Author/s:
Wu, Z;Nguyen, NH;Wang, D;Lynch, BM;Hodge, AM;Bassett, JK;White, VM;Borland, R;English, DR;Milne, RL;Giles, GG;Dugué, PA

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Hodge Allison (Orcid ID: 0000-0001-5464-2197)
Bassett Julie (Orcid ID: 0000-0003-0799-4821)
Dugué Pierre-Antoine (Orcid ID: 0000-0003-2736-3023)

Original research article

# Social connectedness and mortality after prostate cancer diagnosis: a prospective cohort study

Zimu Wu[1], Nga H Nguyen[1], Dawei Wang[1], Brigid M Lynch[1,2,3], Allison M Hodge[1,2], Julie K Bassett[1], Vicki White[4,5], Ron Borland[6], Dallas R English[1,2], Roger L Milne[1,2,7], Graham G Giles[1,2,7], Pierre-Antoine Dugué[1,2,7,*]

[1] Cancer Epidemiology Division, Cancer Council Victoria, Melbourne VIC, Australia

[2] Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health, The University of Melbourne, VIC, Australia

[3] Physical Activity Laboratory, Baker Heart and Diabetes Institute, Melbourne, VIC, Australia

[4] Centre for Behavioural Research in Cancer, Cancer Council, Melbourne, VIC, Australia

[5] School of Psychology, Deakin University, Melbourne, VIC, Australia.

[6] Nigel Gray Fellowship group, Cancer Council Victoria, Melbourne, VIC, Australia

[7] Precision Medicine, School of Clinical Sciences at Monash Health, Monash University, Clayton, VIC, Australia

* **Correspondence and requests for reprints**: Dr Pierre-Antoine Dugué, Precision Medicine, School of Clinical Sciences at Monash Health, Monash University, 246 Clayton Road, Clayton VIC 3168, Australia | Tel: +61 3 8572 2097 | E-mail: pierre-antoine.dugue@monash.edu

**Novelty and impact:** Social support and interactions are associated with better health outcomes, but scarce evidence exists regarding their potential benefit to prostate cancer survivors. Our study included 1,421 men with prostate cancer, among whom 338 deaths from any cause were observed. Those living alone had substantially higher mortality than those living with someone. No associations were observed for other measures of social connectedness, such as visits to friends/relatives, visits from friends/relatives, and time involved in social activities.

**Short title:** Social connectedness and mortality after prostate cancer

**Keywords:** social connectedness, social support, social interactions, social networks, psychosocial factors, prostate cancer, overall survival, mortality, cohort study

**Abbreviations:** MCCS: Melbourne Collaborative Cohort Study; VCR: Victorian Cancer Registry; NDI: National Death Index; HR: hazard ratio; CI: confidence interval; IQR: interquartile range.

**Tables:** 3 | **Figures:** 1 | **Supplementary Tables and Figures:** 3

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**ABSTRACT**

Men with prostate cancer experience side effects for which a supportive social environment may be beneficial. We examined the association between four measures of social connectedness and mortality after prostate cancer diagnosis. Male participants in the Melbourne Collaborative Cohort Study in 1990-94, who developed incident prostate cancer and attended follow-up in 2003-07, were eligible for the study. Information on social connectedness, collected at follow-up, included: 1) living arrangement; 2) frequency of visits to friends/relatives and 3) from friends/relatives; 4) weekly hours of social activities. A total of 1,421 prostate cancer cases was observed (338 all-cause deaths, 113 from prostate cancer), including 867 after follow-up (150 all-cause deaths, 55 from prostate cancer), and 554 before follow-up (188 all-cause deaths, 58 from prostate cancer). Cox models stratified by tumour Gleason score and stage, and sequentially adjusted for socioeconomic, health-, and lifestyle-related confounders, were used to calculate hazard ratios (HR) and 95% confidence intervals (95% CI) for the association between social connectedness and all-cause mortality after prostate cancer. Men who reported living alone before diagnosis had higher overall mortality (HR=1.6, 95% CI: 1.0-2.5), after adjustment for socioeconomic, health and lifestyle confounders. Lower mortality was observed for men with more social activities (P-trend=0.07), but not in comprehensively adjusted models. Consistent with these findings, men living alone after prostate cancer diagnosis had higher mortality (HR=1.3, 95% CI: 0.9-1.9). Lower mortality was observed with increasing socialising hours in the age-adjusted model (P-trend=0.06) but not after more comprehensive adjustment. Our findings suggest that living with

someone, but not other aspects of social connectedness, may be associated with decreased mortality for men with prostate cancer.

## INTRODUCTION

Prostate cancer is the most commonly diagnosed cancer and the third most common cause of cancer-specific death in Australian men.[1] Despite high survival, men with prostate cancer face side effects of treatment and long-term physical and psychological sequelae, such as metabolic dysfunction, urinary incontinence, erectile dysfunction, anxiety and distress.[2, 3] Evidence from epidemiological studies suggests that being socially connected is associated with better health outcomes for cancer survivors.[4-18] One measure of social connectedness, social networks, is a construct based on the web of social relationships that surround an individual, with their spouse, children, relatives, friends and colleagues, from which individuals may receive social emotional, practical and functional support.[19, 20] Social support has also been found to be associated with lower levels of psychological distress in cancer patients and with more invasive treatment choices such as prostatectomy.[9, 21-24]

The majority of previous studies on the beneficial effects of social connectedness after cancer diagnosis have been based on breast cancer survivors, and less evidence has accumulated for other individual cancer types.[14, 15, 17, 18, 25] Regarding prostate cancer survivors specifically, several studies have reported increased social connectedness to be associated with healthier lifestyles, better emotional well-being, earlier diagnosis, choice of more aggressive treatment and better adherence to treatment.[8-10, 21, 26-28] A qualitative study of Australian men indicated that social support in domains of psychological needs, health information, daily living needs, patient care and sexuality were important aspects of quality of life for men with prostate cancer.[2] The most commonly examined indicators of social connectedness are marital/partnership status and social network size, i.e. number of social contacts. The influence of social connectedness on health outcomes after cancer diagnosis may depend on quality, frequency and availability of social interactions. Despite prior evidence for various health benefits of social connectedness, its association with mortality after prostate cancer diagnosis

has been seldom studied.

It has also been observed that cancer diagnosis may be associated with change in social contacts and, hence, in available social support.[29] A meta-analysis by Pinquart and Duberstein suggested that the predictive value of social networks may differ according to whether they were assessed before or after diagnosis,[29] but limited research has investigated this aspect, particularly for prostate cancer. Kroenke and colleagues found that participation in group activities after the diagnosis of breast cancer was associated with lower risk of mortality, which was contrary to the results of pre-diagnosis analyses.[15]

The present study of 1,421 men with prostate cancer aimed to examine the association of mortality after prostate cancer diagnosis with four social connectedness indicators: 1) frequency of visiting friends and relatives or 2) receiving visits from them, 3) number of hours per week involved in social activities outside house or work and 4) living alone or with someone, measured either pre- or post- prostate cancer diagnosis.

## METHODS

### Study participants

The Melbourne Collaborative Cohort Study (MCCS), is a prospective cohort study of 41,513 participants from the Melbourne metropolitan area (17,044 men and 24,469 women), aged between 27 and 76 years at baseline (99% aged between 40 and 69 years with an average of 55 years). Participants were recruited between 1990 and 1994 (baseline) through the Victorian Electoral Enrolment Register, the Melbourne metropolitan phone directory, mobile recruitment units, advertisements and announcements in mass media. All participants were of white-

European origin (69% were born in Australia/New Zealand, 6% in the UK, 13% in Italy and 11% in Greece). Baseline information including sociodemographic characteristics, health behaviours and medical history were collected by questionnaires and anthropometric measures were made by trained personnel. Between 2003 and 2007, participants were followed-up, repeating the majority of baseline measures and collecting additional information, including social networks and psychological distress. Further details of the cohort study have been published elsewhere. [30] All participants provided written informed consent and the Cancer Council Victoria's Human Research Ethics Committee approved the MCCS study protocol.

MCCS participants who were diagnosed with an incident prostate cancer between baseline and 30 November 2015 were eligible for the study if they answered the social connectedness questions at follow-up. Men with a diagnosis of prostate cancer before baseline (N=46), or after 30 November 2015 (date at which the National Death Index data were considered complete) (N=8) or had missing information on social connectedness (N=19) were excluded. After exclusions, data for 1,421 men with prostate cancer were available for analysis; 338 deaths from any cause were observed during the follow-up (***Supplementary Figure***). The analysis was split into pre- and post-diagnosis social connectedness leaving 867 cases and 150 deaths from any cause (including 55 [37%] from prostate cancer) in the pre-diagnosis group, and 554 cases and 188 deaths from any cause (including 58 [31%] from prostate cancer) in the post-diagnosis group. A schematic representation of data collection and follow-up is presented in ***Figure 1***.

**Data collection**

*Assessment of social connectedness*

Information on social connectedness was collected by a self-administered questionnaire at MCCS follow up (2003-2007). The questionnaire included four items: 'visits to friends and relatives' (<once/week, once/week, 2-3 times/week, 4-6 times/week, ≥7 times/week), 'visits

from friends and relatives' (<once/week, once/week, 2-3 times/week, 4-6 times/week, ≥7 times/week), 'hours per week involved in social activities outside work or home' (0, 1-2, 3-4, 5-9, 10+) and 'living arrangement' (living alone or not living alone).

*Ascertainment of cancer and deaths*

Cases of prostate cancer and dates of diagnosis were identified by record linkage with the Victorian Cancer Registry (VCR) and deaths were ascertained through record linkage with the National Death Index (NDI). For both linkages, the data were considered complete up to 30 November 2015. Information on cancer severity, including tumour stage and grade was determined from the pathology reports provided by the VCR. Cancer stage was classified into three categories (1A-1C, 2A-2C, 3A-4) and cancer grade was assessed from the Gleason score which ranges from 2 to 10 (categorised into 4 groups by the level of differentiation: 2-4, 5-6, 7, 8-10) with a higher score indicating a higher tumour grade.[31]

Cause-specific mortality was defined according to the WHO International Classification of Diseases codes version ICD-10, using the underlying cause of death from the death certificate. We used in priority the cause of death retrieved by the VCR (which follows cancer cases in order to improve death classification), and when missing, used the NDI-defined cause of death. Causes of death classified as 'not from cancer' by the VCR but with a cancer ICD code in the NDI were considered to be missing.

*Other covariates*

Information on country of birth and educational level was self-reported at baseline. Other covariates such as physical health status, comorbidities (history of heart attack, heart bypass, angioplasty, stroke, angina and diabetes), smoking status, alcohol consumption, diet, psychological distress (Kessler 10 score ranging from 10 to 50 [32]) and physical activity were

self-reported by participants at follow-up (2003-2007) via questionnaires. Socioeconomic status was also measured at follow-up by deciles of the Index of Relative Socioeconomic Disadvantage (SEIFA-10), based on geographical area of the participants' residential address.[33] A categorised physical activity score was calculated based on time per week spent walking and in recreational physical activity (moderate and vigorous intensity activities). These questions were based on the International Physical Activity Questionnaire (IPAQ)-short form ("Inactive", 0 hour/week; "Insufficiently active", >0 to 2.5 hours/week; "Sufficiently active", >=2.5 hours/week.[34] The Mediterranean diet score (modified version of the score developed by Trichopoulou et al.[35]) was used as a measure of diet quality.

**Statistical analysis**

Cox proportional hazards regression models were used to estimate hazard ratios (HR) and 95% confidence intervals (CI) for the association with all-cause mortality of social connectedness assessed before or after cancer diagnosis. For the pre-diagnosis group, participants were followed up from date of cancer diagnosis to date of death, date of the end of follow up (30 November 2015) or date left Australia, whichever came first. For the post-diagnosis group, follow-up started at date of cancer diagnosis with left-truncation at the date of follow-up attendance to avoid immortal time bias, and ended at date of death, end of follow-up or date left Australia, whichever came first. Four measures of social connectedness were considered: 'living arrangement' (living alone vs living with someone); 'visits to friends and relatives', 'visits from friends and relatives' (both coded as less than once/week; once/week; 2-3 times/week; 4-6 times/week; ≥7 times/week) and 'hours per week involved in social activities outside work or home'. The three latter variables were first treated as categorical variables and then as pseudo-continuous variables (1: lowest level to 5: highest level) to test for a linear trend.

Potential confounding factors considered were: sociodemographic variables (age at diagnosis,

country of birth, education, socioeconomic status), health status (self-reported general health status, comorbidities), psychological distress (Kessler 10 score), health behaviours (smoking status, alcohol consumption, Mediterranean diet score, physical activity) and cancer severity (cancer stage, tumour grade). Three regression models were considered: Model 1 adjusted for age only; Model 2 additionally adjusted for country of birth (Australia/New Zealand/Other; Southern Europe, Northern Europe), education (primary, secondary, tertiary, other qualifications) and socioeconomic status (continuous score), self-reported general health status (excellent, very good, good, fair, poor) and comorbidities of diabetes, stroke, heart bypass, heart attack, angina, angioplasty (yes/no); Model 3 adjusted for all variables in Model 2 and further adjusted for Kessler 10 (<16, 16-29, >29), smoking status (never, former, current), alcohol consumption (0g, 1-39g, 40-59g, 60+g), physical activity (sufficiently active, insufficiently active, inactive), Mediterranean diet score (continuous score) and body mass index (continuous). All models were stratified by cancer stage and tumour grade (thus controlling for these factors while allowing baseline hazard rates to vary by cancer severity [36]) and all analyses were conducted separately according to whether social connectedness assessment was made before or after prostate cancer diagnosis. For all models, the proportional hazard assumption for social connectedness variables was tested, and no evidence of violation was found.

Because socialising activities and living arrangements may change over time, we tested their interactions with time between follow-up and cancer diagnosis (within 5 years and more than 5 years), for both the pre- and post-diagnosis groups, by comparing models with and without interaction terms using the likelihood ratio test.

In all analyses, multiple imputation was used (50 imputed datasets) to handle missing values for covariates, including in the imputation model all variables in Model 3, and survival time and death status.[37] Analyses were conducted using Stata MP12.1.

**Data availability**

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## RESULTS

Altogether, 1,421 prostate cancer cases were included in the analysis, including 867 cases (150 all-cause deaths; 55 [37%] from prostate cancer) with social connectedness assessed before diagnosis (pre-diagnosis group) and 554 cases (188 all-cause deaths; 58 [31%] from prostate cancer) with social networks measured after cancer (post-diagnosis group)***, Table 1***. The median time between measurement of pre-diagnosis exposures and prostate cancer diagnosis was 4.8 years (interquartile range [IQR]: 2.4 to 7.3 years), with a median follow-up time after diagnosis of 5.3 years (IQR: 2.9 to 7.7 years). The median time between–prostate cancer diagnosis and measurement of post-diagnosis exposures was 4.0 years (IQR: 1.8 to 7.5 years), with a median follow-up time after exposure measurement of 10.2 years (IQR: 8.7 to 11.2 years) (***Figure 1***). Compared with participants in the pre-diagnosis group, those in the post-diagnosis group were younger at diagnosis, less educated, less socioeconomically advantaged and had worse self-reported health status. They also had lower levels of physical activity, lower Mediterranean diet score and higher BMI. Regarding social network indicators, those in the post-diagnosis group had more visits from friends and relatives per week and were more likely to live alone (***Table 1***).

*Pre-diagnosis social connectedness and overall survival*

In the pre-diagnosis group (***Table 2***), decreased mortality risk was observed in the age-adjusted

model for men who visited friends and/or relatives 4-6 times per week, compared with those who visited less than once per week (HR=0.6, 95% CI: 0.3-1.0), but not in more comprehensively adjusted models (Model 1: P for trend=0.09, Model 3: P for trend=0.19) or for participants with 7 or more visits per week (HR=1.1, 95% CI: 0.6, 2.1). Lower mortality was observed as the number of hours involved in social activities increased per week before diagnosis in Model 1 (P for trend=0.07; per category of the pseudo-continuous socialising hours variable: HR=0.9, 95% CI: 0.8-1.0; data not shown), but it was attenuated in Model 2 and Model 3 (***Table 2***). Compared with those who lived with someone, men who reported living alone before diagnosis had 60% higher mortality (HR=1.6; 95% CI: 1.0-2.4 in Model 1). This association remained the same after adjustment for confounders (HR=1.5, and 1.6 in Models 2 and 3). Further analyses did not indicate that the association of social connectedness with mortality differed by time between exposure measurement and diagnosis ***(Supplementary Table 1)***.

*Post-diagnosis social connectedness and overall survival*

***Table 3*** shows the HRs for Cox models in the post-diagnosis group. No significant association was found for visits to or from friends and relatives after diagnosis. Lower mortality was observed with increasing socialising hours in the age-adjusted model (P for trend=0.06, HR=0.9, 95%CI: 0.8-1.0, data not shown), but not in more comprehensively adjusted models. Participants who indicated they lived alone had 30% higher all-cause mortality than men living with someone (Model 1: HR=1.3, 95%CI: 0.9-1.8; Model 2: HR=1.3, 95%CI: 0.9-1.8; Model 3: HR=1.3, 95%CI: 0.9-1.9). There was no evidence that the association between measures of social connectedness and mortality differed by time between prostate cancer diagnosis and exposure measurement ***(Supplementary Table 2)***.

## DISCUSSION

In our study, men with prostate cancer who lived alone had higher mortality than those who lived with another person(s) and this was true for both the pre- and post-diagnosis groups. Other social connectedness indicators collected in our study, i.e. frequency of contacts with friends and/or relatives and socialising hours, either measured before or after diagnosis, were not associated with mortality. Crude associations were observed for men engaging in more social activities, both before and after diagnosis, but there were no clear trends, and these largely disappeared after adjustment for confounding variables (health status, psychological distress, and lifestyle behaviours).

The main strengths of our study are its prospective and community-based design with lengthy follow-up. Few studies have focused on social connectedness, including living arrangements, and mortality after prostate cancer diagnosis, so our study makes an important contribution. Also, because the interpretation of the association of pre- and post-diagnosis social connectedness with health outcomes may differ, we divided the study sample into two groups by pre- and post-diagnosis exposure assessment. We employed several models that adjusted for different sets of confounders sequentially. Model 3 adjusted for psychological distress and health behaviours which most likely have bidirectional and complex associations with social connectedness, but the results were very similar to those from Model 2 (adjusting for socioeconomic and health-related variables) so these factors seem to play only a minor role. Confounding variables controlled for in previous studies have been highly diverse, although sociodemographic characteristics, health status and cancer severity were adjusted for in most studies of other cancer types.[5, 6, 10, 12, 13, 15, 17, 18, 26, 29, 38] In our study, the association between living alone and the mortality after prostate cancer was the same in all models, suggesting it was not due to confounding by variables traditionally collected by cohort studies but rather acted through other pathways.

In the post-diagnosis analysis, the main limitation of our study was the lack of information regarding cancer aggressiveness at the time of social connectedness assessment, potentially creating confounding by cancer severity. Another limitation was the fact that participants self-selected to participate in the follow-up visit; it is likely that participants with a more favourable prognosis were over-represented compared with the clinical setting. Additionally, although the MCCS was community-based, participants were likely to be healthier and more outgoing and socially connected than the general population in Australia, as is often the case in cohort studies. Approximately 70% of the cohort participated in the 2003-2007 follow-up visit, and the vast majority of participants who participated in the follow-up visit completed the social connectedness questionnaire. Despite the potential self-selection, over 33% of the deaths observed in our study were from prostate cancer and ~25% of diagnoses were stage II or higher, so our sample might have been reasonably representative of prostate cancer survivorship in Australia. The collider bias resulting from self-selection, usually considered to be small,[39] was therefore likely negligible in our setting. Many of our study participants were long-term cancer survivors for which social connectedness assessment was made long before or after diagnosis. Also, our sample size was reasonably large but inadequate to examine prostate cancer-specific mortality, so we used all-cause mortality as the primary survival endpoint; similarly, we did not undertake subgroup analyses by stage and grade, hence implicitly assumed that relative risks of mortality by social connectedness were constant across tumour severity strata. Finally, we could not consider the potential importance of who the patients lived with by subgroup analysis due to the sample size, but there might be qualitative differences in the supportive care provided by spouse, children or other persons. The vast majority (90%) of men with prostate cancer included in the analysis who did not live alone lived with a partner, and 98% lived with either a spouse or a family member. No information was collected at follow-up on why participants lived alone and it is likely that widowed, single, and divorced men had different sociological and health profiles. While this was beyond the scope of our study, other studies that examined

this aspect usually found relatively similar associations for single, widowed, or divorced cancer survivors, compared with partnered patients, for example in the context of bladder cancer,[40] colon cancer,[41] or cancer overall.[10, 42] Associations also do not appear to strongly vary by gender, but a thorough comparison is difficult because substantially fewer men than women live alone at older ages, hence are a more selected group, which may tend to result in larger effect estimates. For example, the large US study by Aizer and colleagues [10] found stronger but consistent associations in married men, compared with women, for all-cancer survival (men: HR=0.77, 95%CI: 0.76-0.79, women: HR=0.84, 95%CI: 0.82-0.86). A similar conclusion was reached in the context of bladder cancer [40] (compared with married counterparts, never-married men: HR=1.22, 95%CI: 1.06-1.39; women: HR=1.12, 95%CI: 0.89-1.42), and colorectal cancer [41] (married compared with non-married men HR=0.86, 95%CI: 0.82-0.90; women: HR=0.87, 95%CI: 0.83-0.91).We also had no information on whether men living alone were in nursing homes, where they could have benefitted from more social connections and access to health care, but these were likely a minority given that most men were aged less than 80 years at the start of follow-up; 2% of our sample indicated living in a 'shared accommodation' and were classified as living with someone.

Our results are consistent with previous studies that examined the association between marital status and prostate cancer overall or cause-specific survival, which found protective associations.[8, 26, 28, 43, 44] For male cancer patients, both marriage and parenting have been reported to be associated with increased survival,[45] suggesting that living with partner or children is important for men. Social connectedness as a whole has been less studied. A study by Jan and colleagues found that there was no association between the number of people with whom men shared emotional problems and prostate cancer survival,[22] which is also consistent with our study. Further studies are needed to investigate whether social isolation, number of close relatives and friends, or other aspects of social connectedness, may be associated with

prostate cancer survival, as found for breast and other cancers.[15, 25, 29] The potential protective effects of living with someone in terms of mortality after prostate cancer diagnosis could be explained by several factors. First, men living with someone may seek more prompt access to health care than those living alone, potentially resulting in a less advanced or aggressive tumour and a better prognosis.[10] We controlled for cancer severity in our analyses, but residual confounding may have existed. We did not have information on whether prostate cancer cases included in our analysis were asymptomatic and detected following a PSA test or diagnosed because of symptoms; participants with lower levels of social connectedness may be less likely to be diagnosed with more indolent tumours following a routine PSA test, for example due to financial constraints or less access to health care / screening. Second, partnered patients were also found in other studies to choose more aggressive treatment, such as radical prostatectomy compared with radiation therapy.[21, 46] Their partners or family member may provide care required after surgery such as catheter management,[21] and daily assistance to tackle the side effects of the treatment and impaired physical conditions. Third, it was also observed elsewhere that partnered patients have better adherence to treatments and procedure guidelines[47] which may further contribute to improved survival. Living alone may also be associated with less healthy lifestyle choices such as smoking, excessive alcohol drinking, lack of physical activity and poor diet, which may lead to increased risk of death from prostate cancer and any cause.[48, 49] In our study, the HRs were robust to adjustment for the lifestyle factors we could account for, but these were not measured repeatedly over the survival course. Finally, another potential explanation for a mortality advantage of patients living with someone is psychological well-being, since psychological distress may be associated with decreased survival through several mechanisms, although adjustment for the K10 score was made in our study.[25] Several studies have suggested that perceived stress elevates prostate cancer-specific mortality,[22] and living with a partner or other family member may buffer the adverse psychological effects of prostate cancer diagnosis by allowing sharing of emotional burden.[4, 10, 11] Socioeconomic factors are

likely to play an important role in explaining social connectedness, access to health care and screening, and mortality after prostate cancer. Although our analysis controlled for country of birth, education, and socioeconomic status (at the local geographical area level), we cannot completely rule out that unmeasured social, cultural, or financial factors influencing both social connectedness and prostate cancer survival may have explained in part the observed associations.

Aizer and colleagues suggested that actively promoting support mechanisms with unmarried/unpartnered patients could be an effective way to improve cancer survival.[10] Actions that promote early cancer detection such as screening programs and health education might prove beneficial to socially isolated population groups. Assistance from a professional caregiver may also improve health outcomes for both the cancer patient and their family members.[50] These findings suggest that provision of appropriate care and assistance to prostate cancer patients living alone could substitute for the supportive care provided by a partner and/or family member. Finally, psychological interventions might improve the quality of life and health outcomes of men with prostate cancer by alleviating negative emotions.[51, 52] Although men with prostate cancer with more frequent and longer periods of social activities have more opportunities to receive support, we found no association of visiting or receiving visits from friends and/or family, or greater time involved in social activities, with mortality after prostate cancer**.** In our study, we only measured the frequency of social connections, but other parameters such as variety, boundedness, and reachability may be more indicative of the quality and perceived satisfaction of social support.[25, 53] In fact, for both the pre- and post-diagnosis assessment of exposure, more hours of social activities showed crude associations with mortality that were substantially attenuated after confounder adjustment, so may not be causally associated with mortality.

**CONCLUSION**

We conclude from our study that living alone may be associated with higher mortality for men with prostate cancer. Other aspects of social connectedness did not appear to be associated with mortality after prostate cancer diagnosis and should be evaluated in further, larger-scale, and more detailed studies.

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**Figure 1.** Timeline of cancer diagnosis, data collection and follow-up period.

**Table 1.** Characteristics of prostate cancer cases in the Melbourne Collaborative Cohort Study

| | Pre-cancer diagnosis group<br>Cases (N=867)<br>Deaths (N=150) | Post-cancer diagnosis group<br>Cases (N=554)<br>Deaths (N=188) |
|---|---|---|
| **Age at diagnosis (years), median (IQR)** | 70.7 (12.3) | 67.7 (7.9) |
| **Age at wave 2 follow-up (years), median (IQR)** | 66.1 (13.2) | 72.5 (9.4) |
| **Country of birth, N (%)** | | |
| AU/NZ/Other | 682 (78.7) | 423 (76.4) |
| Southern Europe | 103 (11.9) | 85 (15.3) |
| UK/Malta | 82 (9.5) | 46 (8.3) |
| **Education, N (%)** | | |
| Primary | 66 (7.6) | 73 (13.2) |
| Secondary | 348 (40.1) | 258 (46.6) |
| Tertiary | 369 (42.6) | 171 (30.9) |
| Other qualifications | 84 (9.7) | 52 (9.4) |
| **Socioeconomic status, N (%)** | | |
| Quintile 1 (most disadvantaged) | 171 (19.7) | 103 (18.6) |
| Quintile 2 | 207 (23.9) | 149 (26.9) |
| Quintile 3 | 188 (21.7) | 147 (26.5) |
| Quintile 4 | 120 (13.8) | 58 (10.5) |
| Quintile 5 (least disadvantaged) | 148 (17.1) | 73 (13.2) |
| Missing | 33 (3.8) | 24 (4.3) |
| **Self-reported health status, N (%)** | | |
| Excellent | 153 (17.7) | 60 (10.8) |
| Very good | 338 (39.0) | 163 (29.4) |
| Good | 278 (32.1) | 211 (38.1) |
| Fair | 80 (9.2) | 99 (17.9) |
| Poor | 17 (2.0) | 19 (3.4) |
| Missing | 1 (0.1) | 2 (0.4) |
| **Self-reported diabetes, N (%)** | 63 (7.3) | 53 (10.9) |
| Missing | 132 (15.2) | 69 (12.5) |
| **Self-reported stroke, N (%)** | 35 (4.0) | 29 (5.2) |
| Missing | 4 (0.5) | 4 (0.7) |
| **Self-reported heart attack, N (%)** | 79 (9.1) | 65 (11.7) |
| Missing | 5 (0.6) | 7 (1.3) |
| **Self-reported angina, N (%)** | 64 (7.4) | 56 (10.1) |
| Missing | 132 (15.2) | 74 (13.4) |
| **Self-reported angioplasty, N (%)** | 60 (6.9) | 55 (9.9) |
| Missing | 4 (0.5) | 4 (0.7) |
| **Self-reported heart bypass, N (%)** | 54 (6.2) | 58 (10.5) |
| **Kessler 10, N (%)** | | |
| <16 | 589 (67.9) | 379 (68.4) |
| 16-29 | 199 (23.0) | 108 (19.5) |
| >29 | 10 (1.2) | 2 (0.4) |
| Missing | 69 (8.0) | 65 (11.7) |
| **Smoking status, N (%)** | | |
| Never | 433 (49.9) | 246 (44.4) |
| Former | 354 (40.8) | 264 (47.7) |
| Current | 80 (9.2) | 44 (7.9) |
| **Alcohol consumption, N (%)** | | |
| 0g | 152 (17.5) | 116 (20.9) |
| 1-39g | 571 (65.9) | 348 (62.8) |
| 40-59g | 77 (8.9) | 44 (7.9) |
| 60+g | 38 (4.4) | 24 (4.3) |
| Missing | 29 (3.3) | 22 (4.0) |

| | | |
|---|---|---|
| **Physical activity, N (%)** | | |
| Inactive | 54 (6.2) | 40 (7.2) |
| Insufficiently active | 177 (20.4) | 114 (20.6) |
| Sufficiently active | 621 (71.6) | 381 (68.8) |
| Missing | 15 (1.7) | 19 (3.4) |
| **Mediterranean diet score, N (%)** | | |
| Quintile 1 | 162 (18.7) | 119 (21.5) |
| Quintile 2 | 151 (17.4) | 89 (16.1) |
| Quintile 3 | 174 (20.1) | 110 (19.9) |
| Quintile 4 | 139 (16.0) | 88 (15.9) |
| Quintile 5 | 142 (16.4) | 66 (11.9) |
| Missing | 99 (11.4) | 82 (14.8) |
| **Body mass index, kg/m$^2$, N (%)** | | |
| <25 | 219 (25.3) | 129 (23.3) |
| 25-30 | 467 (53.9) | 298 (53.8) |
| 30+ | 181 (20.9) | 127 (22.9) |
| **Tumor stage, N (%)** | | |
| T1-T1C | 566 (65.3) | 364 (65.7) |
| T2-T2C | 171 (19.7) | 120 (21.7) |
| T3A-T4 | 79 (9.1) | 50 (9.0) |
| Missing | 51 (5.9) | 20 (3.6) |
| **Tumor grade, N (%)** | | |
| Well-differentiated | 5 (0.6) | 54 (9.8) |
| Intermediate | 276 (31.8) | 249 (45.0) |
| Moderately-poorly differentiated | 245 (28.3) | 125 (22.6) |
| High-grade | 122 (14.1) | 54 (9.8) |
| Missing | 219 (25.3) | 72 (13.0) |
| **Cause of death, N (% of deaths)** | | |
| Prostate cancer | 55 (36.7) | 58 (30.9) |
| Other cancer | 36 (24.0) | 52 (27.7) |
| Cardiovascular disease | 18 (12.0) | 21 (11.2) |
| Other cause | 11 (7.3) | 26 (13.8) |
| Missing | 30 (20.0) | 31 (16.5) |
| **Visits to friends or relatives, N (%)** | | |
| <Once/week | 142 (16.4) | 97 (17.5) |
| Once/week | 121 (14.0) | 67 (12.1) |
| 2-3 times/week | 274 (31.6) | 165 (29.8) |
| 4-6 times/week | 254 (29.3) | 160 (28.9) |
| ≥7 times/week | 76 (8.8) | 65 (11.7) |
| **Visits from friends or relatives, N (%)** | | |
| <Once/week | 346 (39.9) | 194 (35.0) |
| Once/week | 236 (27.2) | 142 (25.6) |
| 2-3 times/week | 239 (27.6) | 161 (29.1) |
| 4-6 times/week | 36 (4.2) | 43 (7.8) |
| ≥7 times/week | 10 (1.2) | 14 (2.5) |
| **Hours involved in social activities outside home or work, N (%)** | | |
| 0/week | 120 (13.8) | 103 (18.6) |
| 1-2/week | 150 (17.3) | 62 (11.2) |
| 3-4/week | 158 (18.2) | 115 (20.8) |
| 5-9/week | 238 (27.5) | 126 (22.7) |
| 10+/week | 201 (23.2) | 148 (26.7) |
| **Living arrangement, N (%)** | | |
| Not living alone | 749 (86.4) | 446 (80.5) |

| | | |
|---|---|---|
| Living alone | 118 (13.6) | 108 (19.5) |

**Table 2**. Hazard ratios for pre-cancer diagnosis social networks and all-cause mortality

| | | Hazard ratios (95%CI) | | |
|---|---|---|---|---|
| | **Cases (Deaths)** | **Model 1 *** | **Model 2 †** | **Model 3 ‡** |
| **Visits to friends or relatives** | | | | |
| <Once/week | 142 (28) | 1 | 1 | 1 |
| Once/week | 121 (27) | 1.3 (0.7, 2.2) | 1.3 (0.7, 2.3) | 1.5 (0.8, 2.7) |
| 2-3 times/week | 274 (45) | 0.8 (0.5, 1.3) | 0.8 (0.5, 1.4) | 0.8 (0.5, 1.4) |
| 4-6 times/week | 254 (32) | 0.6 (0.3, 1.0) | 0.6 (0.3, 1.0) | 0.6 (0.4, 1.1) |
| ≥7 times/week | 76 (18) | 1.1 (0.6, 2.1) | 1.1 (0.6, 2.3) | 1.3 (0.6, 2.6) |
| | $P_{trend}$ § | 0.09 | 0.13 | 0.19 |
| **Visits from friends or relatives** | | | | |
| <Once/week | 346 (54) | 1 | 1 | 1 |
| Once/week | 236 (42) | 1.1 (0.7, 1.7) | 1.0 (0.7, 1.6) | 1.0 (0.7, 1.6) |
| 2-3 times/week | 239 (40) | 0.9 (0.6, 1.4) | 1.0 (0.6, 1.5) | 1.0 (0.6, 1.6) |
| 4-6 times/week | 36 (10) | 1.4 (0.7, 3.0) | 1.2 (0.6, 2.6) | 1.1 (0.5, 2.5) |
| ≥7 times/week | 10 (4) | 1.2 (0.4, 6) | 1.2 (0.4, 3.7) | 1.5 (0.5, 4.6) |
| | $P_{trend}$ § | 0.81 | 0.77 | 0.69 |
| **Hours involved in social activities outside home or work** | | | | |
| 0/week | 120 (22) | 1 | 1 | 1 |
| 1-2/week | 150 (30) | 1.3 (0.7, 2.4) | 1.3 (0.7, 2.3) | 1.4 (0.7, 2.6) |
| 3-4/week | 158 (29) | 1.2 (0.7, 2.3) | 1.2 (0.7, 2.3) | 1.3 (0.7, 2.4) |
| 5-9/week | 238 (34) | 0.8 (0.5, 1.5) | 0.9 (0.5, 1.6) | 0.9 (0.5, 1.7) |
| 10+/week | 201 (35) | 0.8 (0.4, 1.4) | 0.8 (0.5, 1.5) | 0.9 (0.5, 1.7) |

| | | $P_{trend}$ § | 0.07 | 0.17 | 0.27 |
|---|---|---|---|---|---|
| **Living arrangement** | | | | | |
| Not living alone | 749 (118) | | 1 | 1 | 1 |
| Living alone | 118 (32) | | 1.6 (1.0, 2.4) | 1.5 (1.0, 2.4) | 1.6 (1.0, 2.5) |

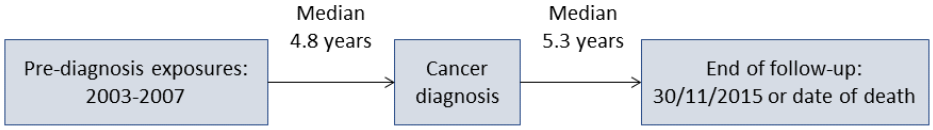
*Model 1 adjusted for age at diagnosis (continuous), stratified by cancer stage (T1-T1C, T2-T2C, T3A-T4) and tumor grade (well-differentiated, intermediate-grade, moderately-poorly differentiated, high-grade). †Model 2 additionally adjusted for country of birth (AU/NZ/Other, Southern Europe, UK/Malta), education (primary, secondary, tertiary, other qualifications) and socioeconomic status (1-10, continuous score), self-reported general health status (excellent, very good, good, fair, poor) and comorbidities of diabetes, stroke, heart bypass, heart attack, angina, angioplasty (yes/no). ‡Model 3 adjusted for all variables in Model 2 and further adjusted for Kessler 10 (<16, 16-29, >29), smoking status (never, former, current), alcohol consumption (0g, 1-39g, 40-59g, 60+g), physical activity (sufficiently active, insufficiently active, inactive), Mediterranean diet score (1-10, continuous score) and body mass index (continuous). § P trend, test for linear trend. Multiple imputation was used to handle missing data (50 imputed datasets), using all variables in Model 3 and survival time and death status.

| | Cases (Deaths) No. | Mode |
|---|---|---|
| **Visits to friends or relatives** | | |
| <Once/week | 97 (37) | 1 |
| Once/week | 67 (27) | 1.2 (0. |
| 2-3 times/week | 165 (53) | 0.9 (0. |
| 4-6 times/week | 160 (46) | 1.0 (0. |
| ≥7 times/week | 65 (25) | 1.1 (0. |
| | $P_{trend}$ § | 0.9 |
| **Visits from friends or relatives** | | |
| <Once/week | 194 (73) | 1 |
| Once/week | 142 (45) | 0.8 (0. |
| 2-3 times/week | 161 (49) | 0.8 (0. |
| 4-6 times/week | 43 (14) | 1.0 (0. |
| ≥7 times/week | 14 (7) | 1.5 (0. |
| | $P_{trend}$ § | 0.9 |
| **Hours involved in social activities outside home or work** | | |
| 0/week | 103 (44) | 1 |
| 1-2/week | 62 (28) | 1.5 (0. |
| 3-4/week | 115 (31) | 0.7 (0. |
| 5-9/week | 126 (42) | 0.8 (0. |
| 10+/week | 148 (43) | 0.7 (0. |
| | $P_{trend}$ § | 0.0 |
| **Living arrangement** | | |
| Not living alone | 446 (139) | 1 |
| Living alone | 108 (49) | 1.3 (0. |

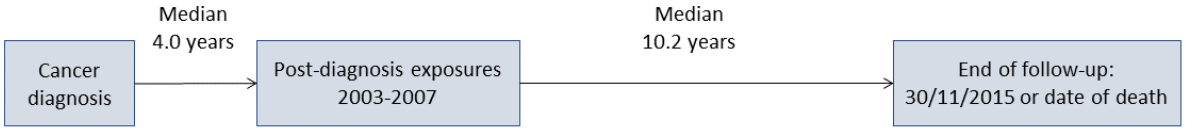
**Table 3**. Hazard ratios for post-cancer diagnosis social networks and all-cause mortality

*Model 1 adjusted for age at diagnosis (continuous), stratified by cancer stage (T1-T1C, T2-T2C, T3A-T4) and tumor grade (well-differentiated, intermediate-grade, moderately-poorly differentiated, high-grade). †Model 2 additionally adjusted for country of birth (AU/NZ/Other, Southern Europe, UK/Malta), education (primary, secondary, tertiary, other qualifications) and socioeconomic status (1-10, continuous score), self-reported general health status (excellent, very good, good, fair, poor) and comorbidities of diabetes, stroke, heart bypass, heart attack, angina, angioplasty (yes/no). ‡Model 3 adjusted for all variables in Model 2 and further adjusted for Kessler 10 (<16, 16-29, >29), smoking status (never, former, current), alcohol consumption (0g, 1-39g, 40-59g, 60+g), physical activity (sufficiently active, insufficiently active, inactive), Mediterranean diet score (1-10, continuous score) and body mass index (continuous). § P trend, test for linear trend. Multiple imputation was used to handle missing data (50 imputed datasets), using all variables in Model 3 and survival time and death status.

**Pre-diagnosis group:**
N cases: 867, N deaths: 150




**Post-diagnosis group:**
N cases: 554, N deaths: 188



**Novelty and Impact**

Social support and interactions are associated with better health outcomes in general, but do they improve mortality rates for prostate cancer survivors? In this study, the authors found that survivors who lived alone did have substantially higher mortality than those who shared their home. No significant impact was observed, however, for other measures of social connectedness, such as visits with friends and relatives or time spent on social activities. Further research on specific factors that improve mortality in survivors who don't live alone is warranted.

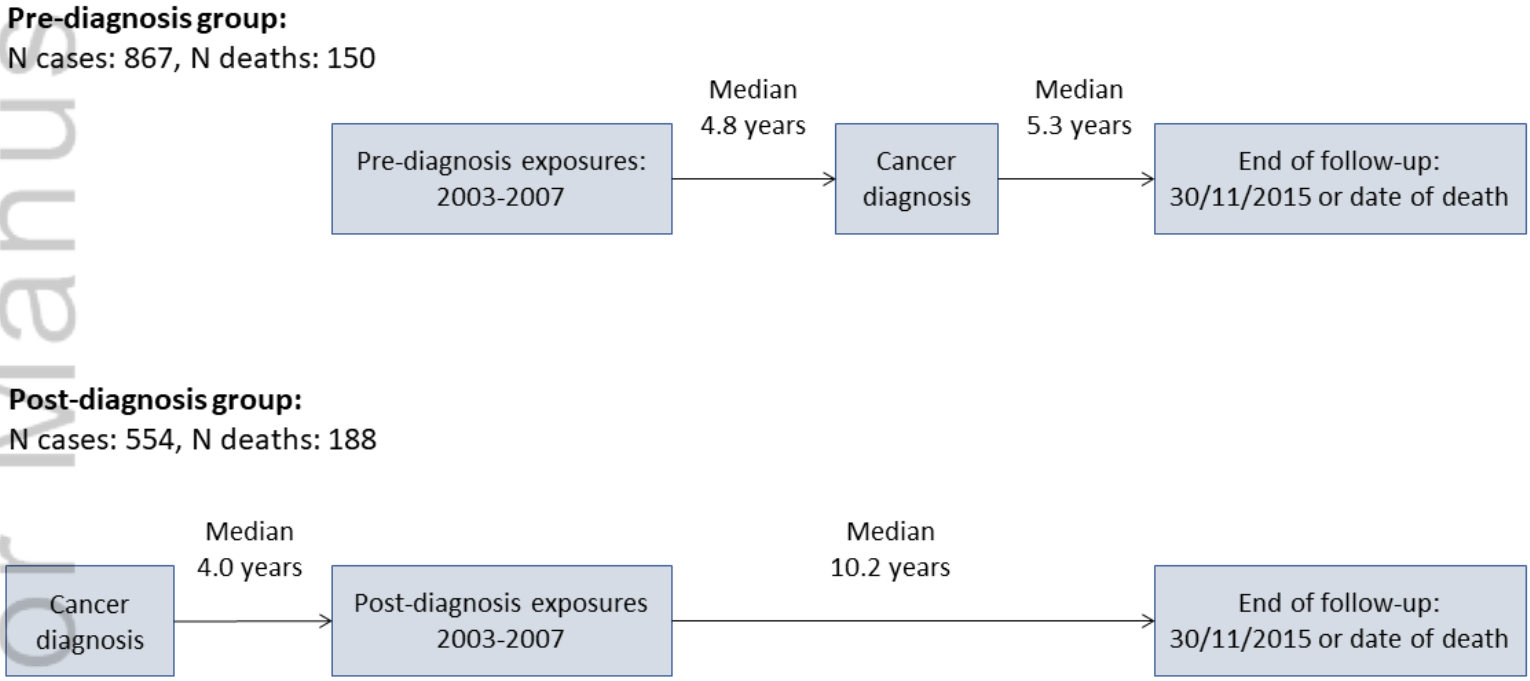



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**Figure 1.** Timeline of cancer diagnosis, data collection and follow-up period.

**Table 1.** Characteristics of prostate cancer cases in the Melbourne Collaborative Cohort Study

| | Pre-cancer diagnosis group<br>Cases (N=867)<br>Deaths (N=150) | Post-cancer diagnosis group<br>Cases (N=554)<br>Deaths (N=188) |
|---|---|---|
| **Age at diagnosis (years), median (IQR)** | 70.7 (12.3) | 67.7 (7.9) |
| **Age at wave 2 follow-up (years), median (IQR)** | 66.1 (13.2) | 72.5 (9.4) |
| **Country of birth, N (%)** | | |
| AU/NZ/Other | 682 (78.7) | 423 (76.4) |
| Southern Europe | 103 (11.9) | 85 (15.3) |
| UK/Malta | 82 (9.5) | 46 (8.3) |
| **Education, N (%)** | | |
| Primary | 66 (7.6) | 73 (13.2) |
| Secondary | 348 (40.1) | 258 (46.6) |
| Tertiary | 369 (42.6) | 171 (30.9) |
| Other qualifications | 84 (9.7) | 52 (9.4) |
| **Socioeconomic status, N (%)** | | |
| Quintile 1 (most disadvantaged) | 171 (19.7) | 103 (18.6) |
| Quintile 2 | 207 (23.9) | 149 (26.9) |
| Quintile 3 | 188 (21.7) | 147 (26.5) |
| Quintile 4 | 120 (13.8) | 58 (10.5) |
| Quintile 5 (least disadvantaged) | 148 (17.1) | 73 (13.2) |
| Missing | 33 (3.8) | 24 (4.3) |
| **Self-reported health status, N (%)** | | |
| Excellent | 153 (17.7) | 60 (10.8) |
| Very good | 338 (39.0) | 163 (29.4) |
| Good | 278 (32.1) | 211 (38.1) |
| Fair | 80 (9.2) | 99 (17.9) |
| Poor | 17 (2.0) | 19 (3.4) |
| Missing | 1 (0.1) | 2 (0.4) |
| **Self-reported diabetes, N (%)** | 63 (7.3) | 53 (10.9) |
| Missing | 132 (15.2) | 69 (12.5) |
| **Self-reported stroke, N (%)** | 35 (4.0) | 29 (5.2) |
| Missing | 4 (0.5) | 4 (0.7) |
| **Self-reported heart attack, N (%)** | 79 (9.1) | 65 (11.7) |
| Missing | 5 (0.6) | 7 (1.3) |
| **Self-reported angina, N (%)** | 64 (7.4) | 56 (10.1) |
| Missing | 132 (15.2) | 74 (13.4) |
| **Self-reported angioplasty, N (%)** | 60 (6.9) | 55 (9.9) |
| Missing | 4 (0.5) | 4 (0.7) |
| **Self-reported heart bypass, N (%)** | 54 (6.2) | 58 (10.5) |
| **Kessler 10, N (%)** | | |
| <16 | 589 (67.9) | 379 (68.4) |
| 16-29 | 199 (23.0) | 108 (19.5) |
| >29 | 10 (1.2) | 2 (0.4) |
| Missing | 69 (8.0) | 65 (11.7) |
| **Smoking status, N (%)** | | |
| Never | 433 (49.9) | 246 (44.4) |
| Former | 354 (40.8) | 264 (47.7) |
| Current | 80 (9.2) | 44 (7.9) |
| **Alcohol consumption, N (%)** | | |
| 0g | 152 (17.5) | 116 (20.9) |
| 1-39g | 571 (65.9) | 348 (62.8) |
| 40-59g | 77 (8.9) | 44 (7.9) |
| 60+g | 38 (4.4) | 24 (4.3) |
| Missing | 29 (3.3) | 22 (4.0) |
| **Physical activity, N (%)** | | |
| Inactive | 54 (6.2) | 40 (7.2) |
| Insufficiently active | 177 (20.4) | 114 (20.6) |
| Sufficiently active | 621 (71.6) | 381 (68.8) |
| Missing | 15 (1.7) | 19 (3.4) |
| **Mediterranean diet score, N (%)** | | |
| Quintile 1 | 162 (18.7) | 119 (21.5) |
| Quintile 2 | 151 (17.4) | 89 (16.1) |
| Quintile 3 | 174 (20.1) | 110 (19.9) |
| Quintile 4 | 139 (16.0) | 88 (15.9) |

| | | |
|---|---|---|
| Quintile 5 | 142 (16.4) | 66 (11.9) |
| Missing | 99 (11.4) | 82 (14.8) |
| **Body mass index, kg/m$^2$, N (%)** | | |
| <25 | 219 (25.3) | 129 (23.3) |
| 25-30 | 467 (53.9) | 298 (53.8) |
| 30+ | 181 (20.9) | 127 (22.9) |
| **Tumor stage, N (%)** | | |
| T1-T1C | 566 (65.3) | 364 (65.7) |
| T2-T2C | 171 (19.7) | 120 (21.7) |
| T3A-T4 | 79 (9.1) | 50 (9.0) |
| Missing | 51 (5.9) | 20 (3.6) |
| **Tumor grade, N (%)** | | |
| Well-differentiated | 5 (0.6) | 54 (9.8) |
| Intermediate | 276 (31.8) | 249 (45.0) |
| Moderately-poorly differentiated | 245 (28.3) | 125 (22.6) |
| High-grade | 122 (14.1) | 54 (9.8) |
| Missing | 219 (25.3) | 72 (13.0) |
| **Cause of death, N (% of deaths)** | | |
| Prostate cancer | 55 (36.7) | 58 (30.9) |
| Other cancer | 36 (24.0) | 52 (27.7) |
| Cardiovascular disease | 18 (12.0) | 21 (11.2) |
| Other cause | 11 (7.3) | 26 (13.8) |
| Missing | 30 (20.0) | 31 (16.5) |
| **Visits to friends or relatives, N (%)** | | |
| <Once/week | 142 (16.4) | 97 (17.5) |
| Once/week | 121 (14.0) | 67 (12.1) |
| 2-3 times/week | 274 (31.6) | 165 (29.8) |
| 4-6 times/week | 254 (29.3) | 160 (28.9) |
| ≥7 times/week | 76 (8.8) | 65 (11.7) |
| **Visits from friends or relatives, N (%)** | | |
| <Once/week | 346 (39.9) | 194 (35.0) |
| Once/week | 236 (27.2) | 142 (25.6) |
| 2-3 times/week | 239 (27.6) | 161 (29.1) |
| 4-6 times/week | 36 (4.2) | 43 (7.8) |
| ≥7 times/week | 10 (1.2) | 14 (2.5) |
| **Hours involved in social activities outside home or work, N (%)** | | |
| 0/week | 120 (13.8) | 103 (18.6) |
| 1-2/week | 150 (17.3) | 62 (11.2) |
| 3-4/week | 158 (18.2) | 115 (20.8) |
| 5-9/week | 238 (27.5) | 126 (22.7) |
| 10+/week | 201 (23.2) | 148 (26.7) |
| **Living arrangement, N (%)** | | |
| Not living alone | 749 (86.4) | 446 (80.5) |
| Living alone | 118 (13.6) | 108 (19.5) |

**Table 2**. Hazard ratios for pre-cancer diagnosis social networks and all-cause mortality

| | | Hazard ratios (95%CI) | | |
|---|---|---|---|---|
| | **Cases (Deaths)** | **Model 1 *** | **Model 2 †** | **Model 3 ‡** |
| **Visits to friends or relatives** | | | | |
| <Once/week | 142 (28) | 1 | 1 | 1 |
| Once/week | 121 (27) | 1.3 (0.7, 2.2) | 1.3 (0.7, 2.3) | 1.5 (0.8, 2.7) |
| 2-3 times/week | 274 (45) | 0.8 (0.5, 1.3) | 0.8 (0.5, 1.4) | 0.8 (0.5, 1.4) |
| 4-6 times/week | 254 (32) | 0.6 (0.3, 1.0) | 0.6 (0.3, 1.0) | 0.6 (0.4, 1.1) |
| ≥7 times/week | 76 (18) | 1.1 (0.6, 2.1) | 1.1 (0.6, 2.3) | 1.3 (0.6, 2.6) |
| | $P_{trend}$ § | 0.09 | 0.13 | 0.19 |
| **Visits from friends or relatives** | | | | |
| <Once/week | 346 (54) | 1 | 1 | 1 |
| Once/week | 236 (42) | 1.1 (0.7, 1.7) | 1.0 (0.7, 1.6) | 1.0 (0.7, 1.6) |
| 2-3 times/week | 239 (40) | 0.9 (0.6, 1.4) | 1.0 (0.6, 1.5) | 1.0 (0.6, 1.6) |
| 4-6 times/week | 36 (10) | 1.4 (0.7, 3.0) | 1.2 (0.6, 2.6) | 1.1 (0.5, 2.5) |
| ≥7 times/week | 10 (4) | 1.2 (0.4, 6) | 1.2 (0.4, 3.7) | 1.5 (0.5, 4.6) |
| | $P_{trend}$ § | 0.81 | 0.77 | 0.69 |
| **Hours involved in social activities outside home or work** | | | | |
| 0/week | 120 (22) | 1 | 1 | 1 |
| 1-2/week | 150 (30) | 1.3 (0.7, 2.4) | 1.3 (0.7, 2.3) | 1.4 (0.7, 2.6) |
| 3-4/week | 158 (29) | 1.2 (0.7, 2.3) | 1.2 (0.7, 2.3) | 1.3 (0.7, 2.4) |
| 5-9/week | 238 (34) | 0.8 (0.5, 1.5) | 0.9 (0.5, 1.6) | 0.9 (0.5, 1.7) |
| 10+/week | 201 (35) | 0.8 (0.4, 1.4) | 0.8 (0.5, 1.5) | 0.9 (0.5, 1.7) |
| | $P_{trend}$ § | 0.07 | 0.17 | 0.27 |
| **Living arrangement** | | | | |
| Not living alone | 749 (118) | 1 | 1 | 1 |
| Living alone | 118 (32) | 1.6 (1.0, 2.4) | 1.5 (1.0, 2.4) | 1.6 (1.0, 2.5) |

*Model 1 adjusted for age at diagnosis (continuous), stratified by cancer stage (T1-T1C, T2-T2C, T3A-T4) and tumor grade (well-differentiated, intermediate-grade, moderately-poorly differentiated, high-grade). †Model 2 additionally adjusted for country of birth (AU/NZ/Other, Southern Europe, UK/Malta), education (primary, secondary, tertiary, other qualifications) and socioeconomic status (1-10, continuous score), self-reported general health status (excellent, very good, good, fair, poor) and comorbidities of diabetes, stroke, heart bypass, heart attack, angina, angioplasty (yes/no). ‡Model 3 adjusted for all variables in Model 2 and further adjusted for Kessler 10 (<16, 16-29, >29), smoking status (never, former, current), alcohol consumption (0g, 1-39g, 40-59g, 60+g), physical activity (sufficiently active, insufficiently active, inactive), Mediterranean diet score (1-10, continuous score) and body mass index (continuous). § P trend, test for linear trend. Multiple imputation was used to handle missing data (50 imputed datasets), using all variables in Model 3 and survival time and death status.

**Table 3**. Hazard ratios for post-cancer diagnosis social networks and all-cause mortality

| | Cases (Deaths) No. | Hazard ratios (95%CI) Model 1 * | Model 2 † | Model 3 ‡ |
|---|---|---|---|---|
| **Visits to friends or relatives** | | | | |
| <Once/week | 97 (37) | 1 | 1 | 1 |
| Once/week | 67 (27) | 1.2 (0.7, 2.0) | 1.1 (0.6, 1.9) | 1.2 (0.7, 2.1) |
| 2-3 times/week | 165 (53) | 0.9 (0.6, 1.4) | 0.9 (0.6, 1.4) | 0.9 (0.6, 1.4) |
| 4-6 times/week | 160 (46) | 1.0 (0.6, 1.6) | 1.0 (0.6, 1.6) | 1.0 (0.6, 1.6) |
| ≥7 times/week | 65 (25) | 1.1 (0.7, 1.9) | 1.0 (0.6, 1.8) | 1.0 (0.6, 1.8) |
| | $P_{trend}$ § | 0.91 | 0.90 | 0.91 |
| **Visits from friends or relatives** | | | | |
| <Once/week | 194 (73) | 1 | 1 | 1 |
| Once/week | 142 (45) | 0.8 (0.6, 1.3) | 0.8 (0.6, 1.3) | 0.9 (0.6, 1.3) |
| 2-3 times/week | 161 (49) | 0.8 (0.6, 1.2) | 0.8 (0.6, 1.2) | 0.8 (0.5, 1.2) |
| 4-6 times/week | 43 (14) | 1.0 (0.5, 1.8) | 0.8 (0.5, 1.5) | 0.8 (0.4, 1.5) |
| ≥7 times/week | 14 (7) | 1.5 (0.6, 3.4) | 1.4 (0.6, 3.4) | 1.6 (0.7, 3.7) |
| | $P_{trend}$ § | 0.96 | 0.70 | 0.66 |
| **Hours involved in social activities outside home or work** | | | | |
| 0/week | 103 (44) | 1 | 1 | 1 |
| 1-2/week | 62 (28) | 1.5 (0.9, 2.4) | 1.4 (0.8, 2.4) | 1.5 (0.9, 2.6) |
| 3-4/week | 115 (31) | 0.7 (0.4, 1.2) | 0.8 (0.5 1.3) | 0.7 (0.4, 1.2) |
| 5-9/week | 126 (42) | 0.8 (0.5, 1.3) | 0.8 (0.5, 1.3) | 0.8 (0.5, 1.4) |
| 10+/week | 148 (43) | 0.7 (0.5, 1.2) | 0.8 (0.5, 1.3) | 0.9 (0.5, 1.4) |
| | $P_{trend}$ § | 0.06 | 0.17 | 0.21 |
| **Living arrangement** | | | | |
| Not living alone | 446 (139) | 1 | 1 | 1 |
| Living alone | 108 (49) | 1.3 (0.9, 1.8) | 1.3 (0.9, 1.8) | 1.3 (0.9, 1.9) |

*Model 1 adjusted for age at diagnosis (continuous), stratified by cancer stage (T1-T1C, T2-T2C, T3A-T4) and tumor grade (well-differentiated, intermediate-grade, moderately-poorly differentiated, high-grade). †Model 2 additionally adjusted for country of birth (AU/NZ/Other, Southern Europe, UK/Malta), education (primary, secondary, tertiary, other qualifications) and socioeconomic status (1-10, continuous score), self-reported general health status (excellent, very good, good, fair, poor) and comorbidities of diabetes, stroke, heart bypass, heart attack, angina, angioplasty (yes/no). ‡Model 3 adjusted for all variables in Model 2 and further adjusted for Kessler 10 (<16, 16-29, >29), smoking status (never, former, current), alcohol consumption (0g, 1-39g, 40-59g, 60+g), physical activity (sufficiently active, insufficiently active, inactive), Mediterranean diet score (1-10, continuous score) and body mass index (continuous). § P trend, test for linear trend. Multiple imputation was used to handle missing data (50 imputed datasets), using all variables in Model 3 and survival time and death status.