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Increased risk of hallucinations among people with cancer: Role of loneliness, job satisfaction, sleep and a moderated-mediated model of anxiety and life satisfaction

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A B S T R A C T

Being diagnosed with cancer and coping with fears about potential death might trigger acute distress. Previous research found that patients with cancer are 1.85 times more at risk of developing mental illness. Whereas previous studies investigated the risk of schizophrenia, no studies have investigated the risk of individual psychotic symptoms such as hallucinations. This was an analysis of the English Longitudinal Study of Ageing involving 7586 adults of whom 1082 have cancer. There were 19 (0.3%) who self-reported hallucinations, and logistic regression showed that cancer patients had higher odds of hallucinating. Loneliness, discrimination, poor job satisfaction, poor life satisfaction, anxiety, low level of autonomy/control and having restless sleep were also associated with hallucinations. Cancer patients had higher odds of poor life satisfaction, which was also predicted by loneliness, discrimination, job satisfaction, anxiety symptoms, autonomy/control and restless sleep. Further results of a moderated mediation model showed that cancer, loneliness, and job satisfaction were directly associated with hallucinations, and life satisfaction was a mediator. Anxiety symptoms also moderated the relationships with hallucinations. Cancer is associated with a higher risk of hallucinations, and other aspects of mental wellbeing (e.g., anxiety and life satisfaction) are also important. Interventions are needed which safeguard mental health after cancer diagnosis and during treatment.

1. Introduction

A previous meta-analysis of 15 studies found that patients with cancer have a higher risk of developing mental illness with odds of 1.85 which, in turn, reduce cancer survival rates (Kim et al., 2022). Sub-group analysis found that cancer was associated with 1.95 higher odds of major depressive disorder (MDD), 2.38 higher odds of an anxiety disorder, 1.16 higher odds of schizophrenia, 1.39 higher odds of bipolar disorder, and 3.34 higher odds of posttraumatic disorder (PTSD) (Kim et al., 2022). Whereas that meta-analysis and previous studies investigated the risk of schizophrenia in patients with cancer, no studies (to our knowledge) have investigated the risk of individual psychotic symptoms such as hallucinations. This is important because they can form part of a range of non-schizophrenia disorders such as brief psychotic disorder which in the Diagnostic and Statistical Manual-5 (DSM-5-TR) is diagnosed when patients present with hallucinations, delusions, or disorganised speech for at least one day but for less than a month. Catatonia and disorganised behaviour are additional potential symptoms. Strong stressors are known triggers, and therefore being diagnosed with cancer, getting cancer treatment, and worrying about prognosis or risk of death might increase the risk. Hallucinations can also be experienced by people without a mental disorder because of a range of triggers (Lincoln et al., 2021).

1.1. Hallucinations and life-threatening conditions

It is plausible that being diagnosed with cancer and coping with fears about potential death might trigger acute distress in patients which might manifest, in some cases, through hallucinations. No studies exist about cancer patients, but we can draw inferences from research about other life-threatening medical conditions. One study found that people with a chronic illness were more at risk of suffering a psychotic

experience during the coronavirus pandemic (Wang et al., 2023). Having an illness like cancer which poses a risk of death might induce worries about mortality and trigger psychotic episodes relating to those fears. A systematic review found that some patients with coronavirus who developed new-onset psychosis had hallucinations about dying and the after life (Chaudhary et al., 2022). 69% of the patients had no history of a mental disorder, and many of the cases occurred at the height of the pandemic in 2020/2021 when many coronavirus-related deaths occurred daily, and many people may have feared that catching coronavirus could lead to death. Research is therefore needed to shed light on whether patients with cancer have a higher risk of hallucinations, which we focused on because they were reported in the database that we examined (Banks et al., 2024).

1.2. Life satisfaction

We aimed to move the literature beyond exploring the link between cancer and mental ill health by controlling for other factors that might contribute to the risk. One important factor is life satisfaction because a study by Choi et al. (2021) found that people with dementia who had auditory hallucinations had lower levels of it, while a study by Rathee et al. (2018) found that people with schizophrenia and auditory hallucinations had poorer objectively rated quality of life. Hayward et al. (2024) found that different types of hallucinations among people with schizophrenia were associated with distress (which affects quality of life), and Gardsjord et al. (2018) conducted a 10-year longitudinal study which found that people with schizophrenia who were in remission (including lacking symptoms such as hallucinations) had better quality of life scores. Another consideration is the quality of patients' lives in other ways, and a study of employed patients with cancer found variations in their level of job satisfaction (Mehnert and Koch, 2013), which led us to control for it because (to our knowledge) no study has hitherto done this in exploring psychotic symptoms such as hallucinations in patients with cancer. Low job satisfaction could indicate poor working conditions which worsen the stress of having cancer, such as through physical strain (e.g., excessive manual labour) or mental strain (e.g., heavy job demands).

1.3. Loneliness

Like job satisfaction, the social support that patients with cancer have from their colleagues and managers also varies (Mehnert and Koch, 2013), raising a question about the implications of loneliness for the mental wellbeing of patients. The link between loneliness and mental illness is well established in meta-analytic literature (Park et al., 2020) and there is growing evidence that loneliness is also linked to hallucinations (Lincoln et al., 2021). This may, in turn, reduce life satisfaction. A study of patients with cancer found that support from managers and colleagues was associated with better existential wellbeing which, in turn, was associated with lower distress (Jin et al., 2022), supporting wider literature showing that loneliness is associated with lower life satisfaction (Park et al., 2020). Therefore, we investigated the link between cancer and hallucinations while controlling for loneliness, life satisfaction and job satisfaction. We hypothesised that life satisfaction would mediate the impact of cancer, job satisfaction and loneliness on the risk of hallucinations.

1.4. Autonomy/control, sleep and discrimination

We controlled for the extent to which patients with cancer feel autonomous and in control, which may be linked with life satisfaction because helping patients become independent is a goal in some supportive care interventions which aim to improve functioning after diagnosis and treatment (Tamminga et al., 2010). Sleep quality is also linked with life satisfaction in patients with cancer, with a meta-analysis reporting that 60.7% of patients with cancer have disturbed sleep (Al

Maqbali et al., 2022) and disturbed sleep is in turn associated with a higher risk of hallucinations (Sheaves et al., 2016). Even mild sleep problems are associated with a 2 to 3 times higher risk of hallucinations (Sheaves et al., 2016). This might be because, among people in the general population who suffer hallucinations, 18% experience hypnagogic hallucinations (at the start of sleep) and 4.9% experience hypnopompic hallucinations as they are waking up (Ohayon, 2000). We therefore controlled for disturbed sleep and feelings of autonomy in exploring the link between cancer and hallucinations, hypothesising that life satisfaction would mediate the links between those variables and the risk of hallucinations. We also controlled for patients' experiences of discrimination because they can reduce mental health in patients with cancer, but not enough research exists about their impact (Grassi and Riba, 2020). We explored whether experiences of discrimination reduced life satisfaction and, in turn, increased the risk of hallucinations.

1.5. Anxiety

It was important to explore the moderating role of anxiety as a predictor of hallucinations because a study of 13,057 people in the general population found that 38.7% suffered hallucinations, anxiety increased the risk of auditory hallucinations by 9 times, and it increased the risk of visual hallucinations by 5 times (Ohayon, 2000). Anxiety might also moderate the impact of cancer, job satisfaction, restless sleep, autonomy/control, and discrimination on life satisfaction as a predictor of the risk of hallucinations. Age and sex are associated with anxiety and other aspects of mental health (e.g., Lopes and Kamau-Mitchell, 2024) therefore we added them as covariates. We tested our hypotheses using a moderated mediated Generalized Linear Model to provide an overview of the implications of cancer for hallucinations, while controlling for other predictor factors, anxiety as a moderator and life satisfaction as a mediator.

1.6. Hypotheses

We investigated the following hypotheses.

- Patients with cancer have a higher risk of hallucinations.
- Loneliness, discrimination, poor job satisfaction, poor life satisfaction, high anxiety, low levels of autonomy and restless sleep are associated with a higher risk of hallucinations
- Cancer, loneliness, discrimination, job satisfaction, anxiety symptoms, autonomy/control and restless sleep predict life satisfaction.
- Life satisfaction mediates the impact of cancer, cancer, loneliness, discrimination, job satisfaction, anxiety symptoms, autonomy and restless sleep on the risk of hallucinations.
- Anxiety symptoms moderate the impact of cancer, loneliness, discrimination, job satisfaction, autonomy/control and restless sleep on the risk of hallucinations, such that participants with high anxiety, cancer, more loneliness, discrimination, poorer job satisfaction, poorer autonomy/control and restless sleep should have higher odds of hallucinating than those with low anxiety, no cancer, less loneliness and discrimination, higher job satisfaction and autonomy/ control and with no restless sleep.
- We therefore tested a moderated-mediated model in which cancer and other predictors of the risk of hallucinations were mediated by life satisfaction and moderated by anxiety.

2. Method

2.1. Participants

This was an analysis of data from 7586 adults aged 50 years old or over who took part in the 2021–2023 wave of the English Longitudinal Study of Ageing (ELSA) (Banks et al., 2024). The mean age for this

sample was M = 67.6, SD = 9.76, range = 26–89. There were 3383 males (44.6%) and 4199 females (55.4%). The predictor variables were cancer diagnosis, job satisfaction, autonomy/control, loneliness, anxiety, discrimination, disturbed sleep, and life satisfaction. We added age and sex as covariates. We assessed hallucinations as the dependent variable.

2.2. Procedures

ELSA study researchers collected data through computer-assisted interviews. The researchers obtained informed consent and full details of the method are provided by ELSA (Banks et al., 2024). No identifying information was collected and ethical approval for the study was obtained from the South Central – Berkshire Research Ethics Committee.

2.3. Measures

Cancer diagnosis was assessed with a single item question which asked participants whether they have a chronic diagnosis of cancer, and we coded No = 0, and Yes = 1, with an additional question asking participants to indicate the organ/part of the body where the cancer first started.

Job satisfaction was assessed with a 7-item scale that contained items such as "*All things considered I am satisfied with my job*" and "*I receive the recognition I deserve at work*" on a 4-point Likert scale ranging from 1 = strongly disagree to 4 = strongly agree. These were items from the Quinn and Staines (1997) Quality of Employment Survey, and we selected items relevant to job satisfaction. Higher scores indicated higher job satisfaction, and the scale had acceptable internal reliability with a Cronbach's alpha of 0.71.

Autonomy/control was measured using the total of four items: "*My age prevents me from doing the things I would like to do*"; "*I feel what happens to me is outside of my control*"; "*I feel free to plan for the future*" and "*I can do things that I want to do*" assessed on a 4-point Likert response scale from 1 = never to 4 = often. These were items from the CASP-19 scale by Hyde et al. (2003), and we selected items which were not similar to other variables in our study e.g., loneliness and life satisfaction to prevent multicollinearity. Higher scores indicated higher self-perceptions of independence or autonomy and control. All items loaded well into one factor and the scale was reliable with a Cronbach alpha of 0.70.

Loneliness was assessed through 5 questions: "*How often do you feel you lack companionship?*"; "*How often do you feel left out?*"; "*How often do you feel isolated from others?*"; "*How often do you feel in tune with the people around you?*" and "*How often do you feel lonely?*" on a 3-point Likert response scale from 1 = hardly ever or never to 3 = often. The items were from the Three-Item Loneliness Scale by Hughes et al. (2004), a shortened version of their Revised UCLA Loneliness Scale based on factor loadings. Higher scores indicated more loneliness. The scale showed acceptable reliability of 0.70.

Anxiety was measured using seven items in the General Anxiety Disorder (GAD-7) (Spitzer et al., 2006) which asked how often participants experienced symptoms of anxiety in the past two weeks. The scale included items such as "*Feeling nervous, anxious or on edge*"; "*Not being able to stop worrying*" and participants responded on a 4-point Likert response scale from 1 = not at all to 4 = nearly everyday. Higher scores indicated more anxiety symptoms. Scores between 0 and 4 indicated minimal anxiety and scores between 5-9 indicated mild anxiety whereas scores between 10-14 indicated moderate anxiety and scores between 15-21 indicated severe anxiety. The scale showed an excellent reliability with a Cronbach alpha of 0.91.

Discrimination was assessed using 5 questions: "*You are treated with less courtesy/or respect than other people*"; "*You receive poorer service than other people at restaurants or stores*"; "*People act as if they think you are not clever*"; "*You are threatened or harassed*"; "*You receive poorer service or treatment than other people from doctors*". These were items from the Everyday Discrimination Scale by Williams et al. (1997) shortened to 5 items by Sternthal et al. (2011). Participants responded using a 6-point

Likert Scale from 1 = never to 6 = Almost every day. Higher scores indicated more perceptions of discrimination. The scale showed good reliability with a Cronbach alpha of 0.80.

Life satisfaction was assessed using the 5-items' Satisfaction with Life Scale (SWLS) (Diener et al., 1985) which has items such as "*I am satisfied with life*". Participants responded in a 7-point Likert response scale ranging from 1 = strongly disagree to 7 = strongly agree. Higher scores indicated higher life satisfaction. This scale showed good reliability with a Cronbach alpha of 0.89.

Hallucinations and restless sleep were measured through self-reports using a Yes/No response scale. Participants were asked, "*What type of emotional, nervous or psychiatric problems do/did you have?*" and those who said yes were asked, "*What type of emotional, nervous or psychiatric problems do/did you have?*" then they chose from a list which included hallucinations. Restless sleep was assessed using the question were "*Did you feel well-rested yesterday morning (that is you slept well the night before)?*"

2.4. Statistical analyses

Statistical analyses were conducted in Jamovi using logistic regressions, linear regressions, Mann-Whitney tests, Chi-squared tests, and an advanced moderated mediation Generalized Linear Model (GLM) using Jamovi software (Galluci, 2020). We chose this type of model because it allows researchers to analyze the impact of categorical (non-continuous) predictor variables which, in this study, were presence/absence of cancer, hallucinations and restless sleep. We also chose the GLM approach because they do not require that dependent variables must be normally distributed. We computed the common language effect sizes for the between groups' differences with uneven sized groups (cancer diagnosis vs. no diagnosis and males vs. females). We used Jamovi software because it allows researchers to test both moderation and mediation effects within the same model, therefore we tested life satisfaction as a mediator, and anxiety as a moderator. We arrived at the final model after testing a series of exploratory models. Sobel tests examined the statistical significance of mediations in the model.

3. Results

Participants were asked about which organ or part of the body the cancer first started and the frequencies per site were: breast (n = 290, 26.2%), prostate (n = 178, 16.1%), melanoma/skin (n = 125, 11.3%), other sites not listed (n = 133, 12%), colon/bowel/rectum (n = 99, 8.9%), head/neck/brain (n = 83, 7.5%), uterus/ovary (n = 74, 6.7%), lymphoma/leukaemia (n = 39, 3.5%), bladder (n = 36, 3.3%), lung (n = 30, 2.7%), kidney (n = 19, 1.7%), and pancreas (n = 1, 0.1%). All assumptions were met for a moderated mediation Generalized Linear model and Skewness and Kurtosis values for all the variables were acceptable (George and Mallery, 2010). Descriptives for all the variables are presented in Table 1.

There were 19 (0.3%) patients who self-reported hallucinations, and logistic regression showed that patients with cancer had higher odds of hallucinating, $\beta = 1.02$, $p = 0.042$. Given that head/neck/brain cancer might be associated with a higher risk of hallucinations, we checked whether they disproportionately numbered among patients who reported hallucinations but found that none of them had head/neck/brain cancer, and descriptive statistics were comparable to the wider sample (Table 1) therefore they were included in further analysis. Logistic regressions showed that loneliness, discrimination, poor job satisfaction, poor life satisfaction, high anxiety, low level of autonomy/control and having restless sleep were all associated with higher odds of hallucinations [$\beta = 6.19$, $p < 0.001$; $\beta = 7.19$, $p < 0.001$; $\beta = -11.18$, $p = 0.012$; $\beta = -3.04$, $p = 0.004$; $\beta = 8.66$, $p < 0.001$; $\beta = -2.50$, $p = 0.004$; $\beta = 5.38$, $p < 0.001$]. Further linear regressions showed that patients with cancer had higher odds of poor life satisfaction $\beta = -0.70$, $p < 0.001$. Moreover, loneliness, discrimination, job satisfaction, anxiety symptoms,

Table 1
Descriptive statistics.

	Cancer diagnosis n = 1082		No Cancer diagnosis n = 6500		Mann-Whitney U	P	Common Language Effect Size	95% CI
	M	SD	M	SD				
Age	71.94	9.13	66.87	9.67	2356751.000	**<0.001**	0.65	−0.593, −0.464
Loneliness	7.51	2.33	7.56	2.34	2455656.500	0.81	0.02	−0.043, 0.086
Anxiety symptoms	10.26	4.23	10.38	4.21	2391918.000	0.21	0.03	−0.036, 0.093
Life Satisfaction	31.83	5.58	32.48	5.54	2282105.000	**<0.001**	**0.53**	**0.053, 0.182**
Job Satisfaction	20.08	3.28	20.22	3.84	132732.000	0.28	0.04	−0.027, 0.102
Discrimination	7.83	3.41	8.08	3.51	2398280.000	0.19	0.07	0.007, 0.136
Autonomy/Control	27.05	4.91	27.52	4.48	2203672.500	**<0.001**	**0.53**	**0.039, 0.168**

	Males n = 3383		Females n = 4199		Mann-Whitney U	P	Common Language Effect Size	95% CI
	M M	SD	**M** M	SD				
Age	68.15	9.41	67.14	10.00	6497872.000	**<0.001**	**0.53**	**−0.149, -0.058**
Loneliness	7.45	2.24	7.40	2.27	4781322.000	**0.006**	**0.51**	**−0.067, 0.023**
Anxiety symptoms	10.04	3.98	10.96	4.29	4260873.500	**<0.001**	**0.56**	**0.176, 0.267**
Life Satisfaction	32.85	5.18	33.12	5.21	4830532.500	**0.041**	**0.52**	**0.007, 0.097**
Job Satisfaction	20.13	3.32	20.08	3.30	485287.000	0.69	0.01	-0.06, 0.03
Discrimination	8.29	3.70	7.89	3.32	4828535.000	0.056	0.11	-0.16, 0.069
Autonomy/Control	27.51	4.37	27.48	4.58	4974855.000	0.84	0.01	-0.052, 0.039

	Cancer diagnosis n = 1082		No Cancer diagnosis n = 6500		Chi-Squared	P	Phi
Restless sleep	No Restless sleep (596) Restless sleep (438)		No restless sleep (3494) Restless sleep (2566)		0.00	0.99	0.00
Hallucinations	No hallucinations (914) Hallucinations (6)		No hallucinations (5515) Hallucinations (13)		4.67	**0.031**	0.03

	Males n = 3383		Females n = 4199		Chi-Squared	P	Phi
Restless sleep	No Restless sleep (1982) Restless sleep (1111)		No restless sleep (2108) Restless sleep (1895)		93.19	**<0.001**	0.12
Hallucinations	No hallucinations (2977) Hallucinations (10)		No hallucinations (3456) Hallucinations (9)		0.31	0.58	0.07
Cancer Diagnosis	No Cancer diagnosis (2915) Cancer diagnosis (469)		No Cancer diagnosis (3585) Cancer diagnosis (613)		0.85	0.36	0.01

Descriptive statistics after excluding patients with head/neck/brain cancer (of which none had hallucinations)

	Cancer diagnosis n = 1004		No Cancer diagnosis n = 6497		Mann-Whitney U	P
	M	SD	M	SD		
Loneliness	7.50	2.31	7.51	2.33	2271334.500	0.71
Anxiety symptoms	10.28	4.25	10.38	4.21	2223479.500	0.27
Life Satisfaction	31.93	5.48	32.48	5.54	2136082.000	**<0.001**
Job Satisfaction	20.08	3.28	20.19	3.86	123210.500	0.30
Discrimination	7.76	3.40	8.08	3.51	2198040.000	0.058
Autonomy/Control	27.08	4.93	27.52	4,48	2061348.500	**<0.001**
			Chi Squared	**P**		
Restless sleep	No restless sleep (557) Restless sleep (402)		No restless sleep (3490) Restless sleep (2565)	0.062	0.83	
Hallucinations	No Hallucinations (845) Hallucinations (6)		No hallucinations (5512) Hallucinations (13)	5.48	**0.032**	

autonomy/control and restless sleep all predicted the variance of life satisfaction [β = −0.49, p < 0.001; β = −0.22, p < 0.001; β = 0.38, p < 0.001; β = −0.41, p < 0.001; β = 0.66, p < 0.001; β = −0.23, p < 0.001], where having restless sleep and the more loneliness, discrimination, and anxiety symptoms the less life satisfaction and the less autonomy/control and job satisfaction the less life satisfaction. As such, life satisfaction was included as a mediator in the final model.

Age predicted the odds of life satisfaction (β = −0.07, p < 0.001) indicating that as age increased, life satisfaction decreased. Age also predicted the odds of anxiety symptoms (β = −0.12, p < 0.001), job satisfaction (β = −0.07, p = 0.003), discrimination (β = −0.18, p < 0.001) and autonomy/control (β = −0.10, p < 0.001), where the older the age the less anxiety symptoms, the less discrimination, the less autonomy/control and the lower job satisfaction. Age also predicted the odds of a diagnosis of cancer (β = 0.06, p < 0.001) with the older the age the higher the odds of a diagnosis of cancer but it did not predict the odds of hallucinations (β = 0.01, p = 0.68). In its turn, sex (0 = Male, 1 = Female) predicted the odds of anxiety symptoms (β = 0.11, p < 0.001), and loneliness (β = 0.19, p = 0.01). These results were replicated

by Mann-Whitney U tests of group differences reported in Table 1, showing that males were slightly older, were slightly more lonely, had slightly less anxiety and less life satisfaction than females. However, sex did not predict the odds of hallucinations (β = 0.26, p = 0.58) or a diagnosis of cancer (β = −0.06, p = 0.36). Overall, due to findings reported in Table 1, age and sex (0 = Males, 1 = Females) were included in the moderated-mediated model as covariates.

Further Mann-Whitney tests reported in Table 1 showed that the participants diagnosed with cancer were more likely to show less life satisfaction and lower levels of autonomy/control than the participants that were not diagnosed with cancer [U = 2282105.00, p < 0.001 and U = 2203672.500, p < 0.001]. These results were replicated after excluding patients with head/neck/brain cancer (Table 1). In contrast, there were no statistically significant differences between participants diagnosed with cancer and those who were not for anxiety symptoms, loneliness, discrimination and job satisfaction [U = 2391918.00, p = 0.21; U = 2455656.500, p = 0.81; U = 2398280.00, p = 0.18; U = 132732.00 p = 0.28], and these results were replicated after excluding patients with head/neck/brain cancer (Table 1).

Following these results, a Generalized Linear moderated mediation model was performed in Jamovi with cancer diagnosis, loneliness, autonomy/control, discrimination, job satisfaction and restless sleep as predictors of the variance of hallucinations through the mediation of life satisfaction (see Fig. 1). Age and sex were inserted as covariates and anxiety symptoms were inserted as a moderator. As it can be seen in Table 2, only cancer diagnosis, loneliness and job satisfaction were directly associated with hallucinations (β = 0.07, Z = 2.37, p = 0.018; β = 0.24, Z = 7.08, p < 0.001; β = −0.14, Z = 3.90, p < 0.001) but there were statistically significant mediation pathways. Indeed, cancer diagnosis and loneliness were both associated with less life satisfaction that then was associated with hallucinations (β = 0.02, Z = 1.19, p = 0.040; β = 0.06, Z = 1.78, p = 0.025), whereas job satisfaction was associated with more life satisfaction which was then associated with no hallucinations (β = −0.06, Z = −1.75, p = 0.025). Also, restless sleep, autonomy/control and discrimination all had indirect relationships with hallucinations through life satisfaction (β = 0.04, Z = 1.58, p = 0.030; β = −0.06, Z = −1.78, p = 0.025; β = 0.06, Z = 1.74, p = 0.025). Finally, there were also some moderator effects of anxiety symptoms on the relationships between cancer diagnosis and hallucinations (β = 0.11, Z = 2.72, p = 0.007); restless sleep and hallucinations (β = 0.06, Z = 2.31, p = 0.021); loneliness and hallucinations (β = 0.26, Z = 7.64, p < 0.001), job satisfaction and hallucinations (β = −0.12, Z = −3.89, p < 0.001) and between life satisfaction and hallucinations (β = −0.36, Z = −2.08, p = 0.038). Sex and age did not predict the odds of hallucinations (β = 0.00, Z = 0.11, p = 0.92; β = 0.04, Z = 1.18, p = 0.24). However, anxiety symptoms did moderate the relationship between age and hallucinations (β = −0.11, Z = −2.72, p = 0.007) but not between sex and hallucinations (β = 0.04, Z = 1.67, p = 0.096). Life satisfaction also did not mediate the relationships between age and hallucinations (β = 0.00, Z = −1.21, p = 0.21) and sex and hallucinations (β = 0.01, Z = 1.68, p = 0.094).

4. Discussion

To our knowledge, this is the first study to find that patients with cancer have higher odds of hallucinating, and our study sheds light on how poor life satisfaction mediates the relationship between having cancer and hallucinations, as well as showing that anxiety moderates this relationship. This meant that when patients have cancer and high anxiety then this is associated with higher odds of hallucinations compared to people without cancer and with low anxiety. Moreover, loneliness and poor job satisfaction were associated with hallucinations, and they also interacted with anxiety to explain the odds of

hallucinations. This was such that participants with higher level of loneliness and poorer job satisfaction and more anxiety symptoms had higher odds of hallucinations compared to those with lower levels of loneliness, high job satisfaction and lower anxiety. The results showed that poor autonomy/control and discrimination were only associated with hallucinations when life satisfaction was taken into consideration. This meant that there was not a direct relationship (without life satisfaction), and meant that the more the level of discrimination and the lower the level of autonomy/control the lower was the level of life satisfaction which was then associated with hallucinations. Finally, the results showed that restless sleep interacted with anxiety to explain hallucinations where having restless sleep and high anxiety was associated with higher odds of hallucinating compared to not having restless sleep and in the presence of low levels of anxiety. Nevertheless, restless sleep was also associated with hallucinations through life satisfaction, where having restless sleep was associated with less life satisfaction which was then associated with hallucinations. The results found sex differences in that males were slightly more lonely than females and had lower life satisfaction, but males had lower anxiety than females which supports previous literature (e.g., Lopes and Kamau-Mitchell, 2024), although sex was not a significant covariate in the moderated-mediation model.

The results suggest that having a diagnosis of cancer was associated with higher odds of hallucinating because of lower levels of life satisfaction among cancer patients, supporting previous literature (Dunn et al., 2013; Martinez-Calderon et al., 2023). The results showing that anxiety was a moderator supports past research that found that anxiety is a trigger for hallucinations and other psychotic symptomatology (Freeman and Garety, 2003). Results also contributed to understanding how loneliness and job satisfaction may be associated with the risk of hallucinations. The results advanced previous literature (Jin et al., 2022; Lincoln et al., 2021) by showing that loneliness is associated with hallucinations because of reduced life satisfaction and the presence of anxiety symptoms. In a similar vein, reduced job satisfaction was associated with hallucinations because of reduced life satisfaction and the presence of anxiety symptoms, supporting past research that found that poor organisational support and poor working conditions increased levels of paranoia (which is a psychotic symptom) and reduced levels of wellbeing in workers (Lopes et al., 2019). Our results thus add to previous literature by showing the importance of job satisfaction in understanding the onset of psychotic symptomatology such as paranoia and hallucinations.

The results also supported previous research linking sleep disturbances with hallucinations and anxiety (Sheaves et al., 2016), while
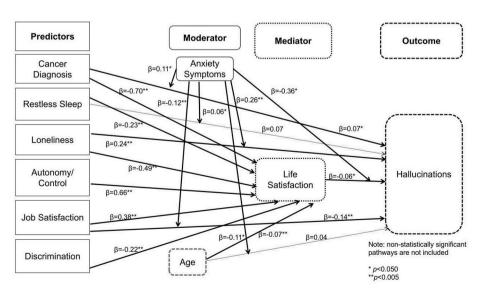

Fig. 1. Figure 1 shows the moderated mediation model.

Table 2

Moderating effects of anxiety symptoms for the direct and indirect pathways between the main predictors (cancer diagnosis, autonomy/control, loneliness, discrimination, job satisfaction and restless sleep) and the covariates of age and sex and the dependent variable (hallucinations) through life satisfaction as the mediator.

Moderating Effects (Interactions) of Anxiety symptoms	β	S.E.	95% CI	Z	p		
Cancer diagnosis (predictor) x anxiety symptoms (moderator) - > life satisfaction (mediator)	0.01	0.07	−0.11, 0.18	0.44	0.66		
Restless sleep (predictor) x anxiety symptoms (moderator) - > life satisfaction (mediator)	−0.03	0.05	−0.19, 0.01	−1.78	0.076		
Loneliness (predictor) x anxiety symptoms (moderator) - > life satisfaction (mediator)	−0.04	0.01	−0.038, 0.002	−1.73	0.084		
Autonomy/control (predictor) x anxiety symptoms (moderator)- > life satisfaction (mediator)	0.01	0.01	−0.01, 0.01	0.42	0.67		
Job satisfaction (predictor) x anxiety symptoms (moderator) - > life satisfaction (mediator)	0.01	0.01	−0.01, 0.02	0.38	0.71		
Discrimination (predictor) x anxiety symptoms (moderator)- > life satisfaction (mediator)	−0.01	0.01	−0.01, 0.01	0.21	0.83		
Age (covariate) x anxiety symptoms (moderator)- > life satisfaction (mediator)	−0.02	0.00	−0.01, 0.001	−1.08	0.28		
Sex (covariate) x anxiety symptoms (moderator) - > life satisfaction (mediator)	0.031	0.05	−0.01, 0.18	1.66	0.097		
Life satisfaction (mediator) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	−0.36	6.08	7.04, 2.45	−2.08	**0.038**		
Cancer diagnosis (predictor) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	0.11	8.42	−0.00, −6.38	2.72	**0.007**		
Restless Sleep (predictor) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	0.06	5.87	2.05, 0.00	2.31	**0.021**		
Loneliness (predictor) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	0.26	1.23	6.99, 0.00	7.64	**<0.001**		
Autonomy/Control (predictor) x anxiety symptoms (moderator)- > hallucinations (dependent variable)	0.02	7.47	−1.15, 1.78	0.42	0.68		
Job Satisfaction (predictor) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	−0.12	8.71	1.68, 5.09	−3.89	**<0.001**		
Discrimination (predictor) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	0.01	7.62	−1.68, 1.30	0.25	0.80		
Sex (covariate) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	0.04	3.77	−1.11, 1.37	1.67	0.096		
Age (covariate) x anxiety symptoms (moderator) - > hallucinations (dependent variable)	−0.11	8.42	−0.00, −6.38	−2.72	**0.007**		
Direct pathways	β	S.E.	95% CI	Z	p		
Cancer diagnosis (predictor) - > hallucinations (dependent variable)	0.07	0.00	−0.02, 0.00	2.37	**0.018**		
Restless sleep (predictor) - > hallucinations (dependent variable)	0.07	0.00	−3.12, 0.01	1.86	0.063		
Loneliness (predictor) - > hallucinations (dependent variable)	0.24	6.72	0.00, 0.00	7.08	**<0.001**		
Autonomy/control (predictor) - > hallucinations (dependent variable)	0.03	4.05	−4.64, 0.00	0.82	0.41		
Job satisfaction (predictor) - > hallucinations (dependent variable)	−0.14	4.63	9.00, 0.00	3.90	**<0.001**		
Discrimination (predictor) - > hallucinations (dependent variable)	0.03	3.95	−0.00, 4.52	0.82	0.41		
Life satisfaction (mediator)- > hallucinations (dependent variable)	−0.06	2.75	−4.30, 0.00	1.59	**0.048**		
Sex (covariate) - > hallucinations (dependent variable)	0.00	0.00	0.00, 0.00	0.11	0.92		
Age (covariate) - > hallucinations (dependent variable)	0.04	2.18	1.70, 6.83	1.18	0.24		
Indirect Pathways	β	S.E.	95% CI	Z	p	Sobel test	p
Cancer diagnosis- > life satisfaction- > hallucinations	0.02	2.93	−2.27, 9.23	1.19	**0.040**	2.03	**0.042**
Restless sleep- > life satisfaction- > hallucinations	0.04	2.74	−9.69, 1.04	1.58	**0.030**	2.48	**0.013**
Loneliness- > life satisfaction- > hallucinations	0.06	1.81	−6.77, 3.24	1.78	**0.025**	2.50	**0.012**
Autonomy/Control- > life satisfaction- > hallucinations	−0.06	1.11	−1.98, 4.17	−1.78	**0.025**	−2.50	**0.012**
Job Satisfaction- > life satisfaction- > hallucinations	−0.06	8.18	−1.73, 3.03	−1.75	**0.028**	−2.48	**0.013**
Discrimination- > life satisfaction- > hallucinations	0.06	1.78	−2.73, 4.25	1.74	**0.028**	2.45	**0.014**
Sex - > life satisfaction- > hallucinations	0.01	2.90	8.23, 0.00	1.68	0.094	−1.49	0.14
Age- > life satisfaction- > hallucinations	0.00	1.23	3.91, 9.28	−1.21	0.23	2.5	**0.012**

Note: Statistically significant effects are in bold.

making it important for healthcare staff to help patients with cancer who are suffering from disturbed sleep given that 60.7% are at risk (Al Maqbali et al., 2022). Moreover, our research adds to the literature by examining how poor autonomy/control increases the risk of developing hallucinations, showing the importance of healthcare staff supporting patients with cancer in regaining functioning after diagnosis and treatment. This is because the results suggested that lower levels of autonomy and control are related to lower life satisfaction (Steckermeier, 2021) and ample evidence links poor life satisfaction with hallucinations in the elderly (Choi et al., 2021). As well, the results found that discrimination was linked with hallucinations only when life satisfaction was included as a mediator. This contributes to recent discussions about the potential role of discrimination in explaining rates of mental illness among patients with cancer (Grassi and Riba, 2020).

4.1. Limitations

The evidence in this study was correlational, but future research should use longitudinal designs to investigate the effects of having cancer on long-term risks of hallucinations, also exploring progression to diagnoses such as brief psychotic disorder and schizophrenia. This will help previous literature move forward. The statistics used in this study are limited because the survey was cross-sectional and therefore causality cannot be inferred. Future research should consider whether longitudinal studies replicate the findings of a meta-analysis which suggested that cancer increases the risk of mental illness, but not vice versa (Kim et al., 2022). Many studies show that patients with mental illness have a similar prevalence of cancer as those without mental illness (Kim et al., 2022) and studies which show higher cancer incidences and mortality rates might be because of less help-seeking and treatment completion among people with mental illness. Future research should investigate the implications of hallucinations for the wellbeing of patients with cancer because they are likely to induce distress which worsens mental health.

The ELSA study asked participants to self-report their experiences of hallucinations, but future research should assess them objectively through appropriate psychiatric assessment. Only 19 (0.3%) of participants self-reported hallucinations therefore future research is needed with a larger sample size. The study did not ask participants about the types of hallucinations that they experienced therefore the content of the patients' hallucinations is unknown. Future research should interview patients and find out, exploring whether they might be near-death experiences or linked with the side effects of cancer treatment as some authors have suggested (Kellehear, 2017). A review of case studies during the COVID-19 pandemic revealed that several patients had hallucinations with religious preoccupations e.g., seeing or hearing

mystical beings such as angels/demons, and fighting death (Chaudhary et al., 2022). To shed light on whether hallucinations experienced by patients with cancer have themes relating to death, we encourage ELSA researchers to introduce new questions delving deeper into their experiences of hallucinations and giving patients the opportunity to describe their hallucinations. Future research should explore whether hallucinations about death are more frequent among those with a worse prognosis.

Another limitation of the current study is that it was not possible to evaluate the impact of different types of cancer on the risk of hallucinations because there were 12 possible primary cancer sites reported by patients and a larger sample size is needed to conduct a meaningful analysis. In previous research, the link between different types of cancer and mental illness has been unclear. A study by Given et al. (1994) found that patients with lung cancer or gastrointestinal/colon cancer reported more depression than patients with breast cancer or lymphoma, whereas the meta-analysis by Kim et al. (2022) reported comparable risks of mental illness for patients with breast cancer (1.42), lung cancer (1.34), and other types of cancer (1.46). Future research is therefore needed to clarify the link, and it should explore the impact of physical symptoms because the study by Given et al. (1994) found that patients' experiences of symptoms and the type of treatment they received predicted depression. For patients who had chemotherapy, each symptom they experienced increased depression by 0.84 on the Center for Epidemiologic Studies Depression Scale (where responses ranged from 0 to 60), whereas for patients who had hormone or radiation therapy each symptom experienced increased depression by 4.32. Future research should therefore explore whether patients with a larger number of cancer-related symptoms and who undergo radiation/hormone therapy are at greater risk of hallucinations.

Future research should explore the links among cancer, hallucinations, factors controlled for in the present study (e.g., life satisfaction, job satisfaction, discrimination), and cancer survival. Previous literature found that giving working patients with cancer occupational support is helpful to their recovery (Kamau, 2017) and there have been calls for better support for patients with cancer who suffer mental ill health (Knippenberg et al., 2023). Therefore, it may be worth recommending interventions which are helpful to people coping with distressing hallucinations, which could include mindfulness (Strauss et al., 2015), cognitive behavioral therapy (CBT) (Pontillo et al., 2016), and relational therapies (Dellazizzo et al., 2022). A systematic review of 15 studies by Strauss et al. (2015) suggested that mindfulness among people suffering from auditory hallucinations was associated with less negative affect, depression, and anxiety. Another systematic review of 8 studies by Pontillo et al. found that CBT was associated with less distress from auditory hallucinations, and it can help coping with command hallucinations. A systematic review of 17 studies by Dellazizzo et al. found that relational-based therapies can be helpful; these help patients learnt to interact with voices during hallucinations, and may include use of avatars or virtual-reality assisted therapy. Interventions are also needed to improve life satisfaction and reduce anxiety in patients with cancer because, as our findings show, this should reduce the risk of hallucinations. The interventions could include life review therapies which a systematic review of 15 randomized or clinically controlled trials by Zhang et al. (2017) found to be beneficial to patients with cancer in reducing anxiety and improving quality of life. Meaning-centred psychotherapy can also be helpful because a randomized-controlled trial found increased life satisfaction in cancer survivors who completed it after a 6-month follow-up period (Marco et al., 2024). Therefore, a range of interventions could be helpful to patients with cancer in improving life satisfaction, reducing anxiety and the risk of hallucinations.

CRediT authorship contribution statement

Caroline Kamau-Mitchell: Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Conceptualization.

Barbara Lopes: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization.

Declaration of competing interest

None to declare.

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