



The intensity and variation of surgical care at the end of life: a retrospective cohort study

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Summary

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Background Although the extent of hospital and intensive-care use at the end of life is well known, patterns of surgical care during this period are poorly understood. We examined national patterns of surgical care in the USA among elderly fee-for-service Medicare beneficiaries in their last year of life.

Methods We did a retrospective cohort study of elderly beneficiaries of fee-for-service Medicare in the USA, aged 65 years or older, who died in 2008. We identified claims for inpatient surgical procedures in the year before death and examined the relation between receipt of an inpatient procedure and both age and geographical region. We calculated an end-of-life surgical intensity (EOLSI) score for each hospital referral region defined as proportion of decedents who underwent a surgical procedure during the year before their death, adjusted for age, sex, race, and income. We compared patient characteristics with Rao-Scott χ^2 tests, resource use with generalised estimating equations, regional differences with generalised estimating equations Wald tests, and end-of-life surgical intensity scores with Spearman's partial-rank-order correlation coefficients.

Findings Of 1802029 elderly beneficiaries of fee-for-service Medicare who died in 2008, 31.9% (95% CI 31.9–32.0; 575 596 of 1802029) underwent an inpatient surgical procedure during the year before death, 18.3% (18.2–18.4; 329 771 of 1802029) underwent a procedure in their last month of life, and 8.0% (8.0–8.1; 144 162 of 1802029) underwent a procedure during their last week of life. Between the ages of 80 and 90 years, the percentage of decedents undergoing a surgical procedure in the last year of life decreased by 33% (35.3% [95% CI 34.7–35.9; 8858 of 25 094] to 23.6% [22.9–24.3; 3340 of 14 152]). EOLSI score in the highest intensity region (Munster, IN) was 34.4 (95% CI 33.7–35.1) and in the lowest intensity region (Honolulu, HI) was 11.5 (11.3–11.7). Regions with a high number of hospital beds per head had high end-of-life surgical intensity ($r=0.37$, 95% CI 0.27–0.46; $p<0.0001$), as did regions with high total Medicare spending ($r=0.50$, 0.41–0.58; $p<0.0001$).

Interpretation Many elderly people in the USA undergo surgery in the year before their death. The rate at which they undergo surgery varies substantially with age and region and might suggest discretion in health-care providers' decisions to intervene surgically at the end of life.

Funding None.

Introduction

The intensity of medical care at the end of life is well known.^{1,2} A fifth of elderly Americans die in intensive-care services and of these patients, about half undergo mechanical ventilation and a quarter undergo cardiopulmonary resuscitation in the days before death.^{3–5} Furthermore, the intensity of end-of-life care varies substantially on the basis of where patients receive care.^{6,7} Although one might assume that more care results in better care, regions with high health-care use at the end of life do not necessarily have better outcomes.⁸ Areas of high use have been associated with lower quality and lower perceptions of quality of dying among bereaved families than in areas with fewer health-care resources.^{8,9} These large variations lead many clinical leaders and policy makers to believe that there is substantial room to improve end-of-life care.

Despite increasing attention on improving care at the end of life, substantial gaps exist in our knowledge about surgical care at the end of life. We are aware of only one study that examined trends in surgical care at the end of life,¹⁰ although others have examined patterns of non-

surgical care at the end of life.^{3,5,11} Because of the high cost and invasiveness of surgical interventions, improved understanding of how much surgical care we provide and how this varies would be potentially helpful. If the proportion of dying patients who receive surgical care is substantial, and if it varies significantly on the basis of patient characteristics or across regions, it would provide an important new focus area for clinical leaders and policy makers hoping to optimise care during this vulnerable period.

We aimed to understand how often elderly Americans undergo surgical interventions in the last year of life and to what degree such interventions vary by age and across health-care markets. We also sought to understand whether key regional factors, such as the number of hospital beds and supply of surgeons, influences the degree to which dying patients receive surgical interventions.

Methods

Study design and patients

We did a retrospective cohort study of 2008 Medicare fee-for-service enrollees with Medicare data from 2007–08.

These data contained diagnosis and procedure codes for all beneficiaries of Medicare enrolled in the fee-for-service programme who were admitted to an acute-care hospital or skilled nursing facility. Data included International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes for comorbidities and procedures undertaken in the hospitals.¹² We also gathered data on beneficiary demographics including age, sex, race, ZIP code of residence, and date of death. US 2000 census data were used to impute income levels by assigning beneficiaries the household median income for the ZIP code in which they resided.¹³ We used the hospital referral region, created by the Dartmouth Atlas of Health Care^{14,15} on the basis of patterns of travel for tertiary hospital care, as our measure of local health-care region. We also obtained supply-side and financial spending data from the Dartmouth Atlas.^{14,16}

We identified and included all patients who died during the 2008 calendar year who were aged 65 years or older at their time of death and for whom we had claims data for at least 12 months before death. We identified the receipt of a surgical procedure 365 days before death with ICD-9-CM codes. We initially chose a broad definition of surgery: any procedure involving incision, excision, manipulation, or suturing of tissue, usually requiring anaesthesia or profound sedation to control pain.¹⁷ Five surgeons (including MES) independently reviewed and classified 3664 ICD-9-CM procedure codes and used a modified-Delphi process¹⁸ to reach a consensus decision on the classification of surgical procedures.¹⁹ We also examined a prespecified conservative definition of surgery, only including procedures that occurred in the operating room.

We classified decedents into three groups: those who had an inpatient surgical procedure; those that were admitted to hospital but did not have a surgical procedure; and those who did not have a surgical procedure or hospital admission in the last year of life. For each group, we examined the distributions of age, sex, race, and household income. For those who had at least one hospital admission, we calculated a comorbidity score using the Deyo adaptation of the Charlson Comorbidity Index with the comorbidity data from the first admission in the study period, thus minimising the possibility of listing postoperative complications as a comorbidity.^{20–22}

Data extraction

For decedents with at least one hospital admission, we examined three measures of resource use: mean number of hospital admissions, mean number of days in hospital, and mean number of days in intensive care. Each of these measures was adjusted for age, sex, race, income, and comorbidities. We initially excluded outliers (those in the top 5% of resource use); we repeated the analyses with outliers included and reported qualitatively similar results. Of those individuals who underwent surgical procedures, we identified the most common procedures done during the last 30 days, 31–90 days, and 91–365 days of life.

We examined the percentage of decedents who underwent a surgical procedure overall and by age at the time of death. We also developed a measure of end-of-life surgical intensity (EOLSI) for each hospital referral region, defined as the rate of receipt of at least one surgical procedure during the last year of life for all decedents, adjusted for age, sex, race, and income. Procedures done during the last 30 days of life were initially excluded (because deaths could be due to the procedure), but as a sensitivity analysis we repeated our approach including procedures in the last 30 days of life. We classified regions into three groups: those with the highest surgical intensity (hospital referral regions in the top 10% of scores); those with the middle intensity (regions in the middle 80% of scores); and those with the lowest surgical intensity (regions in the bottom 10% of scores), although we also examined additional cut points and surgical intensity as a continuous variable.

The institutional review board of the Harvard School of Public Health (Boston, MA, USA) approved this study.

Statistical analysis

We assessed the proportion of decedents undergoing surgical procedures at the end of life and presented these data as proportions with 95% CIs. We also examined how the likelihood of undergoing surgery varied by age. We compared characteristics of patients in the three groups of decedents with Rao-Scott χ^2 tests to account for clustering at the hospital level.²³ We compared resource use in the two groups that had hospital admissions with generalised estimating equations to adjust for clustering by hospital.²⁴

Our primary analytical question was does regional surgical intensity vary by number of hospital beds in the region or by the number of surgeons? Because some people have expressed concerns that regions with high intensity might be more aggressive with medical or surgical treatments and therefore have low population-level death rates²⁵ and high spending, we also examined the relation between regional surgical intensity and its mortality and spending rate.

We standardised the EOLSI scores to the population distribution of age, sex, race, and income. Generalised estimating equations Wald tests with two degrees of freedom were used, accounting for clustering at the hospital level, to compare regional differences for the four outcomes of interest. Spearman partial-rank-order correlation coefficients were used to assess the relations between adjusted EOLSI and each of the four outcomes of interest at the hospital-referral-region level.

We used the Bonferroni approach for multiple testing and classed *p* values less than 0.0125 to be significant. We conservatively assumed an intraclass (within hospital) correlation of 0.1. This study had greater than 80% power ($\alpha=0.0125$) to detect an effect size of 1, in which the effect size was defined as the difference in means between the high and low intensity regions divided by the standard deviation.

	Decedents who were admitted to hospital and had an inpatient surgical procedure (n=575 596)	Decedents who were admitted to hospital but did not have an inpatient surgical procedure (n=750 568)	Decedents who were not admitted to hospital and did not have an inpatient surgical procedure (n=475 865)	p value
Age (years)				<0.0001
65–69	13% (73 287/575 596)	8% (60 801/750 568)	11% (50 043/475 865)	..
70–79	35% (201 713/575 596)	26% (194 161/750 568)	27% (128 268/475 865)	..
80–89	42% (232 784/575 596)	44% (327 251/750 568)	39% (187 102/475 865)	..
≥90	12% (67 702/575 596)	22% (168 355/750 568)	23% (110 452/475 865)	..
Sex				<0.0001
Female	52% (298 557/575 596)	57% (429 956/750 568)	56% (264 367/475 865)	..
Race				<0.0001
White	85% (487 425/575 596)	88% (661 221/750 568)	86% (407 085/475 865)	..
Black	11% (61 646/575 596)	8% (59 987/750 568)	8% (35 996/475 865)	..
Hispanic	2% (11 682/575 596)	2% (11 809/750 568)	3% (13 389/475 865)	..
Asian	1% (6859/575 596)	1% (7929/750 568)	2% (9188/475 865)	..
Other (Native American, other, unknown)	1% (7984/575 596)	1% (8337/750 568)	2% (10 207/475 865)	..
Income distribution by quintile (in year 2000 US\$)*				<0.0001
1st (\$0–17 920)	1% (6307/555 434)	1% (7671/724 064)	3% (11 168/443 664)	..
2nd (\$17 921–33 000)	27% (147 692/555 434)	26% (187 016/724 064)	23% (103 544/443 664)	..
3rd (\$33 001–52 174)	49% (271 480/555 434)	50% (358 560/724 064)	50% (220 955/443 664)	..
4th (\$52 175–81 766)	20% (113 129/555 434)	21% (148 331/724 064)	21% (93 804/443 664)	..
5th (≥\$81 767)	3% (16 826/555 434)	3% (224 86/724 064)	3% (14 193/443 664)	..
Charlson score				<0.0001
Score 0	19% (107 983/575 596)	20% (148 369/750 568)
Score 1	23% (133 025/575 596)	26% (197 342/750 568)
Score 2	21% (122 872/575 596)	21% (159 635/750 568)
Score ≥3	37% (211 716/575 596)	33% (245 222/750 568)

Comparisons made with Rao-Scott χ^2 tests. *Income denominators differ due to missing data.

Table 1: Age, gender, race, income, and comorbidity distributions for 2008 Medicare decedents

	Decedents who were admitted to hospital and had an inpatient surgical procedure (n=575 596)	Decedents who were admitted to hospital but did not have an inpatient surgical procedure (n=750 568)	p value
Number of hospital admissions	3.0 (3.0–3.0)	2.2 (2.2–2.2)	<0.0001
Number of days in hospital	26.8 (26.7–28.0)	18.0 (17.9–18.2)	<0.0001
Number of days in intensive care	5.5 (5.4–5.6)	2.9 (2.8–3.0)	<0.0001

Data are mean (95% CI). Comparisons made with generalised estimating equations.

Table 2: Comparison of patient-level mean number of hospital admissions, days in hospital, and days in intensive care for 2008 Medicare decedents, adjusted for age, sex, race, income, and comorbidity, who have been admitted to hospital and did or did not undergo a surgical procedure during their last year of life

We undertook a series of sensitivity analyses. First, we reran our analyses to examine patterns of care for patients who received a surgical procedure in the last 6 months of life or in the last 30 days of life. We also examined regional variations in surgery restricted to just those over the age of 80 years. Next, we examined patterns of care for decedents who underwent the conservative definition of surgical procedures (ie, those that occur in the operating room). For patients with information about comorbidities from previous hospital admissions, we examined patterns of care with those data to adjust for severity of illness.

Role of the funding source

There was no sponsor for this study. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

1802029 beneficiaries of fee-for-service Medicare aged 65 years or older died in 2008. Nearly a third of these decedents (31.9% [95% CI 31.9–32.0; 575 596 of 1802029]) underwent an inpatient surgical procedure during their last year of life (median 2 [IQR 1–3]), compared with 13.9% (13.90–13.91; 4893 241 of 35 185 017) of survivors during 2008. During the last 3 months of life, more than a quarter (25.1% [95% CI 25.0–25.2; 452 309 of 1802029]) of decedents underwent a procedure, whereas 18.3% (18.2–18.4; 329 771 of 1802029) underwent a procedure in the last month of life and 8.0% (8.0–8.1; 144 162 of 1802029) underwent a surgical procedure in the last week of life.

Decedents who underwent a surgical procedure were, on average, younger (79.8 [95% CI 79.8–79.8] years old vs 82.5 [82.5–82.5] years old; $p<0.0001$), more often men, and more often non-white than were decedents who did not undergo surgery. Patients who underwent a surgical

procedure more often had a Charlson Comorbidity Index of 3 or higher (table 1) than did those who did not undergo a procedure. We did not find meaningful differences in the imputed incomes of patients across groups (table 1).

Decedents who underwent a surgical procedure had higher adjusted mean number of hospital admissions than did those who were admitted to hospital without a surgical procedure (table 2), spent nearly 50% more days in hospital, and had almost twice as many days in intensive care (table 2). The ten most common procedures done in the last year of life made up 450 532 (31.0%) of all procedures and were common in each of the time periods examined (the last 30, 31–90, and 91–365 days before death; webappendix p 2).

We identified substantial age-related variation in the likelihood of undergoing a surgical procedure at the end of life. Although the likelihood of having a surgical procedure was 38.4% (95% CI 37.6–39.2; 5268 of 13 719) at age 65 years and only fell to 35.3% (34.7–35.9; 8858 of 25 094) by age 80 years, between the ages of 80 years and 90 years, the percentage of decedents undergoing a surgical procedure in the last year of life decreased by 33% (35.3% [95% CI 34.7–35.9; 8858 of 25 094] to 23.6% [22.9–24.3; 3340 of 14 152]; figure).

We noted substantial regional variations in the adjusted EOLSI scores with the highest surgical intensity region (Munster, IN) having a three-times higher adjusted score than the lowest intensity region (Honolulu, HI, webappendix p 1). The average population-level adjusted death rates were higher in high-intensity regions than in other regions ($p < 0.0001$, table 3). Although no significant association was identified between surgical intensity at the end of life and the average number of surgeons per region ($p = 0.33$), we reported that high-intensity areas had nearly 40% (95% CI 31–66) more beds per head compared with the low-intensity areas (table 3). Furthermore, high-intensity regions had significantly higher Medicare spending ($p < 0.0001$, table 3). In analyses that assessed surgical intensity in hospital-referral regions as a continuous variable, we identified positive correlations with hospital referral region adjusted death rates ($r = 0.13$, 95% CI 0.02–0.24; $p = 0.03$), hospital beds per head ($r = 0.37$, 0.27–0.46; $p < 0.0001$), and Medicare reimbursements ($r = 0.50$, 0.41–0.58; $p < 0.0001$; webappendix p 3).

In sensitivity analyses that restricted our samples to patients who had a procedure in the last 6 months of life or the last 30 days of life, the patterns of care recorded were very similar: declining surgical care with higher age,

See Online for webappendix

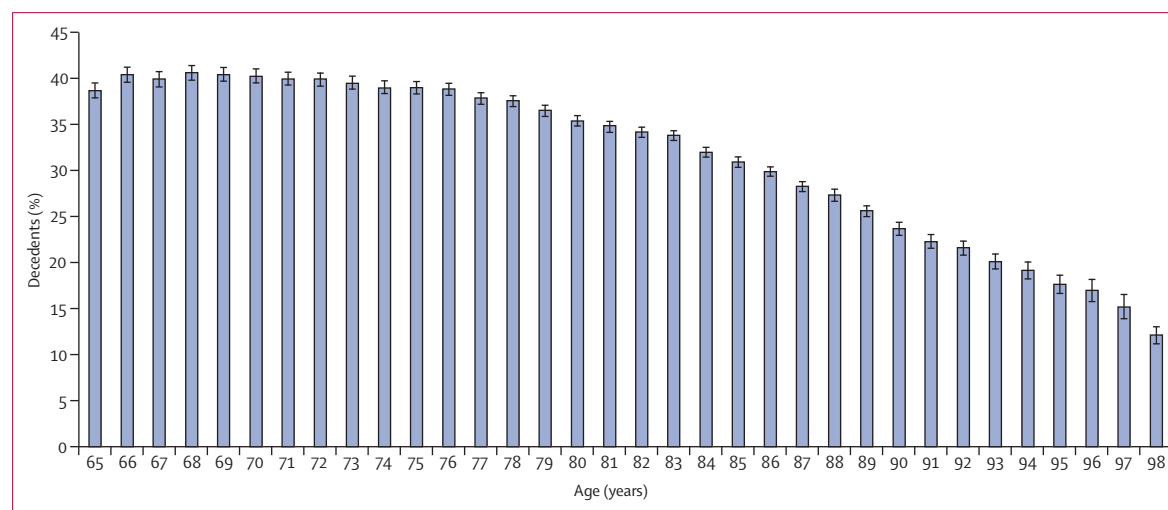


Figure: Percentage of 2008 elderly Medicare decedents who underwent at least one surgical procedure during their last year of life by age. Black lines are error bars.

	EOLSI score	Adjusted death rate per 100 decedents		Number of acute-care hospital beds*		Number of surgeons*		2007 Medicare-enrollee reimbursements (part A and B)	
		Mean (SE)	p value	Mean (SE)	p value	Mean (SE)	p value	Mean (SE)	p value
High-intensity regions†	28.2	5.0 (0.08)	<0.0001	2.8 (0.13)	<0.0001	0.43 (0.014)	0.33	\$10 384.71 (\$250.8)	<0.0001
Middle-intensity regions†	22.1	4.9 (0.03)	..	2.5 (0.04)	..	0.41 (0.004)	..	\$8147.73 (\$78.6)	..
Low-intensity regions†	13.7	4.5 (0.05)	..	1.9 (0.07)	..	0.41 (0.009)	..	\$7645.41 (\$239.6)	..

Comparisons were made with generalised estimating equations Wald tests. EOLSI=end-of-life surgical intensity. *Per 1000 residents in the community. †Within each end-of-life surgical intensity (EOLSI) category, average EOLSI score per 100 decedents is adjusted for age, sex, race, and income. Decedents who died within 30 days of their procedure were excluded. High-intensity regions are the top decile (31 regions) with the highest EOLSI; the low-intensity regions are the bottom decile (31 regions) with the lowest EOLSI; the middle-intensity regions are the 80% of regions in between.

Table 3: Comparison of mean adjusted death rate, mean number of acute-care hospital beds, mean number of surgeons, and mean total Medicare-enrollee reimbursements by regions of high, middle, and low adjusted surgical intensity at the end of life

and similar patterns of regional variation and correlation with regional factors. The analyses of regional variation were nearly identical for patients older than 80 years of age as they were for the entire sample. Results from our subanalysis of patterns of care in patients with information about comorbidities from previous hospital admissions were nearly identical to the full analyses and were therefore not presented. Finally, we noted that 20% (360 405 of 1 802 029) of decedents underwent a surgical procedure that probably occurred in the operating room and that other key findings (declining rates of surgery with age and regional variations) were comparable even when this more conservative definition of surgical care was used.

Discussion

Nearly a third of elderly Americans had a surgical intervention during the last year of life and most of these procedures occurred in the month before death. Beneficiaries who underwent surgery typically had more hospital admissions, longer duration of stay, and a greater number of days spent in intensive care than did those who did not have a surgical procedure in the year before death. The likelihood of receiving surgery at the end of life varied substantially with patients' age and where they lived, probably suggesting substantial discretion among health-care providers as to whether a dying patient should undergo a procedure (panel). Areas of high surgical intensity at the end of life had higher health-care capacity and spending than did areas of low and middle surgical intensity.

Presumably, severity of illness is associated with the need for surgery, which is why decedents, who were by definition sicker than non-decedents, had more surgical interventions. However, we also reported that despite increasing comorbidities with age, the rate of surgery actually declined as patients got older. Health-care providers might have a high threshold to undertake surgery for elderly patients or a perception that these patients are more likely to have complications or less likely to benefit from such interventions than might younger patients. Some of these age-related differences could also be due to the preferences of patients and their families. Studies have shown that health-care use is inversely associated with age, although such research was not necessarily focused on surgical

procedures.^{11,26–28} Although our data do not allow us to understand why these variations exist, we suspect that as the population ages, health-care providers' thresholds for intervention for elderly patients will probably change.

We identified substantial variation in surgical intensity across local regions. Although the reasons for these variations are not clear, we suspect that it reflects a variety of factors including population health, practice patterns, culture, and potentially, availability of other end-of-life services such as hospices. Some have suggested that regions or providers that seem to be more surgically intensive might have better outcomes than do those that are less intensive—by only assessing the decedents, these regions or providers could inappropriately seem to be wasteful.²⁹ Our finding that regions with high surgical intensity have high (not low) death rates does not support this hypothesis. These high-intensity regions could just have a sicker population of patients than do low intensity regions. We attempted to risk-adjust our analyses on the basis of the available data, but such adjustments are imperfect.

We showed that regions with a high number of hospital beds per head had higher surgical intensity at the end of life than did those with fewer beds. Fisher and colleagues³⁰ reported that residents of areas with a high number of hospital beds per head were up to 30% more likely to be admitted to hospital than in those in areas with fewer beds per head, suggesting substantial discretion of health-care providers in deciding which patients to admit to hospital. Our finding that surgical intensity is related to the number of hospital beds (although not the number of surgeons) suggests that wide-ranging practice patterns could exist in intensive regions that affect other aspects of care, such as when and how aggressively to intervene at the end of a patient's life. Findings that showed substantially higher spending in these regions underscore these results. Future research needs to focus on why these large variations exist. For policy makers seeking to reduce variation in care, focus could be directed to factors that lead to excess supply, such as a fee-for-service payment system.

Barnato and colleagues³⁰ reported that the rate of receipt of 88 intensive surgical procedures (a subset of the 2511 procedures we studied) in the last year of life increased by more than 50% between 1985 and 1999. Although these and our results are from the USA, they might provide insight to surgical care at the end of life in other countries and should prompt other investigators outside the USA to examine how much patterns of surgical care vary between nations.

There are important limitations to our study. First, we only examined inpatient surgical procedures. About 44% of all procedures are done in the outpatient setting.³¹ Although many of these procedures are similar to the ones we examined (such as oesophagogastroduodenoscopy or colonoscopy), our failure to account for those led to an underestimation of the number of interventions provided at the end of life. Another limitation is that we examined

Panel: Research in context

Systematic review

We used Medline to search for articles published in English between Jan 1, 1985, and May 1, 2011, with the keywords "end-of-life", "surgery", and "regional variation". We chose to include peer-reviewed articles that were quantitative in nature and excluded qualitative articles. We did not identify any systematic reviews that explored the use of surgical treatment at the end-of-life.

Interpretation

We noted substantial regional variations in surgical intensity across health-care markets. Such variation in surgical intensity suggests room for change in policies and guidelines regarding the care offered at the end of life.

the care of decedents as opposed to the care of patients at risk of dying. Use of administrative data to examine end-of-life care for decedents has been criticised for several reasons: it might not accurately mirror the care of patients who are dying, clinicians often have difficulty predicting which patients are near the end of life, and it does not reflect care provided to patients that survived. We attempted to account for the limitations of this retrospective analysis by adjusting for risk factors for death, although such adjustments are imperfect and some comorbidities could have been due to surgical intervention. We could not assess whether surgical procedures were palliative or consistent with patients' goals.

For clinicians, these data should prompt careful consideration of a patients' goals when assessing the need for surgical intervention at the end of life. Furthermore, such wide regional variation in surgical intensity suggests room for change in policies and guidelines regarding the care offered at the end of life. Because we could not establish which of the surgical procedures was appropriate or not, these findings should lead to a renewed effort to identify the optimum care for dying patients, taking their wishes into account, to ensure that interventions help extend life and reduce suffering.

Contributors

ACK, MES, SRL, AMB, AAG, and AKJ conceived and designed the study. ACK, MES, and AKJ gathered the data. ACK, MES, SRL, and AKJ did the statistical analyses. ACK and MES wrote the article, which was critically revised by AMB, AEB, AAG, and AKJ. AKJ supervised the study. All authors reviewed and approved the final report.

Conflicts of interest

We declare that we have no conflicts of interest.

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