We used economic data as there is evidence that these alone can be used in health research as a strong indicator of SES.[24]

CONCLUSION

SES is associated with use of CT scans in all patients and in patients presenting to the ED with headache and abdominal pain. Within each of these subgroups, patients in the lowest SES quintile received fewer CT scans than patients in all four of the higher SES quintiles. No difference was seen among complex abdominal pain patients, suggesting that as the clinical indications for the test become more clearcut, use of the test across SES quintiles is more uniform. Ultimately, our results help inform the discussion regarding the mechanisms by which SES may act as a social determinant of health in Ontario EDs.

Acknowledgement: Dr Michael Schull is supported by the Canadian Institutes for Health Research as an Applied Chair in Health Services and Policy Research.

Competing interests: None declared.

REFERENCES

1. Adler NE, Ostrove JM. Socioeconomic status and heath: what we know and what we don't. *Ann N Y Acad Sci* 2000; 896:3-15, doi:10.1111/j.1749-6632.1999.tb08101.x.
2. Shah PC. *Public health and preventative medicine in Canada.* 5th ed. Toronto: Elsevier Canada; 2003.
3. Krajewski SA, Hameed SM, Smink DS, et al. Access to emergency operative care: a comparative study between the Canadian and American health care systems. *Surgery* 2009; 146:300-7, doi:10.1016/j.surg.2009.04.005.
4. Jackson P. The impact of health insurance status on emergency room services. *J Health Soc Policy* 2001;14:61-74, doi:10.1300/J045v14n01_04.
5. Hsia RY, Asch SM, Weiss RE, et al. Hospital determinants of emergency department left without being seen rates. *Ann Emerg Med* 2011;58:24-32, doi:10.1016/j.annemergmed.2011.01.009.

6. Raine R, Wong W, Scholes S, et al. Social variations in access to hospital care for patients with colorectal, breast, and lung cancer between 1999 and 2006: retrospective analysis of hospital episode statistics *BMJ* 2006;340:b5479, doi:10.1136/bmj.b5479.
7. Paszat LF, Mackillop WJ, Groome PA. Radiotherapy for breast cancer in Ontario: rate variation associated with region, age, and income. *Clin Invest Med* 1998;21:125-34.
8. Alter DA, Naylor CD, Austin P, et al. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. *N Engl J Med* 1999;341:1359-67, doi:10.1056/NEJM199910283411806.
9. Hawkins NM, Jhund PS, McMurray JJ, et al. Heart failure and socioeconomic status: accumulating evidence of inequality. *Eur J Heart Fail* 2012;14:138-46, doi:10.1093/eurjhf/hfr168.
10. Barr HL, Britton J, Smyth AR, et al. Association between socioeconomic status, sex, and age at death from cystic fibrosis in England and Wales (1959 to 2008): cross sectional study *BMJ* 2011;243:d4662, doi:10.1136/bmj.d4662.
11. Moineddin R, Meaney C, Agha M, et al. Modeling factors influencing the demand for emergency department services in Ontario. *Emerg Med* 2011;11:13.
12. McCusker J, Roberge D, Levesque JF, et al. Emergency department visits and primary care among adults with chronic conditions. *Med Care* 2010;48:972-80, doi:10.1097/MLR.0b013e3181eaf86d.
13. Menec VH, Sirski M, Attawar D. Does continuity of care matter in a universally insured population? *Health Serv Res* 2005;40:389-400, doi:10.1111/j.1475-6773.2005.0p364.x.
14. Khan Y, Glazier RH, Moineddin R, et al. A population-based study of the association between socioeconomic status and emergency department utilization in Ontario, Canada. *Acad Emerg Med* 2011;18:836-43, doi:10.1111/j.1553-2712.2011.01127.x.
15. Canadian Institute for Health Information. *National Ambulatory Care Reporting System*. Available at: http://www.cihi.ca/CIHI-ext-portal/internet/en/document/types+of+care/hospital+care/emergency+care/services_nacrs (accessed August 1, 2012).
16. Statistics Canada. *Postal Codes Conversion File (PCCF), reference guide*. Available at: http://www.statcan.gc.ca/pub/92-153-g/92-153-g2011001-eng.pdf (accessed February 2, 2013).
17. Larson LB, Johnson LW, Schnell BM, et al. National trends in CT use in the emergency department. *Radiology* 2011;258:164-73, doi:10.1148/radiol.10100640.
18. Chang WC, Kaul P, Westerhout CM, et al. Effects of socioeconomic status on mortality after acute myocardial infarction. *Am J Med* 2007;120:33-9, doi:10.1016/j.amjmed.2006.05.056.
19. Moore L, Turgeon AF, Sirois MJ, et al. Influence of socioeconomic status on trauma center performance evaluations in a Canadian trauma system. *J Am Coll Surg* 2011;213:402-9, doi:10.1016/j.jamcollsurg.2011.05.007.
20. Safaei J. A ride to care—a non-emergency medical transportation service in rural British Columbia. *Rural Remote Health* 2011;11:1637.
21. Friedman SM, Vergel de Dios J, Hanneman K. Noncompletion of referrals to outpatient specialty clinics among patients discharged from the emergency department: a prospective cohort study. *Can J Emerg Med Care* 2010;12:325-30.
22. Brenner DJ, Hall EJ. Computed tomography—an increasing source of radiation exposure. *N Engl J Med* 2007;357:2277-84, doi:10.1056/NEJMra072149.
23. Canadian Association of Emergency Physicians. *Canadian Triage and Acuity Score (CTAS)*. Available at: http://caep.ca/resources/ctas (accessed August 15, 2012).
24. Daly MC, Duncan GJ, McDonough P, et al. Optimal indicators of socioeconomic status for health research. *Am J Public Health* 2002;92:1151-7, doi:10.2105/AJPH.92.7.1151.