Social and geographical factors affecting access to treatment of colorectal cancer: a cancer registry study

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ABSTRACT

Objective: Cancer outcomes vary between and within countries with patients from deprived backgrounds known to have inferior survival. The authors set out to explore the effect of deprivation in relation to the accessibility of hospitals offering diagnostic and therapeutic services on stage at presentation and receipt of treatment.

Design: Analysis of a Cancer Registry Database. Data included stage and treatment details from the first 6 months. The socioeconomic status of the immediate area of residence and the travel time from home to hospital was derived from the postcode.

Setting: Population-based study of patients resident in a large area in the north of England.

Participants: 39 619 patients with colorectal cancer diagnosed between 1994 and 2002.

Outcomes measured: Stage of diagnosis and receipt of treatment in relation to deprivation and distance from hospital.

Results: Patients in the most deprived quartile were significantly more likely to be diagnosed at stage 4 for rectal cancer (OR 1.516, p<0.05) but less so for colonic cancer. There was a trend for both sites for patients in the most deprived quartile to be less likely to receive chemotherapy for stage 4 disease. Patients with colonic cancer were very significantly less likely to receive any treatment if they came from any but the most affluent area (ORs 0.639, 0.603 and 0.544 in increasingly deprived quartiles), this may have been exacerbated if the hospital was distant from their residence (OR for forth quartile for both travel and deprivation 0.731, not significant). The effect was less for rectal cancer and no effect of distance was seen.

Conclusions: Residing in a deprived area is associated with tendencies to higher stage at diagnosis and especially in the case of colonic cancer to reduced receipt of treatment. These observations are consistent with other findings and indicate that access to diagnosis requires further investigation.

ARTICLE SUMMARY

Article focus
There is evidence that the poorer survival of British patients' with bowel cancer is related to more advanced stage than in similar countries.
- Is this related to the environment in which people live?
- Are there differences in this regard between colonic and rectal cancer?

Key messages
Residing in a deprived area is associated with:
- tendencies to higher stage at diagnosis.
- especially in the case of colonic cancer with reduced receipt of treatment.

Strengths and limitations of this study
- A cancer registry study looks at the whole population of a defined area and so does not depend on access to specific institutions.
- A large number of patients have been studied.
- The patients analysed were diagnosed some years ago.
- Deprivation indices relate to area of residence rather than to individuals.
- This is a cross-sectional study so inferences of causality must be cautious.

the UK is inferior to that in comparable economies within Europe[1] and beyond.[2] This is particularly true of colonic cancer but much less so for rectal cancer. A 'high-resolution' study in which more detailed information about each patient was analysed than is the case for the main analysis was undertaken as part of the EUROCARE Project. This suggested that the discrepancy for colonic cancer could be ascribed to later stage at presentation.[3]

In Scotland, an association between reduced survival and rural residence attributable to more advanced stage at diagnosis has previously been reported[4] and patients with colorectal cancer are less likely to receive radiotherapy if they live in a rural area.[5] In New Zealand, both living in

Access to treatment for cancer has been the subject of detailed policy within the National Health Service over the past 15 years. This has been stimulated by comparative studies which show that survival from cancer within

a deprived area of residence and at increased distance from a cancer centre have been associated with reduced survival.[6]

We have conducted a large study using data from the Northern and Yorkshire Cancer Registry and Information Service (NYCRIS) for patients diagnosed with common epithelial cancers in the period 1994–2002. In this, we explored the relationship between measures of access to transport and medical services and disease-related outcomes. For all primary sites studied, it was shown that, after controlling for age, sex and socioeconomic deprivation, the likelihood of receiving radiotherapy was reduced with increasing travel time to the nearest radiotherapy hospital, and rectal cancer patients were less likely to receive chemotherapy if they lived distant from a hospital providing this treatment.[7] Late stage of colorectal cancer at diagnosis was associated with greater travel time to the general practitioner, living in a rural location and in one without access to community transport.[8]

In this paper, we have investigated the possible joint effect of deprivation and rural inaccessibility on the stage of presentation and receipt of active treatment for colorectal cancer patients in our study. Building on our previous findings, we test whether distance to diagnostic treatment hospitals may interact with area socioeconomic deprivation to amply the disadvantage of those living furthest from hospital and in the most deprived areas.

PATIENTS AND METHODS

The process of developing a database appropriate for geographical analyses from the Registry records has been described in detail elsewhere.[4] Briefly, for the purpose of this analysis, we assembled a database of all patients registered with cancer of the colon or rectum held by the NYCRIS during the period 1994–2002. This database included the treatment or treatments delivered in the period up to 6 months, but usually shorter, following diagnosis.

Car travel times from the patient's residence to healthcare providers were estimated in a geographical information system (ArcGIS 9.2) using the shortest road route and average driving speeds along specific classes of road. An independent survey of 475 patients attending cancer clinics in the same study area had already established that 87% of patients made the journey by car and that travel estimates based on the road network and average speeds were closely related to actual car journey times reported by patients.[9]

Deprivation was determined from the Index of Multiple Deprivation, an area-level measure associated with the postcode.[10] We removed the access to services domain from the Index of Multiple Deprivation scores so as to eliminate the potential of double counting. Patients were divided into equal quartiles for deprivation and for travel time to the closest hospital providing diagnostic access. Patients were allocated to deprivation quartiles on the basis of socioeconomic deprivation in their area of residence and travel quartiles on the basis of distance of residence from the closest hospital providing diagnostic and surgical treatment services for bowel cancer.

Statistical analyses were carried out using the SPSS V.16 software package. ORs were calculated for the stage distribution at presentation and for the receipt of treatment. Logistic regression models were fitted to determine how the covariates of hospital travel time and deprivation quartile were associated with the likelihood of receiving treatment or being diagnosed at late stage. For all models, ORs were estimated across the quartiles of both deprivation and travel time, with the least deprived and shortest travel time groups forming the respective reference categories. To test for synergies between quartiles of deprivation and travel time, interactions between the two categorical variables were fitted. In the results tables, ORs from the interactions are presented for each matching quartile category (ie, quartile 2 of deprivation by quartile 2 of travel time). The reference category for these interactions was quartile 1 by quartile 1 of each variable. As age and male sex had an adverse effect for all the variables that were studied, all ORs were adjusted for these covariates. In addition, all ORs for the receipt of treatment were adjusted for tumour stage.

RESULTS

During the time period studied, there were 39 619 colorectal tumours recorded by NYCRIS. From this, information on residential location was available for 11 406 rectal tumours and 16 850 colon, making a data set of potential 28 256 records for analysis (71.3% of the total records). From these, data on stage at diagnosis were available for 7058 of the rectal cancers (62% completeness) and 11 163 of the colon cancers (66% completeness). The mean age of patients was 70.3 years (SE 0.11) and 61.5% were men. Mean drive time to the nearest hospital was estimated to be 14 min (SE 0.09) with the longest estimate being 1.5 hr.

Stage at presentation

Table 1 shows that patients with carcinoma of the rectum who were in the most deprived quartile (n=2939 patients) were significantly more likely to present at stage 4 than at earlier stages. This relationship was weaker and less consistent for colonic cancer. There was no effect of distance on this observation for either tumour site and no evidence of an interaction between the two factors.

Treatment

We calculated the odds of receiving any surgical, radiotherapy or chemotherapy treatment, adjusted to account for the effects of age, sex and stage at presentation. Among those with rectal cancer (table 2), there was

Table 1 ORs (adjusted for age and sex) of being diagnosed at stage 4 rather than stages 1–3 for rectal cancer and colonic cancer

	Main effect: travel	Main effect: deprivation	Interaction term: travel × deprivation
Rectal			
Quartile 1	1	1	1
Quartile 2	0.940 (0.616 to 1.433)	1.072 (0.716 to 1.605)	1.258 (0.739 to 2.140)
Quartile 3	1.314 (0.895 to 1.928)	1.319 (0.900 to 1.932)	0.754 (0.465 to 1.223)
Quartile 4	1.172 (0.819 to 1.677)	1.516* (1.053 to 2.182)	0.868 (0.527 to 1.430)
Colonic			
Quartile 1	1	1	1
Quartile 2	0.938 (0.697 to 1.263)	1.156 (0.871 to 1.1535)	1.062 (0.725 to 1.555)
Quartile 3	0.993 (0.750 to 1.315)	1.334* (1.019 to 1.747)	0.997 (0.700 to 1.418)
Quartile 4	0.969 (0.750 to 1.252)	1.157 (0.892 to 1.501)	1.121 (0.770 to 1.633)

*p<0.05, 95% CIs shown.

a tendency for patients to be less likely to receive any active treatment with increasing deprivation of their area of residence, but there was no evidence that increasing distance reduced the likelihood of treatment. There was a strong tendency among patients with colonic cancer residing among the two most deprived quartiles (n=8425) to be significantly less likely to receive treatment (table 2). Although those outside the most proximal quartile were less likely to receive any treatment, these differences did not reach statistical significance and there was again no evidence of an interaction between deprivation and travel time.

When the analysis was made for receiving chemotherapy for stage 4 cancer (table 3), colonic patients living in the most deprived quartile were less than half as likely to receive the treatment. The trend with deprivation did not reach statistical significance for rectal cancer, and there were no associations with travel and nor any evidence of interactions. Overall, the impression is that there is a disadvantage for the quartile of society residing in the most deprived areas with no real effect of distance of residence from the treating hospital.

DISCUSSION

We have demonstrated a difference between colonic cancer and rectal cancer in the proportion of patients from socioeconomically deprived localities of residence receiving any treatment. Colorectal cancer is usually considered as one entity when considering how diagnostic services work, but there is a developing body of evidence that points to a difference between them.

Recent studies addressing the presentation of colorectal cancer have emphasised that features such as rectal bleeding and microcytic anaemia <10 g/dl identify a minority of patients.[11] However, Stapley et al[12] found that while presentation with an alarm symptom such as rectal bleeding is associated with earlier stage, presentation with mild anaemia (10–12.9 g/dl), which is likely not to cause symptoms prompting the patient to seek advice, is associated with more advanced stage and worse survival. Symptoms are otherwise non-specific: weight loss, abdominal pain and altered bowel habit. In this study, which avoided recall bias by using primary care records, increasing duration of these was not associated with advancing stage.

Table 2 ORs of receiving any treatment (adjusted for age, sex and stage) for rectal and colonic cancer

	Main effect: travel	Main effect: deprivation	Interaction term: travel × deprivation
Rectal			
Quartile 1	1	1	1
Quartile 2	0.900 (0.547 to 1.482)	0.867 (0.539 to 1.393)	0.898 (0.486 to 1.661)
Quartile 3	0.863 (0.534 to 1.396)	0.712 (0.453 to 1.118)	1.158 (0.646 to 2.075)
Quartile 4	0.987 (0.634 to 1.538)	0.544** (0.343 to 0.838)	1.394 (0.762 to 2.548)
Colonic			
Quartile 1	1	1	1
Quartile 2	0.825 (0.559 to 1.216)	0.639* (0.445 to 0.917)	1.476 (0.913 to 2.386)
Quartile 3	0.757 (0.525 to 1.091)	0.603** (0.425 to 0.854)	1.324 (0.847 to 2.068)
Quartile 4	0.810 (0.577 to 1.137)	0.544** (0.390 to 0.760)	0.731 (0.451 to 1.159)

*p<0.05, **p<0.01, 95% CIs shown.

Table 3 ORs of receiving chemotherapy (adjusted for age and sex) for stage 4 rectal cancer and colonic cancer

	Main effect: travel	Main effect: deprivation	Interaction term: travel × deprivation
Rectal			
Quartile 1	1	1	1
Quartile 2	0.702 (0.299 to 1.647)	1.037 (0.463 to 2.319)	1.304 (0.452 to 3.764)
Quartile 3	0.858 (0.402 to 1.833)	0.821 (0.386 to 1.745)	1.143 (0.443 to 3.375)
Quartile 4	1.058 (0.521 to 2.149)	0.732 (0.357 to 1.499)	1.080 (0.416 to 2.806)
Colonic			
Quartile 1	1	1	1
Quartile 2	1.310 (0.730 to 2.352)	0.815 (0.465 to 1.429)	0.973 (0.461 to 2.056)
Quartile 3	0.941 (0.540 to 1.639)	0.776 (0.455 to 1.321)	0.991 (0.496 to 1.981)
Quartile 4	1.024 (0.617 to 1.697)	0.454** (0.268 to 0.768)	1.097 (0.521 to 2.314)

**p$<$0.01, 95% CIs shown.

In a meta-analysis, a weak association of longer delay and increased survival in colonic cancer was found.[13] This was identifiable only after many studies were excluded for various reasons. In a further analysis, the same authors showed that there is a tendency for longer duration of symptoms to be associated with higher stage in rectal cancer but lower stage in colonic lesions.[14] This fits with the concept that colonic cancers cause few major symptoms until the flow of faecal matter is impeded by an advanced lesion, whereas prompt diagnosis following bleeding from rectal cancers permits successful intervention. This interpretation is supported by evidence from Denmark, a country with reliance on primary care, which is similar to that in the UK. In the presence of alarm symptoms, survival was shown to decrease with their duration before diagnosis with a trend to the converse for vague symptoms.[15]

A difference between colonic and rectal cancer, which is consistent with the concept of colonic cancer presenting later has been described by Møller et al.[16] The difference in death rates of patients both with colonic and with rectal cancer was greatest in the first month after diagnosis, more so for colonic cancer. It was markedly greater in the deprived groups as well as being strongly related to age. This is entirely consistent with our finding that patients from deprived areas are more likely to have no active treatment, a phenomenon that is stronger for colonic cancer. However, when death rates in excess of what is expected in the population occurring after the first month are considered, the disadvantage for those from a deprived background as well as older people persists up to 2 years and is stronger for rectal cancer.[16] Our finding that for rectal cancer, there is a greater likelihood of being diagnosed at stage 4 associated with deprivation is entirely consistent with this, reduced likelihood survival to 2 years being associated with the visceral metastases that define this stage. Both tumour sites exhibit a minor trend against the most deprived patients with stage 4 disease receiving chemotherapy. It is most likely that this relates to patients being too ill to be treated and as such adds detail to the observations in table 2.

This analysis of observations in colorectal cancer follows the one previously reported in lung cancer.[17] They differ in that the NYCRIS Database holds adequate staging information for bowel tumours but not for lung cancer, whereas in the latter tumour site, attainment of a histological diagnosis is a variable that reflects diagnostic activity. The colorectal cancer results show consistent effects of deprivation, but the effect of distance of residence from the diagnosing facility that we saw in lung cancer was not significant in this study.

There are consistent effects that apply to the patients living in the more deprived areas which indicate that in planning the development of services, it is the needs of these patients that should be paramount; it seems that the better off are more able to find their own way through the system. This is supported by the finding that patients from deprived backgrounds are more likely to be admitted to hospital as an emergency[18] and indeed to have their first inpatient episode for this diagnosis as an emergency admission.[19] On the other hand, increased demand for diagnostic services will mean that the costs of investigation of patients who turn out not to have cancer will increase. They already, it is estimated, account for 35% of the cost of managing colorectal cancer.[20]

However, the existence of such differences suggests that there is an avoidable cause for them. It is possible that people may experience symptoms without recognising that they signify anything of importance; therefore, the duration is not recalled and the primary care physician's advice is not sought. Encouraging early results have been obtained from one study of measures to promote understanding of early symptoms in deprived communities.[21] To do this requires proactive approaches to people in such circumstances because deprived people are not necessarily aware that they have disadvantages in receiving healthcare.[22] These cancer sites share the fact that presenting symptoms are ambiguous.

There are a number of caveats to our findings. In order to be comparable to previous work among this cohort, the analysis was based on data for patients

diagnosed between 1994 and 2002, a period up to almost a decade ago. In our data set, staging was available for 64.5% of records. In 2009, this figure stood at 65.1% so there has been no significant improvement in staging since then.[23] Furthermore, registration personnel collected data from NHS hospital records, a process that is not affected by any of the variables affecting access to care that we have studied. We therefore believe that there are unlikely to be biases associated with incomplete staging. Although pathways from primary care to diagnosis have not been addressed by any changes in practice since our patients were diagnosed, future studies will be need to determine if modifications to policy may alter the associations we observed.

Additional limitations include the fact that our study is cross sectional in nature and therefore we cannot determine if the associations we have observed are causal. Furthermore, the large number of statistical comparisons we have made raises the possibility that some associations may be due to chance. Our measure of deprivation was area rather than individual based and we relied on estimated rather than actual travel times to hospital, although these estimates have been found to be accurate in a previous validation study.[9] Nevertheless, a limitation of our analysis of associations with distance is that the most distant travel quartile includes a wide variety of circumstances: the outer suburbs of cities that host major cancer centres, towns that have no hospital and the furthest rural locations. In the future, it will be of interest to evaluate the deficiencies in access in each of these separately.

A new version of the UK Guidance on the diagnosis and management of colorectal cancer has recently been developed.[24] It has not addressed those points in the patient's pathway that precede referral to a gastrointestinal specialist; our work and other registry studies indicate that work needs to be done in this area. Timely diagnosis of cancer when symptoms are non-specific will require an increase in the number of patients with such symptoms undergoing investigation and therefore consuming more resources. These will especially need to be deployed in areas of deprivation.

CONCLUSIONS
Patients with large bowel cancer are less likely to receive a timely diagnosis and to receive active treatment if they live in a socioeconomically deprived locality. This finding is particularly strong for colonic cancer. These findings add to the evidence that colonic and rectal cancer differ in their presentation and that these differences affect the outcome. They support the view that patients in different circumstances differ in the way they are able to access diagnosis and treatment.

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1 ✓	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Social and geographical factors affecting access to treatment of colorectal cancer: a Cancer Registry study
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2 ✓	Explain the scientific background and rationale for the investigation being reported
Objectives	3 ✓	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4 ✓	Present key elements of study design early in the paper
Setting	5 ✓	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 ✓	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7 ✓	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8* ✓	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 ✓	Describe any efforts to address potential sources of bias (this is a whole-population study)
Study size	10 ✓	Explain how the study size was arrived at (all cases in our time period)
Quantitative variables	11 ✓	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (grouping is by site of disease within the large bowel)
Statistical methods	12 ✓	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
Participants	13* ✓	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (This study used all data available through the Cancer Registry)
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14* ✓	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (This is the focus of the study.)

		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures
	✓	(Odds ratios are the main means of analysis)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and
	✓	their precision (eg, 95% confidence interval). Make clear which confounders were
		adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a
		meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and
		sensitivity analyses (N/A)

Discussion

Key results	18	Summarise key results with reference to study objectives
	✓	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or
	✓	imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations,
	✓	multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
	✓	

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if
	✓	applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

bmjopen-2011-000410 "Social and geographical factors affecting access to treatment of colorectal cancer: a cancer registry study."

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The manuscript explores the effect of socio-economic f and accessibility to hospitals, on the survival of colon and rectum cancer for patients registered at the Northern & Yorkshire Cancer Registry and Information Service. I however have some concerns on how the analyses were carried out and presentation of results.

1. The analysis was based on colon and rectum cancer data for patients diagnosed during the period 1994-2002. One would expect information of stage to be more complete and reliable for more recent data. The authors should justify the use of such old data.

RESPONSE: The data set we used was, as stated in the paper, used for a previous analysis. Since the issues we discuss regarding the pathway from primary care to diagnosis have not been addressed by any changes in practice since these patients were diagnosed, the observations are unlikely to be affected. Because the comparisons we make are all from groups within this data set, any deficiencies in the quality of recording of stage will apply to all groups of patients, that is all cells in the tables and not affect the analysis. Using an older data set means that future studies can test our analyses from patients diagnosed subsequently and if they are confirmed move on to measure the effect of policy changes.

In our dataset staging was available for 64.5% of records. In 2009, this figure stood at 65.1% so there was no significant improvement in staging over this time. Furthermore, registry clerks' access to notes is not affected by any of the things we have studied, so we believe any biases associated with incomplete staging would be random. We have added discussion of these issues to paragraph 8 of the Discussion section.

2. The last paragraph of Patients and Methods (page 8), states that logistic regression models were fitted to determine how the covariates of hospital travel time and deprivation quartile were associated with the odds of receiving treatment. It is however well known that logistic regression models estimate odds ratios.

RESPONSE: We apologise for the omission of 'ratios' here and the confusion it may have caused – we have now corrected the manuscript accordingly.

3. The first paragraph of the results section does not clarify how the cells of tables 1 and 2 were estimated. For example the cell of deprivation quartile 2 and travel quartile 3 in table 1 is 1.235 is the odds of what? And how was that adjusted for age and sex. If a logistic regression model was fitted I would expect odds ratios, which can never be presented in the form of a cross tabulation between deprivation quartile and travel quartile.

RESPONSE: We have reworded the article to state "For all models the reference group was those patients that fell into the closest quartile for access and the least deprived quartile for residence, and the odds ratios in each cell represent the outcome for each deprivation/travel time quartile relative to that." and we hope this is now clear. By definition the cell that represents this group has a value of 1 and the other cells are odds ratios relative to this, with the stated adjustment by logistic regression, "for Stage 4" compared with "Stage 1-3". We estimated the model by fitting cross-term dummies for each deprivation/travel time quartile. To clarify for the reviewer, we present the raw model for Table 2 below:

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	diag_age	-.010	.002	28.408	1	.000	.990
	gender	.142	.042	11.578	1	.001	1.153
	col_dep1_trav2	-.064	.152	.176	1	.675	.938
	col_dep1_trav3	-.007	.143	.002	1	.962	.993
	col_dep1_trav4	-.031	.131	.057	1	.811	.969
	col_dep2_trav1	.145	.145	1.004	1	.316	1.156
	col_dep2_trav2	.142	.140	1.025	1	.311	1.152
	col_dep2_trav3	.133	.140	.904	1	.342	1.142
	col_dep2_trav4	.200	.138	2.086	1	.149	1.221
	col_dep3_trav1	.288	.138	4.388	1	.036	1.334
	col_dep3_trav2	.052	.140	.137	1	.712	1.053
	col_dep3_trav3	.278	.137	4.131	1	.042	1.320
	col_dep3_trav4	.207	.144	2.055	1	.152	1.230
	col_dep4_trav1	.146	.133	1.208	1	.272	1.157
	col_dep4_trav2	.124	.137	.830	1	.362	1.133
	col_dep4_trav3	.328	.142	5.364	1	.021	1.388
	col_dep4_trav4	.229	.167	1.883	1	.170	1.257
	Constant	-.361	.175	4.245	1	.039	.697

4. Titles of table 1 & 2 are not clear. One would expect (adjusted for age and sex) and (*P<0.05, **P<0.01, 95% confidence interval) to be presented as a footnote and may be in the methods section. Double parenthesis in the last part!!

RESPONSE: Double parenthesis is a typographical error which has been corrected, and we have reworded the table titles accordingly. We hope they are now clear.

5. According to the first paragraph of results table 1 and table 2 present odds of being diagnosed at stage 4 compared to stages 1-3 in colon and rectum cancers. However Table 1 present deprivation quartile by travel quartile, while table 2 present deprivation quartile by hospital quartile.

RESPONSE: This inconsistency is corrected

6. The same concerns detailed above in point 4, apply to the odds of treatment presented in tables 3 and 4

RESPONSE: This has been corrected.

Reviewer: Paolo Bruzzi MD MPH PhD
Head, Unit of Clinical Epidemiology
Director, Department of Epidemiology and Prevention National Cancer Research
Institute Genova - Italy

This paper presents new analyses of the colorectal cancer part of the data reported in a previous paper from the same group (Travel time to hospital and treatment for breast, colon, rectum, lung, ovary and prostate cancer.
Jones AP, et al, Eur J Cancer. 2008 May;44(7):992-9) with a more specific focus, beside that on distance from hospital which was already discussed in the original paper, on the role of deprivation as assessed by the place of residence. An original analysis is included on the association between these two variables and stage at presentation. The issue is an important one, even though studies on quality of care based on current data are proving of questionable reliability.
The methodology is that of the original study, the study population is the same (39000 colorectal cancer patients diagnosed during the period 1994-2002 in Northern England), and also the data analyzed are the same.
Even though the indications provided by this paper are somewhat clearer than those given by the previous one, mostly because of the focus on a single disease, it provides little original evidence of real interest, and has several weaknesses:

a) The presentation of the results is poor: no crude numbers, simple stratified analyses, wrong tests of significance (p-values for single odds ratios instead of tests for trend). No attempt was made to formally assess the interactions (i.e. synergisms) between the two variables, even though this was declared as the primary aim of the study (last sentence of the introduction section).

RESPONSE: We have added some descriptives providing crude numbers and sample sizes at the start of the results section. Rather than add sample sizes of each cell of every table, which we feel would considerably complicate them, we have added 'n' values at various points in the results. We are unsure why the reviewer is not happy with our stratification. We do not agree that the test for significance is incorrect – as we state in the paper the aim is to make comparisons with the most benefitted group (shortest travel time and lowest deprivation) rather than identify trends down the individual columns. Therefore the use of p-values for single odds ratios is appropriate. We feel the format of presenting data cell by cell in comparison with a group which has the least socioeconomic and geographic disadvantage enables the pattern of diagnostic (including diagnosis at late stage) and therapeutic disadvantage to be seen most clearly. We also do not agree that we have failed to address the synergy between deprivation and travel time as our models consist of the cross terms between the two measures, not their independent effects. We hope that our response to the third comment of the first reviewer will clarify this.

b) At first glance, some the results are very difficult to believe (e.g. the odds of receiving any treatment for colon or rectal cancer are almost halved). This, obviously, derives from the use of the odds ratio as a summary indicator of association. However, as previously stated, without the Odds ratios without the support of the crude figures cannot be meaningfully interpreted :

RESPONSE: We feel the odds ratios are consistent with expectations from clinical practice. We hope that that addition of key sample sizes in the text will aid interpretation.

c) The discussion is long (4 pages), and unfocused, with conjectures and unwarranted statements.

RESPONSE: We believe that the interpretations of the findings we have presented can be tested in confirmatory studies within similar health services to the UK NHS. If confirmed, they offer opportunities for interventions to give poorer UK residents to have access to care for colorectal cancer which matches that elsewhere in Western Europe. We have made some modifications to the discussion and hope the reviewer now feels it is more coherent.

d) The limitations of this study are not discussed at all, nor are the differences between this study and the previous one. The results and the observed associations are taken for granted, without even mentioning some of the possible fallacies and biases that may affect studies of this kind, where both the exposures (deprivation and accessibility to hospital) and the outcome (quality of care) are indirectly estimated from proxy variables. Furthermore, these studies may suffer from biases related to the increased diagnostic pressure in more affluent socio-economic subgroups, leading to an increase in the absolute number of early disease without a corresponding decrease in the absolute numbers of late disease, which however appears to be reduced in absolute terms.

RESPONSE: We agree the study limitations were not well covered in the previous draft of the manuscript. We have added a section covering them in the discussion section of the manuscript.

We do not agree that increased diagnostic pressure generates a bias. Diagnosis at an early stage ought to be regarded as the norm which members of more affluent socioeconomic groups are more likely to attain. Perhaps the reviewer is making comparisons with prostate cancer and to some extent breast cancer where there is evidence that some cancers can be detected that are no threat to the patients' future wellbeing. There is no known equivalent in colorectal cancer.

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