BMJ Open

Scanxiety: a scoping review about scan-associated anxiety

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To cite: Bui KT, Liang R, Kiely BE, *et al*. Scanxiety: a scoping review about scan-associated anxiety. *BMJ Open* 2021;**11**:e043215. doi:10.1136/bmjopen-2020-043215

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-043215).

Received 30 July 2020
Revised 19 April 2021
Accepted 29 April 2021

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ABSTRACT

Objectives To identify available literature on prevalence, severity and contributing factors of scan-associated anxiety ('scanxiety') and interventions to reduce it.

Design Systematic scoping review.

Data sources Ovid MEDLINE, Ovid EMBASE, Ovid PsycINFO, Ovid Cochrane Central Register of Controlled Trials, Scopus, EBSCO CINAHL and PubMed up to July 2020.

Study selection Eligible studies recruited people having cancer-related non-invasive scans (including screening) and contained a quantitative assessment of scanxiety.

Data extraction Demographics and scanxiety outcomes were recorded, and data were summarised by descriptive statistics.

Results Of 26 693 citations, 57 studies were included across a range of scan types (mammogram: 26/57, 46%; positron-emission tomography: 14/57, 25%; CT: 14/57, 25%) and designs (observation: 47/57, 82%; intervention: 10/57, 18%). Eighty-one measurement tools were used to quantify prevalence and/or severity of scanxiety, including purpose-designed Likert scales (17/81, 21%); the State Trait Anxiety Inventory (14/81, 17%) and the Hospital Anxiety and Depression Scale (9/81, 11%). Scanxiety prevalence ranged from 0% to 64% (above prespecified thresholds) or from 13% to 83% ('any' anxiety, if no threshold). Mean severity scores appeared low in almost all measures that quantitatively measured scanxiety (54/62, 87%), regardless of whether anxiety thresholds were prespecified. Moderate to severe scanxiety occurred in 4%–28% of people in studies using descriptive measures. Nine of 20 studies assessing scanxiety prescan and postscan reported significant postscan reduction in scanxiety. Lower education, smoking, higher levels of pain, higher perceived risk of cancer and diagnostic scans (vs screening scans) consistently correlated with higher scanxiety severity but not age, gender, ethnicity or marital status. Interventions included relaxation, distraction, education and psychological support. Six of 10 interventions showed a reduction in scanxiety.

Conclusions Prevalence and severity of scanxiety varied widely likely due to heterogeneous methods of measurement. A uniform approach to evaluating scanxiety will improve understanding of the phenomenon and help guide interventions.

Strengths and limitations of this study

- ► This is the first scoping review on scanxiety.
- ► A comprehensive search strategy and broad inclusion criteria have resulted in an extensive summary of all available literature.
- ► Summary statistics for prevalence and severity of scanxiety were not possible due to heterogeneity in the type and timing of measurement tools between the studies.

INTRODUCTION

Anxiety may increase when people have scans to screen for, diagnose, or stage cancer, or to monitor cancer for recurrence or progression. Scan-associated anxiety, or the distress before, during or after a scan, was first dubbed 'scanxiety' by a patient writing for the Time Magazine in 2011.[1]

Qualitative research on the experience of having a scan has shown some people experience dread in the weeks before a scan,[2] perceive scans as dehumanising, unpleasant or causing claustrophobia,[2–5] and find scans trigger fear of the unknown and fear of cancer recurrence.[2 3 6] Scanxiety is recognised as a common clinical concern on social media and public forums, and is acknowledged by international cancer institutions[7 8] and cancer-specific support networks.[9–11] Despite this, scanxiety is not uniformly recognised or measured in published studies. We conducted a systematic scoping review to identify the available literature on scanxiety in people having cancer-related scans.

METHODS

We conducted a systematic scoping review based on the six-step methodological framework developed by Arskey and O'Malley[12] and modified by Levac *et al*,[13] and guided by the Preferred Reporting Items for Systematic review and Meta-Analysis protocols extension for Scoping Reviews (PRISMA-ScR) checklist.[14] The study protocol and amendments are available (online supplemental files 1 and 2).

#	Search	#	Search	#	Search	#	Search
1	Exp Neoplasms/	10	Exp Diagnostic Imaging/	15	exp Anxiety/	22	or/1-9
2	Exp Medical oncology/	11	imaging.ti,ab	16	exp Anxiety Disorders/	23	or/10-14
3	neoplasm*.ti,ab	12	scan.ti,ab	17	exp Fear/	24	or/15-21
4	cancer*.ti,ab	13	tomography.ti,ab	18	anxi*.ti,ab	25	22 and 23 and 24
5	neoplasm*.ti,ab	14	ultraso*.ti,ab	19	fear.ti,ab		
6	malignan*.ti,ab			20	worr*.ti,ab		
7	tum??r*.ti,ab			21	distress*.ti,ab		
8	oncolog*.ti,ab						
9	carcinoma*.ti,ab						

Figure 1 Search strategy used for Ovid MEDLINE (1946 onwards).

Step 1: research question

Our aim was to increase the understanding of scanxiety by: determining the prevalence and severity of scanxiety; identifying contributing factors to scanxiety; identifying interventions to reduce scanxiety in people having cancer-related scans; and, exploring patient experiences with scanxiety.

Step 2: search strategy

Published studies were identified from seven electronic databases: Ovid MEDLINE (1946 onwards), Ovid EMBASE (1947 onwards), Ovid PsycINFO (1806 onwards), Ovid Cochrane Central Register of Controlled Trials (1991 onwards), Scopus (any year), EBSCO CINAHL (any year) and PubMed (any year). The search strategy combined the subject headings and keywords of cancer, imaging and anxiety. An example is provided in figure 1. Reference lists of included articles were hand-searched for additional studies. All references were imported into Endnote V.9.

The initial search was conducted on 11 April 2019 and updated on 3 July 2020.

Step 3: study selection

Inclusion criteria were full-text original research studies that recruited adults (≥18 years old) who had a non-invasive scan for a cancer-related reason, and which quantitatively assessed the prevalence or severity of scanxiety, reported a statistical comparison between prescan and postscan scanxiety, reported a statistical comparison between scanxiety and possible contributing factors, or evaluated the impact of an intervention on scanxiety.

Cancer-related reasons included screening (detection of cancer in asymptomatic person), diagnosis (detection of cancer in symptomatic person), staging (determining extent of cancer in person with confirmed or suspected cancer), surveillance (detection of recurrence in person with cancer treated with curative intent) or monitoring (detection of progression in person with cancer treated with non-curative intent).

The measurement of scanxiety was defined as any measure of anxiety, distress or worry occurring around the time of a scan. This included any period before, during or after a scan where the scan was used as a reference point for the measurement of scanxiety. All non-invasive imaging modalities were accepted. No date restrictions were applied. Foreign language material was included if an English translation was available.

After initial review of citations and based on increasing familiarity with the literature, and in line with recommendations on scoping review methodology,[12] exclusion criteria were developed post hoc. Exclusion criteria were: studies involving invasive scans (eg, transvaginal ultrasound, ultrasound with fine needle aspirate or endoscopic ultrasound) due to differences in scan preparation and risk of adverse events and studies of scans performed to investigate a positive initial screening result because the psychological experiences of asymptomatic persons facing a potential new cancer diagnosis may lead to higher anxiety than is attributable to scanxiety. Due to feasibility of conducting quantitative and qualitative analysis with the volume of literature identified, studies reporting only a qualitative assessment of scanxiety were also excluded, and the objective to explore patient experiences was abandoned.

After removal of duplicate citations, two authors (KTB and RL) independently reviewed and screened publication titles and abstracts based on the eligibility criteria. Of the studies deemed potentially eligible, full texts were evaluated for final inclusion. Discrepancies were resolved by discussion between the two authors (KTB and RL) and were escalated to all authors if a consensus could not be reached.

Step 4: charting the data

Relevant data were independently extracted by two authors (KTB and RL) into an electronic data extraction form in Microsoft Excel, which included study demographics and methodology, scanxiety measurement tools, and the outcome measures of prevalence and severity of scanxiety, contributing factors to scanxiety, and interventions to reduce scanxiety.

Step 5: collating, summarising and reporting the results

Study data were tabulated to assist with a descriptive numerical summary of the range of cancer types, imaging modalities, study methodology and scanxiety measurement tools. Associations between scanxiety and potential contributing factors were tabulated if three or more studies reported a statistical comparison.

The prevalence of scanxiety was identified in two ways:

- The percentage of people who scored above the prespecified clinically important anxiety threshold, if reported.
- The percentage of people who scored any degree of anxiety, if no prespecified threshold was reported.

Severity of scanxiety was defined in three ways:

- Any mean score of the anxiety measure above the prespecified clinically important anxiety threshold, if reported.
- Any mean score of the anxiety measure that was at least half the total score, if an anxiety threshold was not reported.
- At least 'moderate' anxiety (or its equivalent) on a descriptive range.

The definitions of prevalence and severity were purposed-designed to allow descriptive comparisons between the studies as we anticipated heterogeneity in scanxiety measurement would preclude meaningful summary statistics.

The components of intervention studies and their effect on scanxiety were summarised and reported descriptively.

Step 6: consultation

Medical oncologists (PB and BEK), a behavioural scientist (HD) and a statistician (CB) were consulted for content expertise to develop the study objectives and to improve clarity on clinically relevant interpretations of the data.

Patient and public involvement

This research did not directly involve patients and public. Our research was initiated by repeated observations of scanxiety in oncology patients.

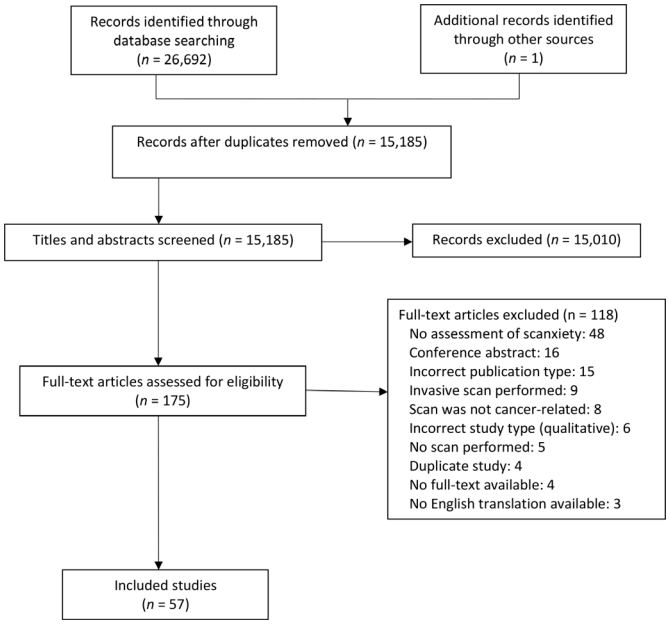

Figure 2 Study search and selection flow diagram.

RESULTS

The study search identified 26 693 citations. The selection process is outlined in figure 2. After removal of duplicates, abstract and title screening, and full-text review, 57 eligible studies involving 21 352 people were included.

Demographics and study details

Observational studies

There were 47 observational studies (table 1) involving 19 498 people.[15–61] Participants most commonly had scans for breast cancer (22 studies, n=14 338 women[16 18–27 29 31 36 38 40 42 43 45 48 56 58]), the most common scans were mammograms (21 studies[16 18–27 29 31 36 38 40 42 43 45 48 56]), and most studies used self-report surveys to assess scanxiety (40 studies[15 16 18–36 38 40–54 56 58 59]).

Twenty-one studies were conducted in people having scans for screening.[15 16 18 20 21 24–27 29–32 35 38 43 45 54 57 58 61] In the remaining studies, reasons for scanning included diagnosis,[23 48] staging,[34 44 52] monitoring,[49 55 60] surveillance to detect recurrence[28 37 56] or a combination of reasons in people with known or suspected cancers (17 studies[17 39 41 46 47 50 51 53 59]). Five studies permitted scans for both screening and non-screening reasons (namely, diagnosis[22 36 40] or surveillance[19 42]).

The mean age of participants, reported by 33 studies, was 56.9 years (range 38–66 years).[20 21 25 26 28–33 35 36 39 41–48 50–61] The majority of participants were women (87%).[15 16 18–61] When studies involving scans for breast cancer were excluded, there were similar proportions of men and women (women 49% and men 51%).[15 27 28 30 32–35 37 39 41 44 46 47 49–55 57 59–61] There was variation in the reporting and proportion of participants who were married (22 studies, range 34%–97%[20 21 24–26 29 31 32 34–38 41 45–49 54 56 58]), who received at least secondary education (29 studies, range 10%–99%[20–22 24–29 31 32 34 36 37 41–43 45–47 49–51 54 55 57–60]) and who were attending their first scan (18 studies, range 0%–100%[17 21 24 27 29 32 36 38 39 41 45 46 48 50 51 55 56 59]).

Intervention studies

There were 10 intervention studies (table 2) involving 1854 people.[62–71] This included people having scans for breast cancer (six studies, n=1449 people[62–65 69 70]) and lung cancer (one study, n=16 people[68]). Scans included mammogram (five studies[62–64 69 70]), positron emission tomography (PET) with CT (three studies[66 67 71]), MRI,[65] CT[68] and ultrasound[70] (one study each). Four studies involved scans for screening,[63 64 68 69] one for diagnosis,[65] three for any reason in people with known or suspected cancers[66 67 71] and two where scans for screening, surveillance and/or diagnosis were permitted.[62 70]

The mean age of participants was reported by five studies and ranged from 47 to 65 years.[63 65 68 69 71] The majority were women (94%[62–66 68–71]). There was variation in the reporting and proportion of participants who were married (two studies, 73% and 75%[64 65]), received at least secondary education (six studies,

Table 1 Demographics and study details for the 47 observational studies

First author	Year	N	Country of study	Cancer type	Age (years) (mean*)	Female (%)	Married or de facto (%)	At least secondary education (%)	First scan (%)	Scan type	Reason for scan	Methods
Andolf[15]	1990	275	Sweden	Ovarian	NR	100	NR	NR	NR	Abdominal ultrasound	Screening	Cross-sectional survey
Bull[16]†‡	1991	541	UK	Breast	50–54: 23% 55–59 s 29% 60–64: 34% 65–70: 7% Unknown: 7%	100	NR	NR	NR	Mammogram	Screening	Longitudinal surveys
Peteet[17]	1992	79	USA	Any	NR	NR	NR	NR	4	CT	Any (except screening)	Cross-sectional interview
Cockburn[18]‡	1994	200	Australia	Breast	NR	100	NR	NR	NR	Mammogram	Screening	Longitudinal surveys
Ellman[19]‡	1995	331	UK	Breast	50–64: 52% 65–78: 48%	100	NR	NR	NR	Mammogram	Screening or surveillance	Cross-sectional survey
Sutton[20]‡§	1995	306	UK	Breast	58	100	76	50	NR	Mammogram	Screening	Longitudinal surveys
Bakker[21]	1998	315	Canada	Breast	61	100	71	76	50	Mammogram	Screening	Longitudinal surveys
Gupta[22]	1999	167	Kuwait	Breast	Range 14–63	100	NR	82	NR	Mammogram±ultrasound	Screening or diagnosis	Cross-sectional survey
Hafslund[23]	2000	170	Norway	Breast	NR	100	NR	NR	NR	Mammogram	Diagnosis	Longitudinal surveys
Meystre-Agustoni[24]	2001	887	Switzerland	Breast	50–54: 36% 55–59: 22% 60–64: 20% 65–69: 22%	100	77	62	27	Mammogram	Screening	Longitudinal surveys
Drossaert[25]	2002	2657	The Netherlands	Breast	58	100	78	32	NR	Mammogram	Screening	Longitudinal surveys
Sandin[26]‡§	2002	598	Spain	Breast	51	100	77	41	NR	Mammogram	Screening	Longitudinal surveys
Brunton[27]	2005	584	New Zealand	Breast	50–54: 38% 55–59: 35% 60–64: 27%	100	NR	74	<20%	Mammogram	Screening	Cross-sectional survey
Geurts[28]	2006	106	The Netherlands	Head and neck	56	36	NR	29	NR	Chest X-ray	Surveillance	Cross-sectional survey
Tyndel[29]‡	2007	1174	UK	Breast	43	100	83	33	87	Mammogram	Screening	Longitudinal surveys
Bunge[30]†	2008	324	The Netherlands, Belgium	Lung	60	49	NR	NR	NR	CT	Screening	Longitudinal surveys
Brown Sofair[31]†	2008	47	USA	Breast	50	100	34	80	NR	Mammogram	Screening	Longitudinal surveys
van den Bergh[32]†	2008	324	The Netherlands, Belgium	Lung	60	49	64	82	66	CT	Screening	Longitudinal surveys

Continued

Table 1 Continued

First author	Year	N	Country of study	Cancer type	Age (years) (mean*)	Female (%)	Married or de facto (%)	At least secondary education (%)	First scan (%)	Scan type	Reason for scan	Methods
Westerterp[33]†	2008	82	The Netherlands	Oesophageal	64	18	NR	NR	NR	CT+PET	Diagnosis and staging	Cross-sectional survey
Bastiaannet[34]	2009	59	The Netherlands	Melanoma	Median: 59	44	69	66	NR	CT, PET±chest X-ray	Staging	Cross-sectional survey
Vierikko[35]†	2009	601	Finland	Lung	65	0	36	NR	NR	CT	Screening	Longitudinal surveys
Bölükbaş[36]	2010	93	Turkey	Breast	48	100	97	10	45	Mammogram	Screening or diagnosis	Cross-sectional survey
Thompson[37]	2010	70	USA	Lymphoma	Median: 47	64	53	97	NR	CT	Surveillance	Cross-sectional interview
Hutton[38]†	2011	527	UK	Breast	Median: 40	100	79	NR	75	Mammogram±MRI	Screening	Longitudinal surveys
Pifarré[39]	2011	200	Spain	Any	52	51	NR	NR	67	PET/CT	Any (except screening)	Cross-sectional interview
Steinemann[40]	2011	227	USA	Breast	NR	100	NR	NR	NR	Mammogram	Screening or diagnosis	Cross-sectional survey
Yu[41]	2011	398	Brazil	Any	54	79	56	57	27	Any	Any (except screening)	Cross-sectional survey
Brédart[42]†	2012	637	France	Breast	50	100	NR	87	NR	Mammogram± ultrasound±MRI	Screening or surveillance	Longitudinal surveys
Hafslund[43]‡	2012	4249	Norway	Breast	58	100	NR	52	NR	Mammogram	Screening	Cross-sectional survey
Adams([44]¶	2014	36	The Netherlands	Lymphoma	50	42	NR	NR	NR	CT and MRI	Staging	Cross-sectional survey
Baena-Cañada[45]	2014	434	Spain	Breast	54	100	72	43	18	Mammogram	Screening	Cross-sectional survey
Andersson[46]	2015	169	Sweden	Any	64	47	62	62	100	PET/CT	Any (except screening)	Cross-sectional survey
Elboga[47]	2015	144	Turkey	Any	63	46	83	52	NR	PET/CT	Any (except screening)	Cross-sectional survey
Hobbs[48]	2015	49	Australia	Breast	55	100	79	NR	75	Mammogram±MRI	Diagnosis	Longitudinal surveys
Bauml[49]	2016	103	USA	Lung	Median: 67	61	73	53	NR	CT, PET±MRI	Monitoring	Cross-sectional survey
Abreu[50]	2017	232	Portugal	Any	61	51	NR	73	71	PET/CT	Any (except screening)	Longitudinal surveys
Grilo[51]	2017	81	Spain and Portugal	Any	55	53	NR	41	47	PET/CT	Any (except screening)	Longitudinal surveys
Evans[52]	2018	115	UK	Colorectal or lung	66	33	NR	NR	NR	Whole body MRI, PET+CT	Staging	Longitudinal surveys
Goense[53]	2018	27	The Netherlands	Oesophageal	64	15	NR	NR	NR	MRI+PET/CT	Staging and monitoring	Cross-sectional survey

Continued

Table 1 Continued

First author	Year	N	Country of study	Cancer type	Age (years) (mean*)	Female (%)	Married or de facto (%)	At least secondary education (%)	First scan (%)	Scan type	Reason for scan	Methods
Hall[54]	2018	169	USA	Lung	64	51	58	96	NR	Low-dose CT	Screening	Cross-sectional survey
Derry[55]	2019	94	USA	Any	61	72	NR	69	0	Any	Monitoring	Longitudinal interview
Soriano[56]	2019	57	USA	Breast	58	100	93	NR	0	Mammogram	Surveillance	Longitudinal survey
Taghizadeh[57]	2019	1237	Canada	Lung	63	56	NR	85	NR	CT	Screening	Longitudinal interview
Bancroft[58]	2020	88	UK and Ireland	Breast	38	61	50	83	NR	MRI	Screening	Longitudinal survey
Grilo[59]	2020	94	Portugal	Any	61	54	NR	99	77	PET+bone scan	Staging, monitoring and surveillance	Longitudinal survey
Morreale[60]	2020	87	USA	Gastrointestinal and lung	62	55	NR	92	NR	CT or MRI	Monitoring	Longitudinal interview
Paiella[61]	2020	54	Italy	Pancreatic	50	61	NR	NR	NR	MRI – MRCP	Screening	Cross-sectional interview

All percentages were rounded to the nearest whole number.
*Unless otherwise stated.
†Demographic data are based on participants who completed the first survey.
‡These studies collected data from other groups who were not included in this review as they did not meet eligibility criteria. This included people having invasive procedures such as fine-needle aspirate or open surgical biopsy,[16 33] people with abnormal screening results[18 26 29] and people who did not have a scan.[18–20 43]
§Demographics based on the entire population even if not all participants were eligible for this review.
¶Four paediatric participants were included in this study.
MRCP, magnetic resonance cholangiopancreatography; NR, not reported; PET, positron emission tomography.

Table 2 Demographics and study details for the 10 intervention studies to reduce scanxiety

First author	Year	N	Country of study	Cancer type	Age (years) (mean*)	Female (%)	Married or de facto (%)	At least secondary education (%)	First scan (%)	Scan type	Reason for scan	Allocation	Intervention and control groups
Mainiero[62]	2001	613	USA	Breast	<40: 8% 50–50: 39% 50–60: 28% >70: 9%	100	NR	95	7	Mammogram	Screening or surveillance	Consecutive†	Educational or entertaining video in waiting room
Domar[63]	2005	143	USA	Breast	52	100	NR	81	8	Mammogram	Screening	Randomised	Relaxation, music or blank audiotape in waiting room and during scan
Fernández-Feito[64]	2005	436	Spain	Breast	50–54: 24% 55–59: 30% 60–64: 23% 65–69: 22%	100	73	28	4	Mammogram	Screening	Randomised	Prescan nursing intervention or usual care
Caruso[65]	2006	44	Italy	Breast	47	100	75	89	NR	MRI	Diagnosis	Randomised	Prescan informative-emotive psychological support or routine information
Vogel[66]	2012	101	The Netherlands	Any	Median: 58	51	NR	NR	41	PET/CT	Any (except screening)	Randomised	Audiovisual installation or usual care during FDG uptake
Acuff[67]	2014	180	USA	Any	NR	NR	NR	NR	NR	PET/CT	Any (except screening)	Unclear	Handheld communication device or usual care during scan
Raz[68]	2014	16	USA	Lung	65	75	NR	100	NR	CT	Screening	Sequential‡	Prescan multimedia education or usual care
Zavotsky[69]	2014	100	USA	Breast	54	100	NR	98	NR	Mammogram	Screening	Non-randomised§	Music or no music during scan
Ashton[70]	2019	113	USA	Breast	18–39: 3.6% 40–59: 51.8% 60–79: 39.3% >80: 5.4%	100	NR	NR	NR	Mammogram±ultrasound	Screening, surveillance or diagnosis	NA¶	Shoulder and neck massage±hand massage
Lorca[71]	2019	108	Spain	Any	59	57	NR	NR	54	PET/CT	Any (except screening)	Randomised	Mindfulness meditation or usual care during FDG uptake

All percentages were rounded to the nearest whole number.
*Unless otherwise stated.
†Each intervention was administered during one half of the study period.
‡Participants were enrolled into the control arm first, followed by the intervention arm.
§Participants attending on Mondays, Wednesdays and Fridays were allocated to the intervention arm, and participants attending on Tuesdays and Thursdays were allocated to the control arm.
¶All participants received the intervention.
FDG, fluorodeoxyglucose; NR, not reported; PET, positron emission tomography.

range 28%–100%[62–65 68 69]) and participants attending their first scan (five studies, range 4%–54%[62–64 66 71]).

Eight studies allocated participants to an intervention or control group,[63–69 71] one study compared two interventions[62] and one study delivered the intervention to all participants.[70] Two interventions were multifaceted.[64 65] Types of interventions included: relaxation, distraction and/or meditation (six studies[62 63 66 69–71]); education (four studies[62 64 65 68]); emotional or psychosocial support (two studies[64 65]); or adjustments to routine logistics of the scan (one study[67]).

Scanxiety measurement

Anxiety measurements varied across the studies, with different measurement tools, variants of the same tool, and different range and thresholds applied to tools.

Observational studies

The 47 observational studies (table 3) used a total of 81 measures of anxiety, with 30 studies using one measure only,[15–19 21 22 25–28 30 33 34 36 39 40 43 44 46 48–51 53 55–57 59 61] and 17 studies using at least two measures.[20 23 24 29 31 32 35 37 38 41 42 45 47 52 54 58 60]

The most common measures used were: purpose-designed Likert scales (17 studies); the State-Trait Anxiety Inventory (STAI) (14 studies); the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS) (nine studies); the Impact of Event Scale (IES) (six studies); the Psychological Consequences Questionnaire (PCQ) (three studies), the Cancer Worry Scale (three studies); and the Perceived Stress Scale (two studies). There were 17 measures used by one study only.[15 20 22 26 31 32 35 52 54 56 58 60]

Likert scales were varied, with a numerical lower range limit of 0 or 1, and an upper range limit between 3 and 12.[17 20 24 25 33 40 44 46 48 50 52 53] Seven studies used a descriptive range.[21 25 27 28 33 34 55] Two studies used both a numerical and a descriptive range.[25 33]

The STAI compromises state and trait anxiety subscales with a possible subscale range of 20– 80. It has no validated anxiety threshold and is usually calculated as a sum of four-point response options.[72] Included studies used and reported the STAI as a total score,[37 39] using one or both subscales,[20 23 36 37 41 42 47 51 57 59] or as a variant (eg, STAI-6[32 38 58]). There were different ranges: none reported[47 57]; no reported lower limit[41]; no reported upper limit[36]; 0– 60;[39 51] or based on a mean of individual item scores.[20] Some studies prespecified an anxiety threshold of 39,[57] 40 and[37 41] 46,[42] calculated based on the relationship between the anxiety and trait subscales,[39] or based on investigator-determined categories.[36] One study used a different method to calculate scores (ie, subtracting the points of reversed statements from direct statements, which were valued at 1, 2, 3 and 20, and then added to a constant of 50[36]).

The HADS anxiety subscale has a range of 0–21 and a validated anxiety threshold of 11.[73] One study reported a range of 0–14,[38] one study reported anxiety categories rather than a threshold,[60] two studies reported an anxiety threshold of 8[41 43] and one study reported an anxiety threshold of 10 (though there was overlap the 'tendency to anxiety' and 'anxiety' categories, classified as scores of 8–10 and 10 or more, respectively).[47]

The IES was used in its original form[30 32 38 42 58] or as a variant (IES-6[49]) and was reported as a total score[30 32 38 49] or as intrusion and avoidance subscale scores.[42 58] The two studies using subscale scores reported threshold levels of 20 or 21[42] and 8.5.[58] When using the PCQ, researchers used either the emotional subscale[18] or the negative consequences subscale.[24 29] The Cancer Worry Scale and the Perceived Stress Scale were used in original[45 61] or variant[29 54 58] forms. The Symptom Checklist-90-Revised score could not be interpreted because the authors did not report a range,[31] and a raw score or a transformed score could have been used.[74]

Intervention studies

The 10 intervention studies (table 4) used 19 measures of anxiety, with five studies using one measure only,[62 66 67 69 70] and five studies at least two.[63–65 68 71] The measures included subscales of the STAI (seven studies), Likert scales (five studies), a variant of the Psychological Consequences Questionnaire (one study[68]) and the Crown Crisp Experimental Index (one study[65]).

Likert scales were varied, with a lower range limit of 0 or 1, and an upper range limit between 5 and 10.[62 63 69–71] The STAI was used and reported using one or both subscales,[63–65 67 68 71] or as a variant (eight-item STAI[66]). There was variation from the usual STAI parameters, with studies using a different range (ie, not reported,[63 65] 0–60,[64] or 18–32[66]) or prespecified anxiety thresholds of 40[68] or 16.[66]

Scanxiety outcomes

Prevalence and severity of scanxiety for each study are provided in table 3. Summary statistics for prevalence and severity were not calculated due to heterogeneity in the type and timing of measurement between the studies.

Prevalence of scanxiety

Twenty-four of the 47 studies reported the prevalence of scanxiety. The prevalence of scanxiety above prespecified anxiety thresholds ranged between 0% and 64% across the 16 measures,[16 19 31 38 41 43 45 52 54 58] though eight of these measures came from only two studies.[41 58] In the 14 measures without a prespecified anxiety threshold, the prevalence of any degree of scanxiety ranged between 13% and 83%.[15 21 22 24 27 28 32–34 37 39 41 48 49]

There were insufficient numbers to compare the prevalence of scanxiety using measures with prespecified anxiety thresholds of people having scans for screening (11 measures[16 31 38 43 45 54 58]), reasons other than screening (four measures[41 52]) and for screening or non-screening reasons (one measure[19]). When no threshold was reported, the prevalence of scanxiety had a similar range (screening 23%–81%, five measures[15 21 24 27 32]; reasons other than

Table 3 Prevalence and severity of scanxiety

		Measurement of scanxiety			Results of scanxiety measurement		
First author	Year	Name of tool	Range of tool (anxiety threshold*)	Timing of assessment	Prevalence (%)	Severity (mean±SD†)	Prescan and postscan comparison
Andolf[15]	1990	Visual analogue scale	0–100 (NA)	Postscan: 1–3 years	81	Median 3.5 (range 0–100)	NA
Bull[16]	1991	HADS: anxiety subscale	0–21 (≥11)‡	Prescan: specific timing NR	4.9	4.97 (range 0–20)	Less severe postscan scanxiety, p<0.001
				Postscan: postresult, specific timing NR	4	4.43 (range 0–17)	
Peteet[17]	1992	10-point Likert scale	1–10 (NA)	Postscan: specific timing NR	NR	First scan 5.5, recent scan 3.5	NA
Cockburn[18]	1994	PCQ: emotional subscale	0–15 (NA)	Prescan: day of scan	NR	<2	No difference
				Postscan: preresults, 1 week postresult and at 8 months	NR	<2	
Ellman[19]	1995	HADS: anxiety subscale	0–21 (≥11)	Prescan: day of scan	6	NR	NA
Sutton[20]	1995	STAI: state anxiety subscale	1–4 (NA)	Prescan: at invitation to screening, specific timing NR	NR	Between 1.65 and 1.95	No significant differences scanxiety at any time point
				Periscan: day of scan	NR		
				Postscan: 9 months	NR		
		STAI: trait anxiety subscale	1–4 (NA)	Prescan: at invitation to screening, specific timing NR	NR	Between 1.65 and 1.95	No significant differences in scanxiety at any time point
				Periscan: day of scan	NR		
				Postscan: 9 months	NR		
		GHQ: anxiety subscale	0–3 (NA)	Prescan: at invitation to screening, specific timing NR	NR	<1	Less severe postscan scanxiety, p<0.001
				Postscan: 9 months	NR	<1	
		3-point Likert scale	1–3 (NA)	Prescan: at invitation to screening, specific timing NR	NR	<2	Less severe postscan scanxiety, p<0.001
				Postscan: 9 months	NR	<2	
Bakker[21]	1998	5-point Likert scale	Descriptive range (NA)	Postscan: immediate and at 3 weeks	39–40	Somewhat, very or extremely: 9%–15%	NA
Gupta[22]	1999	HSCL-25	0–3 (NA)	Postscan: specific timing NR	40	Moderate to severe: 25%	NA
Hafslund[23]	2000	STAI: state anxiety subscale	20–80 (NA)	Prescan: day of scan	NR	35.5±11.0	No statistical comparison reported
				Postscan: day of scan	NR	32.1±10.9	
		STAI: trait anxiety subscale	20–80 (NA)	Prescan: day of scan	NR	35.9±9.1	No statistical comparison reported
				Postscan: day of scan	NR	NR	
Meystre-Agustoni[24]	2001	PCQ: negative consequences subscale	0–36 (NA)	Prescan: day of scan	NR	<1	No statistical comparison reported
				Postscan: preresult, 2 weeks postresult and 8 weeks postresult	NR	<2	
		6-point Likert scale	0–5 (NA)	Prescan: immediate	26	<1	
				Postscan: preresult, 2 weeks postresult and 8 weeks postresult	NR	<1	
Drossaert[25]	2002	Composite seven-item score of 4-point Likert scales	1–4 (NA)	Baseline: 8 weeks post-first scan	NR	1.6	No statistical comparison reported
				Prescan: 6 weeks (second and third scans)	NR	1.6 to 1.7	
				Postscan: 6 weeks (second and third scans)	NR	1.5	
			Descriptive range (NA)	Baseline: 8 weeks post-first scan	NR	Moderate to severe: 10%	NA

Continued

Table 3 Continued

		Measurement of scanxiety			Results of scanxiety measurement		
First author	Year	Name of tool	Range of tool (anxiety threshold*)	Timing of assessment	Prevalence (%)	Severity (mean±SD†)	Prescan and postscan comparison
Sandin[26]	2002	HSCL-90-R: anxiety subscale	0–4 (NA)	Pr-scan: day of scan	NR	0.41±0.33	No statistical comparison reported
				Postscan: 2 weeks	NR	0.28±0.30	
Brunton[27]	2005	4-point Likert scale, three items	Descriptive range (NA)	Postscan: within 4 years	56–77	Quite or very: 11%–28%	NA
Geurts[28]	2006	4-point Likert scale	1–4 (NA)	Periscan: specific timing NR	61	Moderate to severe: 21%	NA
Tyndel[29]	2007	PCQ: negative consequences subscale	0–36 (NA)	Prescan: 1 month	NR	5.1±6.7	Less severe postscan scanxiety, p=0.000
				Postscan: 1 month post result and 6 months postresult	NR	3.8±6.0to 4.2±6.2	
		Cancer Worry Scale – Revised	6–24 (NA)	Prescan: 1 month	NR	11.0±2.9	Less severe postscan scanxiety, p=0.000
				Postscan: 1 month post result and 6 months postresult	NR	10.1±2.5to 10.6±2.6	
Bunge[30]	2008	IES in low affective risk people	0–75 (NA)	Prescan: 1 day	NR	5.6±7.9	Less severe postscan scanxiety in both low and high affective risk groups, p<0.05
				Postscan: 6 months	NR	4.3±7.2	
		IES in high affective risk people	0–75 (NA)	Prescan: 1 day	NR	14.7±14.4	
				Postscan: 6 months	NR	10.3±11.0	
Brown Sofair[31]	2008	Penn State Worry Questionnaire	16–80 (60)	Prescan: within 1 month	NR	50.18 (range 40–60)	No statistical comparison reported
				Postscan: day of scan (postresult)	NR	NR	
		SCL-90-R: anxiety subscale	NR (NA)	Prescan: within 1 month	NR	48.75	No difference
				Postscan: day of scan (postresult)	NR	42.07	
		Individualised Questionnaire: anxiety response	1–3 (2)	Prescan: within 1 month	35	NR	No statistical comparison reported
				Postscan: day of scan (postresult)	24	NR	
van den Bergh[32]	2008	STAI-6	20–80 (NA)	Prescan: 1 day	NR	34.1±7.7	Less severe postscan scanxiety, p<0.01
				Postscan: within 1 week and at 6 months	NR	32.7±8.4 to 34.3±9.1	
		IES	0–75 (NA)	Prescan: 1 day	NR	6.9±9.6	Less severe postscan scanxiety, p<0.01
				Postscan: within 1 week and at 6 months	NR	5.1±8.0to 5.6±8.8	
		EuroQol questionnaire: anxiety subscale	1–3 (NA)	Prescan: 1 day	23	NR	No statistical comparison reported
				Postscan: 6 months	NR	NR	
Westerterp[33]	2008	5-point Likert scale	1–5 (NA)	Postscan (after both scans): 2 weeks	NR	CT 1.2±0.6, PET 1.4±1.0	NA
			Descriptive range (NA)	Postscan (after both scans): 2 weeks	CT 13, PET 23	Moderate to severe: CT 4%, PET 10%	NA
Bastiaannet[34]	2009	5-point Likert scale	1–5 (NA)	Postscan: 2–6 weeks after lymph node dissection	Chest x-ray 20, CT 31, PET 36	Moderate to severe: chest X-ray 13%, CT 5%, PET: 9%	NA
Vierikko[35]	2009	Health anxiety inventory	0–24 (NA)	Prescan: specific timing NR	NR	6.7±4.7	Less severe postscan scanxiety, p<0.001
				Postscan: 1 year	NR	5.8±4.6	
		Worry about lung cancer	0–8 (NA)	Prescan: specific timing NR	NR	3.0±2.4	No difference
				Postscan: 1 year	NR	3.1±2.3	
Bölükbaş[36]	2010	STAI: state anxiety subscale	0-NR (20–39 mild, 40–59 moderate, 60–79 severe,≥80 help needed)	Periscan: specific timing NR	NR	46.2±4.9	NA

Continued

Table 3 Continued

		Measurement of scanxiety			Results of scanxiety measurement		
First author	Year	Name of tool	Range of tool (anxiety threshold*)	Timing of assessment	Prevalence (%)	Severity (mean±SD†)	Prescan and postscan comparison
Thompson[37]	2010	STAI	40–160 (NA)	Postscan: specific timing NR	37	65.8±21.0	NA
		STAI: state anxiety subscale	20–80 (≥40)	Postscan: specific timing NR	NR	30.4±10.9	NA
		STAI: trait anxiety subscale	20–80 (≥40)	Postscan: specific timing NR	NR	35.4±11.3	NA
Hutton[38]	2011	HADS: anxiety subscale	0–14 (≥11)	Baseline: 4 weeks pre-first scan	20	6.9±4.2	No difference
				Prescan: day of each scan (for five scans)	MRI 17, mammogram 20	MRI 5.2±4.0 to 6.5±4.2, mammogram 5.0±3.9 to 6.5±4.1	
				Postscan: 6 weeks (for five scans)	ten to 13	5.1±4.2 to 5.9±4.1	
		STAI-6	20–80 (NA)	Prescan: day of scan (for five scans)	NR	MRI 10.8±3.8 to 12.1±4.0, mammogram 10.1±3.9 to 11.3±4.1	Less severe postscan scanxiety for MRI (p<0.0005) and mammogram (p=0.002)
				Postscan: day of scan (for five scans)	NR	MRI 9.6±3.2 to 10.7±3.8, mammogram 9.7±3.1 to 10.5±3.9	
		IES	0–75 (NA)	Postscan: 6 weeks (for five scans)	NR	MRI 17.8±5.8 to 19.3±7.0, mammogram 17.2±4.4 to 18.6±5.2	NA
Pifarré[39]	2011	STAI	0–60 for each subscale (state more than 10 than trait)	Prescan: day of scan	68	NR	NA
Steinemann[40]	2011	7-point Likert scale	1–7 (NA)	Prescan: day of scan	NR	4.1	NA
Yu[41]	2011	HADS: anxiety subscale	0–21 (≥8)	Prescan: day of scan	38	NR	NA
		STAI: state anxiety subscale	NR-80 (≥40)	Prescan: day of scan	46	39.4±12.2	NA
		STAI: trait anxiety subscale	NR-80 (≥40)	Prescan: day of scan	46	39.9±12.2	NA
		Dichotomous reporting§	Yes/No (NA)	Prescan: day of scan	41	NR	NA
Brédart[42]	2012	STAI: state anxiety subscale	20–80 (≥46)	Prescan: 1 week	NR	MRI 42.1, mammogram 41.1	No statistical comparison reported
				Postscan: day of scan and between 15 days to 3 months	NR	MRI 34.9, 40.8, mammogram 34.3, 38.8	
		IES: intrusion subscale	0–35 (≥20)	Prescan: 1 week	NR	MRI 8.9, mammogram 8.4	No statistical comparison reported
				Postscan: day of scan and between 15 days to 3 months	NR	MRI 8.5, mammogram 7.7	
		IES: avoidance subscale	0–40 (≥21)	Prescan: 1 week	NR	MRI 12.1, mammogram 9.8	No statistical comparison reported
				Postscan: day of scan nd between 15 days to 3 months	NR	MRI 11.8, mammogram 8.9	
Hafslund[43]	2012	HADS: anxiety subscale	0–21 (≥8)	Prescan: within 2 weeks	15	4.1±3.3	NA
Adams[44]	2014	4-point Likert scale	1–4 (NA)	Postscan: day of scan (after each scan)	NR	MRI 1.5±0.7, CT 1.8±0.8	NA
Baena-Cañada[45]	2014	HADS: anxiety subscale	0–21 (≥11)	Postscan: specific timing NR	4	1.86±3.26	NA
		Cancer Worry Scale	6–24 (NA)	Postscan: specific timing NR	NR	9.4±3.0	NA
Andersson[46]	2015	Sum of three items on 5-point Likert scale	0–12 (NA)	Postscan: within 4 weeks	NR	4 (range 0–10)	NA

Continued

Table 3 Continued

First author	Year	Measurement of scanxiety			Results of scanxiety measurement		
		Name of tool	Range of tool (anxiety threshold*)	Timing of assessment	Prevalence (%)	Severity (mean±SD†)	Prescan and postscan comparison
Elboga[47]	2015	HADS: anxiety subscale	0–21 (≥10)	Prescan: day of scan	NR	9.2±3.8	NA
		STAI: state anxiety subscale	NR (NA)	Prescan: day of scan	NR	40.4±8.5	NA
		STAI: trait anxiety subscale	NR (NA)	Prescan: day of scan	NR	46.6±7.8	NA
Hobbs[48]	2015	5-point Likert scale	1–5 (NA)	Postscan (after both scans), specific timing NR	Mammogram 17, MRI 44	NR	NA
Bauml[49]	2016	IES-6	0–24 (NA)	Postscan: specific timing NR	83	6.4±5.3	NA
Abreu[50]	2017	10-point Likert scale	1–10 (NA)	Prescan: day of scan	NR	6.4±2.7	Less severe postscan scanxiety, p=0.000
				Postscan: day of scan	NR	5.7±2.6	
Grilo[51]	2017	STAI: state anxiety subscale	0–60 (NA)	Prescan: day of scan	NR	31.1±5.2	More severe postscan scanxiety, p=0.000
				Postscan: day of scan	NR	33.9±4	
Evans[52]	2018	GHQ-12	0–12 (≥4)	Periscans: specific timing NR	42	NR	NA
		7-point Likert scale	1–7 (NA)	Postscan: 1 month	NR	MRI 2.5±1.3, CT or PET/CT 2.2±1.2	NA
Goense[53]	2018	5-point Likert scale	1–5 (NA)	Postscan (after both scans): day of scan	NR	MRI 1.0±0.2, PET 1.0±0.2	NA
Hall[54]	2018	Generalised Anxiety Disorder two-item	0–6 (≥3)	Periscan: specific timing NR	26	1.62±1.78	NA
		Perceived Stress Scale 4	0–16 (NA)	Periscan: specific timing NR	NR	5.14±3.35	NA
Derry[55]	2019	4-point Likert scale	Descriptive range (NA)	Periscan: preresult	NR	'A great deal' or 'completely': 23%	NA
Soriano[56]	2019	PROMIS Anxiety Short Form	1–5 (NA)	Prescan: 2 weeks	NR	1.55±0.64	NA
Taghizadeh[57]	2019	STAI: state anxiety subscale	NR (39)	Baseline	NR	30.9	More severe postscan scanxiety, p<0.001
				Postscan: 1 month postresult and at 12 months	NR	33.1, 31.7	

Continued

Table 3 Continued

First author	Year	Measurement of scanxiety: Name of tool	Range of tool (anxiety threshold*)	Timing of assessment	Results of scanxiety measurement: Prevalence (%)	Severity (mean±SD†)	Prescan and postscan comparison
Bancroft[58]	2020	HADS: anxiety subscale	0–21 (11)	Baseline	Carriers¶: 14 Controls: 7	Carriers: 6.2±3.9 Controls: 4.9±3.3	No difference in prevalence Less severe postscan in carriers (p=0.04)
				Postscan: preresults, at 12 weeks, 26 weeks and 52 weeks	Carriers: 5 to 14 Controls: 2 to 7	Carriers: 5.3±3.9 to 5.9±4.1 Controls: 4.1±3.1 to 4.6±3.3	
		Cancer Worry Scale – Revised	8–32 (NA)	Baseline	NR	Carriers: 14.4±3.6 Controls: 12.2±1.7	No difference
				Postscan: at 12 weeks, 26 weeks and 52 weeks	NR	Carriers: 13.6±4.4 to 14.7±4.2 Controls: 11.9±1.4 to 12.1±1.9	
		IES-cancer: intrusion subscale	0–35 (8.5)	Postscan: preresults, at 12 weeks, 26 weeks and 52 weeks	Carriers: 35 to 58 Controls: 5 to 13	Carriers: 8.3±9.1 to 11.4±9.1 Controls: 1.7±3.5 to 3.0±4.9	NA
		IES-cancer: avoidance subscale	0–40 (8.5)	Postscan: preresults, at 12 weeks, 26 weeks and 52 weeks	Carriers: 55 to 64 Controls: 12 to 37	Carriers: 9.9±9.0 to 13.3±10.5 Controls: 2.6±4.6 to 7.0±8.2	NA
		IES-MRI: intrusion subscale	0–35 (8.5)	Postscan: at 12 weeks, 26 weeks and 52 weeks	Carriers: 4 to 7 Controls: 0 to 3	Carriers: 1.2±3.2 to 3.1±8.8 Controls: 0.1±0.3 to 0.5±1.8	NA
		IES-MRI: avoidance subscale	0–40 (8.5)	Postscan: at 12 weeks, 26 weeks and 52 weeks	Carriers: 14 Controls: 8	Carriers: 1.8±3.4 to 4.1±9.3 Controls: 0.8±1.4 to 2.8±1.8	NA
		STAI-6	6–24 (NA)	Prescan: day of scan	NR	Carriers: 7.2±3.3 Controls: 7.3±3.2	NA
		Health Questionnaire	0–14 (NA)	Baseline	NR	Carriers: 7.0±2.6 Controls: 6.8±2.2	No difference
				Postscan: preresults, at 12 weeks, 26 weeks and 52 weeks	NR	Carriers: 7.1±2.5 to 8.1±2.8 Controls: 6.9±2.2 to 7.7±2.1	
Grilo[59]	2020	STAI: state anxiety subscale	20–80 (NA)	Prescan: day of scan	NR	Bone scan: 51.75±3.77 PET/CT: 44.76±10.0	Less severe postscan scanxiety for both: bone scan. p=0.02 PET/CT, p<0.001
				Postscan: day of scan	NR	Bone scan: 36.70±12.12 PET/CT: 38.82±11.33	
Morreale[60]	2020	Distress thermometer	0–10 (4)	Periscan: day of scan	NR	3.73±2.60	No statistical comparison
				Postscan: 1 week postresult	NR	3.91±2.69	
		HADS: anxiety subscale	0–21 (0–7 none, 8–10 mild, 11–14 moderate, 15–21 high)	Periscan: day of scan	NR	6.12±3.98	No statistical comparison
				Postscan: 1 week postresult	NR	5.32±4.31	
Paiella[61]	2020	Perceived Stress Scale	0–40 (15–18 moderate, ≥19 high)	Postscan: preresult	NR	14.8	NA

All percentages were rounded to the nearest whole number.
*NA is listed as the anxiety threshold when the study did not state a prespecified threshold. In these cases, the definition of scanxiety prevalence was the percentage of people who reported any degree of anxiety.
†Mean listed unless otherwise described; SD listed only when available.
‡This study did not specify an anxiety threshold; however, the Anxiety subscale of the Hospital Anxiety and Depression Scale has validated thresholds. These thresholds were included in this table
§Dichotomous reporting assumed given description of question (self-perception of anxiety) and results '40.5% of the patients considered themselves to be anxious'.[41]
¶This study included participants who were *TP53* mutation carriers and population controls.
GHQ, General Health Questionnaire; HADS, Hospital Anxiety and Depression Scale; HSCL, Hopkins Symptom Checklist; HSCL-90-R, Hopkins Symptom Checklist 90-Revised; IES, Impact of Event Scale; NA, not applicable; NR, not reported; PCQ, Psychological Consequences Questionnaire; PET, positron emission tomography; PROMIS, Patient-Reported Outcomes Measurement Information System; SCL-90-R, Symptom Checklist-90-Revised; STAI, State-Trait Anxiety Inventory.

Table 4 Effect of interventions to reduce scanxiety

			Measurement of scanxiety			Impact of intervention on scanxiety	
First author	Year	Intervention	Name of tool	Range of tool (anxiety threshold)	Timing of assessment	Description of results	P value
Mainiero[62]	2001	Arm A: an educational video about breast cancer and mammography Arm B: an entertaining movie (from the 1940s to 1960s)	6-point Likert score	0–5 (NA)	Prescan: immediate Postscan: immediate	No difference	NR
Domar[63]	2005	Arm A: relaxation audiotape or Arm B: music audiotape or Arm C: control (blank audiotape)	STAI: state anxiety subscale	NR (NA)	Prescan: immediate	No difference Arm A versus arm B versus arm C: 34.8 versus 33.6 versus 33.2	0.18
					Postscan: immediate	No difference Arm A versus arm B versus arm C: 30.4 versus 30.9 versus 33.2	0.78
			STAI: trait anxiety subscale	NR (NA)	Prescan: immediate	No difference Arm A versus arm B versu arm C: 32.6 versus 32.7 versus 32.5	0.99
			11-point Likert scale	1–10 (NA)	Postscan	No difference Arm A versus arm B versus arm C: 2.6 versus 3.2 versus 2.8	0.43
					Postscan: immediate	NR	NR
Fernández-Feito[64]	2005	Arm A: a protocolised nursing intervention (information and emotional support) and usual care or arm B: usual care alone	STAI: state anxiety subscale	0–60 (NA)	Prescan: immediate (postintervention)	Less severe	<0.001
						Less severe if fear of cancer present	0.002
						Less severe if no fear of cancer present	0.003
						No difference if fear of cancer outcome present	0.09
						Less severe if no fear of scan outcome	<0.001
			STAI: trait anxiety subscale	0–60 (NA)	Prescan: immediate (postintervention)	No difference	0.34

Continued

Table 4 Continued

First author	Year	Intervention	Measurement of scanxiety: Name of tool	Measurement of scanxiety: Range of tool (anxiety threshold)	Measurement of scanxiety: Timing of assessment	Impact of intervention on scanxiety: Description of results	Impact of intervention on scanxiety: P value
Caruso[65]	2006	Arm A: routine information and 45 min of informative-emotive psychological support with a psychologist or arm B: routine information	Crown Crisp Experimental Index	NR (0–96)	Prescan: immediate (postintervention)	Less severe Arm A versus arm B: 39.4 versus 42.3	0.03
			STAI: state anxiety subscale	NR (NA)	Prescan: immediate (postintervention)	No difference Arm A versus arm B: 57.7 versus 58.6	0.77
					Postscan: immediate	Less severe	0.048
			STAI: trait anxiety subscale	NR (NA)	Prescan: immediate (postintervention)	NR	NR
Vogel[66]	2012	Arm A: uptake room with an audio-visual installation involving a video of nature scenes on a 119 cm television, dynamic lighting and ambient electronic music Arm B: uptake room without the audio-visual installation	8-item STAI	18–32 (≥16)	Prescan: immediately before and immediately after fluorodeoxyglucose uptake period	Less severe Arm A versus arm B: reduction by 2.39 versus 1.02	0.04
Acuff[67]	2014	Arm A: receive a handheld device to contact imaging staff during the scan Arm B: no device	STAI: state anxiety subscale	20–80 (NA)	During scan: immediately before completion of the scan	Less severe Arm A versus arm B: 22.87 versus 26.45	0.014
						Less severe if previous PET/CT Arm A versus arm B: 20.78 versus 24.64	0.023
						No difference if first time PET/CT Arm A versus arm B: 23.09 versus 27.25, p=0.249	0.249
Raz[68]	2014	Arm A: multimedia education session and usual care or arm B: usual care	STAI: state anxiety subscale	20–80 (≥40)	Prescan: within 2 weeks Postscan: immediate, at 1 week and 3–7 months postscan	No difference at any time point	NR
			STAI: Trait Anxiety subscale	20–80 (≥40)		No difference at any time point	NR
			PCQ: lung cancer adaptation, anxiety subscale	0–18 (NR)		No difference at any time point	0.11 to 0.76
Zavotsky[69]	2014	Arm A: music of their choice played via dock during the scan Arm B: no music	11-point Likert scale	0–10 (NA)	Postscan: immediate	No difference Arm A versus arm B: 2.36 versus 2.98	0.21
Ashton[70]	2019	All participants: 10 min shoulder and neck massage and/or hand massage before, during or after imaging, or between two imaging tests	11-pointLikert scale	0–10 (NA)	Postintervention (prescan or postscan)	81% had a reduction in anxiety following massage*	<0.01

Continued

Table 4 Continued

First author	Year	Intervention	Measurement of scanxiety		Timing of assessment	Impact of intervention on scanxiety	
			Name of tool	Range of tool (anxiety threshold)		Description of results	P value
Lorca[71]	2019	Arm A: mindfulness meditation Arm B: routine care	STAI: State Anxiety subscale	NR (NA)	Postscan: immediate	Less severe Arm A versus arm B: 10.47 versus 29.07	0.000
			STAI: Trait Anxiety subscale	NR (NA)		No difference	NS
			11-item Likert scale	0–10 (NA)		Less severe Arm A versus arm B, 1.07 versus 5.70	0.000

*Mean scores for overall study population not provided.
NA, not applicable; NR, not reported; PCQ, Psychological Consequences Questionnaire; STAI, State-Trait Anxiety Inventory.

screening 14% to 83%, eight measures[28 33 34 37 39 41 48 49]; either screening or reasons other than screening 40%, one measure[22]).

Severity of scanxiety

Severity of scanxiety was reported in 44 of 47 observational studies. Mean severity scores appeared low in almost all measures, which quantitatively measured scanxiety (54/62, 87%).

The mean severity scores were below prespecified anxiety thresholds on 17 of the 19 measures where a threshold was reported.[16 31 37 38 41–43 45 47 54 57 58] The two exceptions were observed in a study comparing people with *TP53* mutations ('carriers') to controls, with all participants undergoing screening scans. In carriers, mean scores were maximally 11.4 (IES intrusion subscale, threshold 8.5) and 13.3 (IES avoidance subscale, threshold 8.5). Mean severity scores for controls were below the thresholds.[58]

Of the 43 measures without a prespecified threshold, the majority had mean scores that were less than half the total scores.[15 18 20 23–26 29 30 32 33 35 37 38 44–46 49 52–54 56 58 60 61] There were six exceptions, which reported maximal mean severity scores of: 5.5 out of 10 (Likert scale)[17]; 6.4 out of 10 (Likert scale)[50]; 4.1 out of 7 (Likert scale),[40] 33 out of 60 (STAI state anxiety subscale),[51] 8.1 out of 14 (Health Questionnaire)[58]; and 51.75 out of 80 (STAI).[59] Four of these scores occurred in studies where scans were performed for reasons other than screening,[17 50 51 59] one allowed scans for diagnosis or screening[40] and one allowed scans for screening only.[58]

Eight measures used a descriptive range of severity, with more severe levels of scanxiety in 4%–28% of participants.[21 22 25 27 28 33 34 55]

Four measures could not be interpreted because they failed to report a range and anxiety threshold.[31 36 47]

Scanxiety before and after a scan

Of the 20 studies that reported a prescan and postscan scanxiety measurement, 14 studies reported a statistical comparison[16 18 20 29–32 35 38 50 51 57–59] and six did not[23–26 42 60] (table 3). There was variation in the timing of scanxiety measurement before a scan from 4 weeks before the scan until immediately before the scan, and after a scan from immediately after the scan until 1 year after the scan. Five studies reported a postscan reduction in scanxiety severity compared with prescan levels.[16 29 30 32 50 59] Two studies reported an increase in postscan scanxiety severity[51 57] and two studies no difference in prescan and postscan scanxiety severity.[18 31]

Four studies reported mixed findings on the change in scanxiety severity across different measures (table 5).

Although Bancroft *et al*[58] reported a reduction in scanxiety severity using HADS (anxiety subscale), there was no difference in scanxiety prevalence.

Contributing factors to scanxiety

Multiple comparisons were made between scanxiety and possible contributing factors across the included studies (table 6).

Table 5 Studies with discrepant results on prescan and postscan scanxiety severity using different measures

	Measurement tool	
First author	Postscan reduction in scanxiety	No difference in prescan or postscan scanxiety
Sutton[20]	General Health Questionnaire: anxiety subscale 3-point Likert scale	STAI: state anxiety subscale STAI: Trait Anxiety subscale
Vierikko[35]	Health Anxiety Inventory	Worry about lung cancer
Hutton[38]	6-item STAI	HADS: anxiety subscale
Bancroft[58]	HADS: anxiety subscale	Cancer Worry Scale – Revised Health Questionnaire

HADS, Hospital Anxiety and Depression Scale; STAI, State Trait Anxiety Inventory.

In summary, higher scanxiety severity was associated with people with:

- Lower education (compared with higher education, eight of 14 studies[22–24 27 36 37 42 43 49 51 59 62 63 69]).
- A history of smoking (compared with non-smoking, three of five studies[40 43 47 49 54]).
- Higher pain levels during the scan (compared with no pain, all six studies[22 23 25 27 62 69]).
- Higher perceived risk of cancer (compared with lower perceived risk of cancer, all three studies[27 30 42]).
- Diagnostic scans (compared with screening scans, all three studies[36 41 62]).

The prevalence or severity of scanxiety was not consistently affected by age (13 of 19 comparisons[20 22 24 27 28 36 37 41–43 45 49–51 59 62 63 70]), gender (6 of 11 comparisons[28 37 39 41 47 49–51 57 59]), ethnicity (five of seven comparisons[22 24 27 37 40 49 63]), income (all three comparisons[27 37 49]), marital status (five of six comparisons[24 36 37 42 49]) or having children (all three comparisons[24 37 43]).

Inconclusive results occurred in the following comparisons:

- Employment (unemployed compared with employed, four of six comparisons[23 27 37 41–43]).
- Scan-naivety (first scan compared with subsequent scans, six of 13 comparisons[19 24 25 27 36 38 39 41 50 51 62 66 67]).
- Risk of cancer (higher compared with lower risk of cancer, 7 of 19 comparisons[15 24 27 36 37 40 42 45 58]).

Although nine studies reported differences in scanxiety between different imaging modalities, the number of comparisons between specific scans were insufficient to draw conclusions.[33 34 41 42 44 48 52 53 59]

Interventions that reduce scanxiety

Five of the 10 intervention studies showed a reduction in scanxiety compared with controls.[64–67 71] Four studies reported no difference in scanxiety between the intervention arms.[62 63 68 69] The study where all participants received the same intervention showed a reduction in anxiety.[70] Details of these results are listed in table 4.

Both multifaceted interventions studies incorporating education and emotional or psychological support showed a reduction in scanxiety.[64 65]

Of the six studies with relaxation, distraction and/or meditation components, three studies showed a reduction in scanxiety,[66 70 71] while three studies did not.[62 63 69]

Interventions with only educational components did not show a reduction in scanxiety.[62 68]

A reduction in scanxiety severity was also observed when a handheld device was available to communicate with radiology staff. This reduction was observed in the subgroup of participants who had had a previous scan but not in participants having their first scan.[67]

DISCUSSION

This is the first systematic scoping review aimed at quantifying the phenomenon of scanxiety in people having cancer-related scans. Scanxiety is a common and important clinical problem, as supported by the large number of studies identified by our search. There is a wide range of reported scanxiety prevalence (0%–83%), and scanxiety is generally not severe. Severity of scanxiety may be lower after a scan and is higher in people who have a lower education, currently smoke, experience pain during a scan, have higher perceived risk of cancer and who are having diagnostic (rather than screening) scans. Interventions may be more likely to reduce scanxiety if they involve active participation (eg, psychological and emotional support, meditation or a handheld communication device) rather than passive participation (listening to music or education only).

Firm conclusions about prevalence and severity could not be drawn due to considerable methodological heterogeneity of the included studies, especially in relation to scanxiety measurement tools. None were designed and validated for scanxiety, and some tools and their thresholds were not designed and/or validated for anxiety. This review did use purpose-designed definitions of prevalence and severity to allow some comparison between studies; however, the lack of a universal definition or specific measurement tool for scanxiety limits confidence in the interpretation of the results and interstudy comparisons. This highlights the need for a universally accepted measure to quantify scanxiety and evaluate scanxiety interventions in the future. A recent literature review by

Table 6 Contributing factors to scanxiety

Variable	Comparison	Effect on scanxiety	Studies	N	P value*
Age	Younger versus older	More prevalent	1	398	0.008[41]
		No difference in prevalence	2	338	NS[28 50]
		More severe	5	1883	0.005,[45] <0.01,[20] <0.01 (for screening),[70] 0.01,[24] NR[63]
		No difference in severity	11	6804	NS,[22 27 36 37 42 43 49 51 59 62] NS (for surveillance)[70]
Gender	Men versus women	More prevalent	1	200	<0.001[39]
		Less prevalent	1	298	0.021[41]
		No difference in prevalence	1	106	NS[28]
		More severe	1	232	0.033 (postscan)[50]
		Less severe	2	1381	0.000,[47] <0.05[57]
		No difference in severity	5	580	NS[37 49 51 59], NS (prescan)[50]
Ethnicity	White versus other races	More severe	1	143	NR[63]
	Maori and Pacific Islanders versus New Zealand European or Asian	More severe	1	584	<0.001[27]
	Any	No difference in severity	5	1454	NS[22 24 37 40 49]
Education	Lower versus higher	More prevalent	1	398	<0.001[41]
		No difference in prevalence	2	338	NS[28 50]
		More severe	8	7400	0.003,[62] 0.007,[36] <0.01,[22] ≤0.01,[42] 0.012,[24] 0.018,[27] 0.04,[43] <0.05[23]
		No difference in severity	6	591	NS[37 49 51 59 63 69]
Employment	Unemployed versus employed	More prevalent	1	398	0.046[41]
		More severe	3	5056	0.01,[43] 0.05,[23] ≤0.05[42]
		No difference in severity	2	654	NS[27 37]
Income	Higher versus lower	No difference in severity	3	757	NS[27 37 49]
Marital status	Married or de facto versus single	More severe	1	637	≤0.01 (using IES – intrusion subscale)[42]
		No difference in severity	5	1790	NS[24 36 37 49], NS (using STAI – state anxiety subscale)[42]
Children	Children versus no children	No difference in severity	3	5206	NS[24 37 43]
Smoking status	Current versus non-smoking†	More severe	3	4562	<0.001,[43 54] 0.031[47]
		No difference in severity	2	330	NS[40 49]
Reason for scan	Diagnostic versus screening	More severe	3	1104	0.007,[41] 0.047,[36] NR[62]
	Staging or surveillance versus monitoring	More severe	1	200	<0.001[39]
	Lower versus higher referral clarity	More severe	1	169	0.048[54]

Continued

Table 6 Continued

Variable	Comparison	Effect on scanxiety	Studies	N	P value*
Type of scan	MRI versus mammogram	More severe	1	49	0.009[48]
		Less severe	1	637	NR[42]
	CT versus MRI	More severe	1	36	0.007[44]
		Less severe	1	115	NR[52]
	PET versus CT	More severe	1	82	0.01[33]
	Nuclear medicine scan versus non-nuclear medicine scan	More severe	1	398	0.004[41]
	MRI versus PET/CT	No difference in severity	2	142	NS[52 53]
	CT versus PET versus chest X-ray	No difference in severity	1	59	NS[34]
	Bone scan versus PET scan	More severe	1	94	<0.001 (postscan)[59]
		No difference in severity	1	94	NS (prescan)[59]
Scan-naïve	First versus subsequent scans	More prevalent	1	398	0.001[41]
		No difference in prevalence	1	200	NS[39]
		More severe	5	3796	<0.0005,[38] <0.01,[25] <0.02,[19] <0.05,[67] NR[66]
		Less severe	1	93	0.038[36]
		No difference in severity	6	2491	NS[24 27 50 51 59 62]
Pain	Pain versus no pain during scan	More severe	6	4291	<0.0001,[25] <0.001,[27] 0.001,[62] <0.01,[23 69] <0.05[22]
Risk of cancer	Past history versus no history of cancer	More severe	2	864	≤0.001,[42] <0.05[40]
		Less severe	1	434	0.013[45]
		No difference in severity	3	1206	NS[15 24 58]
	Family history versus no family history of cancer	More severe	1	584	0.002[27]
		No difference in severity	3	1255	NS[15 24 36]
	Mutation carrier versus not a carrier	More severe	1	88	<0.05 (three comparisons, using IES cancer – Intrusion and Avoidance subscales, and postscan Health Questionnaire)[58]
		No difference	1	88	NS (five comparisons, using HADS-Anxiety subscale, Cancer Worry Scale – Revised, IES MRI – Intrusion and Avoidance subscales, and prescan Health Questionnaire)[58]
	Higher, not otherwise specified versus lower	More severe	1	70	<0.05[37]
Perceived risk of cancer	Higher versus lower	More severe	3	1545	<0.001,[27] ≤0.001[42] <0.01[30]

*The p values listed in this table were reported by individual studies based on their own datasets. This scoping review has not performed additional analysis or attempted quantitative comparisons between studies.
†One study compared current smokers versus former smokers,[54] and one study compared current and former smokers versus never smokers.[49]
HADS, Hospital Anxiety and Depression Scale; IES, Impact of Event Scale; NR, not reported; NS, not significant; STAI, State Trait Anxiety Inventory.

Al-Dibouni[75] provided a narrative overview of scanxiety in people having scans for any reason and also recognised the lack of a specific measurement tool for scanxiety and variable scanxiety prevalence among studies.[75]

Given the STAI and Likert scales were the most common tools used, we propose that future studies use the state anxiety subscale of the STAI, with a range of 20–80 and no specific anxiety threshold[72] (or variants, such as the STAI-6[76]), and/or the distress thermometer, with a range of 0–10 and a clinically significant threshold of ≥4,[77] to measure scanxiety. These tools can be combined with other validated anxiety measures, such as the HADS,

to further refine the relationship between tools. Using existing measures rather than developing a scanxiety specific tool allows scanxiety assessment to occur immediately and broadly in clinical research.

Strengths of this scoping review include the rigorous methodology using a published framework,[12 13] two independent researchers for study selection and data extraction and the implementation of a comprehensive search strategy and broad inclusion criteria to achieve an exhaustive review of the available literature. Limitations include the use of purpose-designed definitions of prevalence and severity and the limited generalisability of the results due to heterogeneity in cancer type, reason for scan, imaging modality and timing of scanxiety measurement between the studies and because the search strategy was restricted to English language databases. Finally, scanxiety in people who were recalled after an abnormal screening result were excluded from this review due to confounding and feasibility. These populations may be at higher risk of scanxiety, and further research may provide further insight about the scanxiety experience in this population.

Additional research implications of our review include the need for research into high-risk populations for scanxiety, including people with advanced cancer. This population was included in only three studies[49 55 60]; however, people with cancer have higher rates of anxiety compared with the general population.[78] As they may be more likely to develop scanxiety, experience more severe scanxiety, or have higher postscan scanxiety while waiting for scan results, longitudinal assessment of scanxiety is required. Further research into effective and feasible interventions is also required, though these will face implementation challenges due to variations in health systems and available resources.

CONCLUSIONS

Prevalence and severity of scanxiety varied widely, although heterogeneity in scanxiety measurement interpretation. A uniform approach to evaluating scanxiety will improve understanding of the phenomenon and help guide the development of interventions to high-risk populations.

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Contributors KTB, PB, BEK, HD and CB contributed to the concept and design of this review. KTB developed and implemented the search strategy. KTB and RL independently screened and reviewed titles, abstracts and full-text articles for inclusion. KTB and RL independently extracted data from the included studies. PB, BEK, HD and CB contributed content expertise to ensure clinically relevant interpretation of the data. KTB drafted the initial manuscript, and RL, PB, BEK, HD and CB reviewed and approved the manuscript prior to submission.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. All data relevant to the study are included in the article or uploaded as supplemental information. The additional data are the data extraction forms for each study.

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Supplementary File 1. Protocol

Scanxiety: A scoping review about scan-associated anxiety

Protocol

Version 1.0, 10/04/2019

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Introduction

Radiological scans are necessary to diagnose and stage cancers, to monitor for cancer recurrence or progression or to investigate new cancer- or treatment-related problems. Imaging modalities include plain X-rays, computed tomography (CT) scans, positron-emission tomography (PET) scans, magnetic resonance imaging (MRI), ultrasound and nuclear medicine bone scans.

Distress before, during or after a scan has been dubbed "scanxiety" by a patient writing for the Time Magazine in 2011[1]. This is a common clinical problem that is widely discussed on social media and patient forms, but there is a paucity in the literature about this topic. This systematic scoping study aims to increase the understanding about scanxiety.

Objectives

The objectives of this study are to:

- determine the incidence and severity of scanxiety in adults who have scans for cancer-related reasons;
- compare tools that measure scanxiety;
- identify contributing and exacerbating determinants of scanxiety;
- identify strategies or interventions that reduce scanxiety; and,
- explore the experiences of scanxiety for patients and other stakeholders

Methods

This protocol is based on the six-step methodological framework developed by Arskey & O'Malley[2] and modified by Levac *et al.*[3], and guided by the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols extension for Scoping Reviews (PRISMA-ScR) checklist[4].

Inclusion and exclusion criteria

Publications will be included if they were original full-text research articles that addressed scanxiety in adults over 18 years of age who had a scan for a cancer-related reason. Outcome measures have to include at least one of the following: the incidence of scanxiety; severity of scanxiety; contributing or exacerbating factors of scanxiety; intervention to improve scanxiety, or; experiences of patients with scanxiety. All types of non-interventional imaging modalities are acceptable. Any type or stage of cancer is acceptable, including populations undergoing cancer screening. No date or language restriction will be applied to electronic database searching.

Bui KT, *et al. BMJ Open* 2021; 11:e043215. doi: 10.1136/bmjopen-2020-043215

Interventional imaging will be excluded. Review articles, editorials, letters and protocols will be excluded.

Search protocol

A systematic review of the following electronic databases will be conducted by one author (KTB): Ovid MEDLINE, Ovid EMBASE, Ovid PsycINFO, Ovid Cochrane, Scopus, ESCBO CINAHL and PubMed. The search strategy will combine the subject headings and keywords of cancer (neoplasm* or cancer* or malignan* or tum??r* or oncolog* or carcinoma*), imaging (diagnostic imaging or imaging or scan* or tomograpy or ultraso* or radionucl*) and anxiety (anxi* or fear* or worr* or distress*). Hand searching of reference lists of included articles will be undertaken.

All references will be imported into Endnote V9. After removal of duplicates, two authors (KTB and RL) will independently review and screen publication titles and abstracts for eligibility. Of the articles deemed potentially eligible, the full text of the article will be evaluated for final inclusion. Discrepancies will be decided by discussion between the two authors (KTB and RL), and will be escalated to all authors if a consensus cannot be reached.

Data extraction and analysis

Standardised data collection forms will be developed. Relevant data will be independently extracted from by two authors (KTB and RL) into an electronic data extraction form (Table 1).

Table 1. Included data items on the electronic data extraction form

Publication details	Study name/Title of article Study authors Date of publication (year) Country the study was held
Study details	Study aims Population including age, gender, type of cancer Study design Measurement tool used for scanxiety
Results/outcomes	Sample size Demographics – gender, age Cancer factors – type of cancers included Incidence of scanxiety

	Severity of scanxiety Contributing and exacerbating determinants of scanxiety Experiences of scanxiety for patients and other stakeholders If intervention: efficacy

Data will analysed depending on the population who underwent imaging (eg for screening, for early cancer or for advanced cancer) and the type of study (eg observational or intervention). Quantitative findings will be synthesised using summary statistics including the mean and range.

Consultation

Health care professionals with clinical experience in oncology and psychology will be consulted for content expertise and to discuss preliminary findings.

References

1. Feiler B. Scanxiety. Fear of a postcancer ritual. Time. 2011;177(24):56.
2. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005;8(1):19-32.
3. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci. 2010;5:69.
4. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169(7):467-73.

Supplementary File 2. Protocol amendments

Scanxiety: A scoping review about scan-associated anxiety

The original protocol dated 10/04/2019 was amended as per the following statements:

1) The objective 'to explore the experiences of scanxiety for patients and other stakeholders' was abandoned due to feasibility of conducting qualitative and quantitative data analysis with the volume of literature identified
2) Inclusion criteria were updated to reflect changes in Amendment 1: experiences of patients with scanxiety were not included; only studies that quantitatively assessed prevalence and severity of scanxiety or met one of the other objectives were included
3) As per recommendations on scoping review methodology, exclusion criteria were updated *post hoc* and were expanded to also exclude studies involving follow-up scans for a positive screening result, because the psychological experiences of asymptomatic persons facing a potential new cancer diagnosis may lead to higher anxiety than is attribute to scanxiety itself.
4) Exclusion criteria were also updated to reflect changes in Amendment 1, where studies that only qualitatively assessed scanxiety were excluded

Bui KT, *et al. BMJ Open* 2021; 11:e043215. doi: 10.1136/bmjopen-2020-043215