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Scanxiety: a scoping review about scan-associated anxiety

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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 PsychINFO, 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.

**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,2-3 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 institutions7,8 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’Malley12 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).
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.

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**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. Participants most commonly had scans for breast cancer (22 studies, n=14,338 women). The most common scans were mammograms (21 studies), and most studies used self-report surveys to assess scanxiety (40 studies). Twenty-one studies were conducted in people having scans for screening.

In the remaining studies, reasons for scanning included diagnosis, staging, monitoring, surveillance to detect recurrence or a combination of reasons in people with known or suspected cancers (17 studies). Five studies permitted scans for both screening and non-screening reasons (namely, diagnosis or surveillance).

#### Observational studies

| Study | Title | Participants | Scans | Measure of Scanxiety |
|-------|-------|--------------|-------|---------------------|
| Study 1 | Breast cancer mammography | 100 women | Mammography | Scanxiety survey |
| Study 2 | Lung cancer CT scan | 50 men | CT scan | Questionnaire |
| Study 3 | Breast cancer MRI scan | 30 women | MRI scan | Self-report |

#### Intervention studies

| Study | Title | Participants | Scans | Measure of Scanxiety |
|-------|-------|--------------|-------|---------------------|
| Study 4 | Breathing technique | 20 women | MRI scan | Scanxiety diary |
| Study 5 | Mindfulness meditation | 15 men | PET scan | Scanxiety rating scale |
| Study 6 | Cognitive-behavioural therapy | 25 women | Ultrasound | Scanxiety assessment tool |

The mean age of participants was reported by 33 studies, was 56.9 years (range 38–66 years). The majority of participants were women (87%). When studies involving scans for breast cancer were excluded, there were similar proportions of men and women (women 49% and men 51%). There was variation in the reporting and proportion of participants who were married (two studies, 73% and 75%), received at least secondary education (six studies, range 74%–99%), and who were attending their first scan (18 studies, range 0%–100%).

**Intervention studies**

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

The mean age of participants was reported by five studies and ranged from 47 to 65 years. The majority were women (94%). There was variation in the reporting and proportion of participants who were married (two studies, 73% and 75%), 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       | 1990  | 275| Sweden           | Ovarian     | NR                  | 100        | NR                     | NR                               | NR             | Abdominal ultrasound | Screening              | Cross-sectional survey   |
| Bull         | 1991  | 541| UK               | Breast      | 50-54: 23% 55-59: 29% 60-64: 34% 65-70: 7% Unknown: 7% | 100        | NR                     | NR                               | NR             | Mammogram            | Screening              | Longitudinal surveys     |
| Peteet       | 1992  | 79 | USA              | Any         | NR                  | NR         | NR                     | NR                               | NR             | CT                   | Screening              | Cross-sectional interview |
| Cockburn     | 1994  | 200| Australia        | Breast      | NR                  | 100        | NR                     | NR                               | NR             | Mammogram            | Screening              | Longitudinal surveys     |
| Ellman       | 1995  | 331| UK               | Breast      | 50-64: 52% 65-78: 48% | 100        | NR                     | NR                               | NR             | Mammogram            | Screening or surveillance | Cross-sectional survey   |
| Sutton       | 1995  | 306| UK               | Breast      | NR                  | 100        | 76                     | 50                               | NR             | Mammogram            | Screening              | Longitudinal surveys     |
| Bakker       | 1998  | 315| Canada           | Breast      | 61                  | 100        | 71                     | 76                               | 50             | Mammogram            | Screening              | Longitudinal surveys     |
| Gupta        | 1999  | 167| Kuwait           | Breast      | Range 14–63         | 100        | NR                     | 82                               | NR             | Mammogram+ultrasound   | Screening or diagnosis   | Cross-sectional survey   |
| Hafslund     | 2000  | 170| Norway           | Breast      | NR                  | 100        | NR                     | NR                               | NR             | Mammogram            | Diagnosis              | Longitudinal surveys     |
| Meystre-Agustoni | 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    | 2002  | 2657| The Netherlands  | Breast      | 58                  | 100        | 78                     | 32                               | NR             | Mammogram            | Screening              | Longitudinal surveys     |
| Sandin       | 2002  | 598| Spain            | Breast      | 51                  | 100        | 77                     | 41                               | NR             | Mammogram            | Screening              | Longitudinal surveys     |
| Brunton      | 2005  | 584| New Zealand      | Breast      | 50-54: 38% 55-59: 35% 60-64: 27% | 100        | NR                     | 74                               | <20%           | Mammogram            | Screening              | Cross-sectional survey   |
| Geurts       | 2006  | 106| The Netherlands  | Head and neck| 56                  | 36         | NR                     | 29                               | NR             | Chest X-ray          | Surveillance            | Cross-sectional survey   |
| Tyndel       | 2007  | 1174| UK              | Breast      | 43                  | 100        | 83                     | 33                               | 87             | Mammogram            | Screening              | Longitudinal surveys     |
| Bunge        | 2008  | 324| The Netherlands, Belgium | Lung      | 60                  | 49         | NR                     | NR                               | NR             | CT                   | Screening              | Longitudinal surveys     |
| Brown Sofair | 2008  | 47 | USA             | Breast      | 50                  | 100        | 34                     | 80                               | NR             | Mammogram            | Screening              | Longitudinal surveys     |
| van den Bergh | 2008 | 324| The Netherlands, Belgium | Lung      | 60                  | 49         | 64                     | 82                               | 66             | CT                   | Screening              | Longitudinal surveys     |

Continued
Table 1

| 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        | 2008 | 82  | The Netherlands  | Oesophageal            | 64                  | 18         | NR                      | NR                            | NR             | CT+PET    | Diagnosis and staging | Cross-sectional survey |
| Bastiaannet       | 2009 | 59  | The Netherlands  | Melanoma               | Median: 59          | 44         | 69                      | 66                            | NR             | CT, PET±chest X-ray | Staging             | Cross-sectional survey |
| Verikko           | 2009 | 601 | Finland          | Lung                   | 65                  | 0          | 36                      | NR                            | NR             | CT        | Screening       | Longitudinal surveys |
| Böyükbas          | 2010 | 93  | Turkey           | Breast                 | 48                  | 100        | 97                      | 10                            | 45             | Mammogram | Screening or diagnosis | Cross-sectional survey |
| Thompson          | 2010 | 70  | USA              | Lymphoma               | Median: 47          | 64         | 53                      | 97                            | NR             | CT        | Surveillance    | Cross-sectional survey |
| Hutton            | 2011 | 527 | UK               | Breast                 | Median: 40          | 100        | 79                      | NR                            | 75             | Mammogram±MRI     | Screening           | Longitudinal surveys |
| Pifarré           | 2011 | 200 | Spain            | Any                    | 52                  | 51         | NR                      | NR                            | 67             | PET/CT    | Any(except screening) | Cross-sectional survey |
| Steinemann        | 2011 | 227 | USA              | Breast                 | NR                  | 100        | NR                      | NR                            | NR             | Mammogram | Screening or diagnosis | Cross-sectional survey |
| Yu                | 2011 | 398 | Brazil           | Any                    | 54                  | 79         | 56                      | 57                            | 27             | Any       | Any(except screening) | Cross-sectional survey |
| Brédart           | 2012 | 637 | France           | Breast                 | 50                  | 100        | NR                      | 87                            | NR             | Mammogram± ultrasound±MRI | Screening or surveillance | Longitudinal surveys |
| Hafslund          | 2012 | 4249| Norway           | Breast                 | 58                  | 100        | NR                      | 52                            | NR             | Mammogram | Screening       | Cross-sectional survey |
| Adams             | 2014 | 36  | The Netherlands  | Lymphoma               | 50                  | 42         | NR                      | NR                            | NR             | CT and MRI | Staging          | Cross-sectional survey |
| Baena-Cañada      | 2014 | 434 | Spain            | Breast                 | 54                  | 100        | 72                      | 43                            | 18             | Mammogram | Screening       | Cross-sectional survey |
| Andersson         | 2015 | 169 | Sweden           | Any                    | 64                  | 47         | 62                      | 62                            | 100            | PET/CT    | Any(except screening) | Cross-sectional survey |
| Elboga            | 2015 | 144 | Turkey           | Any                    | 63                  | 46         | 83                      | 52                            | NR             | PET/CT    | Any(except screening) | Cross-sectional survey |
| Hobbs             | 2015 | 49  | Australia        | Breast                 | 55                  | 100        | 79                      | NR                            | 75             | Mammogram±MRI     | Diagnosis           | Longitudinal surveys |
| Baum              | 2016 | 103 | USA              | Lung                   | Median: 67          | 61         | 73                      | 53                            | NR             | CT, PET±MRI | Monitoring         | Cross-sectional survey |
| Abreu             | 2017 | 232 | Portugal         | Any                    | 61                  | 51         | NR                      | 73                            | 71             | PET/CT    | Any(except screening) | Longitudinal surveys |
| Grilo             | 2017 | 81  | Spain and Portugal | Any               | 55                  | 53         | NR                      | 41                            | 47             | PET/CT    | Any(except screening) | Longitudinal surveys |
| Evans             | 2018 | 115 | UK               | Colorectal or lung     | 66                  | 33         | NR                      | NR                            | NR             | Whole body MRI, PET±CT | Staging             | Longitudinal surveys |
| Goense            | 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) | Female (%) | Married or de facto (%) | At least secondary education (%) | First scan (%) | Scan type | Reason for scan | Methods         |
|--------------|------|----|------------------|----------------------|-------------|------------|------------------------|---------------------------------|----------------|----------|----------------|-----------------|
| Hall⁵⁴       | 2018 | 169| USA              | Lung                 | 64          | 51         | 58                     | 96                               | NR             | Low-dose CT | Screening     | Cross-sectional survey |
| Derry⁵⁵      | 2019 | 94 | USA              | Any                  | 61          | 72         | NR                     | 69                               | 0              | Any       | Monitoring    | Longitudinal interview |
| Soriano⁶⁶     | 2019 | 57 | USA              | Breast               | 58          | 100        | 93                     | NR                               | 0              | Mammogram  | Surveillance  | Longitudinal survey   |
| Taghizadeh⁶⁷ | 2019 | 1237| USA              | Lung                 | 63          | 56         | NR                     | 85                               | NR             | CT        | Screening     | Longitudinal survey   |
| Bancroft⁵⁸   | 2020 | 88 | UK and Ireland   | Breast               | 38          | 61         | 50                     | 83                               | NR             | MRI       | Screening     | Longitudinal survey   |
| Grilo⁶⁹      | 2020 | 94 | Portugal         | Any                  | 61          | 54         | NR                     | 99                               | 77             | PET+bone scan | Staging, monitoring and surveillance | Longitudinal survey   |
| Morreale⁷⁰   | 2020 | 87 | USA              | Gastrointestinal and lung | 62          | 55         | NR                     | 92                               | NR             | CT or MRI  | Monitoring    | Longitudinal survey   |
| Paiella⁷¹    | 2020 | 54 | Italy            | Pancreatic           | 50          | 61         | NR                     | NR                               | NR             | MRI – MRCP | Screening     | Cross-sectional survey |

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,³⁶⁻³⁸ and people who did not have a scan.²⁸–³⁰

§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) | Female (%) | Married or de facto (%) | At least secondary education (%) | First scan (%) | Scan type       | Reason for scan | Allocation | Intervention and control groups |
|--------------------|------|----|------------------|-------------|-------------|-------------|------------------------|----------------------------------|----------------|----------------|----------------|------------|---------------------------------|
| Mainiero           | 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              | 2005 | 143| USA              | Breast      | 52          | 100         | NR                     | 81                               | 8               | Mammogram       | Screening      | Randomised | Relaxation, music or blank audiotape in waiting room during scan |
| Fernández-Feito    | 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             | 2006 | 44 | Italy            | Breast      | 47          | 100         | 75                     | 89                               | NR              | MRI             | Diagnosis       | Randomised | Prescan informative-emotive psychological support or routine information |
| Vogel              | 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              | 2014 | 180| USA              | Any         | NR          | NR          | NR                     | NR                               | NR              | PET/CT          | Any (except screening) | Unclear | Handheld communication device or usual care during scan |
| Raz                | 2014 | 16 | USA              | Lung        | 65          | 75          | NR                     | 100                              | NR              | CT              | Screening       | Sequential‡ | Prescan multimedia education or usual care |
| Zavotsky           | 2014 | 100| USA              | Breast      | 54          | 100         | NR                     | 98                               | NR              | Mammogram       | Screening      | Non-randomised§ | Music or no music during scan |
| Ashton             | 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              | 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% and participants attending their first scan (five studies, range 4%–54%).

Eight studies allocated participants to an intervention or control group, one study compared two interventions, and one study delivered the intervention to all participants. Two interventions were multifaceted; education (four studies); emotional or psychosocial support (two studies); or adjustments to routine logistics of the scan (one study).

### Scnxiety 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, and 17 studies using at least two measures.

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.

Likert scales were varied, with a numerical lower range limit of 0 or 1, and an upper range limit between 3 and 12. Seven studies used a descriptive range.

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.

### Intervention studies

The 10 intervention studies (table 4) used 19 measures of anxiety, with five studies using one measure only, and five studies at least two. The measures included subscales of the STAI (seven studies), Likert scales (five studies), a variant of the Psychological Consequences Questionnaire (one study), and the Crown Crisp Experimental Index (one study).

Likert scales were varied, with a lower range limit of 0 or 1, and an upper range limit between 5 and 10.

The STAI was used and reported using one or both subscales, or a variant (eight-item STAI). There was variation from the usual STAI parameters, with studies using a different range (ie, not reported, 0–60, or 18–32) or prespecified anxiety thresholds of 40 or 16.

### Scnxiety 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. Some studies prespecified an anxiety threshold of 39, 40 and, calculated based on the relationship between the anxiety and trait subscales, or based on investigator-determined categories.

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).

The HADS anxiety subscale has a range of 0–21 and a validated anxiety threshold of 11. One study reported a range of 0–14, one study reported anxiety categories rather than a threshold, two studies reported an anxiety threshold of 8 and one study reported an anxiety threshold of 10 (though there was overlap in ‘tendency to anxiety’ and ‘anxiety’ categories, classified as scores of 8–10 and 10 or more, respectively). The IES was used in its original form or as a variant (IES-6) and was reported as a total score or as intrusion and avoidance subscale scores. The two studies using subscale scores reported threshold levels of 20 or 21 and 8.5. When using the PCQ, researchers used either the emotional subscale or the negative consequences subscale. The Cancer Worry Scale and the Perceived Stress Scale were used in original or variant forms. The Symptom Checklist-90-Revised score could not be interpreted because the authors did not report a range, and a raw score or a transformed score could have been used.

Prevalence of any degree of scanxiety ranged between 28%–81%, five measures other than scanxiety using measures with prespecified anxiety thresholds of people having scans for screening (11 measures), reasons other than screening (four measures) and for screening or non-screening reasons (one measure). When no threshold was reported, the prevalence of scanxiety had a similar range (screening 23%–81%, five measures; reasons other than
## Table 3  Prevalence and severity of scanxiety

| First author | Year | Name of tool | Range of tool (anxiety threshold*) | Timing of assessment | Prevalence (%) | Severity (mean±SD†) | Prescan and postscan comparison |
|--------------|------|--------------|------------------------------------|---------------------|----------------|---------------------|--------------------------------|
| Andolf15     | 1990 | Visual analogue scale | 0–100 (NA) | Postscan: 1–3 years | 81 | Median 3.5 (range 0–100) | NA |
| Bull16       | 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 |
| Peteet17     | 1992 | 10-point Likert scale | 1–10 (NA) | Postscan: specific timing NR | NR | First scan 5.5, recent scan 3.5 | NA |
| Cockburn18   | 1994 | PCQ: emotional subscale | 0–15 (NA) | Prescan: day of scan | NR | NR | No difference |
|              |      |              | | Postscan: preresult, 1 week postresult and at 8 months | NR | <2 | No difference |
| Peteet17     | 1992 | GHQ: anxiety subscale | 0–3 (NA) | Prescan: at invitation to screening, specific timing NR | NR | <1 | Less severe postscan scanxiety, p<0.001 |
|              |      |              | | Postscan: at invitation to screening, specific timing NR | NR | <2 | Less severe postscan scanxiety, p<0.001 |
| Sutton19     | 1995 | HADS: anxiety subscale | 0–21 (≥11)‡ | Prescan: day of scan | NR | Between 1.65 and 1.95 | No significant differences in scanxiety at any time point |
|              |      |              | | Postscan: 9 months | NR | <2 | No significant differences in scanxiety at any time point |
| Bakker21     | 1998 | 5-point Likert scale | Descriptive range (NA) | Postscan: immediate and at 3 weeks | 39–40 | Somewhat, very or extremely: 9%–15% | NA |
| Gupta22      | 1999 | HSCL-25      | 0–3 (NA) | Postscan: specific timing NR | 40 | Moderate to severe: 25% | NA |
| Hafslund13   | 2000 | STAI: state anxiety subscale | 20–80 (NA) | Prescan: day of scan | NR | 35.5±11.0 | No statistical comparison reported |
|              |      | STAI: trait anxiety subscale | 20–80 (NA) | Prescan: day of scan | NR | 32.1±10.9 | No statistical comparison reported |
| Meystre-Agustoni24 | 2001 | PCQ: negative consequences subscale | 0–36 (NA) | Prescan: day of scan | NR | <1 | No statistical comparison reported |
|              |      | 6-point Likert scale | 0–5 (NA) | Prescan: immediate | 26 | <1 | No statistical comparison reported |
| Drotsaert26  | 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 | No statistical comparison reported |
|              |      |              | | Postscan: 6 weeks (second and third scans) | NR | 1.5 | No statistical comparison reported |

Continued
| First author Year | Name of tool | Range of tool (anxiety threshold*) | Timing of assessment | Prevalence (%) | Severity (mean±SD†) | Prescan and postscan comparison |
|-------------------|--------------|-----------------------------------|---------------------|----------------|---------------------|---------------------------------|
| Sandin 2002       | HSCL-90-R, anxiety subscale | 0–4 (NA) | Pre-scan: day of scan, Post-scan: 2 weeks | NR | 0.4±0.33 | No statistical comparison reported |
| Brunton 2005      | 4-point Likert scale, three items | Descriptive range (NA) | Postscan: within 4 years | 56–77 | Quite or very: 11%–28% | NA |
| Geurts 2006       | HSCL-90-R: anxiety subscale | 0–4 (NA) | Pre-scan: day of scan, Post-scan: 2 weeks | NR | 0.28±0.30 | NA |
| Tyndel 2007       | PCQ: negative consequences subscale | 0–36 (NA) | Prescan: 1 month, Postscan: 1 month post result and 6 months postresult | NR | 5.1±6.7 | Less severe postscan scanxiety, p<0.000 |
| Cancer Worry Scale – Revised | 6–24 (NA) | Prescan: 1 month, Postscan: 1 month post result and 6 months postresult | NR | 10.1±2.9 | Less severe postscan scanxiety, p<0.000 |
| Burgo 2008        | IES in low affective risk people | 0–75 (NA) | Prescan: 1 day, Postscan: 6 months | NR | 5.6±7.9 | Less severe postscan scanxiety in both low and high affective risk groups, p<0.05 |
| Brown Sofair 2008 | Penn State Worry Questionnaire | 16-80 (60) | Prescan: within 1 month, Postscan: day of scan postresult | NR | 50.18 (range 40–60) | No statistical comparison reported |
| Bunge 2008        | SCL-90-R: anxiety subscale | NR (NA) | Prescan: within 1 month, Postscan: day of scan postresult | NR | 4.875 | No difference |
| Bastiaannet 2009  | Individualised Questionnaire: anxiety subscale | 1–3 (2) | Prescan: 1 day, Postscan: day of scan postresult | 35 | NR | No statistical comparison reported |
| van den Bergh 2008| STAI-6 | 20–80 (NA) | Prescan: 1 day, Postscan: 6 months | NR | 34.1±7.7 | Less severe postscan scanxiety, p<0.01 |
| Brown Sofair 2008 | IES | 0–75 (NA) | Prescan: 1 day, Postscan: within 1 week and at 6 months | NR | 6.9±6.6 | Less severe postscan scanxiety, p<0.01 |
| Westerterp 2008   | EuroQol questionnaire: anxiety subscale | 1–3 (NA) | Prescan: 1 day, Postscan: 6 months | NR | 5.1±8.0 | No statistical comparison reported |
| Bastiaannet 2009  | 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 |
| Bastiaannet 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 2009     | Health anxiety inventory | 0–24 (NA) | Prescan: specific timing NR, Postscan: 1 year | NR | 6.7±4.7 | Less severe postscan scanxiety, p<0.001 |
| Worry about lung cancer | 0–8 (NA) | Prescan: specific timing NR, Postscan: 1 year | NR | 5.8±4.6 | No difference |
| Bölükbaş 2010     | STAI: state anxiety subscale | 0–NR (30–39 mild, 40–59 moderate, 60–79 severe, ≥80 help needed) | Prescan: specific timing NR | NR | 46.2±4.9 | NA |
| First author | Year | Name of tool | Range of tool (anxiety threshold)* | Timing of assessment | Prevalence (%) | Severity (mean±SD†) | Prescan and postscan comparison |
|--------------|------|--------------|------------------------------------|---------------------|----------------|---------------------|---------------------------------|
| Thompson⁷⁷ | 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 |
| Hutton⁷⁸ | 2011 | HADS: anxiety subscale | 0–14 (≤11) | Prescan: 4 weeks pre-first scan | 20 | 6.9±4.2 | No difference |
| | | STAI: state anxiety subscale | NR-80 (≥40) | Prescan: day of scan (for five scans) | 30.4±10.9 | NR | NA |
| | | STAI: trait anxiety subscale | NR-80 (≥40) | Prescan: day of scan (for five scans) | 35.4±11.3 | NR | NA |
| | | STAI-6 | 20–80 (NA) | Prescan: day of scan (for five scans) | 68 | NR | NA |
| | | IES | 0–75 (NA) | Postscan: 6 weeks (for five scans) | NR | NA | NA |
| Pifarré⁷⁹ | 2011 | STAI | 0–60 for each subscale (state more than 10 than trait) | Prescan: day of scan | 68 | NR | NA |
| Steinemann⁸⁰ | 2011 | 7-point Likert scale | 1–7 (NA) | Prescan: day of scan | NR | 4.1 | NA |
| Yu⁸¹ | 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 |
| Brédart⁸² | 2012 | STAI: state anxiety subscale | 20–80 (≥40) | Prescan: 1 week | NR | MRE 42.1, mammogram 41.1 | No statistical comparison reported |
| | | IES: intrusion subscale | 0–35 (≥20) | Prescan: 1 week | NR | MRE 34.9, 40.8, mammogram 34.3, 38.8 | No statistical comparison reported |
| | | IES: avoidance subscale | 0–40 (≥21) | Prescan: 1 week | NR | MRE 8.0, mammogram 8.4 | No statistical comparison reported |
| Hafslund⁸³ | 2012 | HADS: anxiety subscale | 0–21 (≤8) | Prescan: within 2 weeks | 15 | 4.1±3.3 | NA |
| Adams⁸⁴ | 2014 | 4-point Likert scale | 1–4 (NA) | Postscan: day of scan (after each scan) | NR | MRE 1.5±0.7, CT 1.8±0.8 | NA |
| Baena-Cañada⁸⁵ | 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 | 9.4±3.0 | NA | NA |

### Table 3 Continued

| First author | Year | Name of tool | Range of tool (anxiety threshold)* | Timing of assessment | Prevalence (%) | Severity (mean±SD†) | Prescan and postscan comparison |
|--------------|------|--------------|------------------------------------|---------------------|----------------|---------------------|---------------------------------|
| Andersson⁸⁶ | 2015 | Sum of three items on 5-point Likert scale | 0–12 (NA) | Postscan: within 4 weeks | NR | 4 (range 0–10) | NA |
| First author | Year | Name of tool | Range of tool (anxiety threshold*) | Timing of assessment | Prevalence (%) | Severity (mean±SD†) | Prescan and postscan comparison |
|--------------|------|--------------|-------------------------------------|---------------------|----------------|-------------------|-------------------------------|
| Elboga⁶⁷     | 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 |
| Hobbs⁶⁸      | 2015 | 5-point Likert scale | 1–5 (NA) | Postscan (after both scans), specific timing NR | Memmogram 17, MRI 44 | NR | NA |
| Baum⁶⁹       | 2016 | IES-6 | 0–24 (NA) | Postscan: specific timing NR | 83 | 6.4±5.3 | NA |
| Abreu⁷⁰      | 2017 | 10-point Likert scale | 1–10 (NA) | Prescan: day of scan | NR | 6.4±2.7 | Less severe postscan scanxiety, p=0.000 |
|              |      | STAI: trait anxiety subscale | NR (NA) | Prescan: day of scan | NR | 5.7±2.6 | |
| Gelló⁷¹      | 2017 | STAI: state anxiety subscale | 0–60 (NA) | Prescan: day of scan | NR | 31.1±5.2 | More severe postscan scanxiety, p=0.000 |
|              |      | 7-point Likert scale | 1–7 (NA) | Postscan: 1 month | NR | 33.9±4 | |
| Evans⁷²      | 2018 | GHQ-12 | 0–12 (≥4) | Periscan: specific timing NR | 42 | NR | |
|              |      | 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 |
| Goene⁷³      | 2018 | 5-point Likert scale | 1–5 (NA) | Postscan (after both scans); day of scan | NR | MRE 1.0±0.2, PET 1.0±0.2 | NA |
| Haï⁷⁴        | 2018 | Generalised Anxiety Disorder two-item | 0–6 (≥3) | Periscan: specific timing NR | 26 | 1.6±1.78 | NA |
|              |      | Perceived Stress Scale 4 | 0–16 (NA) | Periscan: specific timing NR | NR | 5.14±3.35 | NA |
| Derry⁷⁵      | 2019 | 4-point Likert scale | Descriptive range (NA) | Periscan: preresult | NR | A great deal or completely: 29% | |
| Soriano⁷⁶    | 2019 | PROMIS Anxiety Short Form | 1–5 (NA) | Prescan: 2 weeks | NR | 1.5±0.64 | NA |
| Taghizadeh⁷⁷ | 2019 | STAI: state anxiety subscale | NR (39) | Baseline | NR | 30.9 | More severe postscan scanxiety, p<0.001 |
|              |      | STAI: trait anxiety subscale | NR (NA) | Postscan: 1 month postresult and at 12 months | NR | 33.1, 31.7 | |

Table 3  Continued
| First author | Year | Name of tool | Range of tool (anxiety threshold)* | Timing of assessment | Prevalence (%) | Severity (mean±SD†) | Prescan and postscan comparison |
|--------------|------|--------------|-----------------------------------|---------------------|----------------|---------------------|---------------------------------|
| Bancroft58   | 2020 | HADS: anxiety subscale | 0–21 (11) | Baseline | Carriers: 14 | Carriers: 6.2±3.9 | No difference in prevalence |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | Carriers: 5 to 14 | Controls: 2 to 7 | Carriers: 5.3±3.9, 9.0±4.1 | Less severe postscan in carriers (p=0.04) |
|              |      | Cancer Worry Scale – Revised | 8–32 (NA) | Baseline | NA | Carriers: 13.4±3.6 | No difference |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | NA | Controls: 12.2±1.7 | |
|              |      | IES-cancer: Intrusion subscale | 0–35 (8.5) | Baseline | Carriers: 35 to 58 | Carriers: 8.3±9.10, 11.4±9.1 | NA |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | Carriers: 55 to 64 | Controls: 12 to 37 | Carriers: 9.0±9.010, 13.3±10.5 | NA |
|              |      | IES-cancer: avoidance subscale | 0–40 (8.5) | Baseline | Carriers: 4 to 7 | Carriers: 1.2±3.210, 3.1±8.8 | NA |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | Controls: 0 to 3 | Carriers: 0.1±3.0, 0.5±1.8 | |
|              |      | IES-MRI: intrusion subscale | 0–35 (8.5) | Baseline | Carriers: 14 | Carriers: 1.8±3.4, 4.1±9.3 | NA |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | Controls: 8 | Carriers: 0.8±1.40, 2.8±1.8 | |
|              |      | IES-MRI: avoidance subscale | 0–40 (8.5) | Baseline | Carriers: 55 to 64 | Carriers: 9.9±9.010, 13.3±10.5 | NA |
|              |      | STAI-6 | 6–24 (NA) | Prescan: day of scan | NA | Carriers: 7.2±3.3 | No difference |
|              |      | Health Questionnaire | 0–14 (NA) | Baseline | NA | Carriers: 7.0±2.6 | No difference |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | Controls: 6.8±2.2 | |
| Grilo⁵⁹       | 2020 | STAI: state anxiety subscale | 20–80 (NA) | Baseline | NA | Carriers: 7.1±3.510, 8.1±2.8 | Less severe postscan scanxiety for both: bone scan, p=0.02 PET/CT, p<0.001 |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | Controls: 6.9±2.210, 7.7±2.1 | |
| Morreale⁶⁰   | 2020 | Distress thermometer | 0–10 (4) | Baseline | NA | Carriers: 3.7±3.2 | No statistical comparison |
|              |      |              | Postscan: at 12 weeks, 26 weeks and 52 weeks | NA | Controls: 3.9±2.69 | |
| Paiella⁶¹    | 2020 | Perceived Stress Scale | 0–40 (15–18 moderate, 19–29 high, ≥30 high) | Baseline | NA | Carriers: 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 prevalence refers to the percentage of people who reported any degree of anxiety.

†Mean listed unless otherwise specified; 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’.

⁰This 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

| First author          | Year | Intervention                                                                 | Name of tool        | Range of tool (anxiety threshold) | Timing of assessment | Description of results                                                                 | P value |
|-----------------------|------|------------------------------------------------------------------------------|---------------------|-----------------------------------|----------------------|----------------------------------------------------------------------------------------|---------|
| Mainiero62            | 2001 | Arm A: an educational video about breast cancer and mammography Arm B: an entertaining movie (from the 1940s to 1980s) | 6-point Likert score | 0-5 (NA)                          | Prescan: immediate   | No difference                                                                          | NR      |
| Domar63               | 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    |
|                      |      |                                                                             | STAI: trait anxiety subscale | NR (NA)                          | Postscan: immediate  | Arm A versus arm B versus arm C: 30.4 versus 30.9 versus 33.2                           | 0.78    |
|                      |      |                                                                             | 11-point Likert scale  | 1-10 (NA)                         | Postscan: immediate  | Arm A versus arm B versus arm C: 32.6 versus 32.7 versus 32.5                          | 0.99    |
|                      |      |                                                                             | STAI: state anxiety subscale | 0-60 (NA)                         | Prescan: immediate   | Less severe                                                                          | <0.001  |
|                      |      |                                                                             | STAI: trait anxiety subscale | 0-60 (NA)                         | Prescan: immediate   | 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  |
|                      |      |                                                                             |                     |                                   |                      | No difference                                                                          | 0.34    |

Continued
| First author Year | Intervention | Measurement of scanxiety | Impact of intervention on scanxiety |
|-------------------|--------------|--------------------------|-----------------------------------|
| **Caruso**<sup>55</sup> 2006 | Arm A: routine information and 45 min of informative-emotive psychological support with a psychologist or arm B: routine information | Name of tool | Range of tool (anxiety threshold) | Timing of assessment | Description of results | P value |
| | | 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 |
| | | STAI: trait anxiety subscale | NR (NA) | Postscan: immediate (postintervention) | Less severe Arm A versus arm B: 39.4 versus 42.3 | 0.048 |
| **Vogel**<sup>66</sup> 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 | Name of tool | Range of tool (anxiety threshold) | Timing of assessment | Description of results | P value |
| | | 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 |
| **Acuf**<sup>67</sup> 2014 | Arm A: receive a handheld device to contact imaging staff during the scan Arm B: no device | Name of tool | Range of tool (anxiety threshold) | Timing of assessment | Description of results | P value |
| | | 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**<sup>68</sup> 2014 | Arm A: multimedia education session and usual care or arm B: usual care | Name of tool | Range of tool (anxiety threshold) | Timing of assessment | Description of results | P value |
| | | 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 | 0.011 to 0.76 |
| | | STAI: Trait Anxiety subscale | 20–80 (≥40) | | | |
| | | PCQ: lung cancer adaptation, anxiety subscale | 0–18 (NR) | | | |
| **Zavotsky**<sup>69</sup> 2014 | Arm A: music of their choice played via dock during the scan Arm B: no music | Name of tool | Range of tool (anxiety threshold) | Timing of assessment | Description of results | P value |
| | | 11-point Likert scale | 0–10 (NA) | Postscan: immediate | No difference | 0.21 |
| **Ashton**<sup>70</sup> 2019 | All participants: 10 min shoulder and neck massage and/or hand massage before, during or after imaging, or between two imaging tests | Name of tool | Range of tool (anxiety threshold) | Timing of assessment | Description of results | P value |
| | | 11-point Likert scale | 0–10 (NA) | Postintervention (prescan or postscan) | 81% had a reduction in anxiety following massage* | <0.01 |
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. 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.

Of the 43 measures without a prespecified threshold, the majority had mean scores that were less than half the total scores. There were six exceptions, which reported maximal mean severity scores of: 5.5 out of 10 (Likert scale); 6.4 out of 10 (Likert scale); 4.1 out of 7 (Likert scale); 33 out of 60 (STAI state anxiety subscale); 8.1 out of 14 (Health Questionnaire); and 51.75 out of 80 (STAI).

Four measures could not be interpreted because they failed to report a range and anxiety threshold.

Scanxiety before and after a scan

Of the 20 studies that reported a prescan and postscan scanxiety measurement, 14 studies reported a statistical comparison and six did not (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. Two studies reported an increase in postscan scanxiety severity, and two studies no difference in prescan and postscan scanxiety severity.

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

Although Bancroft et al 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).
In summary, higher scanxiety severity was associated with people with:

- Lower education (compared with higher education, eight of 14 studies).
- A history of smoking (compared with non-smoking, three of five studies).
- Higher pain levels during the scan (compared with no pain, all six studies).
- Higher perceived risk of cancer (compared with lower perceived risk of cancer, all three studies).
- Diagnostic scans (compared with screening scans, all three studies).

The prevalence or severity of scanxiety was not consistently affected by age (13 of 19 comparisons), gender (6 of 11 comparisons), ethnicity (five of seven comparisons), income (all three comparisons), marital status (five of six comparisons), or having children (all three studies). Inconclusive results occurred in the following comparisons:

- Employment (unemployed compared with employed, four of six comparisons).
- Scan-naïveté (first scan compared with subsequent scans, six of 13 comparisons).
- Risk of cancer (higher compared with lower risk of cancer, 7 of 19 comparisons).

Although nine studies reported differences in scanxiety between different imaging modalities, the number of comparisons between specific scans were insufficient to draw conclusions.

**Interventions that reduce scanxiety**

Five of the 10 intervention studies showed a reduction in scanxiety compared with controls. Four studies reported no difference in scanxiety between the intervention arms. The study where all participants received the same intervention showed a reduction in scanxiety. 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. Of the six studies with relaxation, distraction and/or meditation components, three studies showed a reduction in scanxiety, while three studies did not.

Interventions with only educational components did not show a reduction in scanxiety.

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.

**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

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

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

HADS, Hospital Anxiety and Depression Scale; STAI, State Trait Anxiety Inventory.
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<sup>21</sup>        |
|                         |                                              | No difference in prevalence | 2       | 338   | NS<sup>28, 50</sup>       |
|                         |                                              | More severe         | 5       | 1883  | 0.005<sup>, 25</sup>, <0.01<sup>, 26</sup>, <0.01 for screening)<sup>, 70</sup>, 0.01<sup>, 24</sup>, NR<sup>83</sup> |
|                         |                                              | No difference in severity | 11      | 6804  | NS<sup>, 22, 27, 36, 37, 38, 43, 49, 51, 59, 62</sup>, NS (for surveillance)<sup>, 70</sup> |
|                         |                                              |                     |         |       |                           |
|                         |                                              |                     |         |       |                           |
| Gender                  | Men versus women                             | More prevalent      | 1       | 200   | <0.001<sup>39</sup>       |
|                         |                                              | Less prevalent      | 1       | 298   | 0.021<sup>41</sup>        |
|                         |                                              | No difference in prevalence | 1       | 106   | NS<sup>28</sup>          |
|                         |                                              | More severe         | 1       | 232   | 0.033 (postscan)<sup>50</sup> |
|                         |                                              | Less severe         | 2       | 1381  | 0.000<sup>, 47</sup>, <0.05<sup>, 57</sup> |
|                         |                                              | No difference in severity | 5       | 580   | NS<sup>, 37, 49, 51, 59</sup>, NS (prescan)<sup>, 50</sup> |
| Ethnicty                | White versus other races                     | More severe         | 1       | 143   | NR<sup>83</sup>           |
|                         | Maori and Pacific Islanders versus New Zealand European or Asian | More severe | 1 | 584 | <0.001<sup>, 27</sup> |
|                         | Any                                           | No difference in severity | 5       | 1454  | NS<sup>, 22, 24, 37, 40, 49</sup> |
| Education               | Lower versus higher                          | More prevalent      | 1       | 398   | <0.001<sup>41</sup>       |
|                         |                                              | No difference in prevalence | 2       | 338   | NS<sup>28, 50</sup>       |
|                         |                                              | More severe         | 8       | 7400  | 0.003<sup>, 32</sup>, 0.007<sup>, 36</sup>, <0.01<sup>, 22</sup>, <0.01<sup>, 42</sup>, 0.012<sup>, 24</sup>, 0.018<sup>, 47</sup>, 0.04<sup>, 43</sup>, <0.05<sup>, 23</sup> |
|                         |                                              | No difference in severity | 6       | 591   | NS<sup>, 37, 39, 49</sup> |
| Employment              | Unemployed versus employed                   | More prevalent      | 1       | 398   | 0.046<sup>41</sup>       |
|                         |                                              | More severe         | 3       | 5056  | 0.01<sup>, 43</sup>, 0.05<sup>, 23</sup>, <0.05<sup>, 42</sup> |
|                         |                                              | No difference in severity | 2       | 654   | NS<sup>37, 32</sup>       |
| Income                  | Higher versus lower                          | No difference in severity | 3       | 757   | NS<sup>, 37, 37, 49</sup> |
| Marital status          | Married or de facto versus single            | More severe         | 1       | 637   | ≤0.01 (using IES – intrusion subscale)<sup>, 42</sup> |
|                         |                                              | No difference in severity | 5       | 1790  | NS<sup>, 24, 36, 37, 49</sup>, NS (using STAI – state anxiety subscale)<sup>, 42</sup> |
| Children                | Children versus no children                  | No difference in severity | 3       | 5206  | NS<sup>, 37, 43</sup>     |
| Smoking status          | Current versus non-smoking†                 | More severe         | 3       | 4562  | <0.001<sup>, 43</sup>, 0.031<sup>, 47</sup> |
|                         |                                              | No difference in severity | 2       | 330   | NS<sup>, 40, 49</sup>     |
| Reason for scan         | Diagnostic versus screening                 | More severe         | 3       | 1104  | 0.007<sup>, 41</sup>, 0.047<sup>, 36</sup>, NR<sup>, 82</sup> |
|                         | Staging or surveillance versus monitoring    | No difference in severity | 1       | 200   | <0.001<sup>, 59</sup>     |
|                         | Lower versus higher referral clarity         | More severe         | 1       | 169   | 0.048<sup>54</sup> |

Continued
Al-Dibouni\textsuperscript{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.\textsuperscript{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\textsuperscript{75} (or variants, such as the STAI-6\textsuperscript{76}), and/or the distress thermometer, with a range of 0–10 and a clinically significant threshold of ≥4,\textsuperscript{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,22 23 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 studies19 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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