Research

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Impact of travel time and rurality on presentation and outcomes of symptomatic colorectal cancer:

a cross-sectional cohort study in primary care

Abstract

Background
Several studies have reported a survival disadvantage for rural dwellers who develop colorectal cancer, but the underlying mechanisms remain obscure. Delayed presentation to GPs may be a contributory factor, but evidence is lacking.

Aim
To examine the association between rurality and travel time on diagnosis and survival of colorectal cancer in a cohort from northeast Scotland.

Design and setting
The authors used a database linking GP records to routine data for patients diagnosed between 1997 and 1998, and followed up to 2011.

Method
Primary outcomes were alarm symptoms, emergency admissions, stage, and survival. Travel time in minutes from patients to GP was estimated. Logistic and Cox regression were used to model outcomes. Interaction terms were used to determine if travelling time impacted differently on urban versus rural patients.

Results
Rural patients and patients travelling farther to the GP had better 3-year survival. When the travel outcome associations were explored using interaction terms, the associations differed between rural and urban areas. Longer travel in urban areas significantly reduced the odds of emergency admissions (odds ratio [OR] 0.62, $P<0.05$), and increased survival (hazard ratio 0.75, $P<0.05$). Longer travel also increased the odds of presenting with alarm symptoms in urban areas; this was nearly significant (OR 1.34, $P = 0.06$). Presence of alarm symptoms reduced the likelihood of emergency admissions (OR 0.36, $P<0.01$).

Conclusion
Living in a rural area, and travelling farther to a GP in urban areas, may reduce the likelihood of emergency admissions and poor survival. This may be related to how patients present with alarm symptoms.

Keywords
access; cancer symptoms; early diagnosis; geography; primary care; rurality.

INTRODUCTION

Studies in the UK have reported that people who live rurally and farther away from health services have poorer cancer outcomes,[1,2] and causative mechanisms have been suggested at the general practice level.[3] First, rural populations may be impacted disproportionately by financial constraints and poor accessibility, compounded by the long distances travelled to obtain primary and secondary health care.[4] For example, longer distance to health services has been associated with fewer in-patient admissions,[5] with poorer uptake of cancer diagnosis and treatment,[1,6,7] and with lower survival.[2] Second, sociocultural factors could manifest as different attitudes or stoicism in rural dwellers, with correspondingly lower rates of primary care consultation and, as a consequence, lower likelihood of GPs being enabled to detect early cancer symptoms.[3,8] Geographical location and considerations of access could also influence GP decision making if they take into account patients' journey to hospital when making referral decisions.[5,9]

Acting together, these mechanisms could conspire against rural patients and their GPs, and lead to disproportionately longer diagnostic delays, later-stage presentation, and poorer survival. A study from the early 2000s in northern Scotland supports this notion by showing that longer straight-line distances from patients' homes to a cancer centre were associated with later stage at diagnosis and poorer survival from colorectal cancer.[2,10] However, research from the US has provided contradictory findings, reporting increased likelihood of late-stage cancer among urban patients.[11,12]

Achieving a true understanding of the relationship between rural residence and cancer outcomes is hindered by a focus on outcomes, survival, and stage, rather than process. There have been few meaningful attempts to compare urban and rural cancer diagnosis at the level of GP–patient interactions. Cancer is easier to detect and refer when alarm symptoms are present,[13,14] and harder when symptoms are atypical.[15] Subsequent diagnosis after presentation with non-alarm symptoms may therefore require more frequent engagement with health services, which may be hindered by poor accessibility. Difficulties in accessing secondary care services could mean rural GPs might delay referral until symptoms are more obvious.[16] It seems plausible, therefore, that for rural populations geographical inaccessibility and sociocultural differences would manifest as a greater likelihood to be diagnosed with colorectal cancer following presentation with alarm symptoms to a GP, or following an emergency admission.

The authors have been able to examine

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How this fits in

Rural–urban differences in cancer survival have been observed in several countries, but the mechanisms to explain these differences are obscure. One possibility is that, due to sociocultural differences and poorer access to services, rural patients delay longer in presenting to their GP when they develop non-specific symptoms. In this study, the authors found that rural patients with colorectal cancer were more likely than their urban counterparts to have alarm symptoms at presentation, but this did not increase the likelihood of diagnosis following emergency presentation, nor did it increase mortality at 3 years. Furthermore, travelling times to a GP appeared to have an opposite association with outcomes between urban and rural areas. Unexpectedly, travel to GPs had a stronger association with colorectal cancer outcomes in urban than in rural areas, whereby longer travel in urban areas significantly reduced the likelihood for emergency admissions and increased survival.

rural–urban differences in the diagnosis of colorectal cancer using a historical, but highly detailed, database from northern Scotland.[17] The Comparing Rural and Urban Cancer Care (CRUX) database linked detailed information from the primary care records of people diagnosed with colorectal cancer to cancer registry and service use data from NHS Scotland. Using these data, the authors have explored the association between rurality and symptoms at presentation, emergency admission, stage, and survival for 926 people diagnosed with colorectal cancer between 1997 and 1998. Furthermore, for the first time, the authors have explored the interaction between rurality, urbanity, and travelling time on these important colorectal cancer outcomes.

METHOD

The study used the CRUX linked dataset that contains primary care data from northern Scotland. CRUX holds records of cancer cases diagnosed between 1997 and 1998, and followed up until 2011. The dataset has information on GP consultations, linked to the Scottish Cancer Registry and the Scottish Death Registry records.[17,18] The index consultation was determined as the first visit to the GP with a recording of potential symptoms of colorectal cancer that preceded diagnosis.[18] The presence of alarm symptoms, emergency admissions, later Dukes' stage (C or D versus A or B),

and survival were identified as the primary outcomes.

Alarm symptoms were categorised according to previous research,[19] along with expert advice (W Hamilton, personal communication, 2017). The following symptoms were defined as alarming enough to likely result in a patient seeking a consultation or a GP making an urgent referral: rectal bleeding, palpable mass, and weight loss. Admission types recorded as emergency and/or accident and emergency were grouped into 'emergency admissions', whereas all inpatient and outpatient admissions, day cases, and domiciliary visits were grouped as 'other admissions'. Stage at diagnosis was recorded as Dukes' stage (A, B, C, or D). Survival time was measured from date of first presentation to primary care.[18]

Travel times were estimated in minutes from the patients' home postcode to the postcode of their GP of registration at diagnosis. These were computed using a geographical information system (GIS) (ArcGIS 10.3). Road travel time was selected as the most appropriate measure of accessibility: a previous study demonstrated that >87% of cancer patients travel to hospital by car.[20] Scottish rural–urban classifications (2003–2004) were used to group patients according to rural or urban residence.[21]

All data were analysed using Stata (version 13). Estimated travel time was analysed as a continuous variable. Symptoms, admissions, and stage data were binary coded as 'alarm symptoms versus not', 'emergency versus not', and 'early stage (CD) versus late stage (AB)'. Logistic regression was used to examine how rurality and travel time were associated with the likelihood of these outcomes. So that parameter estimates were conservative, models were adjusted for variables deemed to have a relationship with the outcomes: age, sex, Carstairs deprivation score,[22] and Charlson comorbidity index.[23] Odds ratios (OR) and 95% confidence intervals (CI) were calculated in all models. Cox survival analysis was used to examine the relationship between rurality, travel time, and survival. For each patient, follow-up began at the date of their index presentation and ended at the date of death, or was censored after 3 years. Hazard ratios (HR) and 95% CIs were calculated.

To test whether travel times may have a different relationship with the outcomes for those living in rural compared with urban settings the authors fitted interaction terms to examine if rurality moderated

Table 1. Sample characteristics and outcome variables

Variable	Frequency, n (%)	Mean travel time, minutes
Sex		
Male	521 (56.3)	8.8
Female	405 (43.7)	7.1
Age, years		
<59	157 (17.0)	8.8
60–69	240 (25.9)	7.6
70–79	347 (37.5)	8.5
>80	182 (19.7)	7.1
Location		
Rural	298 (32.2)	12.0
Urban	628 (67.8)	6.2
Travel time to GPs , percentile		
25th	232 (25)	2.8
50th	463 (50)	5.5
75th	695 (75)	10.3
99th	917 (99)	43.8
Deprivation		
Least deprived Q1	191 (20.6)	8.6
Q2	191 (20.6)	7.8
Q3	171 (18.5)	9.1
Q4	188 (20.3)	8.1
Most deprived Q5	185 (20.0)	6.5
Comorbidities		
0	441 (47.6)	7.8
1–2	312 (33.7)	8.3
>3	173 (18.7)	8.3
Symptoms		
1–3	825 (89.1)	7.7
>4	101 (10.9)	10.7
Alarm symptoms	373 (40.3)	7.9
Emergency admissions	243 (26.2)	7.7
Dukes' stage CD	424 (48.9)[a]	7.9

[a] Information on disease stage was missing in 58 patients.

RESULTS

associations between travel times and the outcomes. They then plotted separate urban and rural slopes for these associations, testing for statistical significance in the differences. A P-value of <0.05 was used to indicate statistical significance.

RESULTS
Data on 926 patients with symptomatic colorectal cancer were used in this analysis. The majority of patients (83.1%) were >60 years of age, and more than half (52.4%) had one or more comorbidities. Nearly one-third (32.2%) lived in a rural area. The median travel time was 55 minutes; 75% of all patients could access their GP within 10 minutes. There were 373 patients with one or more alarm symptom, 243 patients were admitted to hospital via an emergency route, and 424 patients had Dukes' stage C or D (Table 1).

Travel times to GPs were longest for those living in rural versus urban areas (12.0 versus 6.2 minutes) and those with four or more symptoms versus one to three symptoms at the index presentation (10.7 versus 7.7 minutes). There was little variation in mean travel times between the other variables (Table 1).

In the model without travel time — rurality interaction terms — there were no independent associations between travel time to GP, rural–urban residence, and the first three primary outcomes (alarm symptoms, emergency admissions, and Dukes' stage). However, both longer travel and rural residence were significantly associated with better survival (0.81 and 0.71, P<0.01, respectively) (Table 2, model 4a and 4b).

The addition of an interaction term to each model (Table 2, models 1d–4d) showed that associations with travel time and each outcome differed between urban and rural patients. This difference was statistically significant for alarm symptoms (OR 0.62,

Table 2. Association between rurality, travel times to the GP, alarm symptoms, and primary outcomes

| Explanatory variables	1) Alarm symptoms OR (95% CI)	2) Emergency admission OR (95% CI)	3) Dukes' stages OR (95% CI)	4) Death within 3 years HR (95% CI)
	Outcome variables without interaction terms			
a) Travel time to GP	0.98 (0.84 to 1.14)	0.91 (0.75 to 1.09)	0.91 (0.78 to 1.07)	0.81[a] (0.72 to 0.92)
b) Rural	1.08 (0.80 to 1.46)	0.83 (0.58 to 1.18)	0.99 (0.72 to 1.34)	0.71[a] (0.57 to 0.88)
c) Alarm symptoms	N/A	0.36[b] (0.25 to 0.53)	0.85 (0.64 to 1.14)	1.15 (0.94 to 1.41)
	Outcome variables with interaction terms fitted			
d) Travel time to GP	1.34 (0.98 to 1.82)	0.62[b] (0.39 to 0.97)	0.94 (0.68 to 1.29)	0.75[b] (0.59 to 0.96)
Rural	1.62[b] (1.05 to 2.48)	0.61 (0.36 to 1.02)	1.11 (0.72 to 1.70)	0.69[b] (0.51 to 0.94)
Travel time/rurality interaction	0.62[b] (0.43 to 0.90)	1.69 (1.02 to 2.79)	0.95 (0.65 to 1.38)	1.18 (0.88 to 1.57)
Alarm symptoms	N/A	0.37[b] (0.26 to 0.54)	0.84 (0.63 to 1.12)	1.17 (0.95 to 1.43)
Age, years	1.00 (0.98 to 1.01)	1.02[b] (1.00 to 1.03)	0.97[a] (0.96 to 0.99)	1.03[a] (1.02 to 1.04)
Female	0.95 (0.72 to 1.23)	0.89 (0.63 to 1.24)	0.76 (0.57 to 1.01)	0.74[a] (0.60 to 0.90)
Index of deprivation (Carstairs)	0.99 (0.94 to 1.04)	0.99 (0.93 to 1.05)	1.05 (0.99 to 1.11)	1.02 (0.99 to 1.06)
0 comorbidities (Charlson score) (reference)	1	1	1	1
1–2 comorbidities (Charlson)	0.53[a] (0.39 to 0.71)	4.87[a] (3.27 to 7.26)	0.87 (0.63 to 1.19)	1.20 (0.95 to 1.50)
>3 comorbidities (Charlson)	0.29[a] (0.20 to 0.44)	7.26[a] (4.63 to 11.39)	1.44 (0.97 to 2.14)	2.53[a] (1.98 to 3.25)

[a]P<0.01. [b]P<0.05. Travel time is the predictor in 'a', rurality is the predictor in 'b', and alarm symptoms is the predictor in 'c'. Travel times are interacted with rurality in 'd'. All models are adjusted for age, sex, deprivation, and comorbidity. For brevity, the coefficients for the covariates are only shown in the models with the interaction term (d). HR = hazard ratio. N/A = not applicable. OR = odds ratio.

Figure 1. Differences in association between rural and urban areas, with and without interaction terms. 1a–4a show differences in association between rural and urban areas (from Table 2, models 1d–4d). The lines show modelled association between travel time and alarm symptoms (1a), emergency admission (2a), Dukes' stage (3a), and 3-year survival (4a). 1b–4b show the difference in the rural versus urban slope, along with 95% CIs. These differences are statistically significant where the CIs do not cross the zero line.

P<0.05) and emergency admissions (OR 1.69, P<0.05). As an example, Table 2, model 1d, shows that longer travel in urban areas increased the likelihood of presenting with alarm symptoms (OR 1.34, P = 0.06), but this likelihood was reduced in rural areas (OR 0.83, P = 0.08, obtained by multiplying OR of the estimate of travel time to GP with the interaction term). Conversely, longer travel time in urban areas reduced the likelihood of having an emergency admission (OR 0.62, P<0.05) (Table 2, model 2d), and of death within 3 years of diagnosis (HR 0.75, P<0.05) (Table 2, model 4d).

Figure 1 illustrates the output from Table 2, models 1d–4d. Figure 1 (1a–4a) shows the differences in association between rural and urban areas. The lines
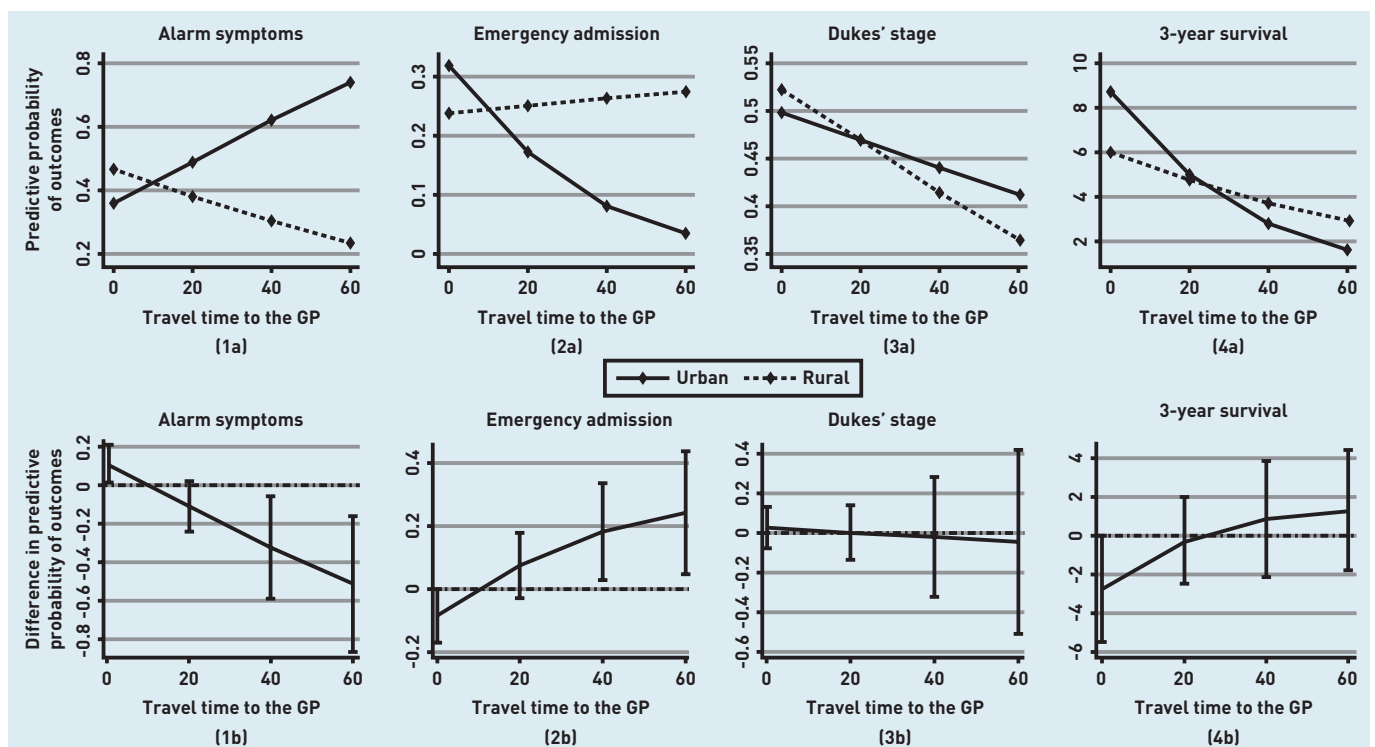
indicate modelled association between travel time and the primary outcomes. Figure 1 (1b–4b) shows the scale of the rural–urban difference in outcomes (solid line). This difference is statistically significance at the $P<0.05$ level where the 95% CI does not cross the zero marker (dashed line).

The odds of emergency admission were significantly lower in the presence of alarm symptoms (OR 0.36, $P<0.01$) (Table 2, model 2c). Alarm symptoms were not significantly associated with survival, and there was no significant interaction between alarm symptoms and rural residence in the models with emergency admission and survival as outcomes.

DISCUSSION
Summary
This study has examined the potential influence that rurality has on how patients present to their GP with symptomatic colorectal cancer and their subsequent outcomes. Additionally, the authors have considered how rurality, urbanity, and estimated travel time interact to influence the same outcomes. The authors believe this work is novel because it considers for the first time whether symptomatic presentation of colorectal cancer to GPs is different in rural compared with urban areas.

The study found that rural patients had superior 3-year survival than their urban counterparts (OR 0.71, $P<0.01$). The association between longer travel and the primary outcomes was opposite in rural areas to that observed in urban localities. The difference was statistically significant for alarm symptoms (OR 0.62, $P<0.05$) and emergency admissions (OR 1.69, $P<0.05$). The moderation by travel times was statistically significant in urban areas but not in rural areas, and may suggest that rural and urban patients may perceive geographical inaccessibility differently.[24] The presence of alarm symptoms significantly reduced the odds of emergency admissions (OR 0.36, $P<0.01$), and alarm symptoms were not associated with survival at 3 years.

Strengths and limitations
The study has several strengths. The sample has high levels of linkage to high-quality routine datasets that include all patients diagnosed within the study period. Record linkage has enabled a detailed analysis using clinical, demographic, and geographical information, and adjustment for a greater array of potential explanatory variables. Finally, the long follow-up period has made it possible to examine associations with long-term survival.

The study has a number of limitations. Except for survival analyses, it is a cross-sectional study; hence, the directions of cause and effect cannot be inferred. To allow for adequate follow-up of deaths, the data are based on diagnoses made more than a decade ago. Furthermore, defining symptoms as either alarm or non-alarm is problematic in the absence of information on symptom severity. For instance, the authors have grouped abdominal pain and anaemia as non-alarm symptoms, but severe cases of these symptoms may be alarming enough to instigate a GP consultation or referral to hospital. Another limitation is that the availability of public transport was not considered, although previous work suggests this is infrequently used by patients with cancer.[20]

Comparison with existing literature
Rural patients had better 3-year cancer survival, confirming some reports from the US of better cancer outcomes in rural areas.[11] Travelling farther to GPs in urban areas increased the odds of presenting with alarm symptoms. This supports the authors' hypothesis that poor access results in greater odds of cancer diagnosis resulting from an alarm symptom presentation. Patients presenting with alarm symptoms were less likely to be diagnosed with cancer following emergency admission, perhaps because patients with alarming symptoms are more likely to be referred using standard referral pathways.[13] Unlike a previous study that associated alarm symptoms with better survival,[25] this analysis could not confirm that finding.

The authors expected that travelling farther in rural areas would also have higher odds of a diagnosis after presenting with alarm symptoms, but found the opposite: longer travel time to GPs in rural areas reduced the odds of presenting with alarm symptoms. It is plausible that, at the onset of such symptoms, those with the poorest geographical access in rural areas will delay seeking health care in comparison with their urban counterparts. Such rural–urban differences may be driven by social cultural differences in health-seeking behaviour, where the most remote rural patients may be displaying stoicism when seeking help.[3,4,8,26] This may be supported by studies from northern Scotland that found rural patients were more likely to present later, had lower expectations of health care, and may pursue their care less tenaciously.[27,28]

Urban patients with shorter travel to their GP had the worst outcomes. This may be related to disadvantages among patients living in inner-city deprived areas. Although the authors controlled for area deprivation, the findings may suffer from residual confounding by deprivation; the Carstairs index may not fully capture individual-level deprivation. Furthermore, a measure of car ownership used in the index may not appropriately capture deprivation in rural areas where a car can be an essential possession.[29]

Implications for research and practice

The starting hypothesis was that living in rural areas and having longer travel to a GP would be associated with greater likelihood of obtaining a diagnosis from alarm symptoms, and via emergency admissions. This in turn would lead to later-stage colorectal cancer diagnosis and poorer 3-year survival. Unexpectedly, the authors found that rural patients and urban patients with longer travel generally had better outcomes, were less likely to have emergency presentations, and had better survival. The authors also found the association between longer travel, alarm symptoms, and emergency presentation was reversed between rural and urban areas.

The findings suggest that the interplay between attitudes and location is more complex than has previously been considered in research into cancer and rurality. Sociocultural attitudes and geographical location may influence how patients present to GPs with symptomatic colorectal cancer, and this may influence differences in outcomes in ways that may be counterintuitive. Most existing research has tended to make straight comparisons between urban and rural populations, or considered distance separately from constructs of rurality or urbanity. Future research should explore the mechanisms driving the interaction between location, access, and outcomes. Such mechanisms may include time delays occurring at various stages of the diagnostic pathway, such as patient, primary care, or system delays.[30]

These findings should reassure most rural patients with cancer and their GPs that where they live may not be conferring the widely perceived rural diagnostic and survival disadvantages. Longer travel in urban areas may also be associated with better outcomes. This has potential implications for urban GPs whose patients travel the least distance. Such patients are more likely to live in the inner cities and may experience other access barriers, such as longer delays due to larger GP list sizes. This has implications for defining catchment areas for urban practices that encapsulate travelling distances, as well as transport options. Considering these in the context of practice list size and appointment availability could facilitate more efficient and effective healthcare access and outcomes.

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REFERENCES

1. Jones AP, Haynes R, Sauerzapf V, *et al*. Travel time to hospital and treatment for breast, colon, rectum, lung, ovary and prostate cancer. *Eur J Cancer* 2008; **44(7):** 992–999.

2. Campbell NC, Elliott AM, Sharp L, *et al*. Rural factors and survival from cancer: analysis of Scottish cancer registrations. *Br J Cancer* 2000; **82(11):** 1863–1866.

3. Emery JD, Walter FM, Gray V, *et al*. Diagnosing cancer in the bush: a mixed-methods study of symptom appraisal and help-seeking behaviour in people with cancer from rural Western Australia. *Fam Pract* 2013; **30(3):** 294–301.

4. Douthit N, Kiv S, Dwolatzky T, Biswas S. Exposing some important barriers to health care access in the rural USA. *Public Health* 2015; **129(6):** 611–620.

5. Haynes RM, Bentham CG. The effects of accessibility on general practitioner consultations, out-patient attendances and in-patient admissions in Norfolk, England. *Soc Sci Med* 1982; **16(5):** 561–569.

6. Lau KKW, Rathinam S, Waller DA, Peake MD. The effects of increased provision of thoracic surgical specialists on the variation in lung cancer resection rate in England. *J Thorac Oncol* 2013; **8(1):** 68–72.

7. Crawford SM, Sauerzapf V, Haynes R, *et al*. Social and geographical factors affecting access to treatment of lung cancer. *Br J Cancer* 2009; **101(6):** 897–901.

8. Farmer J, Iversen L, Campbell NC, *et al*. Rural/urban differences in accounts of patients' initial decisions to consult primary care. *Health Place* 2006; **12(2):** 210–221.

9. Sladden MJ, Thomson AN. How do general practitioners manage rectal bleeding? *Aust Fam Physician* 1998; **27(1–2):** 78–82.

10. Campbell NC, Elliott AM, Sharp L, *et al*. Rural and urban differences in stage at diagnosis of colorectal and lung cancers. *Br J Cancer* 2001; **84(7):** 910–914.

11. McLafferty S, Wang F. Rural reversal? Rural–urban disparities in late-stage cancer risk in Illinois. *Cancer* 2009; **115(12):** 2755–2764.

12. McLafferty S, Fahui W, Lan L, Butler J. Rural–urban inequalities in late-stage breast cancer: spatial and social dimensions of risk and access. *Environ Plann B Plann Des* 2011; **38(4):** 726–740.

13. Jensen H, Tørring ML, Olesen F, *et al*. Cancer suspicion in general practice, urgent referral and time to diagnosis: a population-based GP survey and registry study. *BMC Cancer* 2014; **14(1):** 636.

14. Hamilton W. Five misconceptions in cancer diagnosis. *Br J Gen Pract* 2009; DOI: https://doi.org/10.3399/bjgp09X420860&#39.

15. Lyratzopoulos G, Wardle J, Rubin G. Rethinking diagnostic delay in cancer: how difficult is the diagnosis? *BMJ* 2014; **349:** g7400.

16. Vedsted P, Olesen F. Are the serious problems in cancer survival partly rooted in gatekeeper principles? An ecologic study. *Br J Gen Pract* 2011; DOI: https://10.3399/bjgp11X588484&#39.

17. Robertson R, Campbell NC, Smith S, *et al*. Factors influencing time from presentation to treatment of colorectal and breast cancer in urban and rural areas. *Br J Cancer* 2004; **90(8):** 1479–1485.

18. Murchie P, Raja EA, Brewster DH, *et al*. Time from first presentation in primary care to treatment of symptomatic colorectal cancer: effect on disease stage and survival. *Br J Cancer* 2014; **111(3):** 461–469.

19. Van Hout AMGH, de Wit NJ, Rutten FH, Peeters PHM. Determinants of patient's and doctor's delay in diagnosis and treatment of colorectal cancer. *Eur J Gastroenterol Hepatol* 2011; **23(11):** 1056–1063.

20. Haynes R, Jones A, Sauerzapf V, Zhao H. Validation of travel times to hospital estimated by GIS. *Int J Health Geogr* 2006; **5(1):** 40.

21. Scottish Executive. Scottish *Executive urban rural classification 2003–2004.* 2004. http://www.gov.scot/Publications/2004/06/19498/38787 (accessed 10 May 2017).

22. Morris R, Carstairs V. Which deprivation? A comparison of selected deprivation indexes. *J Public Health Med* 1991; **13(4):** 318–326.

23. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; **40(5):** 373–383.

24. Field KS, Briggs DJ. Socioeconomic and locational determinants of accessibility and utilization of primary health care. *Health Soc Care Community* 2001; **9(5):** 294–308.

25. Dregan A, Charlton J, Gulliford MC, Møller H. Are alarm symptoms predictive of cancer survival? Population-based cohort study. *Br J Gen Pract* 2013; DOI: https://10.3399/bjgp13X675197&#39.

26. Elliott-Schmidt R, Strong J. The concept of well-being in a rural setting: understanding health and illness. *Aust J Rural Health* 1997; **5(2):** 59–63.

27. Bain NSC, Campbell NC, Ritchie LD, Cassidy J. Striking the right balance in colorectal cancer care — a qualitative study of rural and urban patients. *Fam Pract* 2002; **19(4):** 369–374.

28. Bain NSC, Campbell NC. Treating patients with colorectal cancer in rural and urban areas: a qualitative study of the patients' perspective. *Fam Pract* 2000; **17(6):** 475–479.

29. Information Services Division Scotland. *Problems with the use of area classifications. The Carstairs and Morris Index.* 2010. http://www.isdscotland.org/Products-and-Services/GPD-Support/Deprivation/Carstairs/_docs/Carstairs-Problems-with-the-use-of-area-classifications.pdf (accessed 10 May 2017).

30. Neal RD. Do diagnostic delays in cancer matter? *Br J Cancer* 2009; **101(Suppl2):** S9–S12.