Hidden in plain sight: psychological barriers to participation in lung cancer screening

Lisa Carter-Harris

Lung cancer screening with low-dose computed tomography (LDCT) became an official recommendation in the US in 2013 in response to the scientific evidence supported by the US-based National Lung Screening Trial.[1] In the years following the US implementation of lung cancer screening with LDCT, scientific evidence from subsequent international trials has supported the mortality reduction benefit of LDCT screening[2 3] and is now recommended in Croatia, some regions of China and Korea, and is currently under review by the UK's National Screening Committee. Despite the implementation of lung cancer screening, uptake remains low among screening-eligible individuals.[4] Low uptake has conventionally been linked to, and supported by, evidence regarding lack of awareness, low knowledge levels and misinformation.[5 6] However, as we consider the aetiology of suboptimal levels of lung cancer screening uptake and potential solutions, there are psychological consequences of lung cancer screening that are an important consideration as a potential barrier for patients who are weighing the option to screen, or not, for lung cancer.[7–9]

Multiple studies have supported an increase in anxiety, depression and cancer worry among individuals who undergo lung cancer screening.[7–9] Cancer screening can understandably evoke worry, fear, anxiety and depression, but may be heightened in a population that perceives themselves at greater risk such as individuals who smoke. Further considerations must be examined in this population such as the negative impact of psychological factors like stigma, mistrust and fatalism, in addition to the variables highlighted above.[10] Lung cancer screening is unique necessitating a different approach from other types of cancer screening that are based on age and family history. Because lung cancer screening targets the individual based on the behaviour of smoking, the stigma that is associated and perpetuated by this association has the potential to feed into additional psychological sequelae in this particular group that may affect screening uptake rates.

In this issue of *Thorax*, Kummer *et al* provide support that psychological distress is higher among high-risk individuals who are undergoing a screening LDCT in a real-world setting.[6] As anticipated, psychological distress was greater in individuals who had abnormal results. However, distress was not raised to clinically significant levels at short term follow-up which is consistent with prior studies.[8] An important gap remains in understanding the range of psychological outcomes longitudinally in routine lung screening practice after an individual begins a lung cancer screening programme regime, which includes annual screening and follow-up for abnormal findings. Further research is needed to more robustly understand how routine lung cancer screening in a real-world setting can impact psychological outcomes longitudinally from the patient perspective including, but not limited to, psychological distress, perceived stigma, anxiety, worry and other emotional sequalae that may result. Kummer *et al* note the importance of high-quality patient education and shared decision-making related to lung cancer screening especially in light of the potential for increased psychological distress.[6] Given the propensity for stigma to be present in this population compared with other cancer screening populations because of its association with smoking, Kummer *et al* results are even more significant when considering lung cancer screening implementation and patient outcomes.

In the US, when lung cancer screening was approved for reimbursement by the nation's largest insurer, the Centers for Medicare and Medicaid Services, documentation of a shared decision-making and counselling visit was mandated in order for LDCT screening to be reimbursed.[11] This was an unprecedented health policy decision in the US because this was the first time that a cancer screening service required documentation of shared decision-making.[11] Because LDCT screening involves a CT scan of the chest of individuals who have consumed cigarettes for a lengthy time period and in a heavy amount, the probability of finding an abnormality on an LDCT scan of the chest is high.[12] Many times, the abnormality is not cancerous. However, the time period between having the scan, being informed that there is an abnormality requiring follow-up testing, and performance of the additional testing to rule out cancer can create great psychological distress for the individual experiencing these events.[6] The potential for false positives, false discoveries and overdiagnosis is important in lung cancer screening elevating the value of the shared decision-making process and patient education even more for the patient considering the option to screen, or not, for lung cancer.[1 11 12] If individuals are at increased risk for psychological distress, this may serve as a barrier to engaging in key conversations with their clinician that could help allay those fears. The recent study by Kummer *et al* support both increased risk for psychological distress in this high-risk patient population and a need to consider this in educational efforts.[6] Tailoring information so the patient knows what to expect and what is common versus uncommon in the process of screening, potential findings and follow-up is essential. Future research is needed testing scalable tailored interventions to support the information sharing process in lung cancer screening to determine how best to (1) identify those as greatest risk for psychological distress; and (2) how best to support those identified at greatest risk for psychological distress. By tailoring information to provide extra support to individuals who may be at risk for greater psychological distress, the patient will not only be informed but may increase the likelihood of patient engagement in their care as well as improved adherence to follow-up and annual screening regimens and ultimately engaging the patient as a partner in their healthcare.

Department of Psychiatry and Behavioral Sciences, Memorial Sloan Kettering Cancer Center, New York, New York, USA

Correspondence to Dr Lisa Carter-Harris, Department of Psychiatry & Behavioral Sciences, Memorial Sloan Kettering Cancer Center, New York, NY 10022, USA; carterl@mskcc.org

Twitter Lisa Carter-Harris @drCarterHarris

Contributors This editorial has been written in whole by the author.

Funding This study was funded by National Cancer Institute (P30CA008748).

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Commissioned; externally peer reviewed.

► Additional material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/thoraxjnl-2020-216191).

To cite Carter-Harris L. *Thorax* 2020;**75**:1033–1034.

Accepted 11 October 2020
Published Online First 2 November 2020

► http://dx.doi.org/10.1136/thoraxjnl-2020-215054

Thorax 2020;**75**:1033–1034.
doi:10.1136/thoraxjnl-2020-216191

ORCID iD
Lisa Carter-Harris http://orcid.org/0000-0002-6448-6033

REFERENCES

1 Final recommendation statement: lung cancer screening. United States preventive services Task force. Available: http://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/lung-cancer-screening [Accessed 29 Sep 2020].
2 van den Bergh KAM, Essink-Bot ML, Borsboom GJJM, *et al*. Short-Term health-related quality of life consequences in a lung cancer CT screening trial (NELSON). *Br J Cancer* 2010;102:27–34.
3 De Koning H. Es 02.01 the Dutch-Belgian lung cancer screening trial (NELSON). *J Thorac Oncol* 2017;12:S1611.
4 Jemal A, Fedewa SA. Lung cancer screening with low-dose computed tomography in the United States-2010 to 2015. *JAMA Oncol* 2017;3:1278–81.
5 Carter-Harris L, Slaven JE, Monahan PO, *et al*. Understanding lung cancer screening behaviour using path analysis. *J Med Screen* 2020;27:105–12.
6 Kummer S, Waller J, Ruparel M, *et al*. Psychological outcomes of low-dose CT lung cancer screening in a multisite demonstration screening pilot: the lung screen uptake trial (LSUT). *Thorax* 2020;75:1065–73.
7 Brain K, Lifford KJ, Carter B, *et al*. Long-Term psychosocial outcomes of low-dose CT screening: results of the UK lung cancer screening randomised controlled trial. *Thorax* 2016;71:996–1005.
8 Wu GX, Raz DJ, Brown L, *et al*. Psychological burden associated with lung cancer screening: a systematic review. *Clin Lung Cancer* 2016;17:315–24.
9 Byrne MM, Weissfeld J, Roberts MS. Anxiety, fear of cancer, and perceived risk of cancer following lung cancer screening. *Med Decis Making* 2008;28:917–25.
10 Carter-Harris L, Davis LL, Rawl SM. Lung cancer screening participation: developing a conceptual model to guide research. *Res Theory Nurs Pract* 2016;30:333–52.
11 Centers for Medicare & Medicaid Services. Decision MEMO for screening for lung cancer with low-dose computed tomography (LDCT) (CAG-00439N), 2020. Available: https://www.cms.gov/medicare-coverage-database/details/nca-decision-memo.aspx?NCAId=274
12 National Lung Screening Trial Research Team, Aberle DR, Adams AM, *et al*. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med* 2011;365:395–409.

Thorax

Thorax

Psychological outcomes of low-dose CT lung cancer screening in a multi-site demonstration screening pilot: The Lung Screen Uptake Trial (LSUT)

Journal:	*Thorax*
Manuscript ID	thoraxjnl-2020-215054.R2
Article Type:	Original research
Date Submitted by the Author:	07-Sep-2020
Complete List of Authors:	Kummer, Sonja; University College London, Research Department of Behavioural Science and Health Waller, Jo; University College London, Health Behaviour Research Centre Ruparel, Mamta; University College London, Lungs for Living Research Centre, UCL Respiratory Duffy, Stephen; Queen Mary University of London, Wolfson Institute of Preventive Medicine, Janes, Sam; University College London, Lungs for Living Research Centre, UCL Respiratory Quaife, Samantha; University College London, Research Department of Behavioural Science and Health
Keywords:	Lung Cancer, Psychology

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Title: Psychological outcomes of low-dose CT lung cancer screening in a multi-site demonstration screening pilot: The Lung Screen Uptake Trial (LSUT)

Authors: Sonja Kummer[1] PhD, Jo Waller[1,2] PhD, Mamta Ruparel[3] PhD, Stephen W Duffy[4] PhD, Samuel M Janes[3] PhD, Samantha L Quaife[1] PhD

Affiliations: [1]Research Department of Behavioural Science and Health, University College London, London, UK; [2]School of Cancer and Pharmaceutical Sciences, King's College London, London, UK; [3]Lungs for Living Research Centre, UCL Respiratory, Division of Medicine, University College London, UK; [4]Wolfson Institute of Preventive Medicine, Barts and the London School of Medicine and Dentistry, Queen Mary University of London, London, UK.

Corresponding author: Dr Samantha L Quaife, samantha.quaife@ucl.ac.uk, Research Department of Behavioural Science and Health, University College London, Gower Street, WC1E 6BT.

Key words: lung cancer, psychology

Abstract word count: was 248 now 250; **Main text word count:** was 3500, now 3992; **Figures:** 0; **Tables:** 6; **References:** 28.

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

KEY MESSAGES

What is the key question?

Is there a clinically significant psychological impact of lung cancer screening when offered in a real-world setting and compared with 'screening unaware' individuals?

What is the bottom line?

Psychological distress was raised among high-risk individuals undergoing LDCT screening in a real-world setting, particularly those with abnormal results or who were ineligible, but differences were unlikely to be clinically meaningful.

Why read on?

This study reports the first real-word data on psychological outcomes from lung cancer screening using a sample representative of high-risk individuals; evidence crucial to informing decision-making about implementing lung cancer screening internationally.

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

ABSTRACT

Background: Previous studies of psychological burden in low-dose CT (LDCT) lung cancer screening trials may lack generalisability due to participation bias and control arms having elevated distress.

Methods: Current and former smokers (n=787, aged 60-75) within a real-world screening demonstration pilot completed measures of lung cancer worry at three time-points (T_0:appointment, T_1:next day, T_2:three months) and anxiety and depression twice (T_0,T_2). A 'screening unaware' community sample (n=383) with the same age and smoking characteristics completed these measures once (T_0). Mean scores were compared by sample type and LDCT result.

Results: Compared with the community sample (T_0), mean scores were higher in the screening sample, and statistically significantly increased in adjusted analyses, for lung cancer worry at T_0 and T_2 (Mean:9.32; 95% Confidence Intervals:8.96-9.69 vs. M:11.34;11.09-11.59 and M:9.32;8.96-9.69), for anxiety at T_0 and T_2 (M:3.32;2.94-3.70 vs. M:4.73;4.42-5.04 and M:5.78;5.33-6.23) and depression at T_2 (M:3.85;3.44-4.27 vs. M:4.15;3.76-4.55). Scores were highest for those with indeterminate (e.g., T_2 anxiety M:6.93;5.65-8.21) and incidental findings (GP follow-up M:5.34;4.67-6.02), and those ineligible for screening (M:6.51;5.25-7.77). Being female, younger, not in paid employment, not married/cohabiting with a partner, and lower education predicted poorer psychological outcomes at T_0, but not T_2 after adjusting for baseline scores. Mean scores remained within 'normal' clinical ranges.

Conclusion: Psychological distress was raised among high-risk individuals undergoing LDCT screening in a real-world setting, but overall differences were unlikely to be clinically meaningful. It will be critical to monitor the psychological impact of services longitudinally across diverse settings, including subgroups vulnerable to clinically elevated distress.

Trial registration: The Lung Screen Uptake Trial was registered prospectively with the ISRCTN (International Standard Registered Clinical/soCial sTudy Number: ISRCTN21774741) on 23rd September 2015 and the NIH ClinicalTrials.gov database (NCT02558101) on 22nd September 2015).

INTRODUCTION

Lung cancer leads cancer-related mortality worldwide, with 35,148 deaths recorded in the UK in 2017 (1) of which most were patients diagnosed with late-stage disease (III or IV) (2). Achieving earlier diagnosis is critical to reducing lung cancer mortality, because survival from early-stage disease is markedly higher (82% five-year survival for stage IA non-small cell) (3). The US National Lung Screening Trial (NLST) and the Dutch-Belgian NELSON trial (Nederlands–Leuvens Longkanker Screenings Onderzoek) have shown that screening high-risk, asymptomatic adults for early-stage lung cancer using low-dose computed tomography (LDCT) reduces the relative risk of lung cancer mortality by 20% and 24%, respectively (4,5). Consequently, LDCT screening is recommended in the US, some regions of China, Korea, and Croatia, and the UK's National Screening Committee are reviewing the recently published NELSON trial results.

Central to policy decision-making about population screening programmes, is ensuring the benefit of screening for the few (i.e. averted cancer deaths) outweighs any potential harm caused to the whole screened population (6). This includes psychological harm, which may be especially likely among those receiving abnormal results. Some earlier LDCT screening trials found a relatively high rate of false positive and incidental results, with one review estimating an average pulmonary nodule detection rate of 20% (range 3%-51%) (7). However, changes to the way nodules are categorised mean the NELSON trial's false positive rate was substantially reduced to 1.2% (5).

Nevertheless, research has sought to determine whether LDCT screening and the different types of screening result cause psychological morbidity. In the short-term, participants with abnormal findings reported lower health-related quality of life (HRQoL) in the NELSON trial (8) and increased psychological distress in the UK Lung Screening (UKLS) trial (9), when compared with participants receiving negative results. However, with the exception of individuals who receive a lung cancer diagnosis, no clinically significant consequences for psychological well-being or HRQoL were observed in the long-term across US and European screening trials when compared with the control trial arms (10,11). While reassuring, evidence suggests a minority experience clinically significant increases in anxiety (12) and that particular characteristics could confer greater propensity for distress. In the UKLS trial, female gender, younger age (<65 years), study site (relatively deprived vs. affluent), and current smoking status were associated with increased distress in both the screening and control arms (9). This potential association of current smoking status and deprivation with increased distress is important because these same characteristics predict lower uptake of LDCT screening trials (13–15) meaning these characteristics are relatively underrepresented in studies to-date. Furthermore, the finding that distress was elevated among these subgroups even within the 'unscreened' control arm is similar to that of the Danish Lung Screening Trial (DLCT) which observed negative

psychological outcomes in both trial arms (16). Control arm trial participants are told they are at high enough risk to enrol, yet not offered screening. They may therefore be more distressed than those who are screening naïve, making them an inappropriate comparison group and potentially underestimating screening-induced distress.

The external validity of psychological outcome data from LDCT screening trials may therefore be limited due both to low participation by those subgroups reporting higher distress and to elevated distress within the 'no screen' control arm with which screening participants' psychological outcomes are often compared. Ours is the first study to compare psychological outcomes among individuals who had undergone LDCT screening in a real-world demonstration pilot, with a community comparison sample who had never been offered LDCT screening. The specific aims were to: i) investigate the sociodemographic and smoking-related characteristics associated with psychological outcomes following screening; and ii) compare the immediate and short-term psychological outcomes of screened individuals with those of the screening unaware community comparison sample both overall and by LDCT screening result.

METHODS

Screening cohort sample

Recruitment was nested within the Lung Screen Uptake Trial (LSUT (17,18)); a real-world demonstration pilot of LDCT screening across two diverse London sites, which aimed to improve uptake and reduce socioeconomic and smoking-related inequalities in participation. Potentially eligible individuals were invited to attend a pre-scheduled Lung Health Check (LHC) appointment via postal invitation letters from their General Practitioner (see 17 for detailed invitation methods). 1005 current and former smokers (quit ≤7 years) aged 60-75, underwent a LHC hospital appointment at which LDCT screening was offered to those eligible (n=845) on the same day. Regardless of LDCT eligibility, all participants were asked to self-complete paper questionnaires containing validated psychological instruments at three time-points: their LHC appointment (T_0), the next day (T_1) and at three-month follow-up (T_2). The latter time-point was chosen both because all participants would have received their LDCT results and any participant requiring a follow-up appointment would have had this within three months of their appointment. Part-way through the study, reminder letters and a prize draw were introduced to improve response rate at T_2.

Community comparison sample

400 participants who had not been invited to screening, but shared the same age (60-75 years) and smoking characteristics (current or former smoker quit ≤7 years) as the screening sample, were

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

recruited via the Smoking Toolkit Study (STS) (19). The STS collects monthly national data on smoking behaviour of current and former smokers in England within Ipsos MORI's face-to-face Omnibus survey (20). Ipsos MORI use a nationally representative random location sampling design and home-based computer-assisted interviewing. Participants self-completed the psychological outcome measures at one time-point (T_0) using an electronic tablet. LDCT screening was not mentioned.

Measures

Psychological outcomes

Anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS) (20). Participants were asked to indicate how they felt during the last week on a 14-item scale with four response options (scored 0-3). Scores for the anxiety and depression scales were summed separately (range 0-21) and interpreted using clinical thresholds: normal (0-7), mild (8-10), moderate (11-14) and severe (15-21) (20).

Lung cancer worry was measured using an adapted version of the Cancer Worry Scale (21). This included seven items with four- or five- point response scales. Total scores were summed (range: 7-29), with higher scores representing higher worry.

Aggregate mean scores for cancer worry, anxiety and depression were then computed at each respective time-point.

Sociodemographic and smoking-related characteristics

For the screening sample, current smoking status, age, gender, ethnicity, marital status, employment status, and highest level of education, were collected during the LHC appointment. For the community sample, these data were obtained via the STS.

LDCT screening results

LDCT results for the screening sample (from clinical records) were categorised as 'negative' (no signs of lung cancer/abnormalities), 'indeterminate pulmonary nodule' (requiring three month follow-up scan), 'suspicious thoracic lesion' (requiring two-week-wait referral), 'incidental finding requiring GP follow up' or 'incidental finding requiring hospital follow-up'. There was also a 'no LDCT scan' group who were not eligible for LDCT screening.

Statistical analysis

Analyses of psychological outcomes within the screening sample were pre-specified within a prospectively registered statistical analysis plan (https://osf.io/hkemm#). This was followed except for analysis by LSUT arm, because there was no overall effect of the intervention on uptake. Further

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

funding was awarded to collect additional data from a community comparison sample. Analyses were pre-specified within the funding application, but were not openly registered.

Descriptive analyses compared the sociodemographic characteristics and smoking status of the two samples, and those within the screening sample who completed the questionnaire measures and those who did not. The latter comparison also included LDCT result. Independent sample t-tests and χ^2-tests explored potential differences.

Analyses tested for differences in mean scores for cancer worry, anxiety and depression by sociodemographic characteristics and smoking status, using ANOVA and independent sample t-tests. The screening sample's overall mean scores on each psychological outcome at each time-point (T_0, T_1 and T_2) were then compared with those of the community sample (T_0) using ANOVA. These analyses were repeated to explore differences in mean scores by LDCT result specifically, with Tukey post-hoc comparisons. Multivariable linear regression analyses then tested whether sample type and LDCT result predicted each of the psychological outcomes independent of sociodemographic characteristics and smoking status.

Additional analyses (not in the pre-specified plan and reported in Supplementary Tables) determined the proportion of participants who scored above the clinical thresholds (≥11) for moderate/severe anxiety and depression (vs. below this threshold, i.e., mild/normal) on the HADS measure. We examined these proportions within each sociodemographic and LDCT screening result sub-group and conducted multivariable logistic regression models to test the independence of these associations when adjusted for sociodemographic characteristics and smoking status.

All analyses were performed in SPSS (V.25) using a complete-case approach. All multivariable analyses of T_1 and T_2 outcomes were adjusted for T_0 scores. Due to multiple testing, a more stringent alpha level of .01 was used. Sensitivity analyses excluded participants who had completed the questionnaire outside the expected timeframes (T_0=same day, T_1=≤2 weeks, T_2=3-5 months). Cognisant of the fact that psychological scores can have skewed distributions, distributions were checked, and positive skewness was found in the cancer worry, anxiety and depression scores at T_0. Multivariable regression analyses were carried out on the log-transformed scores, which found qualitatively the same results. The results are presented in the original scale, as the differences these describe are more readily interpretable.

Statistical power

We anticipated a priori that 700 screening participants would complete the baseline measure and 45% (n=315) would return the follow-up measures based on previous research (22). A quota of 400

participants was set for the community comparison sample. 315 screening participants and 400 community controls provides ≥80% statistical power to detect small between- and within- group differences (*d*=0.2) using two-tailed tests and including eight predictors in multivariable regression modelling (f^2=0.05).

RESULTS

Sample characteristics

At T_0, both samples had a similar proportion of men (54%) and average age of 66 years (see Table 1). Relative to the community sample, the screening sample were more ethnically diverse, more frequently retired, more commonly married/cohabiting, and reported lower education (all p's<.01). A smaller proportion of the screening sample were current smokers (69% vs. 81% in community sample, p<.001).

Response rates

Response rates were unknown for the community comparison sample but missing data among respondents was low (1.0%, n=17).

For the screening sample, 82.5% (n=829) completed the questionnaire at T_0, 51.6% at T_1 (n=519) and 43.1% at T_2 (n=433) out of the 1005 LSUT participants attending the LHC. Of those completing the questionnaires, an average of 94.2% had complete data across time-points. Table 2 shows the baseline (T_0) characteristics of 'completers' (completing every item) and 'non-completers' (including both non-responders and responders who had incomplete/missing data on ≥1 item) for each psychological outcome measure. Compared with completers, a higher proportion of non-completers had a lower level of education, were unmarried/not cohabiting, were of a non-White ethnic background and were current (rather than former) smokers (all p's<.01, except for response by ethnicity for cancer worry). Non-completers of the cancer worry and anxiety measures were also older on average than completers (~1 year), more frequently ineligible for LDCT screening and less frequently received a negative or indeterminate result (p<.001). Similar differences were observed at T_1 and T_2 (data not reported).

The majority of respondents completed their T_0 survey on the same day as their appointment (85.8%), their T_1 survey within two weeks of their appointment (90.5%) and their T_2 survey within three to five months of their appointment (91.8%).

Sociodemographic and smoking-related differences in psychological outcomes within the screening sample

There were few statistically significant differences in baseline psychological outcomes by sociodemographic characteristics, none by smoking status, and none at T_1 or T_2 after adjusting for sociodemographic factors and baseline psychological outcome score (Table 3).

For cancer worry, women had a higher mean score (Mean:11.79; 95% Confidence Intervals:11.40-12.18) than men (M:10.95;10.63-11.27 p<.01) at T_0 in unadjusted and adjusted analyses, but the absolute difference was small.

For anxiety, women again reported higher mean levels compared with men at both T_0 (M:5.61;5.12-6.10 vs. M:3.95,3.56-4.33, respectively, p<.001) and T_2 (M:6.40;5.71-7.10 vs. M:5.25;4.66-5.83, p<.01) in unadjusted analyses. Women were also more likely to score above the threshold for moderate/severe anxiety at T_0 than men (aOR:2.83;1.70,4.71, p<.001, see Supplementary Table 1). The mean scores for both men and women remained within the 'normal' clinical range and differences were no longer statistically significant at T_2 in adjusted analyses of both mean scores and dichotomised scores (normal/mild vs. moderate/severe). Younger age was also associated with higher anxiety at both these time-points (T_0 B:-0.11;-0.18- -0.30, T_2 B:-0.22;-0.32- -0.11, p's<.01) in unadjusted analyses, as was employment status. For example, participants who were unemployed/disabled/homemakers, had significantly higher mean anxiety scores at T_2 (M:7.92;5.97-9.87) than those who were employed (M:5.07;4.31-5.84) or retired (M:5.98;5.40-6.55, p<.001). In this instance, these differences were clinically meaningful, because those in the unemployed/disabled/homemaker group had a mean anxiety score within the 'mild' clinical range. However, in adjusted analyses the differences by age and employment were no longer statistically significant at T_2 and in multivariable logistic regression analyses, these groups were no more likely to score above the cut-off for moderate/severe anxiety at either T_0 or T_2 (Supplementary Table 1).

For depression, the pattern by employment status was similar to that of anxiety. At T_2, those who reported being unemployed/disabled/homemakers, had a statistically significantly higher mean depression score (M:5.96;4.15-7.78) in unadjusted analyses compared with those who were employed (M:2.73;2.14-3.31) or retired (M:4.62;4.10-5.14, p <.001). Further analyses (Supplementary Table 2) also showed that an 'unemployed/disabled/homemaker' status (vs. retired), increased the odds of scoring above the threshold for moderate/severe depression at T_0 (aOR:3.19;1.39-7.35, p<.01) while older age reduced the odds (aOR:0.86;0.78-0.96, p<.01). Having less education was also associated with higher depression scores at both time-points in unadjusted analyses (e.g., left school ≤15 T_2 M:5.02;4.41-5.64 vs. university degree T_2 M:3.04;2.32-3.75, p<.01).

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

In addition, those who were married/cohabiting reported lower depression scores at T_0 (M:2.86;2.49-3.23) and T_2 (M:3.33;2.81-3.84) than those who were not married/cohabiting (M:3.68;3.33-4.03 and M:4.82;4.25-5.40 at T_0 and T_2, respectively). Despite these differences, all mean scores for depression remained within the 'normal' clinical range. Furthermore, in adjusted analyses these differences and associations were no longer statistically significant at T_2.

Overall differences in psychological outcomes between the screening and community samples

In unadjusted analyses, the screening sample had statistically significantly higher mean cancer worry scores at all time-points (T_0 M:11.34;11.09-11.59, T_1 M:10.97;10.66-11.28, T_2 M:11.88;11.49-12.27) than the community sample at T_0 (M:9.32;8.96-9.69, all p's<.001), although absolute differences were small (~2; Table 4). In analyses adjusted for sociodemographic characteristics, smoking status and baseline (T_0) cancer worry score, this association was no longer significantly higher at T_1.

The screening sample also had higher mean anxiety scores at T_0 (M:4.73;4.42-5.04) and T_2 (M:5.78;5.33-6.23) than the community sample at T_0 (M:3.32;2.94-3.70), in unadjusted and adjusted analyses (all p's<.001). Again, absolute differences were small (~2) and scores remained with the 'normal' clinical range for anxiety. For depression, a statistically significant difference between samples was only observed in adjusted analyses at T_2 (M:4.15;3.76-4.55 vs. M:3.85;3.44-4.27, p<.001) and not T_0. The absolute difference was 0.3 and all scores were within the 'normal' clinical range.

Differences in psychological outcomes between the screening and community samples by LDCT result

Mean scores for cancer worry at T_2 among the screening sample were significantly higher for all but one (incidental findings requiring hospital follow-up) of the LDCT result sub-groups at T_0 when compared with the community sample at T_0 (Table 5). Except for those receiving a negative LDCT result, cancer worry scores were highest at T_2 and significantly higher across all the screening sub-groups compared with the community sample at T_0, including those who had not been screened (M:12.03;10.70-13.36 vs. M:9.32;8.96-9.69, p<.001). In analyses adjusted for sociodemographic characteristics, smoking status and T_0 worry score, receiving an indeterminate result (B:2.06;1.37-2.76), an incidental finding (GP (B:0.82;0.32-1.33) and hospital (B:2.41;1.15-3.66) follow-up) or not being screened (B:1.31;0.62-2.00) were associated with statistically significantly higher cancer worry scores at T_2 relative to the community sample at T_0 (p<.01; Table 6).

For anxiety, participants with a negative LDCT result, an incidental finding requiring GP follow-up or who had not been screened had significantly higher mean scores at T_0 and T_2 compared with the community sample in unadjusted and adjusted analyses. Participants found to have an indeterminate

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

pulmonary nodule also had statistically significantly higher anxiety at T_2 than those in the community sample (M:6.93;5.65-8.21 vs. M:3.32;2.94-3.70, p<.001), but not at T_0. There were no statistically significant differences in anxiety at either T_0 or T_2 for those with a suspicious thoracic lesion or an incidental finding needing hospital follow-up. As with cancer worry, mean anxiety scores were highest at T_2 for all screening result sub-groups except those with a negative LDCT result. However, all mean scores remained within the 'normal' clinical range.

In unadjusted analyses, there were no statistically significant differences in either T_0 or T_2 mean depression scores when comparing each of the screening result sub-groups with the community comparison sample at T_0. However, in adjusted analyses, having an indeterminate pulmonary nodule (B:1.02;0.42-1.62), an incidental finding requiring GP follow-up (B: 0.59;0.15-1.03) or not being screened (B:1.57;0.95-2.19) were associated with higher depression scores at T_2 (all p's<.01) relative to the community sample at T_0. Mean scores for each sub-group remained within clinically normally ranges; however, further analyses showed that those with a suspicious thoracic lesion were significantly more likely to report moderate/severe depression at T_2 (aOR:17.61;2.26-137.00,p<.01, see Supplementary Table 3).

DISCUSSION

This is the first study to investigate psychological outcomes among LDCT screening participants in a real-world demonstration pilot service. We compared scores for anxiety, depression and cancer worry with those of a community sample of 'screening unaware' individuals; thus, eliminating any potential psychological impact of screening invitation within the comparison group. There was no evidence that screening participation had a clinically significant impact on psychological well-being. Nevertheless, differences by type of screening result, eligibility status, and sociodemographic factors suggest potential risk factors for psychological distress.

While within the normal clinical range, mean psychological outcome scores were highest at three months' follow-up and for those with indeterminate or incidental results. This was expected given previous research showing similar short-term distress responses to abnormal results (8,9). Without any long-term follow-up, it is unknown whether these responses would have decreased over time, but existing research suggests any adverse impact is likely to be transient (9–11). Previous studies have demonstrated the importance of patient-centred and evidence-based communication in minimising surveillance-related anxiety among individuals diagnosed with incidental pulmonary

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

nodules (23). Pre-emptively implementing such strategies could minimise any potential for psychological distress and prepare participants psychologically for abnormal screening results. While mean psychological outcomes were not statistically significantly elevated among those with a suspicious thoracic lesion in adjusted analyses, binary logistic regression analyses showed that this group was more likely to report clinically significant moderate/severe depression at T_2. The smaller number of cases within the abnormal results sub-groups at T_2, and the binary approach to analysis, reduced statistical power meaning we cannot be confident these groups did not experience significantly elevated psychological distress. Further research using real world data is needed to understand psychological outcomes among screening participants routed through surveillance and urgent referral pathways.

Interestingly, the psychological outcomes of those who received a negative LDCT result were relatively unchanged at three months' follow-up, whereas the subgroup within the screening sample who were not screened had increased cancer worry, anxiety and depression relative to the community sample. Previous research has shown negative psychosocial consequences of allocation to 'no screen' control arms of LDCT screening trials (16,24,25), but unlike these participants, those not screened in the present screening sample were predominantly ineligible for screening due to their lower risk of lung cancer. An individual's perceived personal risk of lung cancer may differ from their objective clinical risk, and this finding suggests that being ineligible could cause a small degree of psychological distress among those with a smoking history who perceive their risk of lung cancer to be high. This is important considering an individual's eligibility status can change over time and suggests that LDCT screening eligibility needs careful communication at both the population and individual level.

Unlike previous research, smoking status did not differentiate psychological responses to LDCT screening, although former smokers in this study had quit more recently (≤7 years) than in LDCT screening trials (≤15 years). However, some of the same sociodemographic predictors of higher short-term psychological distress (9) were observed at T_0. These included female gender and younger age, which were associated with increased cancer worry and anxiety, but also lower education, and not being employed or married/cohabiting, which were associated with higher depression (and anxiety in the case of education). However, these differences were not statistically significant at three months after adjusting for T_0 scores. This could suggest sociodemographic differences are present from the outset when individuals first approach and undergo screening, rather than there being differences in the degree of psychological response to screening. Perhaps the prospect and process of screening evokes more adverse psychological reactions in these groups.

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

Alternatively, this may reflect more widely observed differences in psychological distress and morbidity. Previous research has shown women and lower socioeconomic position (SEP) individuals report higher cancer worry (26), that younger age is associated with higher anxiety among cancer patients (27), that education level is inversely associated with anxiety and depression (28), and that non-married/cohabiting status predicts increased depression (29). While no clinically meaningful differences were observed here, further research is needed to establish the origins of poorer psychological outcomes among these subgroups and how these can be improved.

Two important strengths of this study are its external validity and the blinding of the comparison sample to the lung cancer screening context of the study; intended to prevent any potential impact of screening awareness on psychological outcomes. The screening cohort was nested within a screening demonstration pilot across two sites, which aimed to improve uptake and reduce inequalities in participation. This ultimately achieved a sample representative of lower SEP current smokers (18), which is important given that these may be risk factors for screening-induced distress (24). Nevertheless, the present study may still be subject to participation bias. While the aim was to recruit participants with similar demographic and smoking characteristics in both the screening and community comparison samples, their compositions differed on all characteristics except gender and age. These differences were adjusted for statistically and it is reassuring that no clinically meaningful differences were observed despite the comparison sample having characteristics that would be expected to make them more psychologically robust. However, we do not know the relative distribution of lung cancer worry among those in our broader screening-invited population, for those who attended compared with those who did not attend. Worry about risk could have motivated attendance leading to higher reported distress in the screening sample, although evidence-to-date suggests worry about lung cancer risk may actually deter participation so lung cancer worry could be higher among non-attenders (29). There were also differences between questionnaire completers and non-completers in the screening sample by ethnicity, education, smoking status and LDCT scan eligibility that may have biased findings. While the absolute amount of missing data was small (~5%), this does further limit the study. Additional limitations are that psychological outcomes were only assessed in the short-term and following a single screen. Participation in a regular screening programme could have a cumulative impact on psychological outcomes that should be studied prospectively and longitudinally in the real-world setting. Finally, response rates to the follow-up surveys (T_1 and T_2) were significantly lower than for baseline, which limits the interpretation of the longitudinal analysis.

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

This study found no clinically significant adverse psychological impact of LDCT screening for lung cancer overall, extending this prior observation from the trial setting to the health service context, as well as to a sample predominantly comprised of lower SEP current smokers. In the event of screening implementation, the longitudinal impact of a repeat screening programme across diverse populations and regions within the health service context needs to be researched, as do the differences in psychological response by LDCT result, ineligibility and sociodemographic factors. It is critical that any potential risk factors for distress are better understood and managed pre-emptively through evidence-based, patient-centred communication and screening practice.

ACKNOWLEDGEMENTS

We would like to acknowledge the substantial intellectual contribution made to the study design by Professor Jane Wardle, who passed away prior to its conduct. We would also like to thank all the study participants who kindly gave up their time to take part.

CONFLICTS OF INTEREST

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure_pdf and declare financial support from the Roy Castle Lung Cancer Foundation and Cancer Research UK for the submitted work. SK, JW, SWD and SLQ declare no support from financial organisations that might have an interest in the submitted work in the previous three years. MR was, and SMJ is, supported by funding from a commercial US healthcare company (GRAIL Inc.) as part of funding for a large trial of low dose CT screening, called the 'SUMMIT Study'. SQ collaborates on the SUMMIT Study. SMJ has been paid by Astra Zeneca, BARD1 Bioscience and Achilles Therapeutics for being an Advisory Board Expert and travel to one US conference. SMJ receives grant funding from Owlstone for a separate research study. MR has received travel funding for a conference and educational meeting from Takeda and Astra Zenica. All authors perceive that these disclosures pose no academic conflict for this study. All authors declare no other relationships or activities that could appear to have influenced the submitted work.

SOURCES OF FUNDING

This study is part of the PEOPLE project (Patient Experience Of, and Psychological responses to Lung cancer scrEening), funded by a Roy Castle Lung Cancer Foundation Project Grant (2016/04/Waller). The screening sample was recruited from the Lung Screen Uptake Trial, which was funded by a National Awareness and Early Diagnosis Initiative (NAEDI) project grant (C1418/A17976) awarded by

Cancer Research UK (CRUK) and a consortium of funders (Department of Health (England); Economic and Social Research Council; Health and Social Care R&D Division, Public Health Agency, Northern Ireland; National Institute for Social Care and Health Research, Wales; Scottish Government). SLQ is supported by a Cancer Research UK Postdoctoral Fellowship (C50664/A24460). JW is supported by a Cancer Research UK Career Development Fellowship (C7492/A17219). SMJ is a Wellcome Trust Senior Fellow in Clinical Science (WT107963AIA). SMJ is supported by the Rosetrees Trust, the Roy Castle Lung Cancer Foundation, and UCLH Charitable Foundation. This work was undertaken at UCLH/UCL who received a proportion of funding from the Department of Health's NIHR Biomedical Research Centre's funding scheme.

DATA SHARING STATEMENT

Relevant individual de-identified participant data (including data dictionaries) will be made available upon reasonable request to SMJ (for the screening sample) and to SLQ (for the community sample). Data will be available to share after the publication of the study primary and secondary endpoints. The Lung Screen Uptake Trial protocol and SAP are openly available online and referenced in this manuscript.

CONTRIBUTORSHIP STATEMENT

JW, MR, SWD, SMJ and SLQ conceived of the study and contributed to the design and/or conduct. SK, JW, SWD and SLQ carried out the analysis. All authors made a significant intellectual contribution to the interpretation of the data and contributed to the preparation and approval of the final version of the manuscript.

Carter-Harris L. *Thorax* 2020;0:1033–1034. doi: 10.1136/thoraxjnl-2020-216191

REFERENCES

1. Cancer Research UK. Lung cancer mortality statistics. Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer/mortality#heading-Zero
2. Cancer Research UK. Lung cancer incidence statistics. Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/lung-cancer/incidence#heading-Three.
3. Goldstraw P, Chansky K, Crowley J, Rami-Porta R, Asamura H, Eberhardt WE, Nicholson AG, Groome P, Mitchell A, Bolejack V. The IASLC Lung Cancer Staging Project: Proposals for Revision of the TNM Stage Groupings in the Forthcoming (Eighth) Edition of the TNM Classification for Lung Cancer. *J Thorac Oncol* 2016; 11: 39-51.
4. National Lung Screening Trial Research Team, Aberle DR, Adams AM, Berg CD, Black WC, Clapp JD, Fagerstrom RM, Gareen IF, Gatsonis C, Marcus PM, Sicks JD. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med* 2011; 365: 395-409.
5. de Koning HJ, van der Aalst CM, de Jong PA, Scholten ET, Nackaerts K, Heuvelmans MA, Lammers JJ, Weenink C, Yousaf-Khan U, Horeweg N, van 't Westeinde S, Prokop M, Mali WP, Mohamed Hoesein FAA, van Ooijen PMA, Aerts J, den Bakker MA, Thunnissen E, Verschakelen J, Vliegenthart R, Walter JE, Ten Haaf K, Groen HJM, Oudkerk M. Reduced Lung-Cancer Mortality with Volume CT Screening in a Randomized Trial. *N Engl J Med* 2020; 382: 503-513.
6. Wilson JMG, Jungner G. Principles and practice of screening for disease. Geneva: World Health Organization; 1968. Available from: http://apps.who.int/iris/bitstream/10665/37650/1/WHO_PHP_34.pdf.
7. Bach PB, Mirkin JN, Oliver TK, Azzoli CG, Berry DA, Brawley OW, Byers T, Colditz GA, Gould MK, Jett JR, Sabichi AL, Smith-Bindman R, Wood DE, Qaseem A, Detterbeck FC. Benefits and harms of CT screening for lung cancer: a systematic review. *JAMA* 2012; 307: 2418-2429.
8. van den Bergh KA, Essink-Bot ML, Borsboom GJ, Th Scholten E, Prokop M, de Koning HJ, van Klaveren RJ. Short-term health-related quality of life consequences in a lung cancer CT screening trial (NELSON). *Br J Cancer* 2010; 102: 27-34.
9. Brain K, Lifford KJ, Carter B, Burke O, McRonald F, Devaraj A, Hansell DM, Baldwin D, Duffy SW, Field JK. Long-term psychosocial outcomes of low-dose CT screening: results of the UK Lung Cancer Screening randomised controlled trial. *Thorax* 2016; 71: 996-1005.
10. Wu GX, Raz DJ, Brown L, Sun V. Psychological Burden Associated With Lung Cancer Screening: A Systematic Review. *Clin Lung Cancer* 2016; 17: 315-324.

11. van den Bergh KA, Essink-Bot ML, Borsboom GJ, Scholten ET, van Klaveren RJ, de Koning HJ. Long-term effects of lung cancer computed tomography screening on health-related quality of life: the NELSON trial. *Eur Respir J* 2011; 38: 154-161.
12. Taghizadeh N, Tremblay A, Cressman S, Peacock S, McWilliams AM, MacEachern P, Johnston MR, Goffin J, Goss G, Nicholas G, Martel S, Laberge F, Bhatia R, Liu G, Schmidt H, Atkar-Khattra S, Tsao MS, Tammemagi MC, Lam SC. Health-related quality of life and anxiety in the PAN-CAN lung cancer screening cohort. *BMJ Open* 2019; 9: e024719.
13. McRonald FE, Yadegarfar G, Baldwin DR, Devaraj A, Brain KE, Eisen T, Holemans JA, Ledson M, Screaton N, Rintoul RC, Hands CJ, Lifford K, Whynes D, Kerr KM, Page R, Parmar M, Wald N, Weller D, Williamson PR, Myles J, Hansell DM, Duffy SW, Field JK. The UK Lung Screen (UKLS): demographic profile of first 88,897 approaches provides recommendations for population screening. *Cancer Prev Res (Phila)* 2014; 7: 362-371.
14. Aberle DR, Adams AM, Berg CD, Clapp JD, Clingan KL, Gareen IF, Lynch DA, Marcus PM, Pinsky PF. Baseline characteristics of participants in the randomized national lung screening trial. *J Natl Cancer Inst* 2010; 102: 1771-1779.
15. Hestbech MS, Siersma V, Dirksen A, Pedersen JH, Brodersen J. Participation bias in a randomised trial of screening for lung cancer. *Lung Cancer* 2011; 73: 325-331.
16. Aggestrup LM, Hestbech MS, Siersma V, Pedersen JH, Brodersen J. Psychosocial consequences of allocation to lung cancer screening: a randomised controlled trial. *BMJ Open* 2012; 2: e000663.
17. Quaife SL, Ruparel M, Beeken RJ, McEwen A, Isitt J, Nolan G, Sennett K, Baldwin DR, Duffy SW, Janes SM, Wardle J. The Lung Screen Uptake Trial (LSUT): protocol for a randomised controlled demonstration lung cancer screening pilot testing a targeted invitation strategy for high risk and 'hard-to-reach' patients. *BMC Cancer* 2016; 16: 281-281.
18. Quaife SL, Ruparel M, Dickson JL, Beeken RJ, McEwen A, Baldwin DR, Bhowmik A, Navani N, Sennett K, Duffy SW, Waller J, Janes SM. Lung Screen Uptake Trial (LSUT): Randomised Controlled Trial Testing Targeted Invitation Materials. *Am J Respir Crit Care Med* 2019.
19. Fidler JA, Shahab L, West O, Jarvis MJ, McEwen A, Stapleton JA, Vangeli E, West R. 'The smoking toolkit study': a national study of smoking and smoking cessation in England. *BMC Public Health* 2011; 11: 479.
20. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand* 1983; 67: 361-370.
21. Lerman C, Daly M, Sands C, Balshem A, Lustbader E, Heggan T, Goldstein L, James J, Engstrom P. Mammography adherence and psychological distress among women at risk for breast cancer. *J Natl Cancer Inst* 1993; 85: 1074-1080.

22. Shih T-H, Xitao F. Comparing Response Rates from Web and Mail Surveys: A Meta-Analysis. *Field Methods* 2008; 20: 249-271.
23. Slatore CG, Wiener RS. Pulmonary Nodules: A Small Problem for Many, Severe Distress for Some, and How to Communicate About It. *Chest* 2018; 153: 1004-1015.
24. Rasmussen JF, Siersma V, Pedersen JH, Brodersen J. Psychosocial consequences in the Danish randomised controlled lung cancer screening trial (DLCST). *Lung Cancer* 2015; 87: 65-72.
25. Vrinten C, van Jaarsveld CHM, Waller J, von Wagner C, Wardle J. The structure and demographic correlates of cancer fear. *BMC Cancer* 2014; 14: 597.
26. Hinz A, Herzberg PY, Lordick F, Weis J, Faller H, Brahler E, Harter M, Wegscheider K, Geue K, Mehnert A. Age and gender differences in anxiety and depression in cancer patients compared with the general population. *Eur J Cancer Care (Engl)* 2019; 28: e13129.
27. Bjelland I, Krokstad S, Mykletun A, Dahl AA, Tell GS, Tambs K. Does a higher educational level protect against anxiety and depression? The HUNT study. *Soc Sci Med* 2008; 66: 1334-1345.
28. Lorant V, Croux C, Weich S, Deliege D, Mackenbach J, Ansseau M. Depression and socio-economic risk factors: 7-year longitudinal population study. *Br J Psychiatry* 2007; 190: 293-298.
29. Noor A, Lifford KJ, Carter B, McRonald F, Yadegarfar G, Baldwin DR, Weller D, Hansell DM, Duffy SW, Field JK, Brain K. Barriers to uptake among high-risk individuals declining participation in lung cancer sreening: a mixed methods analysis of the UK Lung Cancer Screening (UKLS) trial. *BMJ Open 2015;* 5:e008254.

Table 1 Comparison of socio-demographic characteristics between those completing each psychological outcome measure in the screening sample (T_0) and the community sample

	Cancer Worry			Anxiety			Depression		
	Community Sample (n=383)[a]	**Screening Sample (n=787)[a]**	**p value**	**Community Sample (n=376)[a]**	**Screening Sample (n=744)[a]**	**p value**	**Comparison Sample (n=384)[a]**	**Screening Sample (n=755)[a]**	**p value**
Gender, n (%)									
Female	176 (46.0)	362 (46.0)	.99[b]	172 (44.8)	351 (47.2)	.45[b]	174 (45.3)	349 (46.2)	.77[b]
Male	207 (54.0)	425 (54.0)		212 (55.2)	393 (52.8)		210 (54.7)	406 (53.8)	
Age, mean (SD)	66.24 *(4.18)*	65.75 *(4.01)*	.06[c]	66.69 *(4.42)*	65.75 *(4.05)*	.05[c]	66.47 *(4.46)*	65.83 *(4.06)*	<.05
Ethnicity, n (%)									
White	367 (96.3)	660 (84.1)	<.001[b]	366 (95.8)	632 (85.2)	<.001[b]	367 (96.1)	640 (84.9)	<.001[b]
Minority ethnic group	14 (10.1)	125 (15.9)		16 (4.2)	110 (14.8)		15 (3.9)	114 (15.1)	
Education, n (%)									
Finished school ≤ age of 15	119 (31.3)	387 (49.2)	<.001[b]	121 (31.5)	363 (48.9)	<.01[b]	120 (31.3)	361 (47.9)	<.001[b]
Completed CSEs/O levels	108 (28.2)	83 (10.5)		107 (27.9)	78 (10.5)		106 (27.6)	78 (10.3)	
Completed A levels/Further/Other	95 (24.8)	138 (17.5)		97 (25.3)	130 (17.5)		96 (25.0)	138 (18.3)	
Completed University degree	61 (15.9)	179 (22.7)		59 (15.4)	172 (23.1)		62 (16.1)	177 (23.5)	
Employment status, n (%)									
Retired	265 (69.2)	481 (62.7)	<.01[b]	268 (69.8)	453 (62.7)	<.001[b]	268 (69.8)	460 (62.8)	<.01[b]
Employed	78 (20.4)	226 (29.5)		75 (19.5)	217 (30.0)		76 (19.8)	220 (30.0)	
Unemployed/Disabled/Homemaker/Other	40 (10.4)	60 (7.8)		41 (10.7)	53 (7.3)		40 (10.4)	53 (7.2)	
Marital status, n (%)									
Married/cohabiting	203 (53.1)	355 (45.2)	<.01[b]	208 (54.3)	329 (44.3)	<.01[b]	205 (53.5)	338 (44.9)	<.01[b]
Not married/cohabiting	179 (46.9)	431 (54.8)		175 (45.7)	413 (55.7)		178 (46.5)	415 (55.1)	
Smoking status, n (%)									
Current smoker (incl. occasional)	308 (80.8)	538 (68.6)	<.001[b]	308 (80.6)	511 (68.9)	<.001[b]	308 (80.6)	515 (68.5)	<.001[b]
Former smoker	72 (19.2)	246 (31.4)		74 (19.4)	231 (31.1)		74 (19.4)	237 (31.5)	

[a] Ns may vary in each cell due to missing data, [b] Chi-square test (categorical variables), [c] Independent samples t-test (continuous variables)

Table 2 Comparison of T_0 completers and non-completers of each psychological outcome in the screening sample

	Cancer Worry			Anxiety			Depression		
	T_0 completers (n=787)[a]	**T_0 non-completers (n=218)[a]**	**p value**	**T_0 completers (n=744)[a]**	**T_0 non-completers (n=261)[a]**	**p value**	**T_0 completers (n=755)[a]**	**T_0 non-completers (n=250)[a]**	**p value**
Gender, n (%)									
Female	362 (46.0)	94 (43.1)	.45	351 (47.2)	105 (40.2)	.05	349 (46.2)	107 (42.8)	.35
Male	425 (54.0)	124 (56.9)		393 (52.8)	156 (59.8)		406 (53.8)	143 (57.2)	
Age, mean (SD)	65.67 *(4.01)*	66.83 *(4.60)*	<.01	65.75 *(4.05)*	66.69 *(4.42)*	<.01	65.83 *(4.06)*	66.47 *(4.46)*	.05
Ethnicity, n (%)									
White	660 (84.1)	168 (77.4)	.02	632 (85.2)	196 (75.4)	<.001	640 (84.9)	188 (75.8)	<.01
Minority ethnic group	125 (15.9)	49 (22.6)		110 (14.8)	64 (24.6)		114 (15.1)	60 (24.2)	
Education status, n (%)									
Finished school ≤ age of 15	387 (49.2)	136 (63.0)	<.01	363 (48.9)	160 (61.5)	<.01	361 (47.9)	162 (65.1)	<.001
Completed CSEs/O levels	83 (10.5)	21 (9.7)		78 (10.5)	26 (10.0)		78 (10.3)	26 (10.4)	
Completed A-levels/Further/Other	138 (17.5)	27 (12.5)		130 (17.5)	35 (13.5)		138 (18.3)	27 (10.8)	
Completed University degree	179 (22.7)	32 (14.8)		172 (23.1)	39 (15.0)		177 (23.5)	34 (13.7)	
Employment status, n (%)									
Retired	481 (62.7)	140 (68.0)	.36	453 (62.7)	168 (67.2)	.18	460 (62.8)	161 (67.1)	.14
Employed	226 (29.5)	51 (24.8)		217 (30.0)	60 (24.0)		220 (30.0)	57 (23.8)	
Unemployed/Disabled/Homemaker/Other	60 (7.8%)	15 (7.3%)		53 (7.3)	22 (8.8)		53 (7.2)	22 (9.2)	
Marital status, n (%)									
Married/cohabiting	355 (45.2)	73 (33.8)	<.01	329 (44.3)	99 (38.1)	.08	338 (44.9)	90 (36.1)	.02
Not married/cohabiting	431 (54.8)	143 (66.2)		413 (55.7)	161 (61.9)		415 (55.1)	159 (63.9)	
Smoking status, n (%)									
Current smoker (incl. occasional)	538 (68.6)	171 (79.2)	<.01	511 (68.9)	198 (76.7)	.02	515 (68.5)	194 (78.2)	<.01
Former smoker	246 (31.4)	45 (20.8)		231 (31.1)	60 (23.3)		237 (31.5)	54 (21.8)	
LDCT scan result, n (%)									
No LDCT scan	156 (19.8)	79 (36.2)	<.001	142 (19.1)	93 (35.6)	<.001	150 (19.9)	85 (34.0)	<.001
Negative LDCT scan	196 (24.9)	41 (18.8)		187 (25.1)	50 (19.2)		189 (25.0)	48 (19.2)	
Indeterminate Pulmonary Nodule	104 (13.2)	23 (10.6)		107 (14.4)	20 (7.7)		105 (13.9)	22 (8.8)	
Suspicious thoracic lesion	27 (3.4)	6 (2.8)		23 (3.1)	10 (3.8)		27 (3.6)	6 (2.4)	
Incidental finding (GP follow-up)	268 (34.1)	60 (27.5)		251 (33.7)	77 (29.5)		250 (33.1)	78 (31.2)	
Incidental finding (Hospital follow-up)	36 (4.6)	9 (4.1)		34 (4.6)	11 (4.2)		34 (4.5)	11 (4.4)	

[a] Ns may vary in each cell due to missing data; [b] Chi-square test (categorical variables) or independent samples t-test (continuous variables)

Table 3 Mean psychological outcome scores for the screening sample by sociodemographic characteristics, and smoking status

	Cancer Worry T_0 (Range 7-29)	Cancer Worry T_1 (Range 7-29)	Cancer Worry T_2 (Range 7-29)	Anxiety T_0 (Range 0-21)	Anxiety T_2 (Range 0-21)	Depression T_0 (Range 0-21)	Depression T_2 (Range 0-21)
	Mean (95% CI)	**Mean (95% CI)**	**Mean (95% CI)**	**Mean (95% CI)**	**Mean (95% CI)**	**Mean (95% CI)**	**Mean (95% CI)**
Gender [a]							
Female	**11.79 (11.40, 12.18)****	11.31 (10.84, 11.78)	12.05 (11.46, 12.64)	**5.61 (5.12, 6.10)****	6.40 (5.71, 7.10)*	3.61 (3.21, 4.00)	4.16 (3.57, 4.75)
Male	**10.95 (10.63, 11.27)****	10.66 (10.25, 11.07)	11.73 (11.21, 12.26)	**3.95 (3.56, 4.33)****	5.25 (4.66, 5.83)*	3.06 (2.73, 3.39)	4.15 (3.60, 4.69)
Age, Beta (95% CI) [b]	-0.04 (-0.10, 0.03)	-0.08 (-0.15, -0.00)	-0.06 (-0.15, 0.04)	**-0.11 (-0.18, -0.30)****	-0.22 (-0.32, -0.11)*	-0.08 (-0.13, -0.01)	-0.08 (-0.18, 0.02)
Ethnicity [c]							
White	11.38 (11.11, 11.64)	11.09 (10.76, 11.42)	11.77 (11.37, 12.17)	4.79 (4.45, 5.14)	5.79 (5.32, 6.25)	3.21 (2.94, 3.50)	4.08 (3.67, 4.49)
Minority ethnic group	11.15 (10.42, 11.88)	10.09 (9.15, 11.02)	13.03 (11.31, 14.74)	4.44 (3.69, 5.19)	5.67 (3.88, 7.46)	3.88 (3.26, 4.49)	5.00 (3.39, 6.61)
Education [c]							
Left school ≤ age 15	11.45 (11.06, 11.85)	10.82 (10.35, 11.30)	12.23 (11.60, 12.86)	4.85 (4.39, 5.31)	6.33 (5.61, 7.04)	3.60 (3.25, 3.95)*	5.02 (4.41, 5.64)*
CSEs/O levels	10.95 (10.22, 11.68)	10.77 (9.93, 11.61)	12.02 (10.76, 13.28)	4.40 (3.45, 5.34)	5.89 (4.35, 7.44)	3.85 (2.93, 4.76)*	4.26 (2.77, 5.75)*
A levels/Further/Other	11.54 (10.98, 12.10)	11.43 (10.58, 12.28)	12.14 (11.21, 13.08)	5.10 (4.33, 5.87)	6.00 (5.02, 6.98)	3.10 (2.49, 3.72)*	3.70 (2.94, 4.45)*
University degree	11.10 (10.63, 11.57)	11.04 (10.48, 11.60)	11.05 (10.41, 11.70)	4.34 (3.72, 4.96)	4.73 (3.96, 5.50)	2.64 (2.12, 3.17)*	3.04 (2.32, 3.75)*
Employment status [c]							
Retired	11.46 (11.12, 11.81)	11.11 (10.67, 11.55)	12.27 (11.76, 12.78)	4.80 (4.39, 5.22)*	5.98 (5.40, 6.55)**	**3.52 (3.19, 3.86)****	4.62 (4.10, 5.14)*
Employed	11.19 (10.79, 11.60)	10.73 (10.31, 11.15)	11.10 (10.42, 11.77)	**4.03 (3.52, 4.53)****	5.07 (4.31, 5.84)**	**2.40 (2.02, 2.79)****	2.73 (2.14, 3.31)*
Unemployed/Disabled/ Homemaker/Other	11.07 (10.05, 12.08)	11.23 (9.87, 12.59)	12.00 (10.27, 13.73)	**6.87 (5.60, 8.14)****	7.92 (5.97, 9.87)**	**5.72 (4.94, 6.94)****	5.96 (4.15, 7.78)*
Marital status [c]							
Married/cohabiting	11.17 (10.82, 11.52)	10.95 (10.49, 11.42)	11.64 (11.12, 12.17)	4.38 (3.91, 4.85)	5.35 (4.72, 5.98)	**2.86 (2.49, 3.23)****	3.33 (2.81, 3.84)*
Not married/cohabiting	11.48 (11.13, 11.84)	10.99 (10.57, 11.41)	12.07 (11.50, 12.64)	5.01 (4.59, 5.43)	6.14 (5.51, 6.77)	**3.68 (3.33, 4.03)****	4.82 (4.25, 5.40)*
Smoking status [a]							
Current smoker [d]	11.37 (11.07, 11.67)	11.10 (10.72, 11.48)	12.07 (11.58, 12.55)	4.76 (4.38, 5.14)	6.02 (5.44, 6.59)	3.39 (3.08, 3.70)	4.50 (3.98, 5.02)
Former smoker	11.29 (10.82, 11.76)	10.75 (10.19, 11.30)	11.53 (10.86, 12.20)	4.64 (4.07, 5.20)	5.37 (4.65, 6.09)	3.16 (2.70, 3.60)	3.55 (2.95, 4.15)

NOTE: 95% CI = 95% Confidence Intervals; *p<.01 in unadjusted analyses ([a] Independent samples t-test, [b] Bivariate linear regression, [c] One-way ANOVA, [d] Including occasional smokers)
p<.01 **(and bolded) in unadjusted analyses AND linear regression models adjusted for gender, age, ethnicity, education, employment status, marital status and smoking status. For psychological outcomes at T_1 and T_2 the models were also adjusted for T_0 outcomes.

Table 4 Multivariable linear regression predicting psychological outcomes for the screening sample compared with the community sample

	Community Sample	Screening sample			
	Estimate (unadjusted)			Estimate (adjusted)*	
	Mean (95% CI)	Mean (95% CI)	p value	Beta (95% CI)	p value
Cancer Worry T_0	9.32 (8.96 to 9.69)	11.34 (11.09 to 11.59)	<.001	1.99 (1.51 to 2.64)	<.001
Cancer Worry T_1		10.97 (10.66 to 11.28)	<.001	0.08 (-0.19 to 0.34)	.56
Cancer Worry T_2		11.88 (11.49 to 12.27)	<.001	0.87 (0.49 to 1.25)	<.001
Anxiety T_0	3.32 (2.94 to 3.70)	4.73 (4.42 to 5.04)	<.001	1.38 (0.85 to 1.92)	<.001
Anxiety T_2		5.78 (5.33 to 6.23)	<.001	1.33 (0.99 to 1.68)	<.001
Depression T_0	3.85 (3.44 to 4.27)	3.32 (3.06 to 3.57)	.02	-0.51 (-0.99 to -0.03)	.04
Depression T_2		4.15 (3.76 to 4.55)	.30	0.64 (-0.32 to 0.95)	<.001

NOTE: 95% CI = 95% Confidence Intervals; Score ranges for each psychological outcome measure are: cancer worry (7-29), anxiety (0-21), depression (0-21); Models adjusted for gender, age, ethnicity, education, employment status, marital status and smoking status. For psychological outcomes at T_1 and T_2 the models were also adjusted for T_0 outcomes.

Table 5 Differences in mean scores on psychological outcomes between the screening and community comparison sample by type of LDCT result

	Community Sample (ref)	LSUT sample by screening result						
		Negative LDCT scan	Indeterminate Pulmonary Nodule	Suspicious Thoracic Lesion	Incidental finding GP follow-up	Incidental finding Hospital follow-up	No LDCT scan	p-value
Cancer Worry T_0, mean (95% CI)	9.32 (8.96 to 9.69)	11.81** (11.27 to 12.35)	11.04** (10.36 to 11.71)	12.11* (10.71 to 13.51)	11.25** (10.86 to 11.65)	10.86 (9.80 to 11.93)	11.06** (10.45 to 11.68)	<0.001
Cancer Worry T_1, mean (95% CI)		11.37** (10.77 to 11.98)	11.00* (10.28 to 11.72)	11.42 (9.58 to 13.26)	10.84** (10.31 to 11.38)	11.20 (9.35 to 13.05)	10.14 (9.32 to 10.96)	<0.001
Cancer Worry T_2, mean (95% CI)		11.24** (10.59 to 11.89)	12.97** (11.96 to 13.98)	12.95* (11.03 to 14.87)	11.52** (10.92 to 12.12)	13.05* (10.80 to 15.30)	12.03** (10.70 to 13.36)	<0.001
Anxiety T_0, mean (95% CI)	3.32 (2.94 to 3.70)	5.25** (4.54 to 5.96)	4.37 (3.56 to 5.19)	5.17 (3.79 to 6.56)	4.49* (3.97 to 5.01)	3.47 (2.31 to 4.63)	4.96* (4.24 to 5.68)	<0.001
Anxiety T_2, mean (95% CI)		5.29** (4.38 to 6.21)	6.93** (5.65 to 8.21)	6.39 (4.04 to 8.74)	5.34** (4.67 to 6.02)	4.94 (2.93 to 6.95)	6.51** (5.25 to 7.77)	<0.001
Depression T_0, mean (95% CI)	3.85 (3.44 to 4.27)	3.58 (3.04 to 4.12)	3.21 (2.51 to 3.91)	3.89 (2.42 to 5.36)	3.28 (2.85, 3.72)	2.65 (1.63 to 3.66)	3.15 (2.58 to 3.73)	0.23
Depression T_2, mean (95% CI)		3.25 (2.49 to 4.02)	4.81 (3.67 to 5.96)	5.28 (2.71 to 7.84)	3.93 (3.35 to 4.51)	3.33 (1.73 to 4.93)	5.38 (4.25 to 6.51)	0.01

NOTE: 95% CI = 95% Confidence Intervals; Score ranges for each psychological outcome measure are: cancer worry (7-29), anxiety (0-21), depression (0-21); * p < .01 for Tukey HSD Post Hoc Test , ** p <.001 for Tukey HSD Post Hoc Test

Table 6 Multivariable linear regression predicting psychological outcomes following LDCT screening for the screening sample compared with the community sample

	Community sample	Negative LDCT scan	Indeterminate Nodule	Suspicious Thoracic Lesion	Incidental finding (GP)	Incidental finding (Hospital)	No LDCT scan
	Beta (95% CI)	**Beta (95% CI)**	**Beta (95% CI)**	**Beta (95% CI)**	**Beta (95% CI)**	**Beta (95% CI)**	**Beta (95% CI)**
Cancer Worry T_2 (n=748)	REF	-0.21 (-0.75 to 0.34)	2.06** (1.37 to 2.76)	1.26 (0.06 to 2.46)	0.82* (0.32 to 1.33)	2.41** (1.15 to 3.66)	1.31** (0.62 to 2.00)
Anxiety T_2 (n=706)	REF	0.75* (0.23 to 1.26)	1.87** (1.23 to 2.51)	1.15 (-0.06 to 2.37)	1.32** (0.84 to 1.79)	1.36 (0.13 to 2.59)	2.05** (1.35 to 2.75)
Depression T_2 (n=706)	REF	0.09 (-0.39 to 0.56)	1.02* (0.42 to 1.62)	0.60 (-0.44 to 1.64)	0.59* (0.15 to 1.03)	0.04 (-1.05 to 1.14)	1.57** (0.95 to 2.19)

NOTE: 95% CI = 95% Confidence Intervals; Score ranges for each psychological outcome measure are: cancer worry (7-29), anxiety (0-21), depression (0-21); * p < .01, ** p <.001; Models adjusted for gender, age, ethnicity, education, employment status, marital status, smoking status, and T_0 psychological outcome scores.

Supplementary Table 1 Frequencies and multivariable logistic regression for scoring above threshold for moderate/severe anxiety among screening sample

	Anxiety T_0			Anxiety T_2		
	%(n)	%(n)	aOR (95% CI)	%(n)	%(n)	aOR (95% CI)
	Normal/Mild	Moderate/Severe		Normal/ Mild	Moderate/Severe	
Gender						
Male	93.6 (368)	6.4 (25)	1.00	88.2 (194)	11.8 (26)	1.00
Female	82.6 (290)	17.4 (61)	**2.83 (1.70,4.71)****	79.8 (150)	20.2 (38)	2.23 (0.97,5.12)
Age	-	-	0.92 (0.86,0.99)	-	-	0.90 (0.79,1.01)
Ethnicity						
White	88.6 (560)	11.4 (72)	1.00	83.7 (313)	16.3 (61)	1.00
Minority ethnic group	87.3 (96)	12.7 (14)	1.23 (0.63,2.41)	90.9 (30)	9.1 (3)	0.20 (0.04,1.09)
Education						
Left school ≤ age 15	88.2 (320)	11.8 (43)	1.00	81.7 (138)	18.3 (31)	1.00
CSEs/O levels	89.7 (70)	10.3 (8)	0.61 (0.25,1.45)	83.0 (39)	17.0 (8)	2.34 (0.68,8.08)
A levels/Further/Other	84.6 (110)	15.4 (20)	1.28 (0.69,2.38)	81.7 (67)	18.3 (15)	0.99 (0.36,2.74)
University degree	91.3 (157)	8.7 (15)	0.81 (0.42,1.56)	90.9 (100)	9.1 (10)	0.32 (0.10,1.06)
Employment status						
Retired	87.6 (397)	12.4 (56)	1.00	82.6 (218)	17.4 (46)	1.00
Employed	93.5 (203)	6.5 (14)	0.42 (0.22,0.81)	89.9 (98)	10.1 (11)	0.58 (0.21,1.57)
Unemployed/Disabled/ Homemaker/Other	75.5 (40)	24.5 (13)	1.53 (0.71,3.27)	76.9 (20)	23.1 (6)	0.31 (0.05,1.82)
Marital status						
Married/cohabiting	89.4 (294)	10.6 (35)	1.00	87.8 (158)	12.2 (22)	1.00
Not married/cohabiting	87.7 (362)	12.3 (51)	1.04 (0.64,1.69)	81.5 (185)	18.5 (42)	1.72 (0.75,3.91)
Smoking status						
Current smoker	88.5 (452)	11.5 (59)	1.00	83.6 (219)	16.4 (43)	1.00
Former smoker	88.7 (205)	11.3 (26)	1.12 (0.67,1.87)	85.5 (124)	14.5 (21)	1.14 (0.50,2.61)

NOTE: aOR = adjusted odds ratio; 95% CI = 95% Confidence Intervals; * p < .01, ** p <.001; Models adjusted for gender, age, ethnicity, education, employment status, marital status, smoking status, and T_0 psychological outcome scores.

Supplementary Table 2 Frequencies and multivariable logistic regression for scoring above threshold for moderate/severe depression among screening sample

	Depression T_0			Depression T_2		
	%(n)	%(n)	aOR (95% CI)			aOR (95% CI)
	Normal/ Mild	Moderate/Severe		Normal/ Mild	Moderate/Severe	
Gender						
Male	94.6 (384)	5.4 (22)	1.00	93.4 (211)	6.6 (15)	1.00
Female	93.7 (327)	6.3 (22)	0.89 (0.46,1.71)	93.0 (173)	7.0 (12)	0.78 (0.26,2.34)
Age	-	-	**0.86 (0.78,0.96)***	-	-	1.01 (0.86,1.19)
Ethnicity						
White	93.8 (600)	6.3 (40)	1.00	93.4 (351)	6.6 (25)	1.00
Minority ethnic group	96.5 (110)	3.5 (4)	0.47 (0.16,1.42)	91.4 (32)	8.6 (3)	1.11 (0.20,6.07)
Education						
Left school ≤ age 15	95.3 (344)	4.7 (17)	1.00	91.5 (162)	8.5 (15)	1.00
CSEs/O levels	89.7 (70)	10.3 (8)	1.67 (0.63,4.39)	87.0 (40)	13.0 (6)	1.50 (0.31,7.20)
A levels/Further/Other	93.5 (129)	6.5 (9)	1.35 (0.56,3.25)	96.2 (76)	3.8 (3)	0.23 (0.04,1.44)
University degree	94.4 (167)	5.6 (10)	1.54 (0.65,3.61)	96.4 (106)	3.6 (4)	0.25 (0.04,1.47)
Employment status						
Retired	94.6 (435)	5.4 (25)	1.00	91.6 (240)	8.4 (22)	1.00
Employed	97.7 (215)	2.3 (5)	0.26 (0.10,0.72)	98.2 (108)	1.8 (2)	1.00 (0.18,5.60)
Unemployed/Disabled/ Homemaker/Other	75.5 (40)	24.6 (13)	**3.19 (1.39,7.35)***	85.7 (24)	14.3 (4)	1.98 (0.31,12.80)
Marital status						
Married/cohabiting	95.0 (321)	5.0 (17)	1.00	95.6 (175)	4.4 (8)	1.00
Not married/cohabiting	93.5 (388)	6.5 (27)	1.24 (0.64,2.40)	91.2 (208)	8.8 (20)	1.34 (0.42,4.25)
Smoking status						
Current smoker	93.6 (482)	6.4 (33)	1.00	91.6 (240)	8.4 (22)	1.00
Former smoker	95.4 (226)	4.6 (11)	0.76 (0.36,1.61)	96.0 (143)	4.0 (6)	0.75 (0.22,2.55)

NOTE: aOR = adjusted odds ratio; 95% CI = 95% Confidence Intervals; * p < .01, ** p <.001; Models adjusted for gender, age, ethnicity, education, employment status, marital status, smoking status, and T_0 psychological outcome scores.

Supplementary Table 3 Frequencies and multivariable logistic regression for scoring above threshold for moderate/severe anxiety and depression

	Community sample	Negative LDCT scan	Indeterminate Nodule	Suspicious Thoracic Lesion	Incidental finding (GP)	Incidental finding (Hospital)	No LDCT scan
Anxiety T_2							
Normal/Mild, % (n)	94.3 (362)	83.5 (81)	73.3 (44)	77.8 (14)	90.0 (126)	100.0 (16)	81.5 (53)
Moderate/Severe, % (n)	5.7 (22)	16.5 (18)	26.7 (16)	22.2 (4)	10.0 (14)	0.0 (0)	18.5 (12)
Moderate/Severe, aOR	1.00	2.55	3.31	6.80	2.07	-	6.26
(95% CI)		(0.80 to 8.09)	(1.01 to 10.78)	(0.80 to 57.67)	(0.71 to 6.02)	-	(1.54 to 25.43)
Depression T_2							
Normal/Mild, % (n)	91.9 (353)	94.4 (101)	91.5 (54)	77.8 (14)	95.8 (136)	100.0 (18)	89.7 (81)
Moderate/Severe, % (n)	8.1 (31)	5.6 (6)	8.5 (5)	22.2 (4)	4.2 (6)	0.0 (0)	10.3 (7)
Moderate/Severe, aOR	1.00	1.77	0.43	**17.61***	1.08	-	3.06
(95% CI)		(0.38 to 8.19)	(0.05 to 3.46)	**(2.26 to 137.00)**	(0.27 to 4.22)	-	(0.49 to 19.11)

NOTE: aOR = adjusted odds ratio; 95% CI = 95% Confidence Intervals; * p < .01, ** p <.001; Models adjusted for gender, age, ethnicity, education, employment status, marital status, smoking status, and T_0 psychological outcome scores.