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Prognostic impact of deprivation on esophagogastroduodenoscopy outcome

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Keywords
Endoscopy Upper GI Tract, Diagnosis and imaging (inc chromoendoscopy, NBI, iSCAN, FICE, CLE), GI Pathology, Epidemiology

received 12.10.2023
accepted after revision 22.3.2024
accepted manuscript online 2.4.2024

Bibliography
Endosc Int Open 2024; 12: E818–E829
DOI 10.1055/a-2297-9905
ISSN 2364-3722

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

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ABSTRACT

Background and study aims Socioeconomic deprivation has long been associated with many gastrointestinal diseases, yet its influence on esophagogastroduodenoscopy (EGD) diagnosis has not been evaluated. The aim of this study was to investigate the influence of deprivation on outcomes of EGD irrespective of referral reason.

Patients and methods Two thousand consecutive patients presenting to four Health Boards in Wales beginning in June 2019 were studied retrospectively with deprivation scores calculated using the Wales Indices of Multiple Deprivation (WIMD). Patients were subclassified into quintiles for analysis (Q1 most, Q5 least deprived).

Results Inhabitants of the most deprived areas were more likely to be diagnosed with peptic ulcer (Q1 7.9%, Q5 4.7%; odds ratio [OR] 0.498, $P=0.018$), severe esophagitis (LA4, Q1 2.7% v Q5 0%, OR 0.089, P 0.002), *Helicobacter pylori* infection (Q1 5.4%, Q5 1.7%; OR 0.284, $P=0.002$), but less likely to be diagnosed with Barrett's esophagus (Q1 6.3% v Q5 12.3%, OR 2.146, $P=0.004$) than those from the least deprived areas. New cancer diagnoses numbered 53 and were proportionately higher after presentation for urgent suspected cancer (USC, n = 35, 4.6%) than for routine referrals (n = 3, 0.6%, $P< 0.001$). Deprivation was associated with more advanced stage cancer (stage III Q1 16.7% v Q5 5.6%, OR 0.997, $P=0.006$: stage IV Q1 16.7% v Q2 38.9% v Q5 22.2%, OR 0.998, $P=0.049$).

Conclusions Deprivation was associated with two-fold more peptic ulcer disease, three-fold more *H. pylori* infection, and 12-fold more severe esophagitis, and more advanced cancer stage.

Introduction

Socioeconomic deprivation can have a significant impact on the outcomes of medical investigations, with individuals from poorer environments experiencing worse outcomes compared with those from more affluent environments. The reasons for this are complex and multifactorial, but arguably include poor access to healthcare services, lower levels of health literacy, and higher rates of comorbidity. The Welsh Index of Multiple Deprivation (WIMD) is an area-based measure of relative deprivation comprising measures of income, employment, health, education, access to service, housing, community, and physical environment across areas of Wales [1].

Several studies have investigated the prognostic significance of deprivation on medical test outcomes. McCutchan et al in 2015 reported that symptom ignorance, fearful cancer beliefs, and emotional barriers combine, prolonging diagnostic delay among lower socioeconomic groups [2]. Pornet et al reported that deprivation was associated with lower rates of compliance with colorectal cancer screening, which could contribute to more advanced disease at diagnosis and poorer outcome [3]. Overall, these studies suggest that targeted interventions in areas of deprivation are required, including strategies such as increasing access to healthcare, improving health literacy, and addressing broader cultural fundamentals such as poverty, education, and government policies.

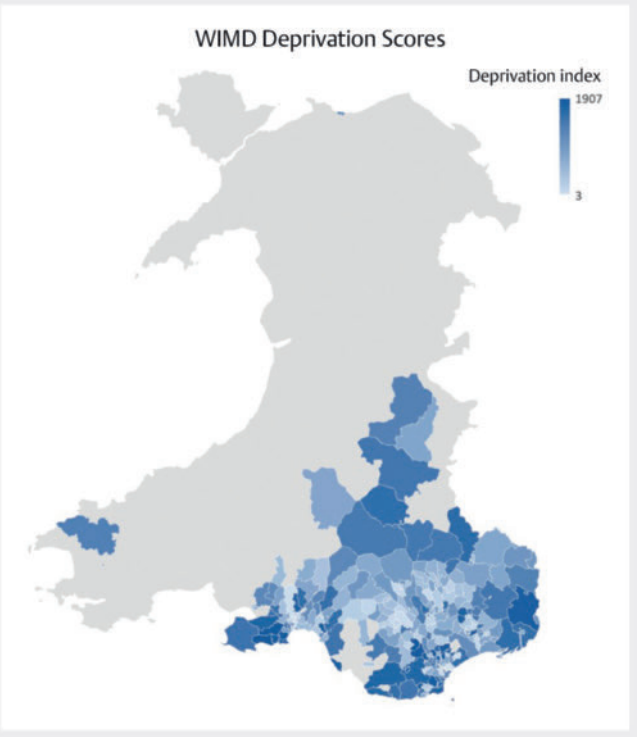
Rapid diagnosis and straight-to-test strategies are considered key to earlier diagnosis, with esophagogastroduodenoscopy (EGD) the gold standard investigation for suspected esophagogastric (EG) cancer. Moreover, understanding the geographical and socioeconomic variation in disease prevalence is especially important for screening programs, to inform service provision and reconfiguration related to EG cancer multidisciplinary team-related treatment. The aim of this study was to investigate the influence of deprivation on outcomes of EGD irrespective of referral reason. The hypothesis was that deprivation would be associated with more EGD pathological findings and poorer prognosis.

Patients and methods

Two thousand consecutive patients presenting to four University Health Boards (UHB) serving a population of 1.6 million from the Wales clinical catchment area were studied retrospectively. Consecutive 500 cases from each UHB were reviewed between June 2019 and October 2019 and deprivation scores were calculated using the WIMD. Patients were analyzed by scale and subclassified into quintiles for ease of interpretation (Q1 most, Q5 least deprived).

Data collected included: age, health board, postcode, WIMD, indication for EGD, EGD findings, therapy received during procedure, and histology. All findings were recorded, and subgroups created for analysis.

Findings were grouped into objective definitive diagnoses. Where appropriate, recognized classification systems such as Prague classification, Los Angeles (LA) classification, and Forrest classification, along with positive serological or histological results were utilized for analysis. Esophageal, gastric, and duodenal ulcers were grouped to define "peptic ulcer" and analyzed further regarding anatomical location [4].



▶ **Fig. 1** Graphical representation of deprivation score per area included in this study across Wales. (Source: Bing, GeoNames, Microsoft, TomTom [CC BY 4.0] https://creativecommons.org/licenses/by/4.0/)

Statistical analysis

The WIMD is the Welsh Government's official measure of relative deprivation for small areas in Wales, retrieved according to postcode (▶ **Fig. 1**), and a continuous scale from 1 to 1909, with 1 being most deprived and 1909 least deprived. The score was recorded on a continuous scale, but for the purpose of statistical analysis and measure of effect, this was transformed into a scale from 0 to 1. Analysis was performed using this continuous scale, although quintiles were presented to allow for ease of comparison between least and most deprived geographical areas.

Dichotomous variables were analyzed using binary logistic regression versus deprivation score, and age. Variables with more than two categorical variables were analyzed using multinomial logistic regression in SPSS version 27 (SPSS, IBM Corp, Armonk, NK, Chicago, Illinois, United States). For patients diagnosed with cancer, overall survival (OS) by deprivation, and stage was calculated using Cox regression and is presented with the aid of hazard ratios (HRs). Age was analyzed as a continuous variable, presented as four groups organized by interquartile range to aid comparison.

Results

The distribution of population studied related to quintile can be found in ▶ **Table 1**.

Of the 2,000 EGDs, 408 (20.4%) were reported as normal, with a further 13 (0.65%) reported as normal to the extent examined, meaning the procedure was limited by patient intolerance or the examination was completed to the extent needed. Mild gastritis was a subjective finding with no specific diagnostic criteria; therefore, patients reported to have mild gastritis only were considered normal for the purposes of the analysis.

Inhabitants of the most deprived areas were more likely to be diagnosed with peptic ulcer disease (Q1 7.9% vs. Q5 4.7%, odds ratio [OR] 0.498, $P=0.018$), namely esophageal ulcers (Q1 3.2% vs. Q5 1.2%, OR 0.276, $P=0.013$). Ulcer severity, determined by the need for intervention, did not differ (Q1 0.9% vs. Q5 1.2%, OR 1.107, $P=0.873$). Severe esophagitis (LA classification 4) was 12.5-fold more likely (LA4, Q1 2.7% vs. Q5 0%, OR 0.079, $P=0.001$) and *Helicobacter pylori* infection 3.5-fold more likely (Q1 5.4% vs. Q5 1.7%, OR 0.277, $P=0.002$) in the most deprived geographical areas. Conversely, those living in these areas were half as likely to be diagnosed with Barrett's esophagus (BE) (Q1 5.7% vs. Q5 12.4%, OR 2.202, $P=0.003$, ▶ **Table 2**, ▶ **Fig. 2**). The odds of finding an abnormality at EGD increased with increasing age (Quartile 1 (≤51 years) 356 vs. Quartile 4 (>74 years) 405, OR 1.028, $P<0.001$, ▶ **Table 2**) specifically: BE (Q1 17 vs. Q4 45, OR 1.025, $P<0.001$), peptic ulcer (Q1 20 vs. Q4 44, OR 1.025 $P<0.001$) and cancer (Q1 4 vs. Q4 24, OR 1.047 $P<0.001$). The association between peptic ulcer and increasing age was sustained for esophageal (Q1 6 vs. Q4 15, OR 1.026, $P=0.010$) and duodenal ulceration (Q1 5 vs. Q4 16. OR 1.029, $P=0.007$), along with ulcer severity (Q1 1 vs. Q4 12, OR 1.062, $P<0.001$, ▶ **Table 2**).

New cancer diagnoses numbered 53 and were proportionately higher after Urgent Suspected Cancer referral (n = 35, 4.6%), with three new cancers diagnosed on routine EGD (0.6%, $P<0.001$), while 63 patients (3.2%) had a current or earlier cancer diagnosis. Overall, there was no association between cancer incidence and deprivation (Q1 2.3% vs. Q5 4.2%, OR 1.145, $P=0.743$), but deprivation was associated with having more advanced cancer at diagnosis: Stage III (Q1 16.7% v Q5 5.6%, OR 0.99, $P=0.006$), and Stage IV cancer (Q1 16.7% v Q2 38.9% v Q5 22.2%, OR 0.998, $P=0.049$, ▶ **Table 3**, ▶ **Fig. 3**).

Adenocarcinoma (AC) (Q1 3 vs Q4 15, OR 1.044, $P<0.001$), and specifically gastric and junctional AC diagnoses, increased with age (Q1 0 vs Q4 7, OR 1.095, $P=0.003$ and Q1 1 vs Q4 5, OR 1.082, $P=0.011$ respectively) along with esophageal squamous cell carcinoma (SCC) (Q1 0 vs Q4 4, OR 1.045, $P=0.049$). There was no observed association of age with esophageal AC (Q1 2 vs Q4 5, OR 1.022, $P=0.152$) (▶ **Table 2**, ▶ **Fig. 2**). Patients receiving palliative care, radical curative treatment, or under active surveillance were younger than those receiving best supportive care (OR 0.915, $P=0.032$, OR 0.903, $P=0.007$, OR 0.673, $P=0.061$, respectively). However, there was no association between treatment intent and deprivation (palliative OR 1.001, $P=0.161$; radical treatment OR 1.001, $P=0.240$; active surveillance OR 1.002, $P=0.367$).

▶ **Table 1** Distribution of patients per WIMD quintile (Q1 – most deprived, Q5 – least deprived)

Quintile	Frequency (n)	Percentage (%)	Median age (IQR)
1	558	27.9	62 (48–73)
2	478	23.9	62 (51–73)
3	302	15.1	61 (47–73)
4	258	12.9	62.5 (52–73.25)
5	404	20.2	68 (54–75)
Total	2000		

Mild esophagitis (LA1) was associated with younger age (Q1 40 vs. Q4 20, OR 0.986, $P=0.011$) (▶ **Table 2**), with men twice as likely to have esophagitis (LA2) (OR 1.935, $P=0.012$) as women. A male predominance also existed for BE, varices, and AC; specifically esophageal AC (OR 1.685 $P=0.002$, OR 2.446 $P=0.011$, OR 2.686 $P=0.044$, respectively, ▶ **Table 2**, ▶ **Fig. 2**).

For patients diagnosed with cancer, median survival was 17.75 months (IQR 4.40– 44.98). Three-year median survival was 33.3% (n = 20). Median OS (n = 17, 27.0%) was not associated with age or deprivation, but patients with more advanced cancer were up to 13-fold more likely to die than patients with earlier disease (Stage I 54.5% vs. Stage IV 5.9% survival: Stage IV HR 13.228, $P<0.001$, ▶ **Table 4**). Cancer-specific OS was not associated with deprivation (▶ **Fig. 4**). All-cause mortality was 17.3% and associated with older age, male sex, and deprivation (HR 0.425, $P<0.001$, ▶ **Table 5**).

Discussion

Deprivation, whether it be related to poverty, social exclusion, or other factors, can affect an individual's access to healthcare services, including diagnostic tools like endoscopy. Moreover, endoscopy's diagnostic effectiveness may be influenced by factors including delayed diagnosis, limited access to specialist services, and poor availability of resources - the Inverse Care Law [6]. This is the first study to investigate the relationship between deprivation and EGD-defined diagnoses in a large cohort of 2,000 consecutive patients, encompassing the four biggest Health Boards in South Wales. The principal findings were that deprivation was associated with two-fold more peptic ulcer disease, three-fold more *Helicobacter pylori* infection (although with an overall low prevalence of 4.1%), 12-fold more severe esophagitis, which correlated with three-fold more advanced cancer, with the probability of diagnosing gastrointestinal pathology directly and significantly proportional to age. In contrast, BE was half as likely in geographically deprived areas. No association was found between a diagnosis of upper gastrointestinal malignancy and deprivation, although deprivation was associated with more advanced radiological cancer stage at diagnosis, and as would be expected, these patients suffered greater mortality. Moreover, overall all-cause mortality was strongly associated with living in geographically deprived areas.

▶ **Table 2** Multivariable analyses of factors associated with diagnostic EGD findings.

Dependent variable	n (%)	Independent variable		*P* value	OR
Barrett's esophagus	157 (7.9)	**Age**		**<0.001**	**1.025 (1.013–1.036)**
		Gender		**0.002**	**1.685 (1.207–2.352)**
		WIMD Deprivation		**0.003**	**2.202 (1.300–3.731)**
		Q1 32/558	5.7%		
		Q5 50/404	12.4%		
Ulcer	139 (7.0)	**Age**		**<0.001**	**1.025 (1.013–1.037)**
		Gender		0.194	1.259 (0.889–1.783)
		WIMD Deprivation		**0.018**	**0.498 (0.279–0.889)**
		Q1 44/558	7.9%		
		Q5 19/404	4.7%		
Helicobacter pylori	81 (4.1)	Age		0.054	0.987 (0.975–1.000)
		Gender		0.158	1.381 (0.882–2.163)
		WIMD Deprivation		**0.002**	**0.277 (0.123–0.621)**
		Q1 30/558	5.4%		
		Q5 7/404	1.7%		
Varices	65 (3.3)	Age		0.819	1.002 (0.987–1.017)
		Gender		**0.025**	**1.781 (1.075–2.953)**
		WIMD Deprivation		0.272	0.568 (0.245–1.317)
		Q1 20/558	3.6%		
		Q5 14/404	3.5%		
Malignancy or cancer resection	63 (3.2)	**Age**		**< 0.001**	**1.047 (1.027–1.068)**
		Gender		0.205	1.389 (0.835–2.311)
		WIMD Deprivation		0.743	1.145 (0.510–2.571)
		Q1 13/558	2.3%		
		Q5 17/404	4.2%		
Adenocarcinoma	38 (1.9)	**Age**		**<0.001**	**1.044 (1.019–1.071)**
		Gender		**0.011**	**2.446 (1.223–4.891)**
		WIMD Deprivation		0.161	2.329 (0.714–7.595)
		Q1 4/557	0.7%		
		Q5 11/404	2.7%		
Squamous cell carcinoma	11 (0.6)	Age		0.073	1.040 (0.996–1.086)
		Gender		0.186	0.407 (0.107–1.543)
		WIMD Deprivation		0.808	0.788 (0.115–5.391)
		Q1 3/557	0.5%		
		Q5 2/404	0.5%		

▶ **Table 2** (Continuation)

Dependent variable	n (%)	Independent variable		*P* value	OR
Esophagitis severity					
▪ **No esophagitis**	1740 (87.0)				
▪ **Esophagitis LA Classification 1**	112 (5.6)	**Age**		**0.009**	**0.985 (0.975–0.996)**
		Gender		0.210	1.279 (0.871–1.877)
		WIMD Deprivation		0.203	0.659 (0.347–1.253)
		Q1 36/558	6.5%		
		Q5 16/404	4.0%		
▪ **Esophagitis LA Classification 2**	63 (3.2)	Age		0.076	0.987 (0.972–1.001)
		Gender		**0.012**	**1.935 (1.156–3.239)**
		WIMD Deprivation		0.730	1.156 (0.508–2.628)
		Q1 12/558	2.2%		
		Q5 13/404	3.2%		
▪ **Esophagitis LA Classification 3**	55 (2.8)	Age		0.124	1.014 (0.996–1.031)
		Gender		0.182	1.444 (0.841–2.479)
		WIMD Deprivation		0.769	0.877 (0.366–2.105)
		Q1 15/558	2.7%		
		Q5 10/404	2.5%		
▪ **Esophagitis LA Classification 4**	30 (1.5)	Age		0.304	1.012 (0.989–1.035)
		Gender		0.057	2.075 (0.977–4.406)
		WIMD Deprivation		**0.001**	**0.079 (0.017–0.364)**
		Q1 16/558	2.7%		
		Q5 0/404	0%		
Ulcer type					
▪ **No ulcer**	1860 (93.0)				
▪ **Esophageal**	48 (2.4)	**Age**		**0.010**	**1.026 (1.006–1.046)**
		Gender		0.071	1.718 (0.954–3.094)
		WIMD Deprivation		**0.013**	**0.276 (0.099–0.765)**
		Q1 19/558	3.4%		
		Q5 5/404	1.2%		
▪ **Gastric**	59 (3.0)	**Age**		**0.046**	**1.017 (1.000–1.034)**
		Gender		0.328	0.768 (0.452–1.303)
		WIMD Deprivation		0.089	0.467 (0.194–1.123)
		Q1 20/558	3.6%		
		Q5 7/404	1.7%		
▪ **Duodenal**	45 (2.3)	**Age**		**0.007**	**1.029 (1.008–1.050)**
		Gender		0.085	1.701 (0.929–3.115)
		WIMD Deprivation		0.716	1.194 (0.461–3.091)
		Q1 9/558	1.6%		
		Q5 9/404	2.2%		

▶ **Table 2** (Continuation)

Dependent variable	n (%)	Independent variable		*P* value	OR
Ulcer severity					
▪ **No ulcer**	1860 (93.1)				
▪ **Ulcer not requiring therapeutic intervention***	114 (5.7)	**Age**		**0.003**	**1.019 (1.006–1.031)**
		Gender		0.470	1.151 (0.787–1.683)
		WIMD Deprivation		**0.008**	**0.417 (0.218–0.797)**
		Q1 40/558	7.2%		
		Q5 14/404	3.5%		
▪ **Ulcer requiring therapeutic intervention****	26 (1.3)	**Age**		**<0.001**	**1.062 (1.028–1.097)**
		Gender		0.075	2.098 (0.927–4.751)
		WIMD Deprivation		0.873	1.107 (0.319–3.839)
		Q1 5/558	0.9%		
		Q5 5/404	1.2 %		
Cancer type					
▪ **No cancer**	1937 (96.9)				
▪ **Esophageal adenocarcinoma**	20 (1.0)	Age		0.152	1.022 (0.992–1.053)
		Gender		**0.044**	**2.686 (1.026–7.030)**
		WIMD Deprivation		0.404	1.827 (0.444–7.509)
		Q1 1/557	0.2%		
		Q5 6/404	1.5%		
▪ **Esophageal squamous cell carcinoma**	11 (0.6)	**Age**		**0.049**	**1.045 (1.000–1.093)**
		Gender		0.189	0.409 (0.108–1.553)
		WIMD Deprivation		0.415	0.435 (0.059–3.219)
		Q1 4/557	0.7%		
		Q5 2/404	0.5%		
▪ **Gastric adenocarcinoma**	11 (0.6)	**Age**		**0.003**	**1.095 (1.032–1.161)**
		Gender		0.271	2.007 (0.580–6.944)
		WIMD Deprivation		0.086	5.726 (0.781–41.990)
		Q1 1/557	0.2%		
		Q5 5/404	1.2%		
▪ **Junctional adenocarcinoma**	9 (0.5)	**Age**		**0.011**	**1.082 (1.018–1.150)**
		Gender		0.287	2.133 (0.529–8.600)
		WIMD Deprivation		0.669	0.725 (0.072–5.411)
		Q1 2/557	0.4%		
		Q5 2/404	0.5%		
▪ **GIST**	4 (0.2)	Age		0.567	1.019 (0.955–1.088)
		Gender		0.416	0.390 (0.040–3.769)
		WIMD Deprivation		0.341	4.850 (0.189–124.682)
		Q1 1/557	0.2%		
		Q5 2/404	0.5%		

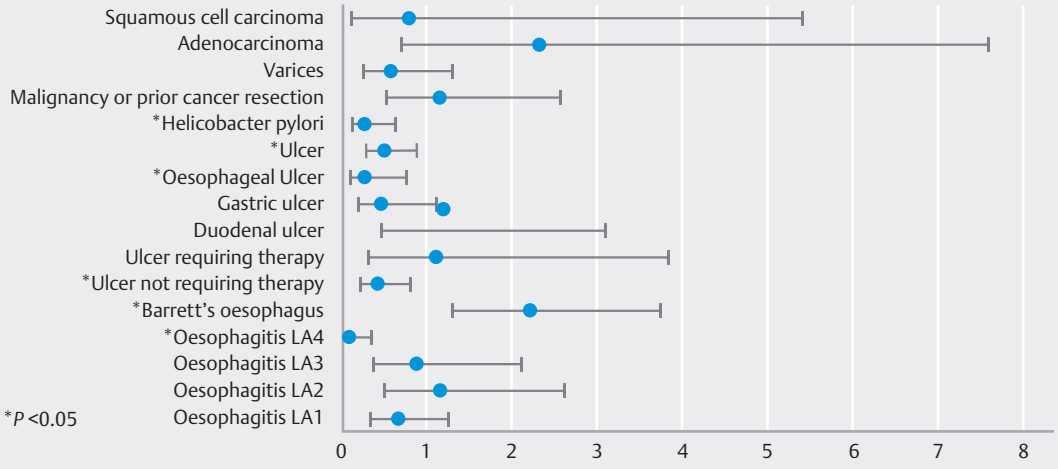
▶ **Table 2** (Continuation)

Dependent variable	n (%)	Independent variable		*P* value	OR
▪ **Duodenal adenocarcinoma**	1 (0.1)	Age		0.718	1.026 (0.893–1.179)
		Gender			
		WIMD Deprivation		0.783	2.418 (0.004–1302.684)
		Q1 0/557	0%		
		Q5 0/404	0%		
▪ **Gastric MALToma**	3 (0.2)	Age		0.450	1.031 (0.952–1.117)
		Gender		0.511	2.241 (0.202–24.842)
		WIMD Deprivation		0.833	0.668 (0.016–28.237)
		Q1 0/557	0%		
		Q5 0/404	0%		
▪ **Metastatic cancer**	3 (0.2)	Age		0.188	1.065 (0.969–1.171)
		Gender		0.577	0.502 (0.045–5.655)
		WIMD Deprivation		0.134	0.001 (0.000–9.613)
		Q1 3/557	0.5%		
		Q5 0/404	0%		
Cancer resection					
▪ **No resection**	1980 (90.0)				
▪ **Esophagectomy**	13 (0.9)	Age		0.218	1.028 (0.986–1.062)
		Gender		0.301	1.808 (0.588–5.557)
		WIMD Deprivation		0.731	0.730 (0.121–4.384)
		Q1 3/557	0.5%		
		Q5 3/404	0.7%		
▪ **Gastrectomy**	6 (0.3)	Age		0.082	1.062 (0.992–1.136)
		Gender		0.365	2.196 (0.400–12.055)
		WIMD Deprivation		0.799	1.394 (0.109–17.866)
		Q1 1/557	0.2%		
		Q5 0/404	0%		
▪ **Pylorus-preserving pancreaticoduodenectomy**	1 (0.1)	Age		0.730	1.025 (0.892–1.176)
		Gender			
		WIMD Deprivation		0.788	2.370 (0.004–1268.418)
		Q1 0/557	0%		
		Q5 0/404	0%		
EGD finding					
▪ **Normal**	408 (20.4)				
▪ **Abnormality identified**	1579 (79.0)	**Age**		**<0.001**	**1.028 (1.021–1.034)**
		Gender		**0.001**	**1.458 (1.162–1.830)**
		WIMD Deprivation		0.169	0.775 (0.539–1.115)
		Q1 442/558	79.2%		
		Q5 322/404	79.7%		

▶ **Table 2** (Continuation)

Dependent variable	n (%)	Independent variable		*P* value	OR
▪ **Normal to extent reached (abandoned/incomplete)**	13 (0.7)	Age		1.708	1.006 (0.974–1.039)
		Gender		0.098	2.611 (0.838–8.135)
		WIMD Deprivation		0.893	1.132 (0.188–6.817)
		Q1 2/557	0.4%		
		Q5 2/404	0.5%		

*Peptic ulcers "not requiring therapy" did not need endoscopic intervention. These include ulcers with a clean base or undisturbed adherent clot (Forest IIb-c/III) [5].
†Peptic ulcers requiring therapy, describe active hemorrhage or recent stigmata (Forrest I/IIa). Therapy included adrenaline injection, clipping, heater probe coagulation [5].
EGD, esophagogastroduodenoscopy; OR, odds ratio; WIMD, Welsh Index of Multiple Deprivation; GIST, gastrointestinal stromal tumor.

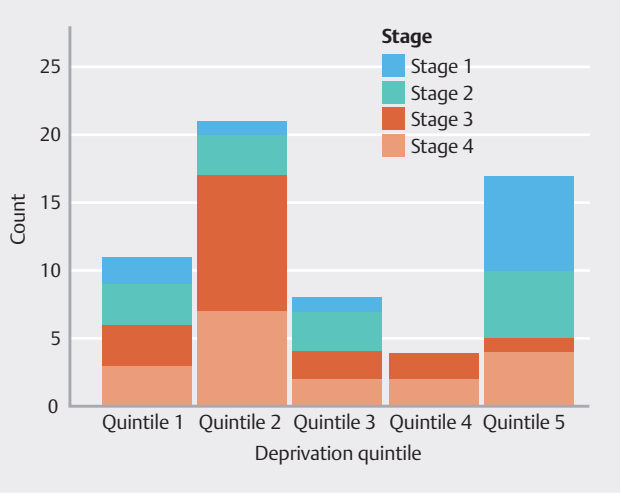


▶ **Fig. 2** Forest plot of odds ratios (ORs) and 95% confidence intervals for regression models with diagnosis and WIMD score adjusted for age and gender.

▶ **Table 3** Multivariable analyses of factors associated with cancer stage at diagnosis of patients with upper gastrointestinal malignancy.

Dependent variable	n (%)	Independent variable	*P* value	OR (95% CI)
Cancer stage				
Stage I	11 (18)			
Stage II	14 (23)	Age	0.275	1.048 (0.963–1.141)
		Gender	0.819	0.824 (0.158–4.302)
		WIMD Deprivation	0.150	0.999 (0.997–1.000)
Stage III	18 (29.5)	Age	0.056	1.089 (0.998–1.187)
		Gender	0.696	1.400 (0.258–7.601)
		WIMD Deprivation	**0.006**	**0.997 (0.996–0.999)**
Stage IV	18 (29.5)	Age	0.147	1.064 (0.978–1.156)
		Gender	0.731	1.329 (0.262–6.725)
		WIMD Deprivation	**0.049**	**0.998 (0.997–1.000)**

OR, odds ratio; CI, confidence interval; WIMD, Welsh Index of Multiple Deprivation.



▶ **Fig. 3** Cancer stage profile at diagnosis related to deprivation quintile: Q1 – most deprived, Q5 – least deprived.

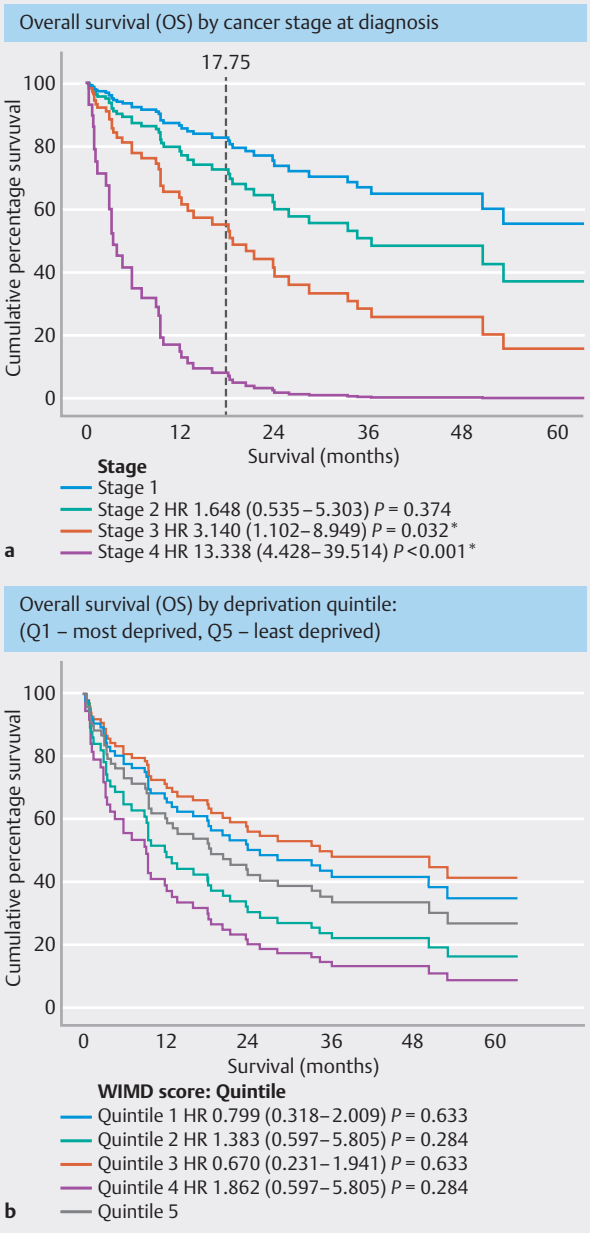
Deprivation and socioeconomic status have been reported to be associated with many gastrointestinal diseases. *H. pylori*, the precursor to a sizable proportion of peptic ulcer disease, gastric cancer, and gastric MALToma cases, has been linked with deprivation on a global scale [7, 8, 9, 10, 11, 12, 13], with gastric cancer three-fold commoner in patients suffering from chronic *H. pylori*[11]. The introduction of *H. pylori* eradication has reduced its prevalence, improving peptic ulcer healing with an associated fall in gastric cancer prevalence [7, 10, 14, 15]. Gossage et al, in 2009, noted a shift between 1993 and 1995 and 2000 and 2002: the incidence of gastric cancer decreased by 32% in the most affluent males and 7% in the least affluent males and may be attributed, in part, to effective *H. pylori* eradication [16]. Conversely, incidence of esophageal cancer increased, although disproportionately; by 51% in the most affluent males, compared with a 2% in the least affluent males. The authors considered gastroesophageal reflux and obesity to be a potential explanation for the association of esophageal cancer with affluence in their population, although they also raised the counterargument that obesity is becoming endemic, despite deprivation, and further research over time may disprove this association. The present study did not demonstrate an association between cancer incidence and deprivation; however, BE, the only known precursor of esophageal AC, reported to feature in up to 15% of routine diagnostic EGDs performed to investigate symptoms of gastroesophageal reflux [14, 17], was more common in patients residing in more affluent geographical areas, in keeping with the findings of other studies demonstrating a change in deprivation profile of patients diagnosed with BE i. e., living in less deprived geographical areas [14, 18, 19]. Exactly why this is so is still opaque. One speculative argument is that there may be an associated protective role played by *H. pylori* infection [12, 13, 20].

Another plausible explanation, however, may be associated with Dr. Tudor Hart's Inverse Care Law, in which distribution of healthcare resources is misaligned with any given population's health needs. Areas of lesser deprivation may have access to improved diagnostic techniques, and a worried-well patient cohort perhaps may be more likely to seek out investigations for non-specific symptoms [2]. Subsequent engagement in BE surveillance endoscopies in more affluent populations may further over-represent the disease profile in this arena [3, 6]. This is further evidenced by the introduction of evolving, less invasive tests in primary care, such as Cytosponge, which have been trialed as potential screening tools for patients with symptomatic gastroesophageal reflux disease (GERD). Low socioeco-

▶ **Table 4** Cox regression analysis of factors associated with overall cancer-specific survival.

Dependent variable	Independent variable	Number survived (%)		*P* value	Hazard ratio (95% CI)
Survival	Age			**0.004**	**1.050 (1.016–1.086)**
	Gender	**Male**	**7 (20.0)**	**0.020**	**2.189 (1.129–4.246)**
		Female	**10 (35.71)**		
	Deprivation	Q1	5 (38.46)	0.633	0.799 (0.318–2.009)
		Q2	4 (19.05)	0.392	1.383 (0.658–2.907)
		Q3	3 (37.5)	0.460	0.670 (0.231–1.941)
		Q4	0 (0)	0.284	1.862 (0.597–5.805)
		Q5	5 (29.41)	ref	
	Stage	I	6 (54.5)	ref	
		II	6 (42.9)	0.374	1.684 (0.535–5.303)
		III	**2 (11.1)**	**0.032**	**3.140 (1.102–8.949)**
		IV	**1 (5.9) 1 (5.6)**	**<0.001**	**13.228 (4.428–39.514)**

*Number includes only patients with malignancy.
CI, confidence interval.



▶ **Fig. 4** Survival plots **a** by stage of disease, **b** by deprivation quintile.

nomic status has been highlighted as a potential barrier to uptake of these new screening technologies due to lower levels of health literacy [21]. However, none of the current trials have included a detailed, individualized evaluation of multiple deprivation scores and the subsequent impact [22, 23]

A lack of association between cancer and deprivation in this study may be influenced by the overall low incidence of cancer detection in this unselected cohort of patients. Deprivation was, however, associated with more advanced radiological cancer stage at diagnosis; a finding not previously found by Morgan et al, or Stephens et al, when studying esophageal cancer patients and gastric cancer patients respectively from a comparable geographical cohort of patients in Wales [24, 25]. Morgan et al found, in a prospective observational cohort study involving 1,196 consecutive esophageal cancer patients in the UK (Wales), that socioeconomic deprivation was associated with higher incidence of esophageal squamous cell carcinoma. Despite no association between deprivation and radiological stage of disease at diagnosis in this, and similar treatment protocols received, patients living in the most deprived geographical areas experienced more operative mortality compared with patients from the least deprived areas [24]. Stephens et al examined 330 consecutive gastric cancer patients from the same geographical area. Despite developing the disease at a younger age and again, showing no significant differences in disease stage at diagnosis, patients from the most deprived areas experienced longer delays in diagnosis, higher operative mortality, and poorer long-term survival after potentially curative surgery compared with patients from the least deprived areas [25].

This study has inherent limitations. The cohort size was modest and data collection retrospective, and so, dependent on individual practitioner procedure notes and reports. Incomplete data related to drug history including nonsteroidal anti-inflammatory drugs and aspirin, prevented analysis. Because of the relatively small incidence of some gastrointestinal pathology, including esophageal and gastric cancer, and the fact that those subgroups of patients require therapeutic intervention for peptic ulcer disease, there is a risk of statistical type II error, which may have resulted in underestimation of the effect of deprivation in these situations. Moreover, the findings are a snapshot of findings from a single diagnostic test on an individual, and therefore, it is not possible to infer causality between recognized risk factors such as BE and later development of an

▶ **Table 5** All-cause mortality of studied patients undergoing diagnostic EGD in Wales.

	Mortality (%)	Independent variable		*P* value	HR (95% CI)
All-cause mortality	346 (17.3)	Age		<0.001	1.085 (1.073–1.097)
		Gender		<0.001	1.625 (1.260–2.096)
		WIMD Deprivation		<0.001	0.425 (0.280–0.644)
		Q1–113/558	20.3%		
		Q5–64/404	15.8%		

EGD, esophagogastroduodenoscopy; HR, hazard ratio; CI, confidence interval; WIMD, Welsh Index of Multiple Deprivation.

esophageal cancer. It is also recognized that there is an appreciable miss rate of significant findings on EGD, with a meta-analysis by Menon and Trudgill reporting that 11.3% of upper gastrointestinal cancers are missed on endoscopy up to 3 years before diagnosis [26]. The WIMD does not measure the level or deprivation in one area; rather, it ranks areas as more or less deprived relative to all other areas in Wales [1]. As will all indices for multiple deprivation, a limitation occurs when using different components and weighting formulas, which obviate direct comparisons internationally [27]. Despite this, a relative understanding in Wales can help inform policymakers, researchers, and organizations about prioritizing resources and interventions to address inequalities and improve the well-being of communities [1].This study has further strengths in terms of its originality, important contemporary alignment with National Health Service (NHS) health care priorities, and statistical power.

Conclusions

Upper gastrointestinal pathology is often an aggressive entity with a poor prognosis, which may arguably negate the effect of deprivation. Diagnostic delays have not been reported to be associated with the severity of disease at presentation, whereas empirical evidence shows that people in the lower social classes (IV & V) who use health services less often experience shorter life expectancy, higher infant mortality rates, and greater morbidity in comparison with those in social classes I, II and III. This cannot be attributed to one factor alone: Disadvantage in one area of life is likely to be associated with disadvantage in others. Improving access to healthcare services is crucial: Focus should include expanding the availability and quality of endoscopy services in deprived areas, increasing the number of healthcare providers, and ensuring reliable transportation options for patients to attend appointments. A multidisciplinary approach is essential to supply holistic care for all patients. This involves setting up a team of healthcare providers, social workers, and community workers who can address not only the medical aspects but also the social and logistical challenges that patients in more deprived areas may face. Targeted interventions, such as screening programs, should focus on accessing and educating deprived areas for early detection of diseases. Addressing the social determinants of health is paramount. This includes tackling issues of poverty and limited access to education, because these factors significantly affect health outcomes. Initiatives aimed at reducing poverty levels, promoting education, and improving overall living conditions can have a positive and long-lasting impact on the health of individuals in deprived areas. Education and awareness campaigns should be implemented to increase knowledge about the importance of endoscopy procedures and the risks associated with not receiving prompt interventions. Despite 50 years since the Inverse Care Law was first described, its effects appear to remain in play; addressing the negative effects of deprivation and ensuring fair access to quality healthcare remain key priorities for the UK government's NHS cancer plan and associated service reconfigurations. By implementing these latter strategies, we can work toward improving outcomes and reducing disparities in deprived populations.

Conflict of Interest

The authors declare that they have no conflict of interest.

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