Cancer Epidemiology 87 (2023) 102494

Contents lists available at ScienceDirect

Cancer Epidemiology

journal homepage: www.elsevier.com/locate/canep

The association between marital status and treatment initiation in lung cancer: A systematic review and meta-analysis of observational studies

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ARTICLE INFO

Keywords:
Lung cancer
Marital status
Relationship status
Health inequalities
Treatment initiation

ABSTRACT

Lung cancer is associated with high mortality, and significant health burden. Marital status has been associated with lung cancer survival. This systematic review and meta-analysis set out to investigate the association between marital status and treatment receipt in lung cancer.

The search was conducted across three databases: Medline (OVID), Embase and CINAHL, from inception to June 2022. Retrospective or prospective observational studies that quantified treatment receipt by marital status were eligible for inclusion. Study quality was assessed via a modified checklist for retrospective databased-based studies. Meta-analysis using a random effects model was undertaken by chemotherapy, radiotherapy, surgery, and any treatment relative to married or not married. Pooled unadjusted odds ratios (ORs) and 95 % confidence intervals (CIs) were calculated for each type of treatment.

837 papers were screened and 18 met the inclusion criteria with eight being eligible for inclusion in the meta-analysis. Studies were excluded from meta-analysis due to overlap in the data reported in papers; the mean quality score of the 18 included papers was 12/17.

Being married was associated with increased odds of overall treatment OR 1.43 (95 % CI 1.14–1.79; $I^2 = 82$ %; $Tau^2 = 0.07$; six studies) and also increased receipt of: chemotherapy 1.40 (95 % CI 1.35–1.44; I2 = 82 %; $Tau^2 = 0.00$); radiotherapy 1.29 (95 % CI 0.96–1.75; $I^2 = 100$ %; $Tau^2 = 0.09$; four studies) and surgery (95 % CI 1.31–1.52; $I^2 = 86$ %; $Tau^2 = 0.00$; five studies).

The results indicate that those who are married are more likely to receive treatment for lung cancer compared to those who are not married. This requires further investigation to better understand the explanations behind this finding and how we can work to combat this inequality.

1. Background

Lung cancer is the second most common cancer worldwide, causing an estimated 1.8 million deaths globally [1]; the disease accounts for around one fifth of all cancer fatalities [2,3]. Treatment for lung cancer is dependent on histology, stage at presentation and functional evaluation of the patient, and can involve surgery, chemotherapy, radiotherapy, and immunotherapy [3,4]. Despite these treatment advances, the five-year survival rate for lung cancer is between 10 % and 20 % [5]. This rate reduces significantly as the stage at diagnosis increases; for example, patients with stage IV lung cancer have an estimated 5-year survival rate of around 5 % [6].

One of the factors that has the potential to influence cancer outcomes is access to treatment. There are many different structural, clinical, and patient-related barriers that can impact on cancer treatment accessibility and utilisation [7]. Structural barriers include geographical inaccessibility to specialist cancer services [4,8]. Clinical factors include things that may influence a clinician's decision-making about potential treatment, and include lung cancer stage and type, multimorbidity and performance status of the patient [9], as well as unconscious clinician bias (e.g., disparities in treatment due to ethnicity [10]). Patient factors include personal beliefs and preferences about treatment, as well as the

Abbreviations: LCNEC, large cell neuroendocrine carcinoma; NSCLC, non-small cell lung cancer; PICOS, Population, Intervention, Comparator, Outcome and Study design; OR, odds ratio; SES, socioeconomic status; SCLC, small cell lung cancer.

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https://doi.org/10.1016/j.canep.2023.102494
Received 14 July 2023; Received in revised form 2 November 2023; Accepted 10 November 2023
Available online 21 November 2023

level of social support available to the patient (e.g., family, spouse, carer support) [7]; socioeconomic factors may also play a role [11].

One factor that has been hypothesised to impact cancer treatment receipt is marital status. Being married (or cohabiting) has the potential to increase social support, and the availability of such support may, in turn, influence the extent to which a patient actively seeks treatment, or is willing to undergo treatment which may come with risk of significant side-effects or toxicities. Marital status may also influence other factors, such as clinical decision-making, for example due to, clinician bias which reflects the interaction between social support and health as complex and multi-faceted. Previous research has shown that married individuals tend to have better self-assessed health compared to unmarried individuals. The reasons for this are complex [12], but married individuals are thought to have greater access to psychological and economic resources, as well as social resources - known as the marital resource model [13]. Having greater economic resources may also increase a patient's likelihood to accept treatment, especially in settings where healthcare is not universal or free at the point of delivery and insurance or sufficient economic resource is necessary. More psychological resources may increase resilience and/or ability to tolerate treatment and through having a partner this is strengthened. Evidence also indicates that married individuals have greater subjective health states, lower incidence of mental and physical health conditions, and greater life expectancy [14,15]. The protective effects of marriage have also been shown to improve quality of life scores [14].

The mechanisms and associations related to these potential positive outcomes warrant further investigation particularly within the context of lung cancer treatment disparities. From a cancer context, prior studies have investigated the association of marital status on lung cancer survival, suggesting better outcomes for married, rather than unmarried, patients [16–18]. Despite this research, there is no systematic summary that seeks to bring together and critically appraise all of the complex information concerning the relationship between marital status and lung cancer treatment receipt. This systematic review aimed to address this evidence gap and investigate the association between marital status and lung cancer treatment receipt.

2. Methods

The systematic review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [19] (see supplementary materials).

2.1. Search strategy and study selection

A bibliographic database search was conducted using Ovid MEDLINE and In-Process, In-Data-Review & Other Non-Indexed Citations (1946 to June 2022), Embase (1974 to June 2022) and CINAHL (1961 to June 2022). Initial searches were conducted using variations and MeSH/Emtree terms for marital status, lung cancer and treatments. The final database search was conducted by a single researcher (CR).

The inclusion criteria for the review were defined by the PICOS framework (Population, Intervention, Comparator, Outcome and Study design) (see Table 1). Only English language full-text papers were included with no restriction in date, geographic location of study or study setting. Conference and poster abstracts, editorials, letters to editors, surveys, opinion papers and unpublished manuscripts were excluded as were studies for which the full text could not be retrieved. Additionally, studies which did not include denominator population (i.e., they only included patients who were treated) were excluded as they did not allow comparison of treated versus untreated. Marital status was defined as *"the condition of being single, married, in domestic partnership, divorced and widowed"* [20]. For the purposes of this review, the 'single' and 'never married' categories were classed as 'not married' unless otherwise stated in the study.

The study selection process – both initial screening of citations and review of potentially eligible full text papers - was conducted by a single researcher (MS) and checked by CR. The search results were pooled and exported to Endnote where duplicate papers were identified and removed before title and abstract and full-text screening was performed according to the eligibility criteria. Papers where the eligibility was undecided by the researcher (MS) were resolved through discussion (CR) and, when.

required consensus with review team (LS, AT). Forwards and backwards citation searching were undertaken on included studies to identify additional relevant texts.

Table 1
Summary of PICOS eligibility criteria.

Population	Patients diagnosed with any type of lung cancer including (but not restricted to) non-small-cell and small-cell lung cancer; only papers including patients aged eighteen years or above were included.
Intervention	Any intervention initiated for the treatment of lung cancer including surgery, radiotherapy, chemotherapy, chemoradiotherapy and immunotherapy. Studies citing a combination of interventions were deemed eligible provided that the number of individuals receiving each treatment type could be determined.
Comparator	Interventions compared between married and not married participants.
Outcome	Lung cancer treatment receipt according to the marital status of participants.
Study design	Retrospective or prospective observational studies that quantified treatment receipt.

2.2. Data extraction and quality appraisal

A data extraction form was developed and piloted based on the Cochrane good practice form [21]. The following information was independently extracted from each study by a single researcher (MS) and checked by CR: first author, article title, type of publication, study aim, design, setting, inclusion and exclusion criteria. Data concerning participant and outcomes characteristics were also extracted including total number of participants enrolled, participant description (data source), lung cancer type and stage, and marital status (not married, single, divorced, separated, widowed, married and unknown). Treatment factors extracted included treatment intent and treatment type. Outcome measures extracted included adjusted and unadjusted crude measures of the association between marital status and treatment receipt (odds ratios (OR), 95 % confidence intervals (CI)); the raw data needed to calculate the unadjusted association between marital status and treatment receipt were also extracted.

All studies were independently assessed by a single researcher (MS) for quality appraisal using a quality appraisal form based on the tool adapted by Norris et al. [22]. The tool was based on the ISPOR checklist for retrospective databases studies [23], revised by Norris et al. and amended here to reflect the nature of the review question (e.g., the exposure measure, marital status, was allocated one point for stating married and not married and two points for further disaggregating the data and reporting additional statuses such as divorced or widowed).

2.3. Synthesis of evidence

Extracted outcome data consisting of outcome measure, crude frequencies, unadjusted and adjusted ORs and 95 % CIs for treatment receipt (yes and no) according to marital status (married and not married) were collated (see supplementary materials; S1). Where a study reported further granularity of marital status (e.g., married, single, divorced, and widowed), these were grouped accordingly into married or not married (yes/no). Similarly, the number of participants that received and did not receive treatment were recorded in terms of total treatment (i.e., any treatment, singly or in combination), surgery, radiotherapy, and chemotherapy receipt by marital status.

Where percentages or frequencies by marital status for the treatment

outcomes were not overtly present these were calculated from data reported in the paper. Although some studies did provide ORs with 95 % CIs for the association between marital status and treatment receipt, computed unadjusted ORs were utilised for all studies to ensure consistency. The computed unadjusted ORs with 95 % CIs, for each category, were pooled as forest plots. Meta-analyses were performed using random-effects, Mantel-Haenszel methods. These assessed the likelihood of (i) treatment receipt and (ii) treatment receipt by marital status (married/not married). Eligibility criteria for studies to be included in the meta-analysis were as follows: married and not married data for one treatment outcome (yes/no) and an independent sampling frame (no data overlap with another study and where overall treatment reports no double entry of participants into more than one treatment group).

Study characteristics were summarised, and risk of bias assessment was conducted, for all papers. For the meta-analysis, only independent populations were included. Where papers included study populations from the same database which overlapped in terms of time period and cancer type, the study reporting the greatest number of participants was included. For treatment outcome. random effects meta-analysis was conducted for the following outcomes: overall treatment, chemotherapy, radiotherapy and surgery. It was decided a priori that if at least two independent papers reported a specific treatment, pooled effect estimates would be computed. The I^2 and Tau^2 statistics were calculated to estimate the degree of statistical heterogeneity [24]; statistical analyses were conducted using RevMan 5.3.

3. Results

3.1. Search results

The database search identified 837 citations; 195 were duplicates and were removed. The titles and abstracts of the remaining 663 papers were screened yielding 39 potential papers for inclusion. After full-text review, 14 papers fulfilled the review inclusion criteria. Hand searching of reference lists yielded a further two papers for inclusion as did forwards searching. Overall, 18 papers [25–42] were included in the review. The primary reason for exclusion at full-text stage are outlined in Fig. 1.

3.2. Study characteristics

All studies utilised USA data sources with the majority (n = 9) using the Surveillance, Epidemiology, and End Results (SEER) database [26,28,30,31,35,36,38,39,41,42]. Other databases used were State or Country level registries. Studies used data from 1975 to 2016 and all were non-randomised observational studies.

The total patient numbers included in the studies ranged from 386 [42] to 285 641 [39]. A range of lung cancer types were present with non-small lung cancer being the most common [25,27,28,30,32–36,38,39,41,42]. Regarding marital status the following categories were stated: not married, single, never married, divorced, separated, widowed, domestic partner, and married. Twelve studies only considered 'married' and 'not married' categories [25,27–29,31,32,35–39,42]. Six studies included data for additional categories such as single, never

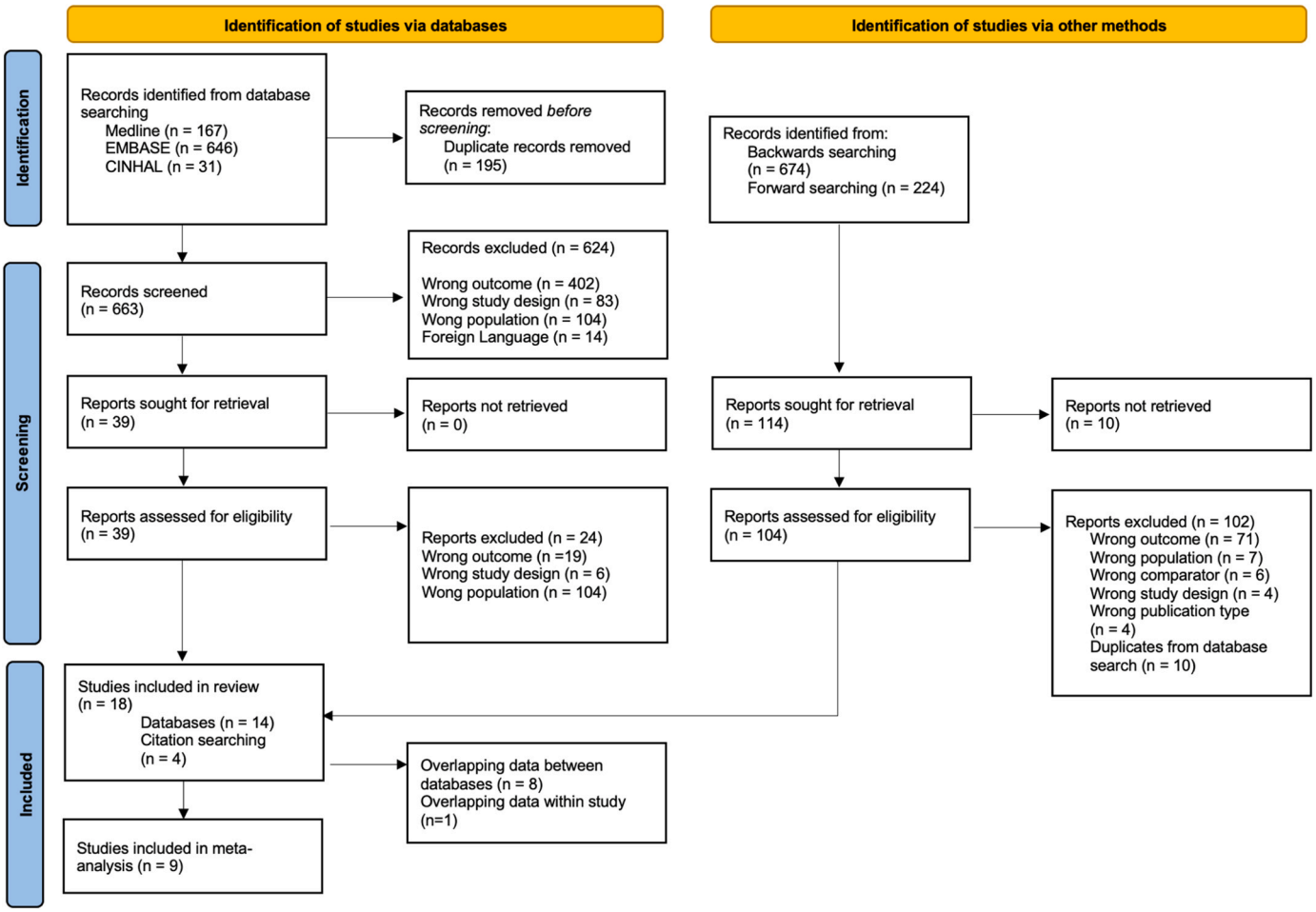

Fig. 1. Study selection and exclusion according to the PRISMA statement.

married, separated and domestic partner [26,30,33,34,40,41], although some studies did combine categories. Treatment receipt and the corresponding treatment types were recorded for all studies and included surgery (14 studies), radiotherapy (9 studies), chemotherapy (8 studies) and chemoradiation (1 study).

3.3. Quality appraisal and risk of bias

Quality appraisal scores ranged from 7 [35] to 16 [34] out of a possible 17, with a mean score of 12 (see supplementary materials). Issues associated with data sources, study populations, data presented as patient numbers, statistical tests and discussion of findings were generally well addressed. Lower scoring questions pertained to statistical analysis to determine association between marital status and treatment receipt (e.g., ORs); this analysis was present in less than half of the studies [25,27,32,34,36,38,42]. Similarly, whether an adjusted analysis was performed and if a list of confounding factors was presented was mixed (complete in six studies, incomplete in three studies and absent in nine studies).

3.4. Data synthesis

The meta-analysis included data from nine studies, the reasons for exclusion from the meta-analysis included overlap of data sources due to use of the SEER database to avoid duplication of data from the same populations within the calculations (n = 8) [26,28,30,31,36,38,39,41], and overlap of outcomes within a study i.e., unable to distinguish participant categories to facilitate OR to be calculated (n = 1) [32].

For chemotherapy, four studies reported positive association of treatment receipt by marital status [29,32,33,40]. Two studies were eligible for meta-analysis [29,40]. The pooled OR for receipt of chemotherapy in those married compared to not married was 1.40 (95 % CI 1.35–1.44; I2 = 82 %; $Tau^2 = 0.00$ (Fig. 2). Six studies reported the association of radiotherapy treatment receipt by marital status [25,27,29,33,37,40]. Four studies were eligible for meta-analysis [25,29,37,40]. The pooled OR for receipt of radiotherapy in those married compared to not married was 1.29 (95 % CI 0.96–1.75; $I^2 = 100$ %; $Tau^2 = 0.09$; four studies) (Fig. 3).

For surgery, eight studies reported the association of treatment receipt by marital status [27,29,32–34,37,40,42]. Five studies were eligible for meta-analysis [29,34,37,40,42]. The pooled OR for receipt of surgery in those married compared to not married was 1.41 (95 % CI 1.31–1.52; $I^2 = 86$ %; $Tau^2 = 0.00$; five studies) (Fig. 4). Concerning overall (i.e., any) treatment, ten studies reported the association of treatment receipt by marital status [25,27,29,32–35,37,40,42]. Six studies were eligible for meta-analysis [25,27,33–35,42]. The pooled OR for overall treatment receipt in those married compared to not married was 1.43 (95 % CI 1.14–1.79; $I^2 = 82$ %; $Tau^2 = 0.07$; six studies) (Fig. 5).

4. Discussion

This is the first systematic review and meta-analysis which has investigated the association between marital status and lung cancer treatment receipt. Overall, the findings show that there are statistically significant differences in overall treatment receipt with married individuals being 20 % more likely to receive lung cancer treatment. Similar findings - where people married people are more likely to be in receipt of treatment compared to unmarried people - were observed for different treatment approaches to lung cancer, with surgery having the greatest strength of association (albeit based only on four studies).

The potential "protective effects" of marriage in the context of cancer more broadly have been demonstrated through several studies exploring the association with earlier stage cancer diagnosis and increased survival [17,43,44]. The finding here that lung cancer treatment receipt is associated with marital status is consistent with previous studies reporting a positive association between being married and lung cancer survival [16–18]. Similar findings in survival have been observed with other cancers [45–49], suggesting that marital status is an important demographic consideration when thinking about cancer treatment outcomes. Our findings suggest that the observed differences in treatment receipt by marital status could potentially help explain - at least in part - why people who are married have better cancer outcomes compared to people who are not married.

Other work has reported that it is possible that marriage increases the likelihood of a patient receiving a more aggressive cancer treatment, but the mechanism for this remains unknown [46,50–52]. One possible explanation is that lung cancer diagnosis and staging are prerequisites for treatment receipt, and therefore these factors warrant further investigation through the lens of marital status. Most lung cancer treatments are dependent on stage with people presenting at later stages, particularly older people with multimorbidity, less likely to receive curative treatment [53]. Although the results in this review do not consider lung cancer stage, it is possible that the findings for the observed positive association between marriage and treatment receipt could be explained, to a degree, by cancer stage at diagnosis. Indeed, a previous meta-analysis demonstrated that married patients were less likely to present with metastatic lung cancer (OR 0.93, 95 % CI 0.91–0.95; P < 0.05), and this association remained significant after adjusting for patient demographics [54]. However, if this was to explain the effect seen in this review, research to explore why married patients are more likely to be diagnosed with less advanced disease would be urgently warranted.

Future research employing statistical approaches which seek to distinguish between direct and indirect effects of marital status on survival would be valuable; stage could usefully be incorporated into these analyses.

It would also be beneficial if further studies were able to stratify the lung cancer treatment according to lung cancer type and stage, as well as considering other potentially important confounding variables, such as socioeconomic status and multimorbidity which, in other contexts, have been shown to be associated with marital status [55–57].

Several social and psychological theories have been postulated to explain the perceived protective effects of marriage which may help to explain the findings of the review. Marriage can augment an individual's social support network [58], and therefore may directly or indirectly impact treatment receipt outcome. It is possible that marriage could influence clinical decision making - either consciously or unconsciously - leading to potential bias. For example, a clinician may perceive a married patient may be more likely to be able to travel to and from hospital

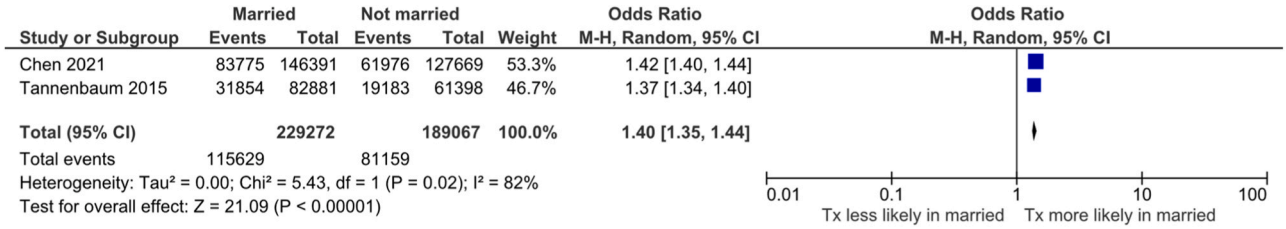

Fig. 2. Forest plot showing odds ratio for chemotherapy treatment in married patients compared to those who are not married.

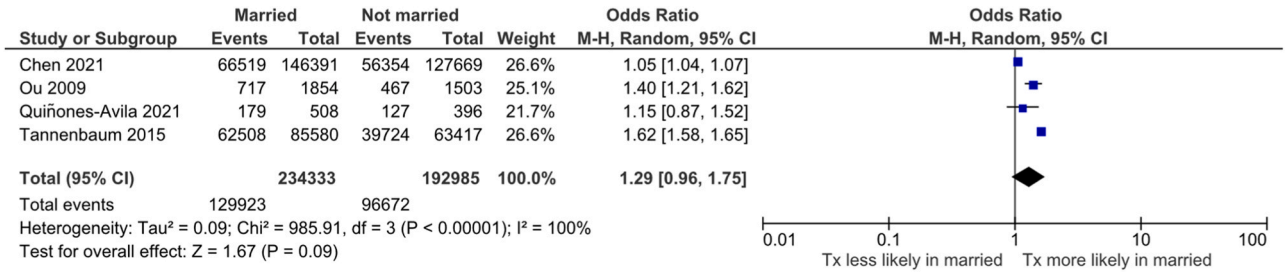

Fig. 3. Forest plot showing predictive treatment receipt odds for radiotherapy treatment in married patients compared to those who are not married.

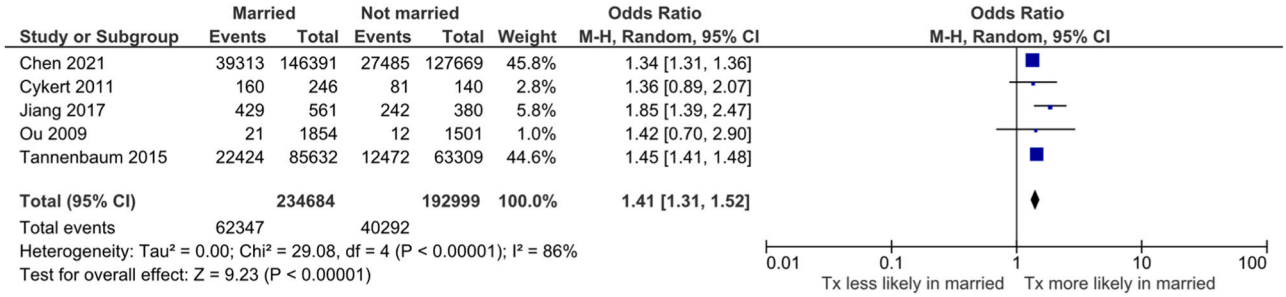

Fig. 4. Forest plot showing predictive treatment receipt odds for surgical treatment in married patients compared to those who are not married.

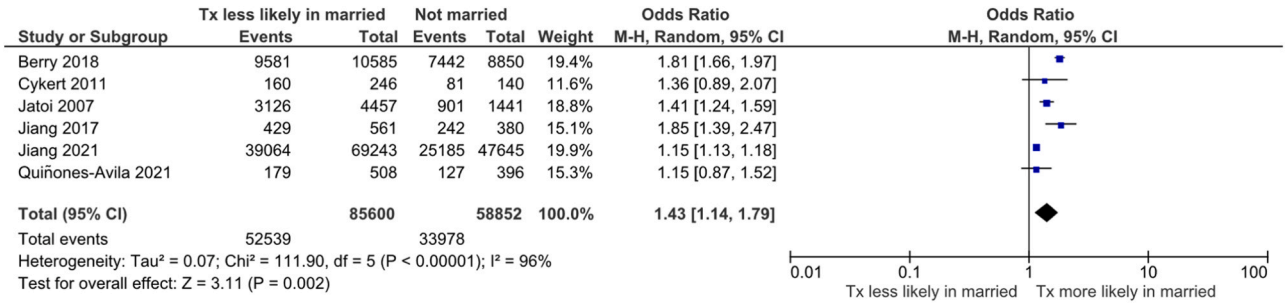

Fig. 5. Forest plot showing predictive treatment receipt odds for any overall treatment in married patients compared to those who are not married.

for multiple treatment appointments (e.g. for chemotherapy or radiotherapy) or tolerate a specific treatment (such as chemotherapy, which can be associated with challenging side-effects) due to having readily-available support. It has also been suggested that the health behaviour of an individual can be influenced by marital status; for example, people who are married may seek healthcare in a more timely fashion leading to an earlier diagnosis, thereby increasing the likelihood of receiving certain treatments. Additionally, a spouse may act as an additional information source, providing vital information about the benefits and potential harms of treatment and, in turn, enhancing the patient's own health literacy when making decisions about whether to receive treatment. Thirdly, a spouse may enhance a patient's motivation in seeking treatment through a stronger will to overcome their disease due to responsibilities to their spouse and higher levels of fulfilment [58]. Exploration of these possible mechanisms lend themselves to further research most likely utilising realist or qualitative approaches to better understand how marital status impacts on treatment decisions making. It is likely the clinical implications of how marital status influences treatment decision making will not be known until further work has been conducted. In the interim, however, it would be prudent for clinicians to acknowledge the findings of this work and consider the potential for (unconscious) bias by tailoring their consultations and discussions to ensure unmarried patients have every possibly opportunity to access treatment.

Another important finding from this review was that all the data from the included studies were from the USA, particularly the SEER database, and as such, the generalizability of conclusions drawn to patients outside the USA must be questioned. The USA health system is a mix of public and private providers; often private health insurance is linked to employment and/or marriage, with those who are not married less likely to have insurance cover (and therefore the means to treatment for many) compared to those who are married [59]. Despite this, there is evidence of an similar inequality by in receipt of treatment for other cancers by marital status from elsewhere including Ireland, which also has a mixed private and public health system [48,49]. It is plausible that healthcare systems have some influence in the role of marital status in cancer treatment however this does not completely explain the observed findings and highlights the need for further investigation in such a way that system and cultural factors are considered.

The study does have several limitations. First, there are challenges comparing studies reporting different treatments and treatment combinations with no consistent method used, for this reason 'overall treatment', meaning treatment of any kind was considered. We acknowledge that some of the Forest Plots contain few studies due to heterogenicity in the reporting of relevant data, so some care should be taken in interpretation. Secondly, the OR were determining from the raw treatment uptake data and, as such the multivariate models where not included in our meta-analysis. This is particularly relevant given the SEER database has been shown to underrepresent people from minority populations [60]. Furthermore, in the meta-analysis we were not able to consider

marital status in any degree of granularity; for example, if someone was widowed, divorced, or never married. Similarly, it may be beneficial for future studies to explore the relationship of marital status and treatment receipt at a population level for people in same-sex relationships, as there could be more nuanced findings which could unearth new treatment inequalities within this field. Additionally, we do acknowledge that marriages are likely to vary considerably in terms of the social, psychological and economic support they provide. Moreover, marital status is not a direct measure of social support which means that misclassification is likely. As such, future work may wish to explore direct measures of social support and whether an association with marital status persists in this context, or the role in treatment decision-making or other factors that are often related to marriage (for example, other familial responsibilities such as being a parent). Finally, recent years has seen an explosion in biological therapies and immunotherapies for a range of cancers, including lung cancer, but none of the studies reported on these treatments. Recent work has reported strong socio-economic inequalities in these treatments [22,61]; investigation of whether inequalities by marital status are also present for these treatments is warranted.

4.1. Conclusion

People who are married are significantly more likely to receive lung cancer treatment compared to people who are not married. This observation was found across all aspects of lung cancer treatment, including chemotherapy, radiotherapy, and surgery, but the number of independent studies was limited and all data, to date, are from the USA. The reasons for this are unknown and require further investigation to better understand the "mechanisms" behind the potentially protective effects of marriage in the context of lung cancer treatment.

Authorship

AT and LS conceived the study concept and design. MS and CR identified the literature and abstracted data. MS, AT, LS, and CR interpreted the data. MS and CR undertook the statistical analysis. MS and CR drafted the manuscript. All authors read and approved the final draft. AT and CR have full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Funding

There is no research funding to declare in relation to this work.

Declaration of Competing Interest

There are no competing interests to declare from the authors.

Data Availability

All data generated or analysed during this study are included in this published article and its supplementary information files.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.canep.2023.102494.

References

[1] World Cancer Research Fund International, Lung cancer statistics, 2022. https://www.wcrf.org/cancer-trends/lung-cancer-statistics/. (Accessed [accessed: 19/06/2023.
[2] H. Sung, J. Ferlay, R.L. Siegel, M. Laversanne, I. Soerjomataram, A. Jemal, F. Bray, Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries, CA Cancer J. Clin. 71 (3) (2021) 209–249.
[3] C.S. Dela Cruz, L.T. Tanoue, R.A. Matthay, Lung cancer: epidemiology, etiology, and prevention, Clin. Chest Med. 32 (4) (2011) 605–644.
[4] T. Sethi, E. Lim, M. Peake, J. Field, J. White, M. Nicolson, C. Faivre-Finn, P. Cane, J. Reynolds, H. Møller, H. Pinnock, Improving care for patients with lung cancer in the UK, Thorax 68 (12) (2013) 1181–1185.
[5] C. Allemani, T. Matsuda, V. Di Carlo, R. Harewood, M. Matz, M. Nikšić, A. Bonaventure, M. Valkov, C.J. Johnson, J. Estève, O.J. Ogunbiyi, E.S.G. Azevedo, W.Q. Chen, S. Eser, G. Engholm, C.A. Stiller, A. Monnereau, R.R. Woods, O. Visser, G.H. Lim, J. Aitken, H.K. Weir, M.P. Coleman, Global surveillance of trends in cancer survival 2000-14 (CONCORD-3): analysis of individual records for 37 513 025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries, Lancet 391 (10125) (2018) 1023–1075.
[6] ONS, Cancer survival in England: adults diagnosed in 2009 to 2013, followed up to 2014, Office for National Statistics, Newport, 2015.
[7] V.L. Shavers, M.L. Brown, Racial and ethnic disparities in the receipt of cancer treatment, J. Natl. Cancer Inst. 94 (5) (2002) 334–357.
[8] K.K. Lau, S. Rathinam, D.A. Waller, M.D. Peake, The effects of increased provision of thoracic surgical specialists on the variation in lung cancer resection rate in England, J. Thorac. Oncol. 8 (1) (2013) 68–72.
[9] A.R. Jazieh, M.J. Kyasa, G. Sethuraman, J. Howington, Disparities in surgical resection of early-stage non-small cell lung cancer, J. Thorac. Cardiovasc. Surg. 123 (6) (2002) 1173–1176.
[10] E.P. Gray, M.D. Teare, J. Stevens, R. Archer, Risk prediction models for lung cancer: a systematic review, Clin. Lung Cancer 17 (2) (2016) 95–106.
[11] U. Nur, M. Quaresma, B. De Stavola, M. Peake, B. Rachet, Inequalities in non-small cell lung cancer treatment and mortality, J. Epidemiol. Community Health 69 (10) (2015) 985–992.
[12] K. Williams, D. Umberson, Marital status, marital transitions, and health: a gendered life course perspective, J. Health Soc. Behav. 45 (1) (2004) 81–98.
[13] H. Liu, D.J. Umberson, The times they are a changin': marital status and health differentials from 1972 to 2003, J Health Soc Behav 49(3) (2008) 239–53.
[14] J. IMA. Marital Status and Health Problems, 2nd ed..,, Academic,, New York, 2007.
[15] N.J. Johnson, E. Backlund, P.D. Sorlie, C.A. Loveless, Marital status and mortality: the national longitudinal mortality study, Ann. Epidemiol. 10 (4) (2000) 224–238.
[16] H. Lai, S. Lai, A. Krongrad, E. Trapido, J.B. Page, C.B. McCoy, The effect of marital status on survival in late-stage cancer patients: an analysis based on surveillance, epidemiology, and end results (SEER) data, in the United States, Int. J. Behav. Med. 6 (2) (1999) 150–176.
[17] O. Kravdal, The impact of marital status on cancer survival, Soc. Sci. Med. 52 (3) (2001) 357–368.
[18] C.M. Tammemagi, C. Neslund-Dudas, M. Simoff, P. Kvale, Lung carcinoma symptoms–an independent predictor of survival and an important mediator of African-American disparity in survival, Cancer 101 (7) (2004) 1655–1663.
[19] D. Moher, A. Liberati, J. Tetzlaff, D.G. Altman, P.G. The, Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement, PLOS Med. 6 (7) (2009), e1000097.
[20] F.Ro Legislation, Sex Discrimination Act, in: A. Government (Ed.) S.6, 1984.
[21] C.E.P.a.O.o.C. (EPOC), Data collection form, EPOC Resources for review authors, Cochrane, 2017.
[22] R.P. Norris, R. Dew, L. Sharp, A. Greystoke, S. Rice, K. Johnell, A. Todd, Are there socio-economic inequalities in utilization of predictive biomarker tests and biological and precision therapies for cancer? A systematic review and meta-analysis, BMC Med. 18 (1) (2020), 282.
[23] B. Motheral, J. Brooks, M.A. Clark, W.H. Crown, P. Davey, D. Hutchins, B. C. Martin, P. Stang, A checklist for retrospective database studies—report of the ISPOR task force on retrospective databases, Value Health 6 (2) (2003) 90–97.
[24] J.P. Higgins, S.G. Thompson, Quantifying heterogeneity in a meta-analysis, Stat. Med 21 (11) (2002) 1539–1558.
[25] V. Quiñones-Avila, K.J. Ortiz-Ortiz, R. Ríos-Motta, H. Marín-Centeno, G. Tortolero-Luna, Use of palliative radiotherapy among patients with metastatic non-small-cell lung cancer in Puerto Rico, BMC Palliat. Care 20 (1) (2021), 127.
[26] Y. Wu, P.Z. Zhu, Y.Q. Chen, J. Chen, L. Xu, H. Zhang, Relationship between marital status and survival in patients with lung adenocarcinoma A SEER-based study (no pagination), Med. (U. S.) 101 (1) (2022) (no pagination).
[27] M.F. Berry, A.J. Canchola, M.F. Gensheimer, S.L. Gomez, I. Cheng, Factors associated with treatment of clinical stage I non-small-cell lung cancer: a population-based analysis, Clin. Lung Cancer 19 (5) (2018) e745–e758.
[28] Z. Chen, K. Yin, D. Zheng, J. Gu, J. Luo, S. Wang, H. Chen, Marital status independently predicts non-small cell lung cancer survival: a propensity-adjusted SEER database analysis, J. Cancer Res. Clin. Oncol. 146 (1) (2020) 67–74.
[29] Z.H. Chen, K.B. Yang, Y.Z. Zhang, C.F. Wu, D.W. Wen, J.W. Lv, G.L. Zhu, X.J. Du, L. Chen, G.Q. Zhou, Q. Liu, Y. Sun, J. Ma, C. Xu, L. Lin, Assessment of modifiable factors for the association of marital status with cancer-specific survival (no pagination), JAMA Netw. Open 4 (5) (2021) (no pagination).
[30] S.M. Dalwadi, J. Zhang, E.H. Bernicker, E.B. Butler, B.S. Teh, A.M. Farach, Socioeconomic factors associated with lack of treatment in early stage non-small cell lung cancer, Cancer Investig. 37 (9) (2019) 506–511.
[31] C. Deng, S.G. Wu, Y. Tian, Lung large cell neuroendocrine carcinoma: An analysis of patients from the surveillance, epidemiology, and end-results (SEER) database, Med. Sci. Monit. 25 (2019) 3636–3646.
[32] X. Hua, K.C. Ward, T.W. Gillespie, J. Lipscomb, M. Goodman, Non-small cell lung cancer treatment receipt and survival among African-Americans and whites in a rural area, J. Community Health 39 (4) (2014) 696–705.

[33] A. Jatoi, P. Novotny, S. Cassivi, M.M. Clark, D. Midthun, C.A. Patten, J. Sloan, P. Yang, Does marital status impact survival and quality of life in patients with non-small cell lung cancer? Observations from the mayo clinic lung cancer cohort, Oncologist 12 (12) (2007) 1456–1463.
[34] X. Jiang, G. Lin, K.M. Islam, Socioeconomic factors related to surgical treatment for localized, non-small cell lung cancer, Soc. Sci. Med. 175 (2017) 52–57.
[35] K.T. Jiang, D.Z. Huang, The risks and trends of cardiac-specific mortality associated with chemotherapy or radiotherapy in a large cohort of non-elderly patients with non-small cell lung cancer, Transl. Cancer Res. 10 (2) (2021) 842–853.
[36] M.B. Lam, L. Li, A. Cronin, D. Schrag, A.B. Chen, Palliative radiation and fractionation in medicare patients with incurable non-small cell lung cancer, Adv. Radiat. Oncol. 3 (3) (2018) 382–390.
[37] S.H.I. Ou, A. Ziogas, J.A. Zell, Prognostic factors for survival in extensive stage small cell lung cancer (ED-SCLC): The importance of smoking history, socioeconomic and marital statuses, and ethnicity, J. Thorac. Oncol. 4 (1) (2009) 37–43.
[38] P.J. Speicher, B.R. Englum, A.M. Ganapathi, M.W. Onaitis, T.A. D'Amico, M. F. Berry, Outcomes after treatment of 17,378 patients with locally advanced (T3N0-2) non-small-cell lung cancer, Eur. J. Cardio-Thorac. Surg. 47 (4) (2015) 636–641.
[39] M.J. Stavas, K.O. Arneson, M.S. Ning, A.A. Attia, S.E. Phillips, S.M. Perkins, E. T. Shinohara, The refusal of palliative radiation in metastatic non-small cell lung cancer and its prognostic implications, J. Pain. Symptom Manag. 49 (6) (2015) 1081–1087, e4.
[40] S.L. Tannenbaum, W. Zhao, T. Koru-Sengul, F. Miao, D. Lee, M.M. Byrne, Marital Status and its Effect on Lung Cancer Survival, 2, SpringerPlus,, 2013.
[41] Y. Wu, Z. Ai, G. Xu, Marital status and survival in patients with non-small cell lung cancer: an analysis of 70006 patients in the SEER database, Oncotarget 8 (61) (2017) 103518–103534.
[42] S. Cykert, G. Corbie-Smith, P. Dilworth-Anderson, M. Monroe, F. McGuire, P. Walker, L. Edwards, Disparities in surgery for early stage lung cancer: an analysis of mortality one year after diagnosis, J. Gen. Intern. Med. 1 (2011) S145.
[43] P.A. Ganz, J.J. Lee, J. Siau, Quality of life assessment. An independent prognostic variable for survival in lung cancer, Cancer 67 (12) (1991) 3131–3135.
[44] K. Nayeri, G. Pitaro, J.G. Feldman, Marital status and stage at diagnosis in cancer, N. Y State J. Med 92 (1) (1992) 8–11.
[45] T.J. Iwashyna, N.A. Christakis, Marriage, widowhood, and health-care use, Soc. Sci. Med 57 (11) (2003) 2137–2147.
[46] T.D. Denberg, B.L. Beaty, F.J. Kim, J.F. Steiner, Marriage and ethnicity predict treatment in localized prostate carcinoma, Cancer 103 (9) (2005) 1819–1825.
[47] A.E. Carsin, L. Sharp, D.P. Cronin-Fenton, A.Ó. Céilleachair, H. Comber, Inequity in colorectal cancer treatment and outcomes: a population-based study, Br. J. Cancer 99 (2) (2008) 266–274.
[48] D.P. Cronin-Fenton, L. Sharp, A.E. Carsin, H. Comber, Patterns of care and effects on mortality for cancers of the oesophagus and gastric cardia: a population-based study, Eur. J. Cancer 43 (3) (2007) 565–575.
[49] L. Sharp, A.E. Carsin, D.P. Cronin-Fenton, D. O'Driscoll, H. Comber, Is there under-treatment of pancreatic cancer? Evidence from a population-based study in Ireland, Eur. J. Cancer 45 (8) (2009) 1450–1459.
[50] N.P. Rowell, P. O'Rourke N, Concurrent chemoradiotherapy in non-small cell lung cancer, Cochrane Database Syst. Rev. 4 (2004) Cd002140.
[51] A.L. Potosky, L.C. Harlan, R.S. Kaplan, K.A. Johnson, C.F. Lynch, Age, sex, and racial differences in the use of standard adjuvant therapy for colorectal cancer, J. Clin. Oncol. 20 (5) (2002) 1192–1202.
[52] L.C. Harlan, L.X. Clegg, E.L. Trimble, Trends in surgery and chemotherapy for women diagnosed with ovarian cancer in the United States, J. Clin. Oncol. 21 (18) (2003) 3488–3494.
[53] R. Lawrenson, C. Lao, L. Brown, L. Moosa, L. Chepulis, R. Keenan, J. Kidd, K. Middleton, P. Conaglen, C. de Groot, D. Aitken, J. Wong, Management of patients with early stage lung cancer – why do some patients not receive treatment with curative intent? BMC Cancer 20 (1) (2020), 109.
[54] A.A. Aizer, M.H. Chen, E.P. McCarthy, M.L. Mendu, S. Koo, T.J. Wilhite, P. L. Graham, T.K. Choueiri, K.E. Hoffman, N.E. Martin, J.C. Hu, P.L. Nguyen, Marital status and survival in patients with cancer, J. Clin. Oncol. 31 (31) (2013) 3869–3876.
[55] D. Wang, D. Li, S.R. Mishra, C. Lim, X. Dai, S. Chen, X. Xu, Association between marital relationship and multimorbidity in middle-aged adults: a longitudinal study across the US, UK, Europe, and China, Maturitas 155 (2022) 32–39.
[56] D.S. Dhindsa, J. Khambhati, W.M. Schultz, A.S. Tahhan, A.A. Quyyumi, Marital status and outcomes in patients with cardiovascular disease, Trends Cardiovasc. Med. 30 (4) (2020) 215–220.
[57] S. Molsted, S. Wendelboe, M.M. Flege, I. Eidemak, The impact of marital and socioeconomic status on quality of life and physical activity in patients with chronic kidney disease, Int. Urol. Nephrol. 53 (12) (2021) 2577–2582.
[58] M. Pinquart, P.R. Duberstein, Associations of social networks with cancer mortality: a meta-analysis, Crit. Rev. Oncol. Hematol. 75 (2) (2010) 122–137.
[59] H. Sohn, Racial and ethnic disparities in health insurance coverage: dynamics of gaining and losing coverage over the life-course, Popul. Res. Policy Rev. 36 (2) (2017) 181–201.
[60] P.B. Bach, E. Guadagnoli, D. Schrag, N. Schussler, J.L. Warren, Patient demographic and socioeconomic characteristics in the SEER-medicare database applications and limitations, Med. Care 40 (Suppl 8) (2002). Iv-19-25.
[61] R.P. Norris, R. Dew, A. Greystoke, A. Todd, L. Sharp, Socioeconomic inequalities in novel NSCLC treatments during the era of tumor biomarker-guided therapy: a population-based cohort study in a publicly funded health care system, J. Thorac. Oncol. (2023).