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The impact of rurality on patient experience and diagnostic pathway intervals in Scotland's cancer patients: Further results from a national cancer diagnosis audit

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ABSTRACT

Background: In Scotland 17 % of the population reside rurally and previous research has demonstrated worse cancer outcomes in this group. The underlying reason for this is unclear. This study aims to determine whether patient presenting factors, GP consultation factors or the diagnostic pathways differ between urban and rural patients within Scotland.

Methods: This study combined two Scottish National Cancer Diagnosis Audits. Participating GPs collected data on the diagnostic pathway from primary to secondary care for cancer patients diagnosed during the audit period. Using the Scottish Government Urban Rural Classification, patients were designated as rural or urban dwellers and compared in descriptive analyses. Key cancer intervals (primary, diagnostic, secondary and treatment interval) were compared between urban and rural dwellers with an additional adjusted analysis for the main cancer sites.

Results: A total of 4309 cancer diagnoses were included in the study; 22 % were in patients from rural locations. Rural patients had significantly more consultations and investigations prior to referral than their urban counterparts. There was no difference in prolonged cancer pathways between the two groups except in lung cancer patients where rural patients had a significantly increased odds of a diagnostic interval of >90 days.

Conclusion: Our findings suggest differences in the interaction between patients and GPs prior to referral in urban and rural settings. However, this does not appear to lead to prolonged patient pathways, except in lung cancer. Further research is needed to determine whether this delay is clinically significant and contributing to poorer outcomes in Scottish rural dwellers with lung cancer.

1. Introduction

The impact of living in a rural setting on cancer diagnosis and outcomes is complex and multifaceted. The weight of evidence suggests rural dwellers have worse survival outcomes compared with their urban counterparts [1], particularly for colorectal, lung and prostate cancer [2–7], although it's a mixed picture. One systematic review found rural cancer patients were 5 % less likely to survive than urban patients [8]. Conversely, other studies have found no-difference [9] or even a rural advantage - probably reflecting the complex interaction between geography and outcomes [4,10–13] and challenges conducting research in this area. Underlying reasons are not fully understood although several contributary factors have been suggested including travel burden and access to care, health service organisation and patient and doctor behaviours [8].

Travel burden has been found to influence patients' treatment options and choices [14–16] and decision-making, along with access to follow-up appointments and clinical trials [17]. It has also been linked with more advanced disease at diagnosis [5,15], although a recent Scottish and Danish study demonstrated mixed results - an inverse U-shaped relationship in Scotland whereby patients had an increased odds of advanced disease and one year mortality up to 40 min travel

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time to hospital with reducing odds thereafter. This effect wasn't seen in Danish patients [18]. In Northeast Scotland, individuals with longer travel times to the regional cancer centre were diagnosed and received treatment quicker despite worse outcomes [18,19], suggesting time to diagnosis and treatment may not be the most important cause of the apparent rural cancer survival disadvantage. These studies reflect the likely complex relationship between travel burden, the experience of cancer and patients' outcomes.

Rural patients have also been demonstrated to have lower uptake of cancer screening globally [20,21], although this effect has not been seen within the UK [22,23] with few published studies. Interestingly colorectal cancer patients living rurally were more likely to be diagnosed via screening than their urban counterparts in NE Scotland [9].

In Scotland 17 % of the population reside rurally [24] and so it is important, in informing policy, to explore how travel burden influences cancer diagnosis, treatment and outcomes. Primary care is the first point of contact within the NHS in Scotland and over 70 % of cancer cases present first to GPs [25]. Understanding the impact of rurality on the interaction between patients and primary care as the usual first step in achieving a cancer diagnosis could provide important insights into the potential mechanisms that lead to worse cancer outcomes for Scottish rural-dwelling patients [7,18,19].

Two National Cancer Diagnosis Audits (NCDA) have been undertaken in Scotland – providing granular data on the cancer diagnostic pathway from primary care with the aim to support service improvement. The first collected data on cancers diagnosed in 2014, and the second from October 2018 to September 2019 inclusive. In 2020 Murchie et al. analysed the geographical impact on cancer diagnosis utilising the first cohort of patients [26]. They found no difference in the route to diagnosis in urban and rural patients or evidence of pathway delays. However, they did find rural patients were more likely to have alarm features at presentation and more visits and blood tests ordered by the GP prior to referral. They postulated that GPs in a rural setting may investigate patients more fully prior to referral.

The current paper aims to develop these findings further by combing both NCDA datasets to include 4332 cancer patients across Scotland. This provides an opportunity to examine whether patient presenting factors, GP consultation factors or the diagnostic pathways differ between rural and urban patients.

2. Methods

The audit and analysis were approved by the Public Benefit and Privacy Panel (PBPP) of NHS Scotland and overseen by a Scottish steering group with representatives from Cancer Research UK, the Scottish Primary Care Cancer Group, Macmillan Cancer Support, Scottish Government, Royal College of General Practitioners, a Patient Representative, academics and Public Health Scotland.

2.1. Study population and data collection

This study combined data from two NCDA datasets; the first collected information on new primary cancers diagnosed in participating practices in Scotland between January 1st and December 31st 2014, the second between October 1st 2018 and September 30th 2019.

Volunteer general practices were recruited following promotion of the audit by the Royal College of General Practitioners and Cancer Research UK. There were different practices in each of the two audits.

Analysts from the Information Services Division (ISD) of NHS Scotland assigned all incident cancers (excluding non-melanoma skin cancer) diagnosed in the practice populations during the study period to each recruited GP practice. Each practice completed a Caldicott Data release form to permit data sharing from practice-held electronic primary care records with ISD. A prepopulated Microsoft Excel form for each individual cancer case was sent securely to a lead GP at each participating practice who then coordinated their completion. These were de-identified and returned securely to ISD.

The Microsoft Excel form included tick boxes and drop-down menus with pre-defined answers, except for dates which were manually entered. Information collected included: patient socio-demographic characteristics; presence of any co-morbidities (categorised into 0, 1, 2 and 3 or more); presenting signs and symptoms; number of primary care consultations and primary care led investigations relevant to the ultimate cancer diagnosis; type of referral from primary care or other means of detection; key dates including first presentation, referral, secondary care appointment and treatment initiation; presence of documented safety netting (guidance on when to re-present or follow up appointments); and whether the individual completing the form judged there to have been avoidable delay to diagnosis.

On receipt of the de-identified data collection forms ISD added available information on cancer type, date of diagnosis, stage and grade at diagnosis using linkage to the Scottish Cancer Registry (SCR) dataset with the patients CHI number (the CHI number is a unique 10-character numeric identifier, allocated to all patients in Scotland). Scottish Index of Multiple Deprivation (SIMD) quintile and Urban-Rural 2-fold classification (Fig. 1) were also assigned based on patient postcode at diagnosis [27] (Fig. 1).

Data were submitted and managed by eDRIS and made available to researchers via the Scottish National Data-Safe Haven.

2.2. Analysis

All analyses were conducted using SPSS version 27.

The distribution of characteristics including sex, age group, cancer site, cancer stage, SIMD category and comorbidities in patients classified as rural were compared with patients classified as urban using the combined data set.

Other key variables detailing the route to diagnosis were grouped using the urban rural classification including number of consultations relevant to the ultimate cancer diagnosis (0, 1, 2 or 3 +), reasons for multiple consultations, referral type, number of signs and symptoms at presentation, presence of alarm features and presence of perceived safety netting by the completing GP and analysed using the Chi-squared test.

Patients were assigned to a category of 'alarm symptoms at presentation' if any of their presenting symptoms aligned with the Scottish cancer referral guidelines criteria for an urgent suspected cancer referral [28].

Key pathway intervals were calculated for the whole cohort [29]. The primary care interval (PCI) was calculated from date of first presentation to primary care with symptoms relevant to the ultimate cancer diagnosis (as judged by the GP completing the proforma), to date of first referral to secondary care. The diagnostic interval (DI) was calculated from date of first presentation as above to date of diagnosis recorded in the Scottish Cancer Registry. The secondary care interval (SCI) measured the number of days between GP referral to date of diagnosis and the treatment Interval (TI) measured the number of days between diagnosis and commencement of treatment. Intervals of < 0 and > 730 days were excluded as per previous studies [25,26]. Medians and inter-quartile ranges were calculated alongside the proportion of patients with intervals of more than 60 or 90 days.

Medians for the four key pathway intervals described above for urban and rural groups were compared, using the medians test. To explore the proportion of prolonged primary care pathway intervals univariate odds (rural vs urban) of having an interval more than 60 and more than 90 days were calculated using univariate binary logistic regression in SPSS V.27 for the PCI and DI.

To adjust for potential confounding and the impact of cancer site a further analysis was completed analysing the median PCI and DI and the proportion of individuals with prolonged pathways ($>$60 days and $>$90 days) for the five main cancer types (colorectal, lung and bronchus, prostate, breast, ovarian/gynaecological cancers) and 'other' in the rural

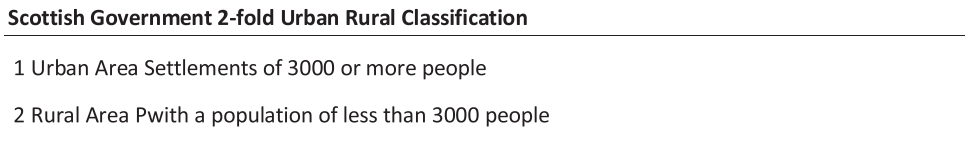

Fig. 1. Scottish Government 2-fold Urban Rural Classification.

and urban groups. Analysis was completed as described above with an additional multivariable analysis to calculate the adjusted odds (rural vs urban) for each interval being prolonged > 60 and > 90 days, adjusting for SIMD, sex, presence of red flags and presence of comorbidities.

3. Results

A total of 4332 cancer diagnoses were included across the two audits. The first NCDA included data from 73 Scottish GP practices on 2014 cancer diagnoses established between 1st January and 31st December 2014. The second NCDA included data from 90 Scottish GP practices on 2318 cancer diagnoses established between 1st October 2018–30 th September 2019. Nineteen practices participated in both audits. A total of 4309 cancer diagnoses were included in the urban rural analysis in this study.

3.1. Patient characteristics

In the combined dataset 3348 (78 %) patients lived in an urban setting, and 961 (22 %) lived rurally. There was a higher proportion of men in the rural than the urban sample (52.9 % vs 48.2 %) (Table 1). The distribution of cancer sites also differed; lung cancer accounted for 18 % of urban vs 13 % of rural diagnoses whereas prostate cancer accounted for 11 % of urban vs 14 % of rural diagnoses. Those living rurally were significantly less-deprived with only 6.8 % in SIMD 1 (most deprived) compared to 25.5 % of urban-dwellers. The number of co-morbidities, age categories and stage of cancer at diagnosis was similar between urban and rural groups.

3.2. Routes to diagnosis

Rural patients had significantly more GP consultations before referral with 24.2 % of patients having 3 or more consultations vs 18 % of urban patients (Table 2). The most common reason described for multiple consultations in both groups was 'complexity of presentation'. There was no difference in the type of referral or emergency presentations between urban and rural groups. Rural GPs were significantly more likely to have perceived a delay in the diagnostic pathway than

Table 1
Characteristics of patients by Urban Rural Classification.

				Urban Rural Classification				
		Total		Urban		Rural		Sig.[1]
		N	%	N	%	N	%	
Total		**4309**	**100**	**3348**	**100**	**961**	**100**	
Sex	Male	2122	49.2	1614	48.2	508	52.9	0.011
	Female	2187	50.8	1734	51.8	453	47.1	
Age Categories (Years)	0–24 years	39	0.9	32	1.0	7	0.7	0.121
	25–49 years	392	9.1	316	9.4	76	7.9	
	50–64 years	1123	26.1	880	26.3	243	25.3	
	65–74 years	1271	29.5	954	28.5	317	33.0	
	75–84 years	1087	25.2	850	25.4	237	24.7	
	85 years and above	397	9.2	316	9.4	81	8.4	
SIMD category (based on quintiles)	1 (most deprived)	918	21.3	853	25.5	65	6.8	< 0.001
	2	821	19.1	678	20.3	143	14.9	
	3	781	18.1	507	15.1	274	28.5	
	4	879	20.4	511	15.3	368	38.3	
	5 (least deprived)	384	8.9	335	10.0	49	5.1	
	Missing	526	12.2	464	13.9	62	6.5	
Cancer site	Head and neck	122	2.8	101	3.0	21	2.2	0.029
	Upper GI	247	5.7	194	5.8	53	5.5	
	Colorectal	597	13.9	466	13.9	131	13.6	
	Liver and bile ducts	110	2.6	86	2.6	24	2.5	
	Pancreatic	106	2.5	78	2.3	28	2.9	
	Lung and bronchus	728	16.9	603	18.0	125	13.0	
	Melanoma	193	4.5	154	4.6	39	4.1	
	Breast	562	13	442	13.2	120	12.5	
	Gynaecological	264	6.1	204	6.1	60	6.2	
	Prostate	509	11.8	371	11.1	138	14.4	
	Urological	251	5.8	184	5.5	67	7.0	
	Haematological	315	7.3	228	6.8	87	9.1	
	Other	305	7.1	237	7.1	68	7.1	
Comorbidity Category	No comorbidities	1086	25.4	846	25.5	240	25.1	0.994
	One comorbidity	1236	28.9	958	28.9	278	29.1	
	Two comorbidities	1012	23.7	784	23.6	228	23.9	
	Three or more comorbidities	939	22	730	22.0	209	21.9	
	Missing	36	0.84	30	0.90	6	0.62	
Stage	1	705	16.4	562	16.8	143	14.9	0.964
	2	612	14.2	478	14.3	134	13.9	
	3	591	13.7	442	13.2	149	15.5	
	4	951	22.1	742	22.2	209	21.7	
	Missing	1450	33.7	*1124*	*33.6*	*326*	*33.9*	

[1]Pearson's Chi—Squared Test.

Table 2
Diagnostic process by Urban Rural Classification.

		Urban Rural Classification						
		Urban		Rural		Total		
		N	%	N	%	N	%	Sig[1]
Total		**3348**	**100**	**961**	**100**	**4309**	**100**	
Number of consultations	0	618	18.5	145	15.1	763	17.7	
	1	1205	36.0	345	35.9	1550	36.0	
	2	648	19.4	169	17.6	817	19.0	
	3 or more	603	18.0	233	24.2	836	19.4	<0.001
	Missing	*274*	*8.2*	*69*	*7.2*	*343*	*7.9*	
Reason for multiple consultations	Multiple consultations due to complexity of presentation	483	14.4	190	19.8	673	15.6	<0.001
	Multiple consultations due to a patient factor	88	2.6	37	3.9	125	2.9	0.047
	Multiple consultations due to a GP factor	96	2.9	46	4.8	142	3.3	0.003
	Multiple consultations due to a diagnostic process factor	287	8.6	115	12.0	402	9.3	0.001
	Multiple consultations due to another or unknown factor	108	3.2	35	3.6	143	3.3	0.525
Type of referral leading to cancer diagnosis	Routine	312	9.4	85	8.9	397	9.3	0.149
	Urgent - not for suspected cancer	298	9.0	96	10.1	394	9.2	
	USC - urgent suspected cancer	1329	40.1	411	43.1	1740	40.8	
	Referral to private health clinic	37	1.1	17	1.8	54	1.3	
	Emergency referral (including patient self-referral)	672	20.3	170	17.8	842	19.7	
	Screening detected	210	6.3	57	6.0	267	6.3	
	Other	221	6.7	66	6.9	287	6.7	
	Direct access test and upgrade	16	0.5	<5	XX	XX	XX	
	MDC (Multidisciplinary Diagnostic Centre)	10	0.3	<5	XX	XX	XX	
	Not known	211	6.4	47	4.9	258	6.0	
GP perceived delay in diagnostic pathway	Yes	909	27.4	334	35.0	1243	29.1	<0.001
	No	1956	59.0	522	54.8	2478	58.0	
	Not known	452	13.6	97	10.2	549	12.9	
	Missing	*31*	*0.93*	*8*	*0.83*	*39*	*0.91*	

[1]Pearson's Chi—Squared Test.

urban GPs (35 % vs 27.4 % $p < 0.001$).

3.3. Consultation characteristics

There was no difference in the number of symptoms or presence of positive examination findings at presentation between urban and rural patients (Table 3).

Rural GPs were significantly more likely to have completed blood tests or imaging prior to referral (49 vs 40 %) and (25 % vs 20 %) respectively (Table 4). This trend was sustained across the major cancer types (Supplementary Table 1). 64 % of GPs in rural areas organised imaging in lung cancer patient's vs 48 % of GPs in urban areas.

Rural GPs were significantly more likely to have deemed safety netting to have taken place than urban GPs (36.2 % vs 34.9 % $p = 0.014$) (Table 3).

3.4. Key cancer intervals- primary care interval

The median PCI in the combined dataset for all cancer types was longer for rural patients (7 vs 3 days, $p < 0.001$) (Table 5). When looking at each of the cancer sites individually there was no difference in the median PCI in patients with colorectal, breast, prostate, and gynaecological cancers. However, there was a significantly increased median PCI in rural lung cancer patients and a non-significant increase in rural patients with 'other' cancers (Table 6).

The odds of a prolonged primary care interval (longer than 60 days or longer than 90 days) was also significantly higher in rural patients in unadjusted analysis [OR 1.36 (1.05–1.77)] and [OR 1.49 (1.10–2.01)] respectively (Table 5). However, an additional analysis looking at prolonged intervals for the individual cancer types found that after adjusting for co-morbidity, sex, presence of red-flag symptoms and SIMD, patients diagnosed with colorectal, breast, prostate, ovarian/gynaecological, or 'other' cancers did not have an increased odds of having a PCI of > 60 or > 90 days (Table 6).

Table 3
Consultation characteristics by Urban Rural Classification.

		Urban Rural Classification						
		Urban		Rural		Total		Sig.
		N	%	N	%	N	%	
Total		**3348**	**100**	**961**	**100**	**4309**	**100**	
Number of symptoms at presentation	0	66	2.0	21	2.2	87	2	p = 0.660
	1	1863	55.6	513	53.4	2376	55.1	
	2	740	22.1	223	23.2	963	22.3	
	3 or more	679	20.2	204	21.2	883	20.5	
Positive examination signs at presentation	Yes	326	20.3	115	24.4	440	21.2	
	No	1276	79.7	357	75.6	1633	78.8	p = 0.061
Presence of alarm symptoms	Yes	2448	73.1	727	75.7	3175	73.68	
	No	900	26.9	234	24.3	1134	26.3	p = 0.116
Did safety-netting occur?	Yes	1167	34.9	348	36.2	1515	35.2	p = 0.014
	No	507	15.1	165	17.2	672	15.6	
	Not known	945	28.2	222	23.1	1167	27.1	
	Not applicable	729	21.8	226	23.5	955	22.2	

Pearson's Chi-Squared Test

Table 4
Investigations undertaken prior to referral by Urban Rural Classification.

		2-Fold Urban Rural Classification						
		Urban		Rural		Total		Sig.[1]
		N	%	N	%	N	%	
Total		3220	96.2	907	94.3	4127	95.8	
Had GP initiated blood test	Yes	1272	40	440	49	1712	41	p = <.001
	No	1948	60	467	51	2415	59	
Had GP initiated imaging	Yes	647	20	231	25	878	21	p = <.001
	No	2573	80	676	75	3249	79	
Had GP initiated endoscopy	Yes	91	3	26	3	117	3	p = 0.950
	No	3129	97	881	97	4010	97	
Had GP initiated urine cytology	Yes	62	2	14	2	76	2	p = 0.450
	No	3158	98	893	98	4051	98	
Had 'other' GP initiated investigation	Yes	125	4	41	5	166	4	p = 0.387
	No	3095	96	866	95	3961	96	
Had GP initiated symptomatic fit test*	Yes	54	3	12	2	66	3	p = 0.551
	No	1756	97	473	98	2229	97	

[1]Pearson's chi-squared test
*only included in 2019 questionnaire (total urban 1810 total rural 485)

Table 5
Overall Key Cancer Journey Intervals by Urban Rural Classification.

Key Diagnostic Intervals	Urban	Rural	Sig[1]	Sig[2]	Unadjusted Odds Ratio (CI)
Primary Care Interval	N = 2190	N = 676			
Median Interval days (IQR)	3 (0–21)	7 (0–29)	<0.001		
> 60 days N (%)	227 (10.4 %)	92 (13.6 %)		0.019	1.362 (1.05–1.77)
> 90 days N (%)	151 (6.9 %)	67 (9.9 %)		0.010	1.486 (1.10–2.01)
Diagnostic Interval	N = 2590	N = 777			
Median Interval days (IQR)	27 (11–61)	33 (13–71)	0.001		
> 60 days N (%)	654 (25.3)	227 (29.2)		0.028	1.22 (1.02–1.46)
> 90 days N (%)	420 (16.2)	149 (19.2)		0.054	1.23 (1.00–1.51)
Secondary Care Interval	N = 1915	N = 961			
Median Interval days (IQR)	63 (36–105)	64 (36–110)	0.459		
Treatment Interval	N = 2608	N = 765			
Median Interval days (IQR)	41 (20–71)	39 (18–68)	0.328		
Overall Interval	N = 2155	N = 650			
Median Interval days (IQR)	71 (41–125)	77 (45–140)	0.092		

[1]Mann-Whitney U test [2]Unadjusted logistic regression

3.5. Kay cancer intervals- diagnostic interval

The overall median DI for all cancers combined was significantly longer for rural patients (33 vs 27 days (p = 0.001)) (Table 5). When analysing by cancer site a non-significant trend towards a longer DI was found in colorectal, lung and gynaecological cancer types and a significantly longer DI in the 'other' cancer category (31 vs 25 p = 0.014) (Table 7).

Unadjusted analysis of the increased odds of a prolonged diagnostic interval for all cancer types showed rural patients had an increased odds of a diagnostic interval > 60 days OR 1.22 (1.02–1.46). There was no statistically significant difference in the prolonged DI category (>90 days) between urban and rural patients. However, in adjusted analyses looking at the individual cancer types, individuals with lung cancer had a significantly increased odds of having a diagnostic interval of > 90 days compared to urban patients OR 2.02 (1.17–3.49).

3.6. Key cancer intervals- secondary care and treatment interval

The median secondary care interval (64 vs 63 p = 0.459) and treatment interval (39 vs 41 p = 0.328) were similar in both groups.

4. Discussion

4.1. Summary of key findings

In this study we used combined data from two national cancer diagnosis audits to analyse the impact of rurality on the cancer diagnostic pathway in Scotland. Rural patients were significantly more likely to have multiple GP consultations and be investigated by their GP with blood tests and imaging prior to referral. Rural GPs were also more likely to perceive that patient's experienced avoidable delays in their cancer journey.

Patients living rurally had longer median PCI and DI by a matter of days, which may be related to the aforementioned increased use of investigations prior to referral by rural GPs and seems unlikely to be clinically significant. There was no increase in prolonged patient pathways (>60 or >90 days) in rural patients for either the PCI or DI in any of the cancer types except lung cancer where the odds of having a prolonged diagnostic interval of > 90 days was significantly increased in rural patients.

4.2. Comparison with other literature

This study complements the analysis of the first NCDA in Scotland which found that rural GPs were more likely to investigate cancer patients prior to referral [26]. Interestingly, when primary care practitioners (PCPs) were surveyed in a large international study, rural PCPs described significantly less access to imaging including x-ray and ultrasound than their urban counterparts [30], perhaps contradicting our results that rural GPs organised more imaging prior to referral, although the study included countries where the scale of rurality and remoteness may have been different to Scotland. The increased use of tests prior to referral seen in our study may be due to rural GPs perceiving their patients 'prefer being looked after by their GP' - and a recognition that further investigations for cancer have a higher burden for rural patients

Table 6
Primary Care Interval for each individual cancer site.

Primary Care Interval	Urban Rural Classification						
	Urban	Rural	Sig[1]	Sig[2]	Unadjusted OR (95 % CI)	Sig[3]	Adjusted OR (95 % CI)
Colorectal							
Total N (Valid N)	466 (284)	131 (86)					
Median Interval (IQR)	6 (0–21)	6 (0–21)	0.975				
> 60 days N (%)	40 (14.1)	12 (14)		0.976	0.99 (0.49–1.98)	0.932	0.97 (0.46–2.07)
> 90 days N (%)	32 (11.3)	8 (9.3)		0.608	0.81 (0.36–1.83)	0.510	0.74 (0.31–1.80)
Lung & Bronchus							
Total N (Valid N)	603 (360)	125 (87)					
Median Interval (IQR)	9 (0–31)	16 (5–42)	0.048				
> 60 days N (%)	42 (11.7)	17 (19.5)		0.0515	1.84 (0.99–3.14)	0.474	1.28 (0.66–2.49)
> 90 days N (%)	20 (5.6)	12 (13.8)		0.0075	2.72 (1.28–5.81)	0.135	1.88 (0.82–4.30)
Breast							
Total N (Valid N)	442 (284)	120 (82)					
Median Interval (IQR)	0 (0–1)	0 (0–1)	0.936				
> 60 days N (%)	11 (3.9)	*		0.692	0.84 (0.34–2.04)	0.596	0.64 (0.12–3.31)
> 90 days N (%)	7 (2.5)	*		0.562	1.50 (0.38–5.95)	0.998	0.99 (0.17–5.92)
Prostate							
Total N (Valid N)	371 (270)	138 (103)					
Median Interval (IQR)	13.5 (3–30)	13 (7–37)	0.974				
> 60days N (%)	35 (13)	14 (13.6)		0.872	1.06 (0.54–2.06)	0.914	0.96 (0.46–2.02)
> 90 days N (%)	27 (10)	11 (10.7)		0.846	1.08 (0.51–2.26)	0.903	0.96 (0.43–2.11)
Ovarian/Gynae							
Total N (Valid N)	204 (145)	60 (51)					
Median Interval (IQR)	2 (0–12)	2 (0–13)	0.968				
> 60 days N (%)	9 (6.2)	*		0.395	1.64 (0.52–5.15)	0.177	2.58 (0.65–10.21)
> 90 days N (%)	5 (3.4)	*		0.209	2.38 (0.61–9.24)	0.063	5.30 (0.91–30.81)
Other							
Total N (Valid N)	1262 (847)	387 (267)					
Median Interval (IQR)	3 (0–22)	7 (0–33)	0.053				
> 60 days N (%)	90 (10.6)	41 (15.4)		0.037	1.53 (1.03–2.27)	0.215	1.34 (0.84–2.14)
> 90 days N (%)	60 (7.1)	29 (10.9)		0.049	1.60 (1.00–2.55)	0.213	1.42 (0.82–2.49)

[1] Mann-Whitney U-test; [2] Unadjusted logistic regression; [3] Logistic regression adjusted for comorbidities (0,1,2 or more), sex, red flag symptoms (as defined in introduction), SIMD

both in terms of increased travel and costs [30]. Consequently, rural GPs may attempt to be 'more certain' by utilising additional tests prior to referral. A Scottish study looking at excision rate of melanomas in primary care found an increased odds of primary care led excisions with increasing rurality [31]. This may suggest a desire of rural GPs to manage 'in house'.

In addition, rural patients have described a greater expectation of primary care availability and a stronger relationship with their GPs [32]. This may account for the higher number of consultations prior to referral seen in our study as rural primary care is deemed more accessible by patients.

Our study found no difference in the type of referral or percentage of emergency presentations between urban and rural patients. This differs to research conducted in England which found a significantly higher rate of emergency presentations in patients with increasing travel distance to the GP and, conversely, significantly lower rates in patients with two week wait referrals [33]. This discrepancy in findings highlights the challenges when defining rurality and comparing studies using different definitions. In our study whilst patients may have been defined as 'rural' our definition did not include travel distance from the GP practice, which in some rural communities may be very short. Therefore, perhaps accessibility is more important than rurality in promoting early engagement with services – as postulated by Murage et al. [33].

The previous analysis of the first NCDA found a longer PCI and DI in rural patients, but it was not statistically significant - perhaps due to its smaller sample size [26]. In contrast, this larger analysis demonstrated a statistically significant longer median primary care and diagnostic intervals in those residing in rural areas, predominately driven by lung and 'other' cancers. In keeping with our findings, a Danish study found a longer travel distance to the diagnosing hospital was associated with longer diagnostic intervals, driven by 'harder to diagnose' cancers (including lung and bronchus cancers) [34]. This supports the finding in our analysis that rural patients with lung and bronchus cancers are disproportionately affected by prolonged delays.

The impact of cancer intervals on outcomes is complex and does vary by cancer site and aggressiveness of the cancers [18,35–38]. A shorter diagnostic interval may be a consequence of an accelerated diagnosis due to disease severity and associated emergency presentation, with subsequent worse outcomes. However prolonged pathways to diagnosis have been associated with advanced stage and increased mortality for several cancer types [39,40]. Our study analysed 'prolonged pathways' which included either a PCI or DI of > 60 or > 90 days which is more likely to be impactful on cancer outcomes. Torring et al. [39] demonstrated, in lung cancer, decreasing odds of advanced disease with increasing primary care interval – while for secondary care intervals these was a U-shaped association. They found a turning point at around 90 days for the secondary care interval where the odds of advanced disease in lung cancer started to increase. Therefore, our finding that rural lung cancer patients have increased odds of a prolonged diagnostic interval > 90 days may be clinically important and partly explain poorer lung cancer outcomes for rural lung cancer patients in Scotland [6,41].

4.3. Strengths and limitations

A strength of this study is its unique linkage of routine and primary care data from multiple participating practices throughout Scotland and its inclusion of information only available from patients' primary care records. It also includes judgements made by participating GPs. This enables an important, GP-reported insight into the patient cancer journey and the patient doctor interaction within primary care - for example on the number and type of investigations in primary care prior to referral. In addition, because GPs completed the forms themselves, they were able to provide an important, albeit subjective view as to whether an avoidable delay in the patient's journey existed - data which

Table 7
Diagnostic Interval for each individual cancer site.

Diagnostic Interval	Urban Rural Classification						
	Urban	Rural	Sig[1]	Sig[2]	Unadjusted OR (95 % CI)	Sig	Adjusted OR (95 %CI)
Colorectal							
Total N (Valid N)	466 (347)	131 (98)					
Median Interval (IQR)	33 (14–79)	41 (14–114)	0.409				
> 60 days N (%)	110 (31.7)	34 (34.7)		0.576	1.15 (0.71–1.84)	0.537	1.18 (0.70–2.01)
> 90 days N (%)	75 (21.6)	25 (25.5)		0.415	1.24 (0.74–2.09)	0.439	1.26 (0.70–2.27)
Lung & Bronchus							
Total N (Valid N)	603 (461)	125 (102)					
Median Interval (IQR)	24 (6–54)	32.5 (13–93)	0.155				
> 60 days N (%)	99 (21.5)	34 (33.3)		0.011	1.83 (1.15–2.92)	0.059	1.61 (0.98–2.64)
> 90 days N (%)	59 (12.8)	27 (26.5)		0.001	2.45 (1.46–4.12)	0.012	2.02 (1.17–3.49)
Breast							
Total N (Valid N)	442 (324)	125 (102)					
Median Interval (IQR)	18 (10–31)	20 (12–29)	0.417				
> 60 days	19 (5.9)	7 (7.4)		0.594	1.28 (0.52–3.14)	0.503	1.43 (0.51–4.01)
> 90 days	10 (3.1)	*		0.972	1.02 (0.28–3.80)	0.974	1.03 (0.20–5.29)
Prostate							
Total N (Valid N)	371 (288)	138 (104)					
Median Interval (IQR)	51.5 (22–1102.5)	49 (29.5–82)	0.652				
> 60days N (%)	126 (43.8)	38 (36.5)		0.202	0.74 (0.47–1.18)	0.163	0.69 (0.42–1.16)
> 90 days N (%)	86 (29.9)	24 (23.1)		0.188	0.71 (0.42–1.19)	0.134	0.65 (0.37–1.14)
Ovarian/Gynae							
Total N (Valid N)	204 (166)	60 (56)					
Median Interval (IQR)	27 (13–57)	41 (12–63.5)	0.122				
> 60 days N (%)	37 (22.3)	16 (28.6)		0.342	1.40 (0.70–2.77)	0.425	1.35 (0.64–2.84)
> 90 days N (%)	20 (12)	*		0.274	1.59 (0.69–3.63)	0.492	1.37 (0.56–3.34)
Other							
Total N (Valid N)	1262 (1004)	387 (322)					
Median Interval (IQR)	25 (9.5–63)	31 (11–76)	0.014				
> 60 days N (%)	263 (26.2)	98 (30.4)		0.137	1.23 (0.94–1.62)	0.214	1.22 (0.89–1.66)
> 90 days N (%)	170 (16.9)	60 (18.6)		0.483	1.12 (0.81–1.56)	0.726	1.07 (0.74–1.55)

[1] Mann-Whitney U-test; [2] Unadjusted logistic regression; [3] Logistic regression adjusted for comorbidities (0,1,2 or more), sex, red flag symptoms (as defined in introduction), SIMD

otherwise would be difficult to produce reliably at any scale.

Cancer cases were centrally allocated to practices reducing the possibility of selection bias. However, our data depended on participating GPs' interpretation of the questions on the collection forms - and GPs may have provided responses designed to reflect favourably on their own practice. However, we believe these limitations arising from self-report will have had minimal impact; most of the data collected were objective and collected via a structured data collection form making this bias less likely.

The Scottish government's Urban Rural classification is sufficiently robust and detailed to reflect how several dimensions of rurality could impact on a patients' experience of healthcare and is, we believe, fit for purpose in examining how rurality impacts patients' cancer journeys. We would add the caveat that the Scottish 6-fold and 8-fold classifications afford greater granularity. However, given our current sample size and the distribution of the Scottish population, this would have led to unbalanced numbers across categories. Further, we believe the two-fold categorization captures the main concept of urbanity versus rurality, differences in proximity to people and services, and is most useful for meaningful international comparisons.

A further strength of this study is its inclusion of data on all cancer types, reflecting the mix of presentations seen within primary care. We recognised that by including such a heterogenous group of cancers with markedly different journeys it would be difficult to reliably analyse the cancer pathway intervals in the complete dataset. We therefore looked at the five main cancer sites individually to interpret the data more accurately and assess the impact of rurality on prolonged pathways.

Our findings of rural-urban differences may have arisen through unequal levels of deprivation in the two groups – a common criticism of studies examining health impacts of rurality. We did, however, use robust methods in adjusting for socioeconomic status (SES) and conclude this would have a minimal impact on our findings.

Our finding that rural GPs investigated more prior to referral with blood tests and imaging was confirmed when analysing each cancer type individually, removing the possibility that cancer mix influenced this result. The lower numbers of lung cancer patients within the rural group despite higher numbers of imaging tests being ordered suggests that rural GPs' increased use of imaging might in fact be under-represented in our pooled analysis.

Importantly, the data in this study were collected on patients diagnosed with cancer prior to the covid pandemic, so we've been unable to capture the known impact of the pandemic on cancer referrals. It is possible that with the increase of remote consultation in primary and secondary care, changes in health seeking behaviours, and changes to the rural general practice workforce resulting from the pandemic, there may be a lasting effect which requires more detailed investigation.

4.4. Implications for future research

Our finding that rural GPs are more likely to investigate patients prior to referral needs further exploration to determine whether this is causing unnecessary delays and impacting patient outcomes – alternatively it may reflect appropriate 'gatekeeping' with improved cancer-detection rates from referrals and reduced waiting times in secondary care.

Rural patients with lung cancer were found to be particularly impacted with a longer PCI and increased odds of having a longer diagnostic interval of > 90 days which could be clinically important. Evaluating differences in pathways available to urban and rural GPs for investigating lung cancer would help inform any policy change. Early

cancer diagnostic centres (ECDCs) are currently being trialled within Scotland; previous research in to ECDC effectiveness has found 20 % of cancer diagnoses in these sites is attributed to lung cancer [42]. Therefore, understanding how these diagnostic centres can be accessible to the 17 % of rural patients within Scotland is crucial as this could be a means of improving lung cancer outcomes in our rural communities.

Additionally, lung cancer screening is also being piloted within Scotland [43] and particular attention should be paid on how to engage rural communities in this new form of screening.

As our data did not capture the effect of the covid pandemic, a further NCDA with urban-rural analysis would give an up-to-date picture of cancer diagnosis in Scotland during the post pandemic recovery.

5. Conclusion

Results from the analysis of two Scottish cancer diagnosis audits found that rural patients have a longer PCI and DI by a matter of days which is unlikely to account for the poorer outcomes in these patients. In adjusted analysis, there is no increase in prolonged delays (>60 or >90 days) for rural patients, except for in lung and bronchus cancers. Further research is needed into the impact of rurality on lung cancer outcomes within Scotland and whether our finding that rural lung cancer patients are more likely to have a prolonged diagnostic interval of > 90 days is impactful. This should include research on the entire cancer pathway-from the development of symptoms to survivor care.

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CRediT authorship contribution statement

Peter Murchie: Conceptualisation; formal analysis; writing- original draft preparation, reviewing and editing; supervision. **Susanne Maxwell**: writing- original draft preparation, reviewing and editing. **Mary Kynn:** writing- original draft preparation, reviewing and editing. **Lesley Anderson:** writing-original draft preparation, reviewing and editing. **David Weller:** conceptualisation, writing, reviewing and editing.

Ethical approval

The 1st NCDA in Scotland received approval from the Public Benefit and Privacy Panel for Health of the Scottish NHS on 20th January 2017 (PBPP 1617-0061). The 2nd NCDA in Scotland received full approval from the Public Benefit and Privacy Panel for Health of the Scottish NHS (project 1819-0169) on 17th June 2019.

Data management

In full compliance with all regulatory and legal requirements data were stored, accessed and analysed within the National Data Safe Haven maintained by NHS National Services Scotland. Outputs were subject to disclosure checks by members of the Electronic Data Research and Innovation (eDRIS) team of the Information and Statistics Division, Scotland prior to release to the research team for inclusion in this manuscript.

Declaration of Competing Interest

None of the authors have a competing interest to declare.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.canep.2023.102414.

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