Geographical distance and reduced access to palliative radiotherapy: systematic review and meta-analysis

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ABSTRACT

Background Palliative radiotherapy (PRT) is an effective way of reducing symptoms caused by advanced incurable cancer. Several studies have investigated factors that contribute to inequalities in access to PRT; distance to a radiotherapy centre has been identified as one potential barrier.

Aim To assess whether there is an association between distance to a radiotherapy centre and utilisation rates of PRT in adults with cancer.

Methods A systematic review and meta-analysis protocol was registered in the PROSPERO database (CRD42020190772). MEDLINE, EMBASE, CINAHL and APA-PsycINFO were searched for relevant papers up to 28 February 2021.

Results Twenty-one studies were included. Twelve studies focused on whether patients with incurable cancer received PRT, as part of their treatment package. Pooled results reported that living ≥50 km vs <50 km from the radiotherapy centre was associated with a reduced likelihood of receiving PRT (OR 0.84 (95% CI 0.80, 0.88)). Nine focused on distance from the radiotherapy centre and compared single-fraction (SF) versus multiple-fraction PRT, indicating that patients living further away were more likely to receive SF. Pooled results comparing ≥50 km versus <50 km showed increased odds of receiving SF for those living ≥50 km (OR 1.48 (95% CI 1.26, 1.75)).

Conclusion Patients living further away from radiotherapy centres were less likely to receive PRT and those who received PRT were more likely to receive SF PRT, providing some evidence of inequalities in access to PRT treatment based on proximity to centres providing radiotherapy. Further research is needed to understand whether these inequalities are influenced by clinical referral patterns or by patients unwilling or unable to travel longer distances.

PROSPERO registration number CRD42020190772.

Key messages

What was already known?
► Numerous studies have identified a range of clinical and non-clinical barriers to receiving palliative radiotherapy.
► Research has shown an inverse association between living further from healthcare facilities and cancer outcomes.

What are the new findings?
► Living further from a radiotherapy centre was associated with being less likely to receive palliative radiotherapy.
► Those who do receive PRT and live further away were more likely to receive single-fraction radiotherapy.

What is their significance?
► There are some patients with cancer who might benefit from palliative radiotherapy that are not receiving it potentially due to where they live.
► Research is needed to explore how to provide equal access to this treatment to improve quality of life in the face of unequal proximity to facilities.

INTRODUCTION

Palliative radiotherapy (PRT) plays an important role in the care of people with incurable cancer through the palliation of symptoms such as pain, bleeding and obstruction.[1] It has been shown to reduce pain in 60% of patients with bone metastases and give complete pain relief in around 25%.[2] Patients receive radiotherapy through linear accelerators in specialist cancer centres.[3] When treatment is palliative, patients receive lower doses of radiation (compared with curative radiotherapy) with aims of maximising symptom control and reducing treatment burden. PRT is used in a range of advanced cancer settings, including to reduce pain due to bone metastases, reduce neurological compromise due to

malignant spinal cord compression, manage symptoms from brain metastases and from advanced head and neck and pelvic cancers.[3] In other words, PRT is seen as an effective and vital treatment for improving quality of life for patients with incurable cancer.

There is evidence of variation in its use across countries, with regards to dosage and number of fractions of radiotherapy that patients receive. Current guidance recommends that patients should receive single-fraction (SF) radiotherapy for uncomplicated bone metastases (usually 8 Gy × 1), which requires patients to have one visit for treatment compared with multiple fractions (MF), which requires treatments over multiple days.[4][5] Trials have shown that SF for treatment of uncomplicated bone metastases provides equal pain relief to MF, but with a slightly higher retreatment rate.[2] While not relevant for all patients who have complicated metastases, SF reduces the need for patients to make multiple trips for treatment.

A number of clinical and non-clinical factors have been identified, which might affect PRT rates. These include type of cancer, performance status, surviving longer after diagnosis allowing more time for treatment, age and deprivation.[6] Due to the need to receive PRT in a specialist cancer centre, usually in an urban location covering large population areas, there is usually a need to travel to receive treatment. Increasing travel distance from healthcare facilities has been identified in a range of studies as leading to worse health outcomes for patients, also known as a 'distance decay effect'.[7] A number of studies focusing on access to radiotherapy centres have shown that patients with cancer living further from the radiotherapy centres were less likely to receive PRT.[6]

The aim of this review was to assimilate the evidence base to assess whether there is an association between living further from a radiotherapy centre and the receipt of PRT for adult patients with cancer.

METHODS
The review protocol was published in advance in the PROSPERO database.[8] The study followed the Population, Intervention, Comparator, Outcome search design[9] and is reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidance.[10] The population were adults with a diagnosis of cancer. The intervention/comparator were measures of proximity (travel distance and time) to radiotherapy centres. The outcome was utilisation of PRT. To identify studies that had focused on palliative care, we reviewed existing search strategies, where available, and combined the two palliative search strategies developed by Sladek et al[11] and Rietjens et al[12] with other search concepts.

The search strategy was developed in OVID MEDLINE All (R) in collaboration with an information specialist (SG) and translated into OVID Embase, APA PsycInfo via OVID and CINAHL via EbscoHOST

for relevant papers on 11 June 2020 and updated on 28 February 2021 (figure 1). Papers were deduplicated in Endnote using the approach published by Bramer et al.[13] Studies were uploaded into the COVIDENCE systematic review software for screening.[14] All titles and abstracts were screened independently by CPC and CK. The inclusion criteria were that the study quantified the distance or travel time to the radiotherapy centre and identified whether there was an association between this and the utilisation of PRT for patients with cancer. We did not restrict by language, date, country or study type. We excluded papers about children, conference abstracts and qualitative studies.

Full papers of studies that met the inclusion criteria were independently reviewed by CPC and CK and the data were extracted and quality assessed for those that met the criteria. The data were extracted by CPC and CK using a predefined set of criteria documented in the study protocol. The quality assessment of studies was undertaken by CPC and CK using the Newcastle Ottawa Scale assessment for cohort studies.[15] No studies were excluded on the basis of the quality assessment.

A meta-analysis was conducted using the Revman software[16] pooling together those studies with raw data that could be grouped into the categories of <50 km or ≥50 km from the treatment centre. This reduced the number of included studies. Pooled OR and 95% CIs were produced for a comparison between those studies that compared SF versus MF and separately the utilisation of PRT. The I^2 statistic was assessed to describe the difference across studies due to heterogeneity rather than chance. A random effects approach was then used to account for unexplained heterogeneity across the included studies.

RESULTS
After deduplication, we screened 2170 titles and abstracts and 94 full text papers resulting in 21 studies that met the inclusion criteria and were included in the review (figure 2).

The quality assessment is summarised in table 1. All studies were retrospective cohorts and had used a range of cancer registry data and hospital records to select their cohorts. In all cases, secure records had been used to determine origins (where patients lived) and destinations (radiotherapy centres) to calculate the travel times and distances to determine the exposure. Two studies did not run a multivariate model controlling for other key variables.[17][18] The majority of studies controlled for age and sex (where relevant) and 90% of studies controlled for a range of other relevant factors (as is seen in online supplemental table 1 and table 2). In all cases, the outcomes were assessed using clinical records of patients with cancer either directly from their hospital records or through records accessed through a cancer registry. Nineteen studies

RADIOTHERAPY TERMS
1. exp Radiotherapy/
2. radiother*.mp.
3. radiat*.mp.
4. irradiat*.mp.
5. exp Neoplasms/rt [Radiotherapy]
6. rt.fs.
7. or/1-6 **[radiotherapy concept]**
CANCER TERMS
8. exp Neoplasms/
9. cancer$.mp.
10. tumor$.mp.
11. tumour$.mp.
12. metasta$.mp.
13. or/8-12 **[cancer concept]**
TRAVEL TERMS
14. (proximit* or travel* or distanc* or journey*).mp.
15. Health Services Accessibility/
16. travel/
17. "Transportation of Patients"/
18. ((travel* adj3 distanc*) or (travel* adj3 time) or (journey* adj3 time) or (journey* adj3 length) or (travel* adj3 length) or (travel* adj3 duration) or (geograph* adj3 location*)).ti,ab,kw.
19. exp spatial analysis/
20. exp Geography, Medical/
21. exp Transportation/
22. rural population/ or suburban population/ or urban population/
23. or/14-22 [travel concept]
24. 7 and 13 and 23 **[Radiotherapy AND Cancer AND Travel]**
PALLIATIVE CARE TERMS
25. exp advance care planning/
26. exp attitude to death/
27. exp bereavement/
28. death/
29. hospices/
30. life support care/
31. palliative care/
32. terminal care/
33. terminally ill/
34. palliat$.tw.
35. hospice$.tw.
36. terminal care.tw.
37. physician-patient relations/
38. prognosis/
39. quality of life/
40. survival rate/
41. attitude to health/
42. Treatment Outcome/
43. or/25-42 [Sladek Care search 2007 revision]
44. exp Terminal Care/
45. caregiver$.mp.
46. bereave$.mp.
47. inpatient.tw.
48. attitude to death.mp.
49. end of life.af.
50. hospice$.mp.
51. terminally ill.mp.
52. palliative$.mp.
53. Advance Care.af.
54. (morphine and cancer).af.
55. cancer pain.af.
56. or/44-55 [Rietjens 2019 sensitive filter]
57. 43 or 56 [combined Sladek 2007 or Reitjens sensitive filter]
58. 24 and 57 [Line 24 AND palliative care]
59. exp animals/ not humans.sh.
60. 58 not 59 **[Final]**

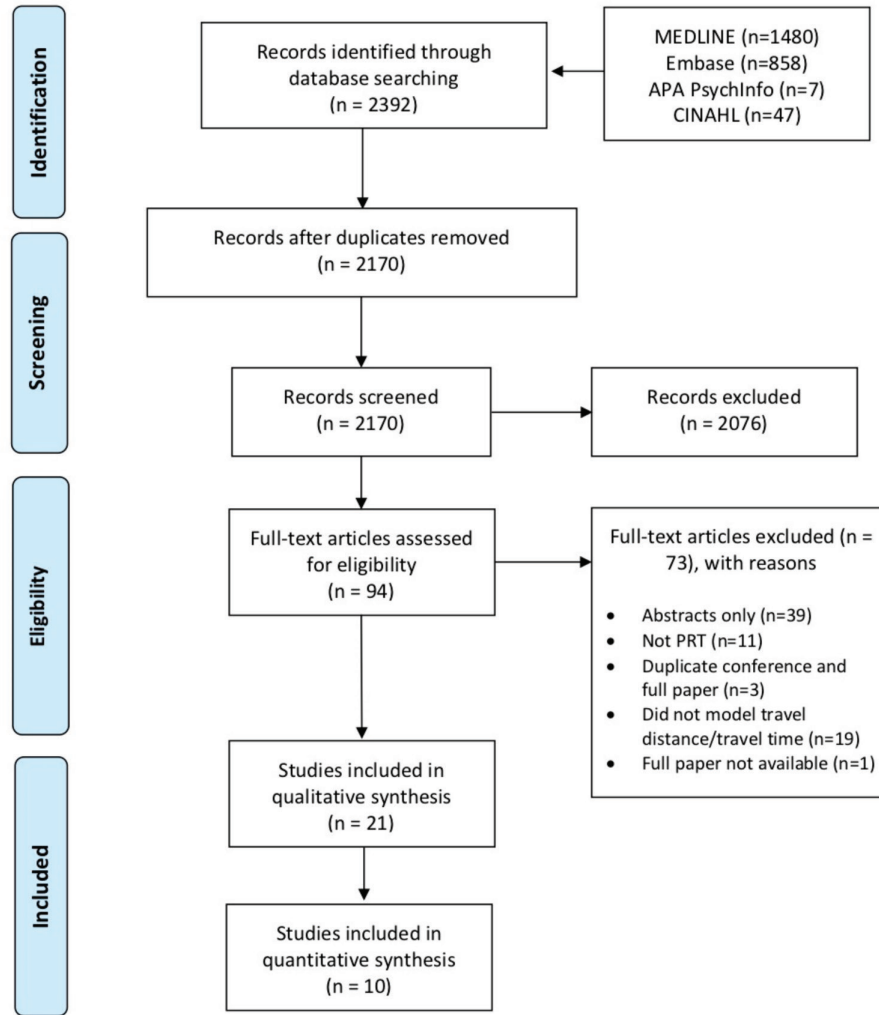**Figure 1** Medline search strategy.

Figure 2 PRISMA flow diagram of papers (adapted from Moher et al[10]). PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analysis; PRT, palliative radiotherapy.

achieved the maximum score of 9/9 and no studies were excluded on the basis of this quality assessment.

Twelve of the 21 included studies focused on whether people diagnosed with cancer received PRT or had retreatment (online supplemental table 1). The other nine studies focused on those who did receive PRT as part of their treatment, but received different dosages or fractions of radiotherapy (SF vs MF) (table 2). The majority of studies had accessed cancer registry data, with two studies accessing hospital records directly.[17 19] The studies covered treatments received by patients between the dates of 1984 and 2015.

The studies were all from Global North countries despite the study team not imposing any restrictions

Table 1 Quality assessment of the studies using the Newcastle Ottawa scale for cohort studies[15]

		Yes (%)	No (%)
Selection	Representativeness of the cohort	21 (100)	0
	Selection of the non-exposed cohort is drawn from the same community as the exposed cohort	21 (100)	0
	Ascertainment of travel distance/ time (derived from hospital records)	21 (100)	0
	Outcome of interest was accounted for	21 (100)	0
Comparability of cohorts	The study controlled for the most important factors (age and where relevant sex)	19 (90)	2 (10)
	The study controlled for additional key variables	19 (90)	2 (10)
Outcome	Ascertainment of the outcome was through clinical records	21 (100)	0
	Length of time was long enough for the outcomes (utilisation of PRT) to occur	21 (1—00)	0
	Adequacy of follow-up of cohort. All subjects accounted for.	21 (100)	0

PRT, palliative radiotherapy.

Table 2 Studies that compared patients who received single fraction versus multi fraction palliative radiotherapy

Author country healthcare system, date	Data source Study design Years Sample size	Description of cancer	Description of palliative radiotherapy	Distance/travel time measure	Characteristics controlled for	Summary of key results
Ashworth et al Canada Publicly funded 2016[20]	Ontario Cancer Registry Retrospective cohort 1984–2012 n=80 899	Bone Metastases Range of primary cancers	SF 8–10 Gy x 1 **vs** MF 20 Gy x 5 or 30 Gy 10	Distance to the radiotherapy centre (<10 m, 10–50 km and >50 km)	Sex, age at treatment, primary cancer site, socioeconomic status quintiles, time to death, primary site, body region treated, retreatment, cancer centre, year of treatment	Patients with longer travel distances were more likely to receive SF. <10 km (RR 0.97 95% CI 0.95 to 0.99) 10–50 km (REF) >50 km (RR 1.07 95% CI 1.05 to 1.09) Included in the meta-analysis
Barnes et al Canada Publicly funded 2015[21]	British Columbia Cancer Agency Retrospective cohort 2007–2011 n=8008	Bone Metastases Range of primary cancers	SF **vs** MF	Distance to the radiotherapy centre (0–50 km, 50–100 km 100–200 km, 200–500 km and >500 km)	Sex, age, treatment year, primary tumour group, treatment centre	Increased travel distance was associated with increased likelihood of receiving SF up to a travel threshold. 0–50 km (REF) 50–100 km (OR 1.18 95% CI 1.02 to 1.35] 100–200 km (OR 1.33 95% CI 1.18 to 1.49) 200–500 km (OR 1.19 95% CI 1.03 to 1.37) >500 km (OR 0.98 95% CI 0.84 to 1.14) Included in the meta-analysis
Fisher-Valuck et al USA Mixed Funding 2018[36]	National Cancer Database Retrospective Cohort 2010–2013 n=2641	Bone Metastases Prostate cancer	Short Course 8 Gy x 1 & 20 Gy x 5 **vs** Long course 30 Gy x 10 fractions & 37.5 Gy x 15 fractions	Distance to the radiotherapy centre (0–5 miles, >5–10 miles, >10–15 miles, >15 miles)	Age, race, year of diagnosis, Charles-Deyo Comorbidity, site of treatment, facility type, insurance status, income	Increased travel distance was associated with increased likelihood of receiving SF 0–5 miles (REF) >5–10 miles (OR 0.91 95% CI 0.66 to 1.25) >10–15 miles (OR 1.31 95% CI 0.91 to 1.87) >15 miles (OR 1.38 95% CI 1.05 to 1.83)
Laugsand et al Norway Publicly Funded 2012[34]	Cancer Registry of Norway Retrospective Cohort 1997–2007 n=8685	Bone Metastases Range of primary cancers	SF 8 Gy x 1 **vs** MF 3 Gy x 10	Shortest distance by road (some cases with car/ ferry) using Google Maps from residence to the radiotherapy centre. Travel distance was a continuous variable	Age, sex, primary diagnosis, anatomical region irradiated, treatment centre	Increased travel distance was associated with increased relative risk of receiving SF. RR >1 Increased relative risk of receiving SF Per 100 km (RR 1.05 95% CI 1.03 to 1.07)
Le Fevre et al France Mixed funding 2018[17]	Single hospital records Retrospective Cohort Received PRT 2014 - 2015) n=91	Uncomplicated Bones Metastases	SF 8 Gy x 1 **vs** 20Gy x5 **vs** 30Gy x10 **vs** 23.31 GyX 3	Travel distance between the patients' home and radiotherapy centre.	N/A (study compared differences in travel distance across the four groups using χ^2 test)	Increased travel distance not associated with differences in the PRT treatment rates (p=0.87). The same sizes were very small across the four groups with a total of 91 patients.
Resende et al USA Mixed funding 2019[28]	National Cancer Database Retrospective cohort Received PRT 2004–2014 n=95 190	Bone Metastases Multiple myeloma	SF 8Gy x1 **vs** MF	Travel distance from the patient area of residence to the reporting facility	Age, sex, race, residence, insurance, facility type, annual income, comorbidity index, high school level, year of diagnosis	Increased travel distance was associated with increased odds of receiving SF. 0–12.5 mile (REF) 12.6–50 mile (OR 1.47 95% CI 1.09 to 1.98) >50 miles (OR 2.91 95% CI 1.83 to 4.63) **Included in the meta-analysis**
Rutter et al USA Mixed funding 2015[29]	National Cancer Database Retrospective cohort Received PRT 2005- 2011 n=24 992	Bone Metastases (non-spinal)	SF **vs** MF	Linear travel distance from the patient's residence to the cancer reporting facility	Age, insurance type, diagnosis year, facility type, Charlson-Deyo score, facility location, radiation therapy site	Increased travel distance was associated with increasing odds of receiving SF. <50 miles (REF) ≥50 miles (2.10 95% CI 1.54 to 2.86) **Included in the meta-analysis**

Continued

Table 2 Continued

Author country healthcare system, date	Data source Study design Years Sample size	Description of cancer	Description of palliative radiotherapy	Distance/travel time measure	Characteristics controlled for	Summary of key results
Schreiber et al USA Mixed funding 2017[30]	National Cancer Database Retrospective cohort Diagnosed between 2004 – 2012 n=3871	Bone Metastases Prostate cancer	SF 8 Gy x one or 4Gy x5 **vs** MF 3 Gy x 10, 2.5 Gy x 14–15 and 2 Gy x 20–30	Residents distance from treatment centre (divided into four quartiles).	Age, year of diagnosis,race, site of treatment, charlson-deyo score, provision of hormonal therapy and chemotherapy, facility type, insurance, income quartiles	Increased travel distance was associated with increasing likelihood of receiving SF. Closest Quartile (REF) second Quartile (OR 1.18 95% CI 0.80 to 1.75) third quartile (OR 1.48 95% CI 1.02 to 2.14) fourth Quartile (OR 1.59 95% CI 1.10 to 2.30)
Wegner et al USA Mixed funding 2020[31]	National Cancer Database Retrospective Cohort Received PRT 2010–2015 n=17 859	Bone Metastases for breast, prostate, and NSCLC primary cancers	SF 8Gy x1 **vs** MF 20–24 Gy × 5–6, 30 Gy × 10, >30 Gy × 10	Travel distance to the treatment facility ≤8.5 miles >8.5 miles	Age, sex, systematic therapy comorbidity score, facility type, education, income, insurance, anatomic location, location, presence of non-bone metastases, race, year of diagnosis	Increased travel distance was associated with increasing likelihood of receiving SF. ≤8.5 miles (REF) >8.5 miles (OR 1.24 955 CI 1.07 to 1.43)

(OR> 1 favours single fraction radiotherapy, RR> 1 favours single fraction radiotherapy).

MF, multiple fraction; NSCLC, non-small cell lung cancer; PRT, palliative radiotherapy; SF, single fraction.

on healthcare system or country in the searches. These included 11 studies from Canada,[6 18–27] four studies from the USA,[28–32] one from Australia,[33] two from Norway[34 35] and one from France.[17] This represented a mixture of healthcare systems from the free at the point of use systems in Canada, Norway and Australia to a mixture of insurance and non-insurance-based healthcare systems in the USA and France.

The majority of the studies in the review (14 studies) drew their populations from cancer registries and included different primary cancer sites in their analysis. Seven studies focused on specific primary cancers, which were prostate cancer,[30 31 36] breast cancer,[18] non-small cell lung cancer[31] and multiple myeloma.[28 32] The majority of studies (19 studies) focused on PRT for bone metastases, with two studies looking specifically at PRT to the whole of the brain.[23 24]

There was variability in definitions of 'palliative' radiotherapy employed in the studies. For this review, we accepted the authors definition. For the studies that focused on radiotherapy utilisation, this varied from radiotherapy during the last 2 years of life,[23 24 35] the last year of life,[6] in the last 9 months of life,[25] radiotherapy recorded as being administered with palliative intent,[18 22] 'received within 4 months of a diagnosis or claim within 2 years of diagnosis containing any code indicating RT',[32] radiotherapy intent,[27] dose <30 Gy,[6] dose <39.5 Gy[35] and ≤10 fractions administered.[22] For the studies that compared SF with MF, the majority of studies described SF as 8 Gy × 1, but varying doses and fractions for the MF (eg, 3 Gy × 10).

Travel time and distance were calculated using a range of available data. The start of the journey to the radiotherapy centre was calculated using either residential location at death,[22 25] residential location at diagnosis[6 27] or the patients' residence.[29] The end point of the journey was described as the nearest radiotherapy centre, the centre attended,[31] the reporting facility[28 29] and the cancer centre most frequently visited by patients in the same census subdivision.[27 35] The calculation of distance and travel time using these origins and destination also varied across the studies with some using straight line distance 'as the crow flies',[22–24 27 29] road distance[17–21 24 26 28 30–36] and travel time.[6 25] All studies with the exception of Laugsand et al[34] (who included travel distance as a continuous variable) split the calculated travel distances and times into categories. There was a large variability in the distances and travel times used in calculations. For example, Wegner et al[31] split the travel distances into two categories (≤ 8.5 miles and >8.5 miles), and this can be compared with Asli et al[35] who split the distances into nine categories, with some patients with cancer living greater than 800 km from the nearest radiotherapy centre.

The majority of studies focusing on utilisation of PRT (online supplemental table 1) identified an association between living further away from a radiotherapy centre and being less likely to receive PRT,[6 18 19 22–27 35] with the exception of only one study, which did not find an association.[32] When comparing the utilisation of SF versus MF (table 2), all but one study[17] identified an association with patients living further away from the radiotherapy centre and being more likely to receive SF.[20 21 28–30 34 36]

With the exception of two studies,[17 33] all others controlled for a range of clinical and non-clinical variables from the patient records in the statistical models. All other studies included age (at diagnosis or death) and gender, where relevant (eg, not for prostate cancer) in their models. The studies controlled for different combinations of variables (as shown in table 2 and online supplemental table 1), which included ethnicity, race,
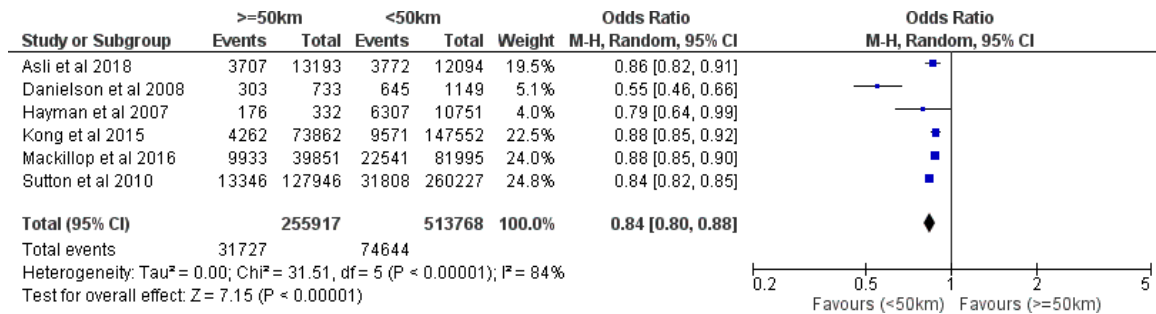
Figure 3 Random effects forest plot: Which patients are more likely to receive palliative radiotherapy: those living <50 km versus those living ≥50 km away??.

insurance type, hospital type, household income, level of education, socioeconomic status, levels of deprivation, year of diagnosis, year of treatment, place of death and being diagnosed at a hospital with radiotherapy facilities. Clinical variables included primary diagnosis, anatomical region irradiated, comorbidity index, access to other therapies (eg, chemotherapy) and time between diagnosis and death. Thus, highlighting the range of important factors in addition to distance/travel time that might influence access to PRT.

Although the studies were heterogeneous and considered a number of distance categories, a number had reported data for distances <50 km and ≥50 km or had provided data allowing the categories of <50 km versus ≥50 km to be created from the raw data, enabling those studies to be pooled together into two meta-analyses. A random effects model was used to account for the high level of heterogeneity across the studies.

The meta-analysis focusing on those receiving PRT versus not receiving PRT is shown in figure 3. Categorising the distances as <50 km versus ≥50 km allowed the pooling of six out of the nine studies that has considered receipt of PRT were included in the review. The included studies were representative of the wider group of studies and were based in similar healthcare settings (eg, publicly funded in Canada) and showed an association between living further away and lower odds of receiving PRT. The pooled results recorded that patients living ≥50 km from the radiotherapy centre had lower odds of receiving PRT as part of their treatment compared with those living <50 km from the radiotherapy centre (OR 0.84 (95%CI 0.80, 0.88) (figure 3).

The meta-analysis focusing on studies that considered SF radiotherapy versus multifraction radiotherapy is shown in figure 4. Categorising distance as <50 km versus ≥50 km allowed four studies out of the original nine to be included in the pooled results. This meta-analysis includes two studies from healthcare settings in the USA and two from Canada. It was not possible to include the studies based in Europe in the meta-analysis due to the measures of travel time/distance used in the studies. In the meta-analysis those living ≥50 km from the radiotherapy centre was associated with higher odds of receiving SF radiotherapy compared with those that lived <50 km away, with pooled OR 1.48 (95%CI 1.26,1.75).

DISCUSSION

The studies in this review have reported that advanced stage cancer patients living further from a radiotherapy centre had a reduced likelihood of receiving PRT, as part of their treatment package and for those that did receive PRT there was a difference in the radiotherapy dosage and number of fractions of radiotherapy provided, thus, indicating evidence of inequalities based on distance. This association was evident in studies based in countries with publicly funded healthcare systems (eg, Canada and Norway) and mixed public/private healthcare settings (eg, USA). Due to the equipment and specialist operators required for radiotherapy treatment, there will always be a conflict between providing treatment to a large geographical area in a centralised centre and some patients having to travel further distances. The question is
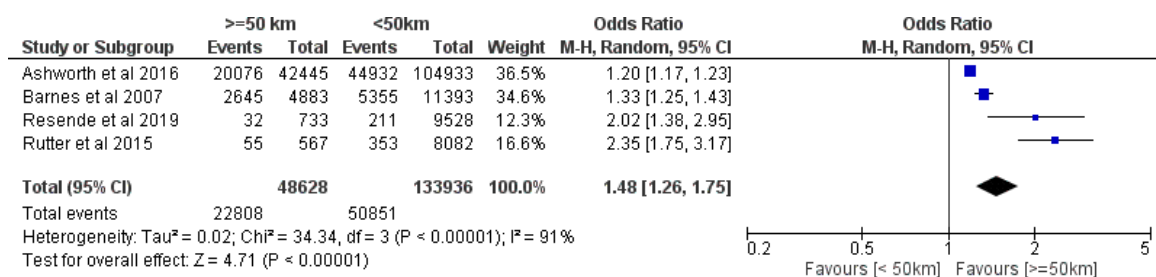

Figure 4 Random effects forest plot: Which patients are more likely to receive single fraction palliative radiotherapy: those living <50 km away versus those living ≥50 km away.

how to minimise the effects of the distance on patients to reduce the levels of inequalities in access identified.

A number of potential barriers to the referral of patients for PRT have been considered in the literature, with Vargas et al[37] reporting the top four perceived barriers as 'patient reluctance, patient's poor performance status, family reluctance and distance to the radiotherapy centre' (p1196). Additionally, further down the list was the absence of a radiation oncologist available to discuss the case. Spencer et al[3] summarised that not all clinicians are aware of the benefits of PRT and maybe less willing to refer end of life patients for this treatment especially those who may have to travel long distances to get there.[3] Similarly, studies have highlighted the critical impact of being diagnosed at a hospital that has radiotherapy facilities, with included study Mackillop and Kong[26] concluding that the association between travel distance and not receiving PRT treatment was stronger for those patients diagnosed at a hospital with no radiotherapy facilities, who may have been less likely to be referred for the treatment.[26]

Evidence-based guidelines in a number of countries have recommended the use of SF radiotherapy for treatment of uncomplicated bone metastases, with evidence highlighting that it can provide equal pain relief to MF, but with a slightly higher retreatment rate.[2] While for complex metastases, MF radiotherapy is supported. Following guidelines concerning the use of SF for uncomplicated metastases in Canada, Ashford et al[20] identified an initial increase in the use of SF (compared with MF), but this declined over time back to similar levels before the guidelines was introduced. In the USA, there are lower levels of SF,[38] which may have resulted in disadvantaging those living closer with incurable cancer, given that they are required to travel more frequently for longer fractions of RT than those living further away. An inequality that is the opposite of what might be expected when focusing on distance, as those living closer are more likely to have more fractions and have more trips to the radiotherapy centre along with the discomfort that this brings. As no studies had included patient data later than 2015, it is unclear whether this may have changed over the last 6 years.

The review identified differences in the distances that some patients with cancer would have to travel to access a hospital with radiotherapy facilities, ranging from 0 km to >800 km away[35] to <8.5 km versus >8.5 km.[31] Indicating again the inequalities in access to specialist radiotherapy facilities that can provide PRT that some patients living in expansive healthcare geographical catchment areas such as in Canada, USA and Australia face. The meta-analyses focused on comparing across the same travel threshold (<50 km vs ≥50 km). Evidence of different travel thresholds, beyond which it becomes less likely to receive treatment or the type of treatment changes emerged from the review. Barnes et al[21] identified evidence that as patients lived further from the radiotherapy centre they were more likely to receive

SF PRT, but for those travelling the furthest distance (>200 km), this association started to break down and patients were increasingly likely to receive MF PRT as they may travel and stay to receive the MF rather than making individual trips. Asli et al[35] also found that patients living in the furthest distances from the treatment centre (>800 km) had higher odds of receiving PRT (compared with patients living 0–9.9 km away) than those closer to the radiotherapy centre. Travelling the furthest distances may mean using faster modes of travel (eg, by air), potentially leading to patients staying for a period of time near the treatment centre, allowing longer treatment schedules compared with those living comparatively closer.

Going beyond the distance, it is key to ensure that patients can access the treatment 'at reasonable cost, in reasonable time and with reasonable ease' (p6).[39] Those that travel the furthest distances would incur higher out-of-pocket costs, often a hidden cost of treatment.[40] In Australia, patients with cancer living >100 km away from a treatment centre are entitled to discounted travel and accommodation, reducing the financial burden of travelling but staying a longer time than those living <100 km away.[33] There may be a trade-off between the discomfort from travel and potential quality of life benefits, which could be particularly difficult for this group of end of life patients[41] and as highlighted by Vargas et al,[37] in identifying patient reluctance to access PRT.

The review highlighted the many different ways that PRT was described and extracted from the cancer registry data sets. This is also illustrated in the range of search terms that were included in the search strategies to identify palliative terms[11 12] and shown in the MEDLINE search in figure 1. There is likely to be considerable differences in how much PRT is utilised in the last 9 months of life[25] compared with the last 2 years of life,[32] which is likely to have an impact on the results. However, it has identified the need for further work to standardise the follow-up periods and classifications of PRT.

The 2017 Lancet Commission on Palliative Care and Pain Relief recognises the integral role that PRT plays in improving the quality of life for patients and urges its integration as countries move towards achieving universal access to palliative care.[42] The studies included in the review are representative of the Global North countries, which although unintentional, does highlight the paucity of literature and research being carried out in this area in other parts of the world, particularly in low-resource settings. The organisation of palliative care services globally is complex, affected by a multitude of factors; however, this review brings to light the need to recognise travel distance and travel time as barriers to accessing PRT. Further work in this area will not only prove beneficial when introducing strategies to mitigate the effects of travel distance but also provide guidance aiming to improve current palliative care practices.

LIMITATIONS

Although the study followed a comprehensive search strategy to maximise the identification of relevant studies from multiple databases, not all the studies were able to be included in the meta-analysis. The <50 km and ≥50 km categories were selected to maximise the number of studies that could be combined, but resulted in comparable data not being available for all studies. Studies differed in how access to PRT had been calculated (travel times or travel distance) and how it had been categorised in the statistical models. All included studies were retrospective in nature and reliant on information recorded in patient records. Studies differed in terms of what variables they accessed from the patient records and how they defined PRT and the time period for assessing whether patients had accessed PRT, highlighting again the heterogeneity of the studies. There may be a case for providing guidance to reduce the heterogeneity and data gaps in future studies of access to PRT. While the review findings are of undoubted value in broadening our understanding of the impact, distance has on utilisation of PRT, its applicability may be limited to countries with similar healthcare and travel systems.

CONCLUSIONS

This review and meta-analysis identified evidence of a distance decay effect with those patients living further away being less likely to receive PRT and where they received PRT as part of their care being more likely to receive SF radiotherapy. There is evidence of inequalities in accessing PRT, which has the potential to reduce the symptoms of advanced incurable cancer and should be available equitably. Further research is needed to understand whether these inequalities are influenced by clinical referral patterns, or by patients unwilling or unable to travel longer distances and to undertake research to expand the evidence base beyond the small number of healthcare settings included in this review.

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