Research Square

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Impact of socioeconomic status on treatment and survival in multiple myeloma in Australia

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Abstract

Outcomes in multiple myeloma (MM) have improved significantly but remain heterogeneous. We assessed the impact of non-biological social determinants of health on treatment and survival outcomes in Australia using data from the Australian and New Zealand Myeloma and Related Diseases Registry. A total of 4405 patients diagnosed with MM between June 2012 and October 2025 across 44 Australian sites were assigned an area-level socioeconomic status (SES) using individual postcodes. Baseline characteristics, treatment and survival outcomes were compared across high (n=1484), medium (n=1463), and low (n=1458) SES tertiles. Lower neighbourhood SES was associated with higher BMI, poorer functional status, more comorbidities (diabetes, cardiac and pulmonary disease), Asian ethnicity and greater remoteness. Independent of these baseline differences, patients from lower SES neighbourhoods were less likely to receive an autologous stem cell transplant (odds ratio = 1.1 medium vs low, p=0.41; 1.5 high vs low, p<0.01) and time to reach ASCT following induction was longer (p<0.001) despite this being standard-of-care therapy with proven survival benefit. Median overall survival was shorter for the low SES group at 78.5 months compared to 92.5 months (HR=0.85, p=0.01) and 86.7 months (HR=0.85, p=0.01) for the medium and high SES groups respectively. These findings demonstrate significant disparities in treatment and outcomes favouring higher SES, independent of biological factors, within a universal healthcare system. This suggests that non-biological factors continue to influence access to standard-of-care therapy and survival, warranting further research to identify and address barriers to equitable care.

Key points

• Patients from high socioeconomic neighbourhoods have 1.5 times the odds of receiving an ASCT relative to their counterparts from lower socioeconomic areas.

• Neighbourhood socioeconomic status is inversely correlated with survival, with patients from lower socioeconomic neighbourhoods having up to 14 months shorter overall survival.

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Introduction

Multiple myeloma (MM) is an incurable malignancy of monoclonal plasma cells characterised by numerous relapses requiring several lines of therapy. The survival of patients diagnosed with MM has improved significantly over the last two decades. Registry data demonstrate that patients considered transplant eligible at diagnosis now have an expected overall survival (OS) of more than 10 years(1, 2).

High-dose chemotherapy followed by autologous stem cell transplant (ASCT) remains standard-of-care treatment for those considered fit enough(3). This is in light of the significant progression free survival (PFS) advantage and increased MRD negativity rates seen with upfront ASCT following proteasome inhibitor and immunomodulatory based induction strategies, even in the novel therapy era(4–6). Furthermore, this benefit has been demonstrated in real-world populations across multiple nations and institutions(7–12).

Outcomes remain highly heterogeneous, however, and certain patient groups experience disproportionately higher mortality rates(13). This disparity is frequently attributed to biological factors, both patient-(14) and disease-related(15). Frequently overlooked, but of equal merit, are the non-biological social determinants of health, which include economic stability, education, healthcare access, built environment and social support networks(16). The term socioeconomic status (SES) is a complex concept encompassing a multitude of these non-biological factors and has consistently been reported to be an important risk factor for worse OS across a range of cancer types(17, 18). For this reason, the need to reduce socioeconomic inequalities in cancer is prioritised within Australia by the Australian Cancer Plan(19), and worldwide by the World Health Organization (WHO)(20) and the United Nations 2030 agenda(21).

Despite there being fewer known lifestyle risk factors for MM relative to many other cancers, MM outcomes are not shielded from the negative effects of socioeconomic disadvantage. A meta-analysis of worldwide data including over 134 000 MM patients demonstrated that individuals with lower SES—whether measured by education, occupational class, income or other indicators—are at a disproportionately higher risk of dying from MM compared to their more advantaged fellow citizens(22).

Australia operates within a universal healthcare model, minimising variables that may affect access to treatment, such as drug and insurance costs. Hence, one might expect that SES should have less impact on survival outcomes of patients with MM in Australia. However, existing studies are limited and do not reflect the current therapeutic landscape(23, 24). We aimed to examine the influence of area-level socioeconomic status on real-world treatment decisions and survival in MM patients across Australia in the modern era. To our knowledge, this is the first occasion that this has been explored at a national level using contemporary registry data.

Methods

Study cohort

This is a prospective cohort study using patient data from the Australian and New Zealand Myeloma and Related Diseases Registry (ANZ MRDR). The registry collects data on patients with plasma cell disorders including demographics, comorbidities and disease characteristics at diagnosis, initial treatment, ASCT and subsequent lines of therapy as well as response to therapy, disease progression and survival status. It links annually with the Australian National Death Index to ensure robust OS data. Details of the MRDR study design have been previously published(25).

Eligible patients were MRDR participants, ≥ 18 years of age, residing in Australia, and diagnosed with MM per International Myeloma Working Group (IMWG) criteria between June 2012 and October 2025. Data came from 44 sites representing all jurisdictions in Australia.

The registry has approval from the Human Research Ethics Committees at Alfred Health (HREC/16/Alfred/213) and Monash University, and from ethics/governance offices at each participating site. The ANZ MRDR Steering Committee approved this study.

Data Source

Patient postcode registered at the time of diagnosis was mapped to a geographical area as defined by the Australian Bureau of Statistics (ABS). This allowed each patient to be assigned an Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD)(26). IRSAD is a validated, comprehensive, composite measure of area-level SES designed by the ABS using latest available census data to summarise information about the economic and social conditions of people and households within an area. IRSAD scores on a continuum with a lower score signifying greater disadvantage and a higher score more advantage. Raw scores are divided into deciles and patients within this analysis represent local government areas spanning all IRSAD deciles. Patients were categorised into tertiles (3 groups of similar size) according to their IRSAD scores; low SES (IRSAD deciles 1–5, n = 1484), medium SES (deciles 5–9, n = 1463) and high SES (deciles 9–10, n = 1458).

Remoteness of residence was calculated by postcode using the Australian Statistical Geography Standard - Remoteness Areas (ASGS RA) Edition 3, July 2021-June 2026(26). This certified method defines remoteness across Australia based on access to services. Patients were assigned to ‘Major cities’, ‘Inner regional’ or ‘More remote’, with the latter combining the three ASGS RA categories of ‘Outer regional’, ‘Remote’ and ‘Very remote’.

Statistical analysis

Baseline characteristics and treatment patterns were compared between SES tertiles as well as between ASCT recipients and non-recipients. Statistical comparisons of categorical variables were made using a chi-squared test and a Kruskal-Wallis test

was used for continuous variables. Multivariate logistic regression analysis (MVA) was performed to compare baseline characteristics between ASCT and non-ASCT groups. Variables were included in the MVA if they had a significant univariate association with ASCT, these were SES, age, ethnicity, cardiac disease, pulmonary disease, diabetes, international staging score (ISS) > 2 and ECOG score ≥ 2. MVA was also performed to determine whether there was an independent association between receiving a triplet therapy and SES tertile, with an adjustment for year of treatment. In the MVAs, categorical independent variables were expanded to include an explicit 'missing' category, allowing observations with missing values to be retained in the models.

Kaplan-Meier methods were used to estimate PFS and OS from the date of diagnosis, with a log-rank test used to determine significance. Multivariate analysis was undertaken for PFS and OS using Cox regression and adjusting for age and ethnicity, which were pre-specified a priori potential confounders.

Results

Final analysis included 4405 patients. Baseline characteristics, as outlined in Table 1, demonstrate that being from a neighbourhood associated with lower SES (low SES vs medium SES and high SES) was correlated with living in a more rural location (major cities/inner regional/more remote RA: 42%/33%/24% for low SES vs 66%/26%/8% for medium SES and 92%/7%/0% for high SES, $p < 0.001$), a more recent date of diagnosis (median year 2021 vs 2020 and 2020, $p < 0.001$) and Asian ethnicity (21% vs 15% and 17%, $p = 0.031$). Lower SES was also associated with having a higher BMI (median BMI: 28.2 vs 27.5 and 26.2, $p < 0.001$), an inferior performance status (ECOG score ≥ 2: 19% vs 17% and 14%, $p = 0.024$) and an increased rate of co-morbidities including diabetes (16% vs 13% and 10%, $p < 0.001$), cardiac disease (14% vs 11% and 11%, $p = 0.026$) and pulmonary disease (7% vs 5% and 4%, $p < 0.001$). There was no statistically significant difference between SES groups for gender (male: 62% vs 60% and 63%, $p = 0.53$), disease stage (ISS-3: 30% vs 29% and 29%, $p = 0.98$), prevalence of liver disease (2% vs 2% and 1%, $p = 0.67$) or peripheral neuropathy (2% vs 3% and 3%, $p = 0.42$). Median age at diagnosis differed between groups but without a consistent SES gradient, with the youngest being those from the medium SES group (median years (IQR) low SES: 68.3 (60.8, 75.8) vs medium SES: 66.9 (58.8, 74.4) vs high SES: 68.3 (60.6, 76), $p = 0.004$).

Treatment regimens used for first line therapy differed among SES groups (see Table 2) with patients from areas associated with low SES being less likely to receive proteasome inhibitors (PIs) as monotherapy or in combination with dexamethasone (42% vs 49% and 47%) and more likely to receive immunomodulatory agents (IMiDs) as monotherapy or with dexamethasone (14% vs 12% and 12%) or triplet regimens (PI with IMiD and dexamethasone) (39% vs 34% and 36%) at first line ($p = 0.012$). The significance of these differences however was lost after adjustment for the date of diagnosis (adjusted odds ratio of triplet vs other regime = 0.90 medium vs low, $p = 0.30$ and 1.13 high vs low, $p = 0.25$). Best clinical response to first line was similar between groups ($p = 0.63$). Clinical trial enrolment at first or second line was almost identical among groups (12% vs 14% and 12%, $p = 0.15$ at first line and 16% vs 15% and 18%, $p = 0.51$ at second line).

Of note, patients from areas of greater disadvantage (low SES group) were significantly less likely to receive high-dose chemotherapy followed by ASCT relative to their counterparts from more advantaged neighbourhoods (medium and high SES) (low SES: 47% vs medium SES: 51% and high SES: 53%, $p = 0.009$, Table 2). Time from commencement of induction to ASCT was also significantly longer in the low SES group (5.5 months vs 5.3 months and 5.2 months, $p < 0.001$). Given there are many factors that may influence decision to transplant, we performed a MVA adjusting for all variables that had a significant univariate association with receiving an ASCT (SES, age, ethnicity, cardiac disease, pulmonary disease, diabetes, ISS > 2 and ECOG score ≥ 2). After this comprehensive multivariate adjustment, being from the most advantaged neighbourhoods remained an independent predictor for likelihood of receiving an ASCT relative to the least advantaged, with the high SES group having 1.5 times the odds of receiving ASCT versus the low group (odds ratio = 1.46 high vs low, $p = 0.01$, Fig. 2). There was a trend for a greater likelihood of ASCT within the medium SES group vs low SES group, however this no longer met significance after MVA (odds ratio = 1.1 medium vs low, $p = 0.41$, Fig. 2). When looking within the < 70-year-old subgroup, findings were similar (odds ratio = 1.35 high vs low, $p = 0.03$).

Median PFS for the whole cohort was 35.4 months (95% CI: 33.9–37.3) with no statistical difference between IRSAD tertiles (p = 0.98, Fig. 3a). Among those who received ASCT, this increased to 50.9 months (95% CI: 47.4–54.1) but there remained no significant difference between groups (p = 0.13, Fig. 3b).

There was a significant OS advantage for both the middle and higher SES groups relative to lower (median OS low SES: 78.5 months vs medium SES: 92.5 months (hazard ratio = 0.85, p = 0.01) and high SES: 86.7 months (hazard ratio = 0.85, p = 0.01, Fig. 4a). No survival benefit was seen in the high SES group when limiting analysis to the patients that received ASCT (median OS low SES: 134.3 months vs medium SES: 123.7 months (hazard ratio = 0.99, p = 0.96) and high SES: not reached (hazard ratio = 0.77, p = 0.06, Fig. 4b).

Discussion

In this large, national, Australian cohort of patients with MM using prospectively collected data, we found that being from an area of lower SES is correlated with higher BMI, poorer functional status, higher rates of diabetes, cardiac disease, pulmonary disease and residing in more remote areas relative to patients from higher SES areas. Importantly, these disparities persisted after adjustment for baseline clinical and demographic differences, with patients from lower SES neighbourhoods less likely to receive high dose chemotherapy with ASCT as upfront therapy, more likely to experience longer delays between induction and ASCT, and more likely to have shorter OS compared to those from higher SES areas.

We demonstrate that factors encompassed within the term “SES” are critical components of the diversity of myeloma outcomes. Lower SES neighbourhoods have fewer health(27), financial, and supportive resources(28), along with lower trust in health-care institutions associated with cultural differences and lack of education(29, 30). Treatment decisions and outcomes are being impacted, to the detriment of many already marginalised patients, with these data showing that patients from more advantaged neighbourhoods have 1.5 times the odds of receiving high-dose chemotherapy and ASCT as standard-of-care upfront therapy. This disparity persists after adjustment for baseline clinical factors and remoteness. In addition, the time between commencement of induction and ASCT was inversely correlated with SES. Extensive evidence demonstrates the survival benefit of ASCT as part of first-line therapy for eligible patients(4–6), as well as the importance of timely delivery following induction(31) and this is reflected in clinical guideline recommendations(32–34). These findings are therefore concerning and highlight the need to address inequities in access to timely ASCT.

Furthermore, we show SES is inversely correlated with OS; compared to those from low SES neighbourhood, those from medium SES neighbourhoods lived 14.5 months longer and those from high SES neighbourhoods lived 8.2 months longer (hazard ratio for medium and high vs low = 0.85, 95% CI = 0.74–0.97, p = 0.01). This survival disadvantage is in keeping with international data(22) as well as the single, regional Australian study(24) published since ASCT has been standard-of-care. Of note, the survival benefit seen for higher SES groups is not observed among patients whoreceived upfront ASCT, suggesting that inequitable access to ASCT may be a key driver of the observed survival disparity.

First-line induction regimens differed between SES groups in our cohort. There was a higher proportion of patients from the low SES cohort treated with triplet induction regimens and single or dual agent induction regimens for this group favoured immunomodulatory agents over proteasome inhibitors. We did however note that patients in the low SES group tended to have been diagnosed more recently, most likely a result of hospitals joining the registry at different times, and after adjustment for date of diagnosis, this difference between first-line therapy regimens was lost. Due to the relapsing-remitting nature of MM, combined with the extensive number of treatment options available, clinical trials play a major role in offering best available care. We are therefore encouraged to report that similar proportions of patients from each SES tertile were enrolled into clinical trials at first and second line.

To the best of our knowledge, these data are the first to look at the impact of SES on treatment patterns and ensuing outcomes in myeloma across Australia. Our analysis has both strengths and weaknesses. Patients in this nationwide, real-world cohort represent local government areas spanning all IRSAD scores, meaning it is broadly representative of the SES spectrum in Australia. However, our dataset includes substantially more patients from the top IRSAD deciles with higher SES.

Consequently, after evenly distributing patients into tertiles, the low SES tertile represents patients up to the 5th IRSAD decile whilst medium and high SES represent deciles 6–9 and 9–10 respectively. Although this may lead to underestimation of the true impact of socioeconomic disadvantage, we still demonstrate a significant survival benefit for both the high and medium SES groups when compared to the lower SES group.

Another detail to our dataset that deserves consideration is that IRSAD measures SES at the neighbourhood or area level rather than individual patient level. Therefore, it is likely that, due to intra-neighbourhood heterogeneity, outliers exist within ABS-defined areas such that their assigned IRSAD does not reflect their true SES. Furthermore, our data assigns an IRSAD based on postcode at diagnosis which is not updated if relocation occurs during the course of treatment. However, our dataset does include individual-level data on mediators of survival such as co-morbidities, ISS and cytogenetic risk. Furthermore, area-level SES has been shown to influence cancer mortality even after accounting for individual-level SES(35, 36), providing strength to our findings.

A recent single-centre study from the United States used electronic healthcare records to identify key barriers to transplantation among patients from geographic areas with lower SES(37). These barriers included financial barriers, limited health literacy, lack of caregiver support, transportation challenges, and medical mistrust. Unfortunately, such granular data on the factors influencing treatment decisions is not captured in the registry; however, it highlights a valuable area for further investigation and qualitative research to gain a better understanding of the factors shaping local treatment decisions and access to care.

Notably, the magnitude of the effect of area-level SES on survival in this dataset is comparable to that seen with novel therapies, highlighting SES as a modifiable and clinically meaningful determinant of outcome (38, 39). By this argument, in addition to investment in novel drug development, there is a need for policies to invest in disadvantaged neighbourhoods and low-income households to improve cancer outcomes and reduce health disparities. This notion is supported by the Australian Government, WHO and United Nations, which put the need to reduce socioeconomic inequalities as a priority for the national cancer plan(19), public health agenda(20) and the Sustainable Development Goals processes(21). Our data highlight that outcomes in MM are influenced by SES, as is known for many other cancers, and therefore the need for MM to be included in such policies. We urge all members of the interdisciplinary team managing MM patients to work to identify patients vulnerable to socioeconomic marginalisation and reduce these barriers to optimal care. This will require implementing broad screening for social determinants of health and making early, appropriate referrals to provide maximum support. Finally, the prognostic impact of SES demonstrated here suggests we are missing a critical component of MM outcome diversity by measuring and reporting national averages. Indeed, SES may need to be considered when stratifying patients for therapeutic clinical trials and when counselling patients.

Declarations

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Data Availability Statement: The datasets generated during and/or analysed during the current study are available upon reasonable request by emailing the corresponding author.

Conflict of Interest Disclosures: The Australian and New Zealand Myeloma and Related Diseases Registry has received funding from Abbvie, Amgen, Antengene, Bristol-Myers Squibb, Celgene, Gilead, GSK, Janssen, Novartis, Pfizer, Roche, Sanofi, and Takeda. No author conflicts of interest to declare.

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Tables

Tables are available in the Supplementary Files section.

Figures

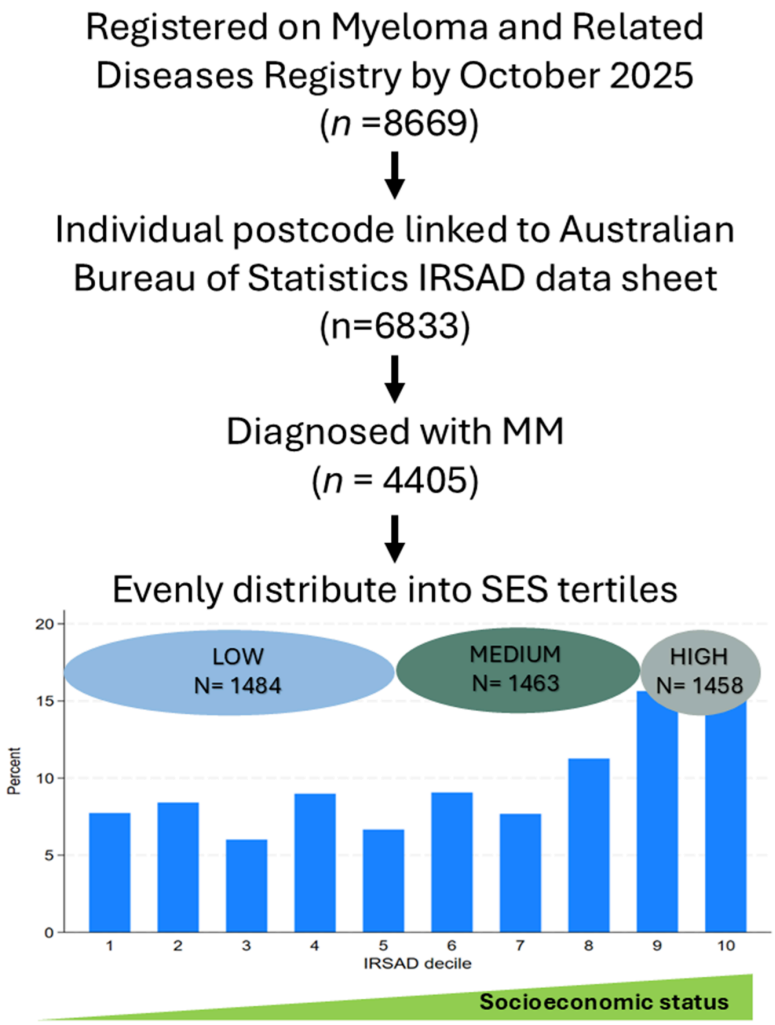


Figure 1: Flow chart describing study cohorts

Figure 1

See image above for figure legend.

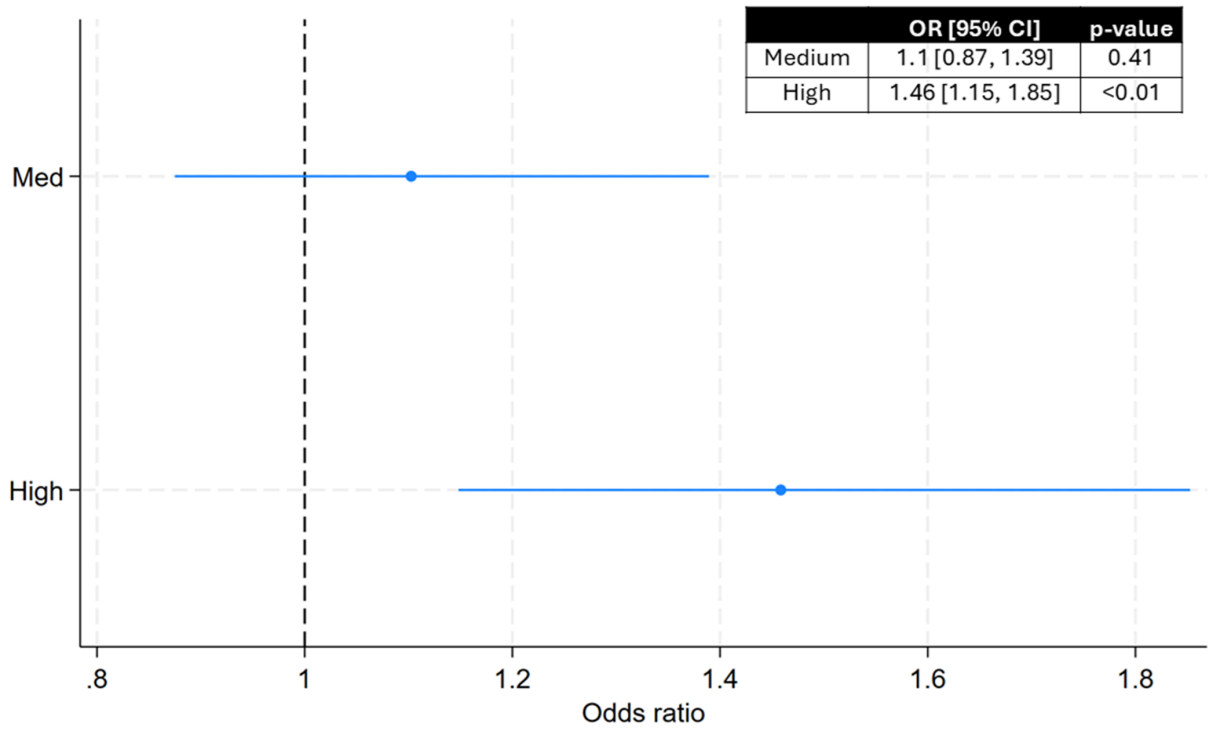
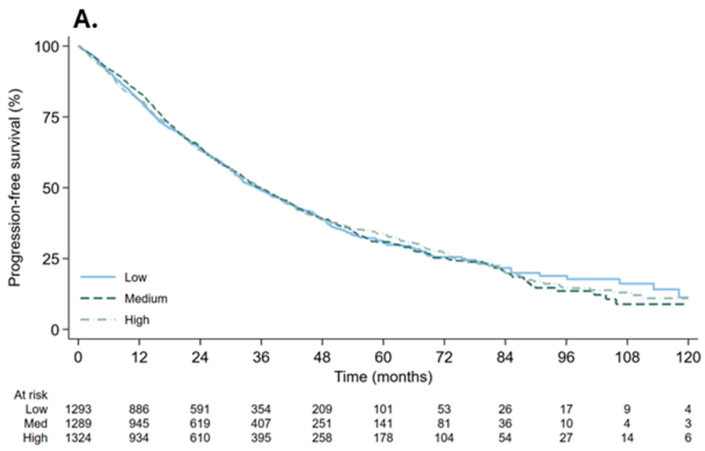
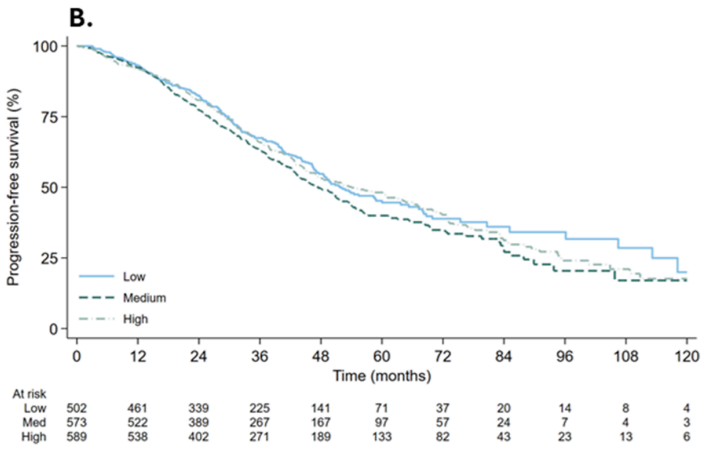


Figure 2: Multivariate logistic model of ASCT utilisation

Figure 2

See image above for figure legend.





IRSAD	Median [95% CI] (months)	Hazard Ratio [95% CI]	p-value
Low	35.0 [32.0-39.2]	Reference	
Med	36.0 [33.0-38.8]	0.96 [0.89-1.11]	0.93
High	35.8 [33.3-38.0]	0.99 [0.89-1.11]	0.91

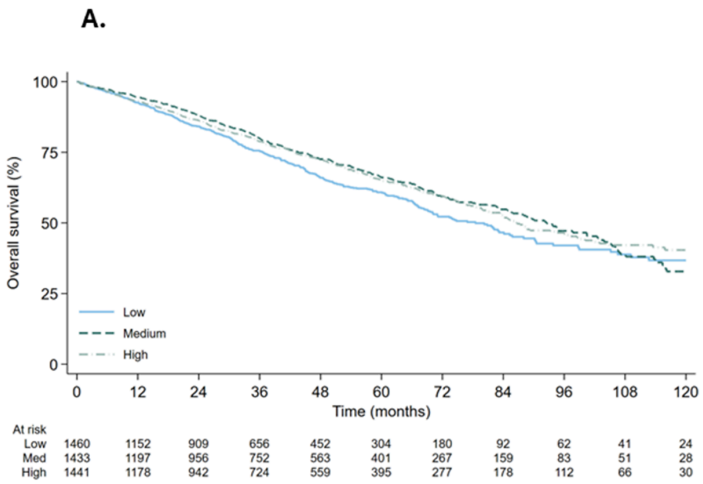
IRSAD	Median [95% CI] (months)	Hazard Ratio [95% CI]	p-value
Low	51.8 [47.2-63.7]	Reference	
Med	47.4 [43.2-52.1]	1.17 [0.98-1.40]	0.08
High	54.0 [47.0-64.6]	1.01 [0.85-1.22]	0.83

Figure 3: Progression free survival.

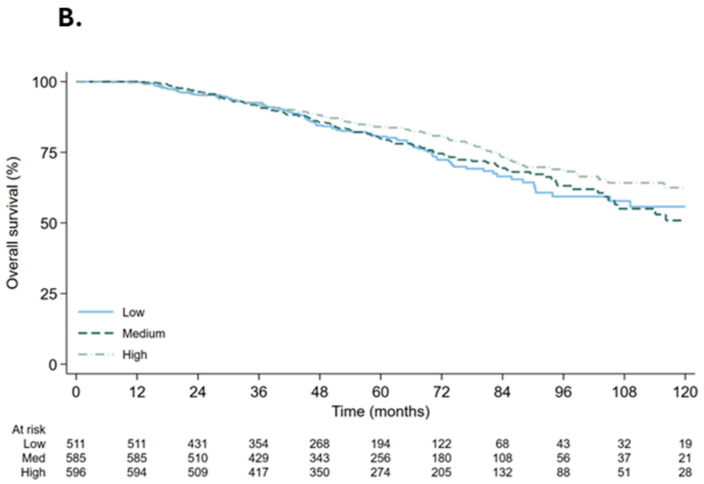
A.) All patients by SES tertile, B. Patients who underwent ASCT by SES tertile

Figure 3

See image above for figure legend.



IRSAD	Median [95% CI] (months)	Hazard Ratio [95% CI]	p-value
Low	78.5 [70.1-85.8]	Reference	
Med	92.5 [85.5-102.6]	0.85 [0.74-0.97]	0.01
High	86.7 [81.7-97.0]	0.85 [0.74-0.97]	0.01



IRSAD	Median [95% CI] (months)	Hazard Ratio [95% CI]	p-value
Low	134.3 []	Reference	
Med	123.7	0.99 [0.77-1.28]	0.96
High	Not reached	0.77 [0.59-1.01]	0.06

Figure 4: Overall survival.

A.) All patients by SES tertile, B. Patients who underwent ASCT by SES tertile

Figure 4

See image above for figure legend.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1BaselineDemographics.xlsx
- Table3DemographicsofASCTvnoASCTinpatientsunder70yearsold.xlsx
- Table2Treatmentregimens.xlsx