



Community distress as a predictor of early hernia recurrence for older adults undergoing ventral hernia repair (VHR)

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Abstract

Background Social cohesion and neighborhood support have been linked to improved health in a variety of fields, but is not well-studied among the elderly population. This is particularly evident in surgical populations. Therefore, this study sought to assess the potential role of community distress in predicting early hernia recurrence among older adults.

Methods The Abdominal Core Health Quality Collaborative (ACHQC) was used to identify patients aged 65 or older undergoing elective ventral hernia repair with zip code data available. Patients were linked to the Distressed Communities Index (DCI), which is a national database that assigns a score of 0–100 to each zip code based on 7 measures of neighborhood prosperity. Quintiles were used to compare groups: prosperous (0–20), comfortable (21–40), mid-tier (41–60), at-risk (61–80), and distressed (81–100). Distressed (0–20), at-risk (21–40), mid-tier (41–60), comfortable (61–80), and prosperous (81–100). Time to recurrence for neighborhood distress quintiles was examined using a Cox proportional hazards model.

Results In total, 9819 patients were included in the study, including 3056 (31.1%) prosperous, 2307 (23.5%) comfortable, 1795 (18.2%) mid-tier, 1390 (14.2%) at-risk, and 1271 (12.9%) distressed. Distressed communities had lower mean age and greater proportion of racial minorities ($p < 0.001$). Open repairs were significantly more common among the distressed group (66.7%), as were all comorbidities ($p < 0.001$). Recurrence-free survival was shorter for distressed communities compared to prosperous after adjusting for baseline characteristics (HR 1.3, 95% CI 1.07–1.67, $p = 0.01$). Mean time to recurrence was lowest for patients living in distressed communities, indicating the worst recurrence rates, while mean time to recurrence was greatest for those in prosperous zip codes ($p < 0.001$).

Conclusion Older VHR patients presenting from distressed zip codes, as identified by the Distressed Communities Index, experience hernia recurrence significantly sooner as compared to patients from prosperous zip codes. This study may provide evidence of the role of neighborhood and environmental factors in caring for older patients following VHR.

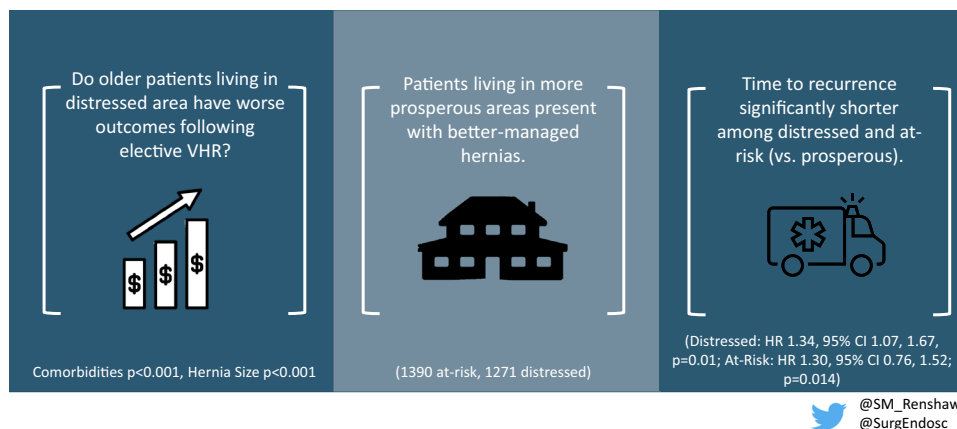
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Graphical abstract

Community Distress as a Predictor of Early Hernia Recurrence for Older Adults Undergoing Ventral Hernia Repair (VHR)



The distribution of poor surgical outcomes among the population has long been viewed as solely representative of clinical complications or preexisting medical concerns. While specific characteristics, like increased hernia size or history of infection, certainly impact the odds of developing postoperative complications, increasing evidence from other fields has found that other factors may also be important in this trajectory. Increasingly, external environmental and sociological factors, ranging from low socioeconomic status to lack of social support, are being considered as affecting the likelihood of poor outcomes in the perioperative period.

Measures of social and community stress exist to quantify environmental stressors of population health that have trickle down effects on individual patient outcomes. Lack of community resources, crime-related vulnerability [1], and economic deprivation assigned to individual regions within the USA using validated scales have been associated with increased mortality following trauma-related injury [2, 3], premature mortality [4], and increased surgical morbidity and cost [5, 6]. Moreover, measures of community distress have been independently associated with postoperative complications and readmission following surgery [6].

Notably, previous studies have evidenced that nearly one quarter of patients requiring surgery present from the most severely distressed neighborhoods in the USA [7]. Quantifying this at the national level demonstrates the magnitude of this patient population currently served by surgical services across the country. Coupled with the growing incidence of hernia repair as one of the most common general surgery procedures, understanding the epidemiology underpinning this procedure represents a crucial gap in existing literature.

Specifically, recurrence is a hernia-specific outcome which drives a vast majority of costly postoperative interventions and subsequent reoperation. Therefore, this study sought to evaluate the epidemiology and trends related to elderly patients undergoing hernia repair in a national dataset using the Distressed Communities Index (DCI) to determine the role of DCI in both presentation characteristics and postoperative outcomes, focusing on time to recurrence.

Methods

Design overview

A validated measure of community distress, the DCI was identified to quantify neighborhood characteristics for every zip code in the USA. The Abdominal Core Health Quality Collaborative (ACHQC), a national hernia-specific registry, was used to identify a cohort of geriatric patients undergoing elective ventral hernia repair. Zip codes were used to assign a distress score to each patient and postoperative outcomes were then reviewed by distress quintile. Institutional Review Board (IRB) approval was received prior to study initiation.

Study population and data source

Data for this analysis were provided by ACHQC, a national hernia-specific registry. The ACHQC is composed of surgeons from academic, private, and community health systems from over 300 sites across the USA and maintains strict standards for data entry and structure. The specific

study population included all adults aged 65 or older in the ACHQC who underwent elective ventral hernia repair (VHR) between 2013 and 2021. Patients were excluded if they did not have zip code data available or did not have ASA class assigned. Data required to calculate the DCI for each zip code were obtained from the Economic Innovation Group (EIG). Data use agreements were executed between the ACHQC and EIG before analysis.

Comparison groups

Patients were divided into distinct comparison groups based on DCI quintile, as has been performed in previous studies utilizing this dataset [8, 9]. DCI is a composite measure of seven unique economic and sociological factors available for each zip code in the USA, including rates of high school diplomas, housing vacancy, poverty, and unemployment, as well as changes in employment and business establishments and median income ratio. These individual metrics are then used to generate a weighted distress score for each zip code ranging from 0 (most prosperous) to 100 (most distressed). Final comparison groups for analysis included prosperous (0–20), comfortable (21–40), mid-tier (41–60), at-risk (61–80), and distressed (81–100).

Outcome measures

The primary outcome measure was time to composite hernia recurrence where composite recurrence is defined as recurrence evaluated by clinical or radiographic exam or a patient-reported bulge as defined by the VHRI [10]. Other variables of interest include differences in clinical characteristics (hernia size, hernia type, comorbidity burden), operative details (surgical approach, use of mesh), and postoperative outcomes (including SSI, SSO, SSOPI, readmission, and reoperation) by DCI quintile.

Data analysis

Demographic, clinical characteristics, and operative details were compared by DCI quintiles for categorical and continuous variables using Pearson and Wilcoxon rank sum tests, respectively. Time to composite recurrence was evaluated using Kaplan–Meier analysis. Multivariable regression was used to assess the association between outcomes and DCI quintile (reference: prosperous) in the presence of confounding variables. Cox proportional hazards model was used to estimate hazard ratios for composite recurrence, and logistic regression was used to estimate odds ratios for SSI, SSO, SSOPI, readmission, and reoperation. Regression models included the following covariates—sex, race, hernia width, hernia type, recurrent hernia, surgeon affiliation, BMI, ASA class, hypertension, COPD, diabetes, nicotine use

(<30 days), and DCI quintile, where age, BMI, and hernia width were modeled with restricted cubic splines with three knots to allow for potential nonlinear effects.

Results

A total of 9819 patients were included in the study, of which 3056 (31.1%) were in prosperous regions, 2307 (23.5%) were in comfortable regions, 1795 (18.2%) were in mid-tier regions, 1390 (14.2%) were in at-risk regions, and 1271 (12.9%) were in distressed regions. Patients from distressed communities were younger and comprised greater proportions of racial minorities with increased comorbidity burden (Table 1). Open repairs and mesh use were most common among at-risk and distressed communities, with robotic repairs greatest among prosperous communities (Table 2).

Patients from distressed and at-risk communities exhibited greater mean hernia size with greater rates of incisional hernia, while the prosperous group had greater rates of umbilical repair (Table 2). Overall comorbidity burden was significantly higher among at-risk (90.3%) and distressed (89.9%) groups ($p < 0.001$). Patients from distressed communities had the highest rates of open repair and among the highest rates of mesh utilization (Table 2). At the univariate level, there were evidence of significant differences between time to recurrence by DCI quintile ($p = 0.004$) (Fig. 1). Postoperative complications were significantly higher in the distressed group ($p < 0.001$), including SSO, but there was no evidence of a significant difference in terms of SSI or SSOPI (Table 3). There were no detectable differences in readmission ($p = 0.34$) or reoperation ($p = 0.23$) by DCI quintile.

Following adjusted analysis, time to recurrence was significantly shorter among distressed (HR 1.34, 95% CI 1.07, 1.67, $p = 0.01$) and at-risk (HR 1.30, 95% CI 0.76, 1.52, $p = 0.014$) communities as compared to prosperous ones (Table 4). No significant differences were detected for complication, including SSI, SSO, and SSOPI, as well as readmission or reoperation (Table 5).

Discussion

In this study, older patients from distressed communities were found to have significantly shorter time to hernia recurrence as compared to patients from prosperous communities. These same patients also presented with greater overall comorbidity burden and more frequently underwent open repairs with mesh utilization. Although this study did not detect a statistically significant difference in postoperative outcomes by neighborhood distress level, the differences exhibited between groups in terms of preoperative condition, operative characteristics, and time to recurrence provide

Table 1 Demographic and clinical characteristics by DCI quintile

	Prosperous (<i>N</i> =3056)	Comfortable (<i>N</i> =2307)	Mid-tier (<i>N</i> =1795)	At-risk (<i>N</i> =1390)	Distressed (<i>N</i> =1271)	<i>p</i> -value
Age						<0.001
Mean (SD)	71.9 (5.5)	72.0 (5.5)	71.7 (5.5)	71.3 (5.5)	71.2 (5.1)	
Sex, <i>N</i> (%)						<0.001
Male	1738 (56.9)	1233 (53.5)	923 (51.4)	661 (47.6)	608 (47.8)	
Race, <i>N</i> (%)						<0.001
Black	66 (2.2)	59 (2.6)	87 (4.9)	85 (6.1)	231 (18.3)	
Hispanic	46 (1.5)	46 (2.0)	57 (3.2)	66 (4.8)	36 (2.9)	
Other	54 (1.8)	38 (1.7)	15 (0.8)	15 (1.1)	14 (1.1)	
White	2865 (94.5)	2148 (93.8)	1621 (91.1)	1220 (88.0)	979 (77.7)	
BMI						<0.001
Mean (SD)	30.1 (5.6)	30.5 (6.0)	30.7 (5.7)	31.4 (6.1)	31.4 (6.2)	
ASA class, <i>N</i> (%)						<0.001
1	78 (2.6)	47 (2.0)	23 (1.3)	15 (1.1)	22 (1.7)	
2	1220 (39.9)	796 (34.5)	574 (32.0)	384 (27.6)	324 (25.5)	
3	1674 (54.8)	1395 (60.5)	1140 (63.5)	923 (66.4)	861 (67.7)	
4+	84 (2.8)	68 (3.0)	58 (3.2)	68 (4.9)	64 (5.0)	
Surgeon, <i>N</i> (%)						<0.001
Academic	1755 (57.4)	1446 (62.7)	1105 (61.6)	919 (66.2)	898 (70.7)	
Private	1010 (33.1)	642 (27.8)	553 (30.8)	295 (21.2)	191 (15.0)	
Private with academic affiliation	291 (9.5)	219 (9.5)	137 (7.6)	175 (12.6)	182 (14.3)	
Any comorbidity						<0.001
Yes	2563 (83.9)	1972 (85.5)	1560 (86.9)	1255 (90.3)	1143 (89.9)	
Hypertension						<0.001
Yes	1925 (63.0)	1442 (62.5)	1199 (66.8)	961 (69.1)	888 (69.9)	
Diabetes						<0.001
Yes	578 (18.9)	473 (20.5)	427 (23.8)	345 (24.8)	373 (29.4)	
COPD						<0.001
Yes	204 (6.7)	220 (9.5)	164 (9.1)	166 (11.9)	160 (12.6)	
Nicotine < 30 days						<0.001
Yes	124 (4.1)	103 (4.5)	99 (5.5)	91 (6.6)	110 (8.7)	

evidence that physical environment plays an important role in patient's health. Together, these findings provide evidence that external community factors impact the perioperative trajectory of older patients seeking elective ventral hernia repair.

Recent years have seen a growing body of research dedicated to investigating the association of socioeconomic status as it pertains to surgery. Tracy et al. described trends in operative approach that differ by neighborhood prosperity level [11], while other financial markers, like insurance type, have linked Medicaid and non-insurance to increased mortality after abdominal surgery [12]. The DCI has specifically found evidence of greater mortality among patients with breast and colon cancer [13] in areas of increased distress and most recently in mortality rates following COVID-19 [14]. However, no study to date has solely focused on the

interaction of increased age on increased community distress in the older adult population.

Understanding this relationship is especially important in this population because advanced age may exacerbate existing differences related to neighborhood environment and systematically disadvantage older patients living in more distressed areas. Older patients in particular may face issues related to mobility or independence. Importantly, previous studies have even linked availability of public transportation and community resources to increased cognition among adults aged 65 or older [15]. Another study found worse cognitive function among older adults living in depopulating areas or with decreasing community support, further highlighting the role of built environments in physically shaping patients' health [16]. Old age also comes with increased concern regarding availability of relational support and feelings

Table 2 Operative and hernia details

	Prosperous (<i>N</i> =3056)	Comfortable (<i>N</i> =2307)	Mid-tier (<i>N</i> =1795)	At-risk (<i>N</i> =1390)	Distressed (<i>N</i> =1271)	<i>p</i> -value
Hernia width						<0.001
Mean (SD)	6.4 (5.8)	6.9 (6.1)	7.6 (6.2)	7.9 (6.6)	7.5 (5.9)	
Hernia length						<0.001
Mean (SD)	8.9 (8.0)	9.8 (8.4)	10.6 (8.6)	11.0 (8.8)	10.7 (8.5)	
Hernia type ^a						
Diastasis	15 (0.5)	8 (0.4)	8 (0.5)	9 (0.7)	9 (0.7)	0.467
Epigastric	144 (4.7)	112 (4.9)	59 (4.2)	50 (3.9)	50 (3.9)	0.097
Incisional	2093 (68.5)	1686 (73.1)	1088 (78.3)	974 (76.6)	974 (76.6)	<0.001
Lumbar	7 (0.2)	15 (0.7)	4 (0.3)	4 (0.3)	3 (0.3)	0.112
Parastomal	207 (6.8)	177 (7.7)	97 (7.0)	109 (8.6)	109 (8.6)	0.074
Spigelian	70 (2.3)	32 (1.4)	29 (2.1)	17 (1.3)	17 (1.3)	0.082
Umbilical	706 (23.1)	442 (19.2)	197 (14.2)	195 (15.3)	195 (15.3)	<0.001
Approach						0.009
Laparoscopic	365 (12.0)	279 (12.1)	186 (10.4)	150 (10.8)	127 (10.0)	
Lap assisted	38 (1.2)	31 (1.3)	24 (1.3)	14 (1.0)	22 (1.7)	
MIS to open	43 (1.4)	41 (1.8)	19 (1.1)	19 (1.4)	17 (1.3)	
Open	1880 (61.5)	1456 (63.1)	1127 (62.8)	855 (61.5)	835 (65.7)	
Robotic	665 (21.8)	439 (19.0)	411 (22.9)	312 (22.5)	252 (19.8)	
Robotic assisted	64 (2.1)	61 (2.6)	28 (1.6)	40 (2.9)	18 (1.4)	
Mesh used						<0.001
Yes	2653 (86.8)	2034 (88.2)	1597 (89.0)	1280 (92.1)	1132 (89.1)	

^aCheck all that apply variable

of connectedness, both of which been linked to decreased levels of depression and loneliness among the oldest demographic of adults [17].

In each of these facets, older adults exhibit signs of increasing susceptibility to their environment and require additional forms of support. Placing these universal concerns related to aging in the context of deteriorating communities, as evidenced by the DCI provides important insight into the health of this demographic. Older adults living in communities with limited resources may make it so they have decreased access to transportation, support, or engagement that all combine to a cumulative quality of life—the absence of which can have negative health impacts. The notion that patients are a product of their environment is further emphasized when it comes to vulnerable older adults who are especially sensitive to changes in their environment.

Evidence of this trend was highlighted in our data, where older adults living in the most distressed regions presented with greater overall comorbidity burden and increased hernia size. Most notable was the shorter time to recurrence exhibited by patients living in increasingly distressed regions. This finding helps to illustrate the idea that built environment and repeated daily exposure to different indicators of neighborhood stress may physically, over time, affect a patient's health outcome. Environment may play a role in the outcome of VHR through mechanisms that exist at the

community level and ultimately impact individual patient outcomes, such as availability of quality healthcare services and education after surgery or access to safe and walkable areas to encourage healing and exercise. While it is clear that differences exist at this level between residents of prosperous and distressed communities, these are just a few examples of resources at the community level which may impact the post-operative course and specific mechanisms by which these occur may vary by region and warrant further investigation with more robust, localized data. Patients in distressed communities may also experience worse outcomes as a result of delayed postoperative care if their distressed neighborhood lacks an urgent care or emergency department, requiring a long and potentially costly drive to access care further from home. This may cause patients to delay accessing care, subsequently presenting with worsened status or more advanced complication. In this example, living in a distressed community may have contributed to factors ultimately causing a difference in postoperative course, especially compared to patients living in more prosperous areas where the same care may have been readily available and accessible.

Despite the important contributions of this work to the overall conversation regarding elective operative intervention in older adults, there are limitations that should be considered in the interpretation of this study. First, the study population was obtained from a dataset for patients

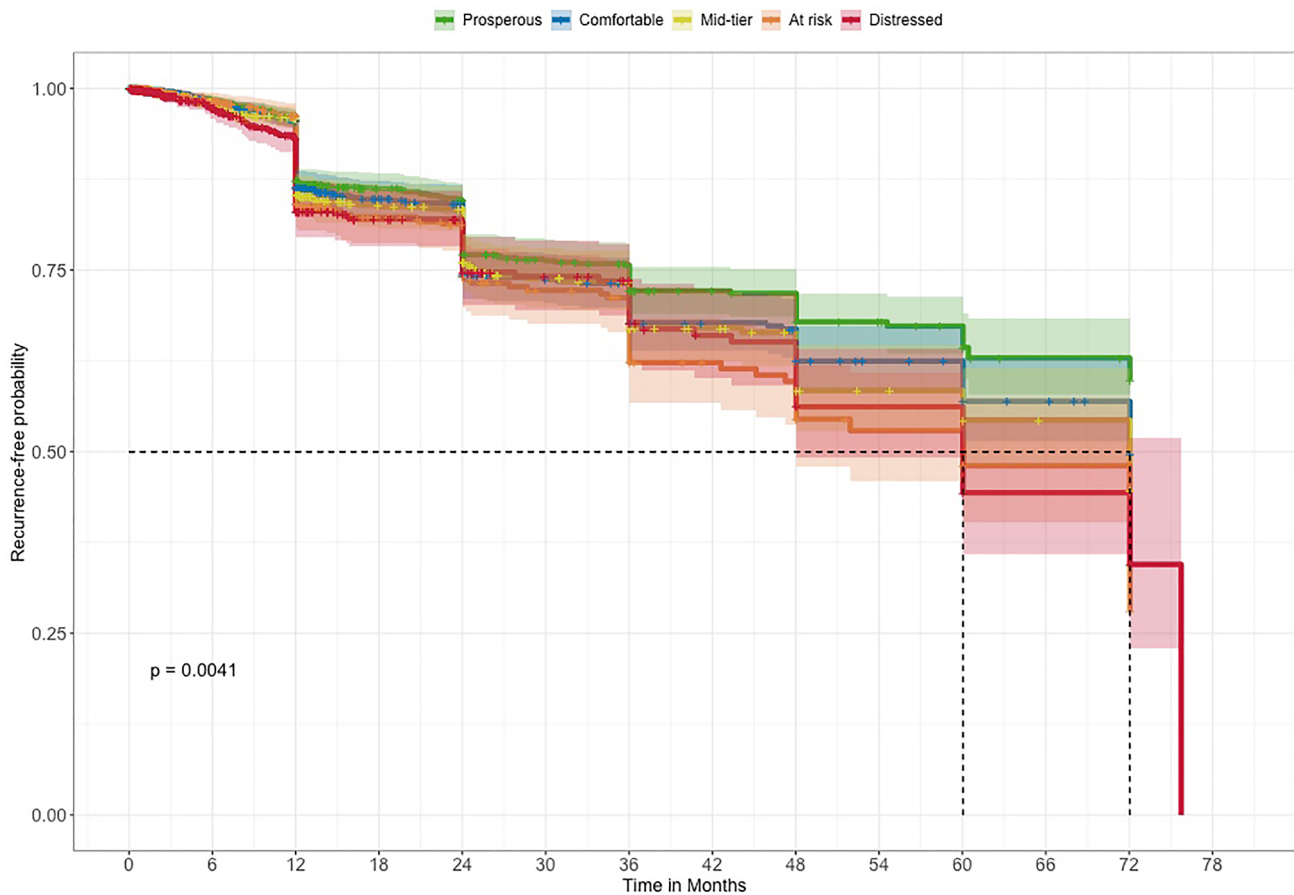


Fig. 1 Kaplan–Meier curve for recurrence (time to event) by DCI Quintile recurrence-free probability significantly decreased for patients in distressed quintile as compared to prosperous ($p=0.0041$)

Table 3 Postoperative 30-day complications

	Prosperous ($N=3056$)	Comfortable ($N=2307$)	Mid-Tier ($N=1795$)	At-Risk ($N=1390$)	Distressed ($N=1271$)	p -value
Complication						<0.001
Yes	419 (16.8)	308 (16.2)	273 (18.5)	236 (20.5)	224 (22.1)	
SSI						0.210
Yes	74 (3.0)	53 (2.8)	46 (3.1)	49 (4.3)	35 (3.5)	
SSO						0.001
Yes	214 (8.6)	141 (7.4)	126 (8.5)	116 (10.1)	122 (12.0)	
SSOPI						0.230
Yes	104 (4.2)	75 (4.0)	61 (4.1)	58 (5.0)	56 (5.5)	
Reoperation						0.228
Yes	40 (1.6)	35 (1.8)	22 (1.5)	22 (1.9)	27 (2.7)	
Readmission						0.340
Yes	99 (4.0)	91 (4.8)	64 (4.3)	60 (5.2)	53 (5.2)	

undergoing hernia repair at participating institutions relating to a national quality improvement initiative and therefore may not be reflective of all hernia patients across the

country. However, the ACHQC maintains strict data reporting standards and includes a variety of sources (i.e., community hospitals, private practice) and therefore does introduce

Table 4 Adjusted analysis—recurrence

	Hazard ratio (HR)	95% Confidence interval	<i>p</i> -value
Recurrence			
Prosperous	Ref.	–	–
Comfortable	1.13	0.94, 1.35	0.187
Mid-Tier	1.16	0.95, 1.41	0.145
At-Risk	1.30	1.06, 1.60	0.014
Distressed	1.34	1.07, 1.67	0.010

Ref. reference group for analysis

some level of heterogeneity. Secondly, DCI was the only scale used in this study but there are others that do exist to measure similar metrics. DCI was selected because of its composite nature in addressing several layers of neighborhood vulnerability (i.e., education, housing, income inequality), but we acknowledge that it is not able to account for other markers that are critical to consider when assessing the strength of neighborhoods, such as levels of crime, experience of racism or microaggressions, quality, and availability of education. Despite these shortcomings, we posit that DCI provides a quantifiable way by which to view common underpinnings of neighborhood stress, which helps to shine a light on areas of potential focus for community-level interventions. It is the hope of the authors that this paper may provide preliminary context for thoughtful design of program or education specifically geared toward older adults and may help to inform the improved care of this vulnerable population which is rapidly increasing in size in the USA.

Conclusion

Older adults living in distressed regions, as evidenced by lower median household income, lower high school education rate, and other important markers of economic opportunity and community cohesion, exhibit lower time to hernia recurrence as compared to similarly aged adults living in more prosperous neighborhoods. Physical environment plays an important role in individual health and may be especially salient among older populations who are increasingly vulnerable to changes to the external environment.

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Declarations

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Table 5 Adjusted analysis—postoperative outcomes

	Odds ratio (OR)	95% Confidence interval	<i>p</i> -value
30-day any complication			
Prosperous	Ref.	–	–
Comfortable	0.84	0.71, 0.99	0.044
Mid-tier	0.91	0.76, 1.08	0.277
At-risk	0.99	0.82, 1.20	0.949
Distressed	1.13	0.93, 1.37	0.223
30-day SSI			
Prosperous	Ref.	–	–
Comfortable	0.79	0.54, 1.14	0.204
Mid-tier	0.82	0.55, 1.19	0.302
At-risk	1.07	0.73, 1.56	0.720
Distressed	0.92	0.60, 1.40	0.709
30-day SSO			
Prosperous	Ref.	–	–
Comfortable	0.78	0.62, 0.97	0.029
Mid-tier	0.83	0.66, 1.05	0.132
At-risk	0.98	0.77, 1.25	0.864
Distressed	1.21	0.94, 1.55	0.129
30-day SSOPI			
Prosperous	Ref.	–	–
Comfortable	0.80	0.58, 1.09	0.152
Mid-tier	0.78	0.56, 1.08	0.142
At-risk	0.90	0.64, 1.26	0.535
Distressed	1.05	0.74, 1.49	0.771
30-day reoperation			
Prosperous	Ref.	–	–
Comfortable	0.99	0.62, 1.58	0.970
Mid-tier	0.74	0.43, 1.25	0.270
At-risk	0.90	0.52, 1.53	0.708
Distressed	1.23	0.72, 2.06	0.436
30-day readmission			
Prosperous	Ref.	–	–
Comfortable	1.09	0.81, 1.47	0.562
Mid-tier	0.91	0.66, 1.26	0.580
At-risk	1.09	0.78, 1.52	0.615
Distressed	1.11	0.77, 1.58	0.561

Ref. reference group for analysis

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