

Oral Self-Care Capability is Associated with Mortality in Nursing Home Residents

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Abstract

Background

Nursing home (NH) residents often have limited life expectancy and high medical complexity, making it important to align oral health care with prognosis. We examined survival after a comprehensive dental examination among NH residents and identified predictors of mortality to support prognosis-informed oral care planning.

Methods

We performed a retrospective cohort study using existing clinical data from 902 NH residents who received care from a community-based geriatric dental clinic affiliated with the University of Minnesota School of Dentistry (1999–2006). Mortality was ascertained by linkage to the National Death Index. The primary outcome was time to death after the initial comprehensive dental examination; residents alive at the end of follow-up were censored (December 31, 2010). Candidate predictors were pre-specified from clinical records and grouped into sociodemographic, medical history, functional status, and oral health domains. Analyses used complete cases ($n = 665$). Predictors were standardized; variable selection used LASSO-penalized Cox regression with 10-fold cross-validation, followed by an unpenalized Cox proportional hazards model for inference.

Results

The median survival time was 36.0 months (95% CI 32.4–40.5), and the estimated 1-year survival probability was 79% (95% CI 0.75–0.82). In the final multivariable model, higher mortality risk was associated with renal disease (HR 3.31, 95% CI 2.25–4.88; $p < 0.001$), older age category (HR 1.48 per one-category increase, 95% CI 1.28–1.69; $p < 0.001$), impaired oral self-care capability (supervision/need assistant vs self-sufficient: HR 1.58, 95% CI 1.27–1.96; $p < 0.001$), congestive heart failure (HR 1.33, 95% CI 1.07–1.64; $p = 0.010$), a higher number of comorbidities (HR 1.03, 95% CI 1.01–1.05; $p = 0.002$), and poorer mobility category (HR 1.25 per one-category increase, 95% CI 1.07–1.47; $p = 0.005$).

Conclusions

Among NH residents receiving a comprehensive dental examination, survival was limited, and mortality risk was associated with medical burden and functional dependence, including impaired oral self-care capability. Integrating prognosis and functional assessment into oral care planning may help align treatment intensity with expected outcomes.

Background

There were about 1.23 million people residing in nursing homes (NH) in the U.S. in 2023.¹ The average life expectancy in NH ranges from less than a year to about 2.6 years.^{2–5} A systematic review showed that

mortality during the first six months of after transitioning was about 20% (range 0–34%)⁶. Additionally, a considerable proportion of NH dental patients die within one year after their first dental appointment⁷, highlighting the urgency of considering prognosis in dental treatment planning. Despite this, Chen et al. reported that 50.8% of long-term care residents received no dental care in the last year of life; among those who received any treatment, 62.9% received usual care.² Furthermore, 60.7% of those receiving usual care completed their dental treatment within the last three months of life. This phenomenon suggests that prognosis is often not integrated into treatment planning, leading to overtreatment or undertreatment in patients nearing the end of life. This can significantly affect the quality of care, the well-being of NH residents while imposing a financial burden that may not be justified by the benefits of the care provided.

Recognizing patients' life expectancy and understanding factors associated with mortality can help dentists plan for appropriate treatments. Several studies have identified other factors associated with nursing home mortality, such as having cognitive impairment, kidney disease, cardiovascular disease, dehydration, weight loss or loss of appetite, ability to perform activities of daily living, and low Body Mass Index (BMI).^{3,8–10} Poor oral health status has been shown to associate with increased mortality risks in older adults in multiple large cohorts.^{11–14} Although studies focusing on mortality rate and oral health status in NH residents are scant, the available literature provides evidence of an association between oral health status and longevity for NH residents. A four-year longitudinal study in Japan found that oral dryness was associated with an 83% increase in mortality rate during the study period after adjusting for potential confounders (HR 1.83, 95% CI = 1.12–3).¹⁵ Another study in Spanish NH found that denture wearing was associated with a significantly higher mortality rate (RR = 2.18, $p = 0.007$), and poor oral hygiene was also found to be associated with higher mortality rate.¹⁶ Caplan et al.⁹ also found that edentulism with or without complete denture was associated with significantly increased risk of NH residents' mortality.⁹

Conversely, some evidence indicates oral health improvements may be associated with improved prognosis. For example, a controlled clinical study from Germany found that dental hygiene education and denture cleansing were associated with lower mortality rate compared to the control group in NH setting. The same study also reported that dentate participants with heavy plaque score (> 93.2%) were more likely to die in 12 months, concordant with the aforementioned associations between oral health problems and mortality.¹⁷

Despite existing evidence, the relationship between oral health and mortality in NH residents remains inconclusive. Previous studies have primarily focused on general health conditions, while the specific impact of oral health and the ability to perform oral self-care on mortality has not been thoroughly examined. Moreover, there is a need to integrate prognostic considerations into dental treatment planning to avoid unnecessary interventions that may not provide meaningful benefits to patients with limited life expectancy.

Therefore, our objective was to explore both systemic and oral factors associated with mortality in NH residents. This will help bridge the gap in the current understanding and contribute to more informed and appropriate dental care for this vulnerable population.

Materials and Methods

This study was a retrospective cohort analysis using existing clinical data collected from 902 NH residents who received dental care from a community-based geriatric dental clinic affiliated with the University of Minnesota School of Dentistry between 1999 and 2006. Data were obtained from clinical records of residents from 20 NHs in the Minneapolis-St. Paul area who underwent a comprehensive oral examination and full-mouth radiographs as part of their new patient visits. Their medical history and medication records from NH facilities were also abstracted from their NH records. Cognitive status, physical mobility, oral self-care function, cooperation with care, and ability to communicate oral health needs were also assessed during the examination. A treatment plan for each resident was developed and carried out. This analysis included all NH residents who underwent a complete oral examination during the period. The follow-up phase for the primary outcome, namely, time to death after the comprehensive dental examination, began after the new patient visits. Residents who were alive at the end of follow-up were censored. The study was approved by the University of Iowa institutional review board (IRB). Clinical trial number was not applicable.

The primary outcome was time to death after the comprehensive dental examination. Mortality was determined by linking participants' sociodemographic data with the National Death Index. Follow-up began on the date of the comprehensive dental examination and continued until death or the end of the study period (December 31, 2010), whichever occurred first.

The potential risk factors for the predictive model were predetermined based on existing literature and clinical expertise. These factors were extracted from dental records and organized into four domains: sociodemographic, medical history, functional status, and oral health measures (Tables 1 and 2). To assess the cumulative impact of chronic health conditions on mortality, medical conditions were initially grouped into 18 categories following the Charlson Comorbidity Index (CCI) guidelines. Certain conditions such as cancers (both non-metastatic and metastatic), diabetes (with and without complications), and liver diseases (mild/moderate/severe) were amalgamated into single categories to simplify model construction and improve interpretability for potential clinical use. The subsequent analysis involved these 14 disease categories (Table 1).

Table 1
General Characteristics of the Participants

Characteristics	Number of participants (%) (N = 665)
<i>Sociodemographic Characteristics</i>	
Sex	
Female	493 (74.1%)
Male	172 (25.9%)
Insurance	
No	88 (13.2%)
Yes	577 (86.8%)
Age Category	
65–74 years	103 (15.5%)
75–84 years	247 (37.1%)
85 years and above	315 (47.4%)
<i>Medical History</i>	
Dementia	
Yes	286 (43.0%)
No	379 (57.0%)
Myocardial Infarction	
Yes	42 (6.32%)
No	623 (93.7%)
Congestive Heart Failure	
Yes	157 (23.6%)
No	508 (76.4%)
Peripheral Vascular Disease	
Yes	58 (8.72%)
No	607 (91.3%)
Cerebrovascular Disease	
Yes	181 (27.2%)
No	484 (72.8%)
Chronic Pulmonary Disease	

Characteristics	Number of participants (%) (N = 665)
Yes	113 (17.0%)
No	552 (83.0%)
Rheumatic Disease	
Yes	24 (3.61%)
No	641 (96.4%)
Peptic Ulcer Disease	
Yes	28 (4.21%)
No	637 (95.8%)
Renal Disease	
Yes	34 (5.11%)
No	631 (94.9%)
Any Liver Disease	
Yes	5 (0.75%)
No	660 (99.2%)
Any Cancer	
Yes	55 (8.27%)
No	610 (91.7%)
Any Diabetes	
Yes	141 (21.2%)
No	524 (78.8%)
<i>Functional/Cognitive Status</i>	
Cooperation	
Generally cooperative	543 (81.7%)
Uncooperative	122 (18.3%)
Communication	
Able to communicate	433 (65.1%)
Not able to communicate clearly	232 (34.9%)
Mobility Categories	
Walks Independently	73 (11.0%)
Walks with assistance	115 (17.3%)

Characteristics	Number of participants (%) (N = 665)
Wheelchair/bed-ridden	477 (71.7%)
<i>Oral Health Status</i>	
Capability for Oral Self-Care	
Self-sufficient	206 (31.0%)
Supervision/need assistant	459 (69.0%)
Oral Hygiene Status	
No issues	506 (76.1%)
One or more issues(e.g. bleeding gum)	159 (23.9%)
Edentulous	
Yes	228 (34.3%)
Has at least one tooth	437 (65.7%)
Dentures	
No	318 (47.8%)
Yes	347 (52.2%)

The data were column-standardized prior to analysis. Variable selection was performed using a Cox proportional hazards model with a LASSO penalty.¹⁸ Ten-fold cross-validation was used in order to choose the optimal parameter for the LASSO penalty. Selected variables were then used in a traditional Cox model in order to perform inference, again using the standardized scale. Age category (65–74, 75–84, ≥ 85 years) and mobility category (walks independently, walks with assistance, wheelchair/bed-ridden) were modeled as ordinal variables, and hazard ratios represent the change in hazard per one-category increase. Capability for oral self-care was modeled as a binary variable (supervision/need assistant vs self-sufficient), systemic conditions were modeled as binary variable (presence/absence of the condition), and number of comorbidities was modeled as a continuous variable representing the total number of chronic conditions present on arrival. All statistical analyses were completed using R (version 4.1).¹⁹

Results

Data from 665 participants had complete information for all variables and were included in analyses (i.e., this was a complete-case analysis). The majority of our participants were female (74.1%) and 86.8% had dental insurance. We found that about 70% were functionally dependent and either wheelchair- or bed-bound and almost 60% had dementia documented in their records. Participants had a mean of 10 comorbidities (Fig. 2). About 34% of the residents (228 residents) were completely edentulous and about half had dentures (52.2%, 347 participants). For those with natural teeth, the median number of natural teeth was 18 (range, 1–32) and the median number of decayed or broken teeth was 4 (range, 0–25), which accounted for 22.2% of the median

remaining teeth. The median number of filled teeth was 9 (range, 0–27), which accounted for 50% of the median remaining teeth. Sixty-nine percent of the residents needed supervision for daily oral care (Table 1).

Of the 665 residents, 456 (68.6%) died before the end of the study. The median survival time was 36.0 months (95% CI 32.4–40.5), and the estimated 1-year survival rate was 79% (95% CI 0.75–0.82) (Fig. 1). Table 3 shows the survival probability at each time point.

In the Cox proportional hazards model, the capability of oral self-care was the only oral–related variable included in the final model (HR = 1.58, 95% CI = 1.27–1.96) (Fig. 3). Renal disease had the strongest association with mortality, followed by age category (HR = 3.31, 95% CI = 2.25–4.88 and HR = 1.48, 95% CI = 1.28–1.69; respectively) (Figs. 4 and 5). All p-values of these three factors were less than 0.001. Other statistically significant factors associated with increased mortality risk were the number of comorbidities, congestive heart failure, and mobility category (see Table 4 for HR and p-values).

Table 1 *General Characteristics of the Participants (see the end of the manuscript)*

Table 2 Oral Health Status of the Participants (Dentate Only; N = 437)	
Oral Health Status	Median (range)
Number of natural teeth	18.0 (1.00;32.0)
Number of teeth with decayed and/or broken	4.00 (0.00;25.0)
Number of filled teeth	9.00 (0.00;27.0)

Table 3 Survival Probability of the Participants at 6, 12, and 18 months			
Months	Survival Probability	95% CI Lower	95% CI Upper
6	0.90	0.87	0.92
12	0.79	0.75	0.82
18	0.71	0.67	0.74

Table 4
Factors Associated with Mortality Chosen by the Cox Model

Factors	HR	95% CI Lower	95% CI Upper	P-values
Renal Disease	3.31	2.25	4.88	< 0.001
Capability for Oral Self-Care	1.58	1.27	1.96	< 0.001
Age Category*	1.48	1.28	1.69	< 0.001
Congestive Heart Failure	1.33	1.07	1.64	0.010
Mobility Category*	1.25	1.07	1.47	0.005
Number of Comorbidities	1.03	1.01	1.05	0.002
*as in Table 1				

Discussion

In this study, we found that the median survival time of the NH participants was 36 months (about 3 years), and the estimated 1-year survival rate was 79%. Impaired capacity for oral self-care, number of comorbidities, history of congestive heart failure, history of renal disease, advanced age, and immobility were found to significantly increase mortality risk in these NH participants. These findings underscore the critical need to integrate prognosis into clinical dental treatment planning to ensure care that aligns with patient needs and expected outcomes.

Our median survival time was 3 years, which is longer than that reported in other studies from Norway, Ireland, Iceland, and the U.S. (2.2 years, 2.33 years, 2.58 years, and 189.4 days; respectively).²⁻⁵ However, our results, together with prior studies, suggest that NH residents generally have a limited life expectancy. The inclusion of patient prognosis in treatment planning is paramount to achieving a balance between providing essential care and avoiding unnecessary interventions. NH residents, by virtue of their limited life expectancy and complex medical needs, are particularly vulnerable to overtreatment or undertreatment. For example, undertaking extensive restorative procedures in patients with a limited prognosis may not provide significant benefits and could inadvertently reduce their quality of life. Conversely, neglecting essential palliative or preventive care could exacerbate oral health issues, leading to pain, infection, or systemic health complications.

We identified capability to perform oral self-care as one of the variables associated with mortality in this study. To our knowledge, no prior studies have investigated the specific associations between oral self-care level and mortality. However, studies from Europe and the U.S. have found that lower Activities of Daily Living (ADL) scores are associated with higher mortality risk.^{2,3,5,20} Since oral self-care ability can be conceptualized as a component of basic ADL, our results align with these previous studies. This finding highlights the importance of evaluating oral self-care abilities as a component of the overall functional assessment when formulating treatment plans. For instance, patients requiring significant assistance with oral care may benefit from simplified, maintenance-focused dental interventions that prioritize comfort and ease of daily management.

Most of the predictors identified in our study, such as age, comorbidities, and immobility, are consistent with those found in medical studies, which supports the robustness of our findings. This alignment underscores the

interplay between systemic and oral health and supports the argument that dental providers should work closely with interdisciplinary teams to integrate comprehensive health assessments into their care planning processes.

We found that congestive heart failure and renal disease were associated with increased risk of mortality, similar to finding of Porock et al.²⁰ and Caplan et al.⁹, who also found that renal disease was associated with mortality in NH residents.^{9,20} However, several studies have found other conditions, such as cognitive impairment^{20,21}, low BMI, weight loss, loss of appetite^{20,22}, and dehydration²⁰, to be associated with higher mortality in NH residents. Our results did not show the same findings because we did not collect data regarding their nutritional status. As for cognitive impairment, the differences could arise from varying definitions of the cognitive impairment in these studies.

We did not find any significant association between oral health status and mortality, which contradicts the study by Caplan et al.⁹, which found a statistically significant association between edentulism with and without complete dentures and mortality in NH residents. This discrepancy may be related to variation in the classification of oral health variables and in the covariates included in the analysis. Compared with the aforementioned study, our analysis incorporated more detailed measures of systemic health and functional status, which may have reduced the independent association between oral health status and mortality. These findings suggest that, in this frail population, systemic and functional factors may be more strongly associated with survival than oral health status measures alone.

Our analysis identified factors associated with mortality in NH residents. These findings informed subsequent development and validation of a mortality prediction model reported elsewhere.⁷ We categorized systemic diseases and simplified oral self-care assessments, which may facilitate the future use of these variables in prognostic assessment by dental providers. Additionally, we found that capability to perform oral self-care increased mortality risk, which, to our knowledge, has never been reported before. However, the oral self-care measure used in this study was subjective and based on caregivers' judgment. Our participants were all white, and the majority were female; thus, generalizability may be limited to similar populations. Oral health status data were collected for clinical purposes, so the examiners were not calibrated. Nonetheless, we performed a complete-case analysis; therefore, results may be biased if missingness is related to the outcome or predictors.

Planning dental treatment for NH residents poses several challenges, such as their systemic conditions and access issues, but most importantly, balancing between comprehensive versus limited dental treatments. This is a difficult question for dentists as they are uncertain about patients' overall prognosis and the benefits of dental treatment. Thus, it is no surprise that a study has shown that NH residents either received extensive dental care during the last year of life or no care at all.² Incorporating prognosis into clinical treatment planning is essential for improving care quality and outcomes for NH residents. For example, knowing that the estimated 1-year survival rate is only 79% can help dental providers choose less invasive, comfort-focused treatments over extensive restorative care. This approach prioritizes the individual's quality of life and overall well-being rather than focusing solely on traditional treatment goals. As discussed by Chen et al.⁷, incorporating NH residents' prognosis into clinical assessment is essential so as to promote patient-centered care, which helps addressing patient's needs and improve their quality of life. This also helps balance

resources and time spent on dental care in this population and ensures those who would benefit the most receive from necessary care. Future studies should aim to refine methods for assessing prognosis in dental settings and explore how these assessments can be seamlessly integrated into routine practice. Additionally, there is a need to examine the cost-effectiveness of incorporating life expectancy evaluations into dental treatment planning to further justify their adoption.

Conclusion

In conclusion, advanced age, renal disease, congestive heart failure, reduced mobility, greater comorbidity burden, and impaired capability for oral self-care were associated with higher mortality among nursing home residents receiving dental care. Among the oral health–related variables examined, capability for oral self-care was the only factor associated with mortality. These findings are important because they suggest that a simple assessment of oral self-care capability may help dental clinicians identify residents with greater functional vulnerability and limited prognosis. Incorporating this information into routine dental assessment may support more appropriate, patient-centered treatment planning and help align care with the likely benefits of intervention in this frail population. Further studies should confirm these findings in other populations and evaluate how prognosis-informed dental planning can be integrated into routine practice.

Abbreviations

NH	Nursing home
BMI	Body Mass Index
HR	Hazard Ratio
RR	Relative Risk
IRB	Institutional Review Board
CCI	Charlson Comorbidity Index
i.e.	id est
CI	Confidence Interval

Declarations

Ethics approval and consent to participate

The study was approved by University of Iowa Institutional Review Board. As this was a retrospective study based on existing records and linked mortality data, the requirement for informed consent was waived by the Institutional Review Board.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JML drafted the manuscript. XC conceived and designed the study. BW and TP planned and conducted the statistical analyses. All authors critically reviewed the manuscript, contributed to the final draft, and approved the submitted version.

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Not applicable

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Figures

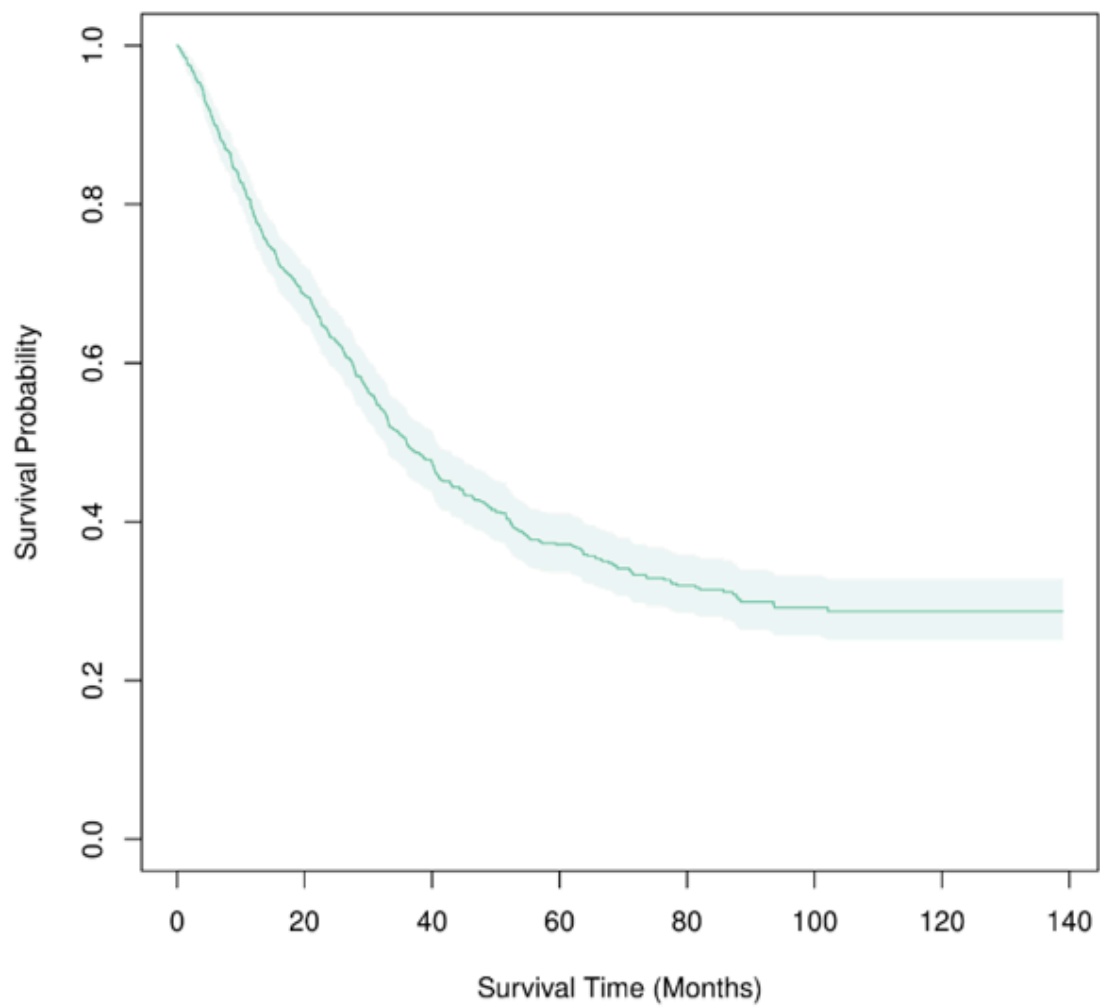


Figure 1

Overall Survival Trajectory

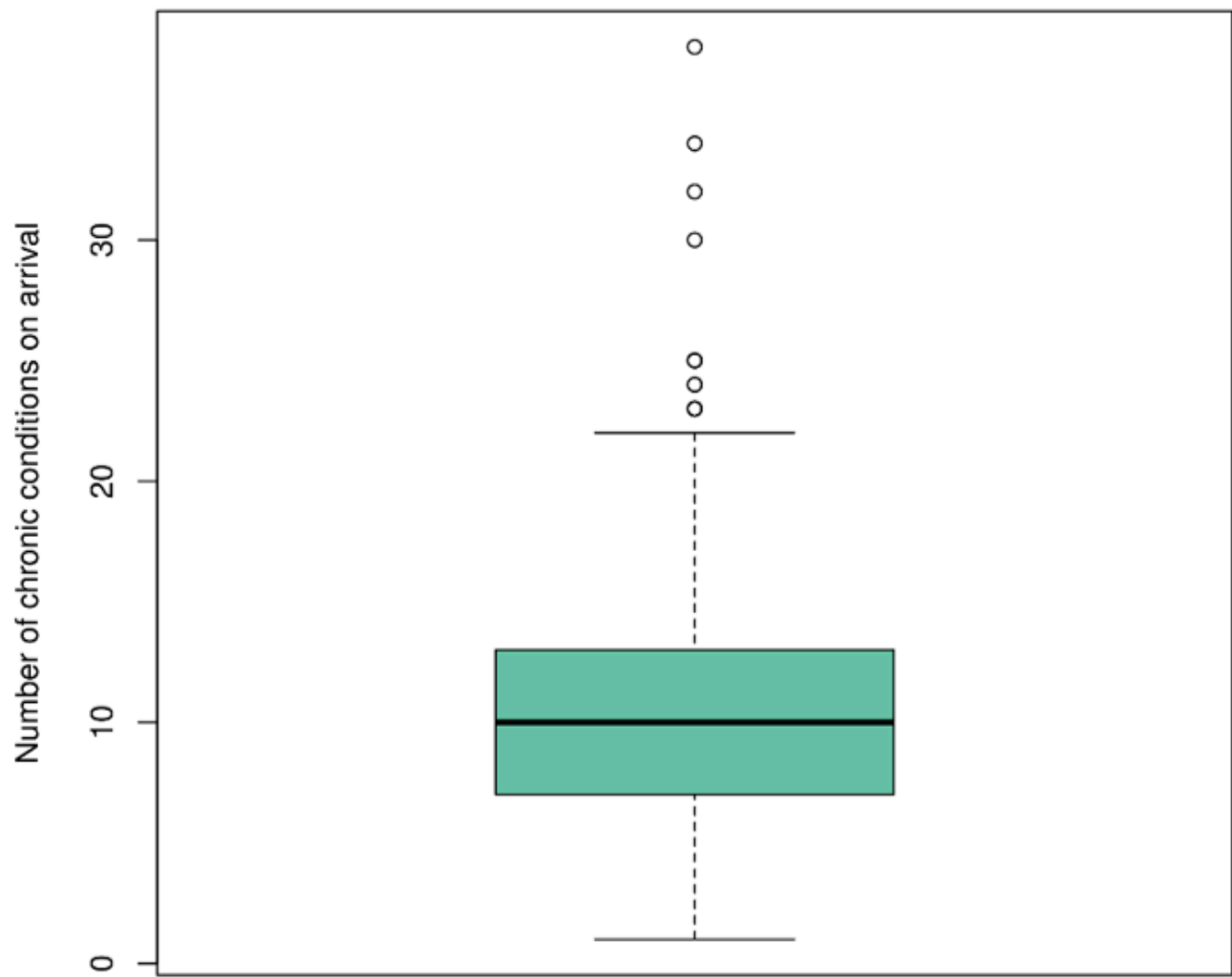


Figure 2

Distribution of Number of Comorbidities

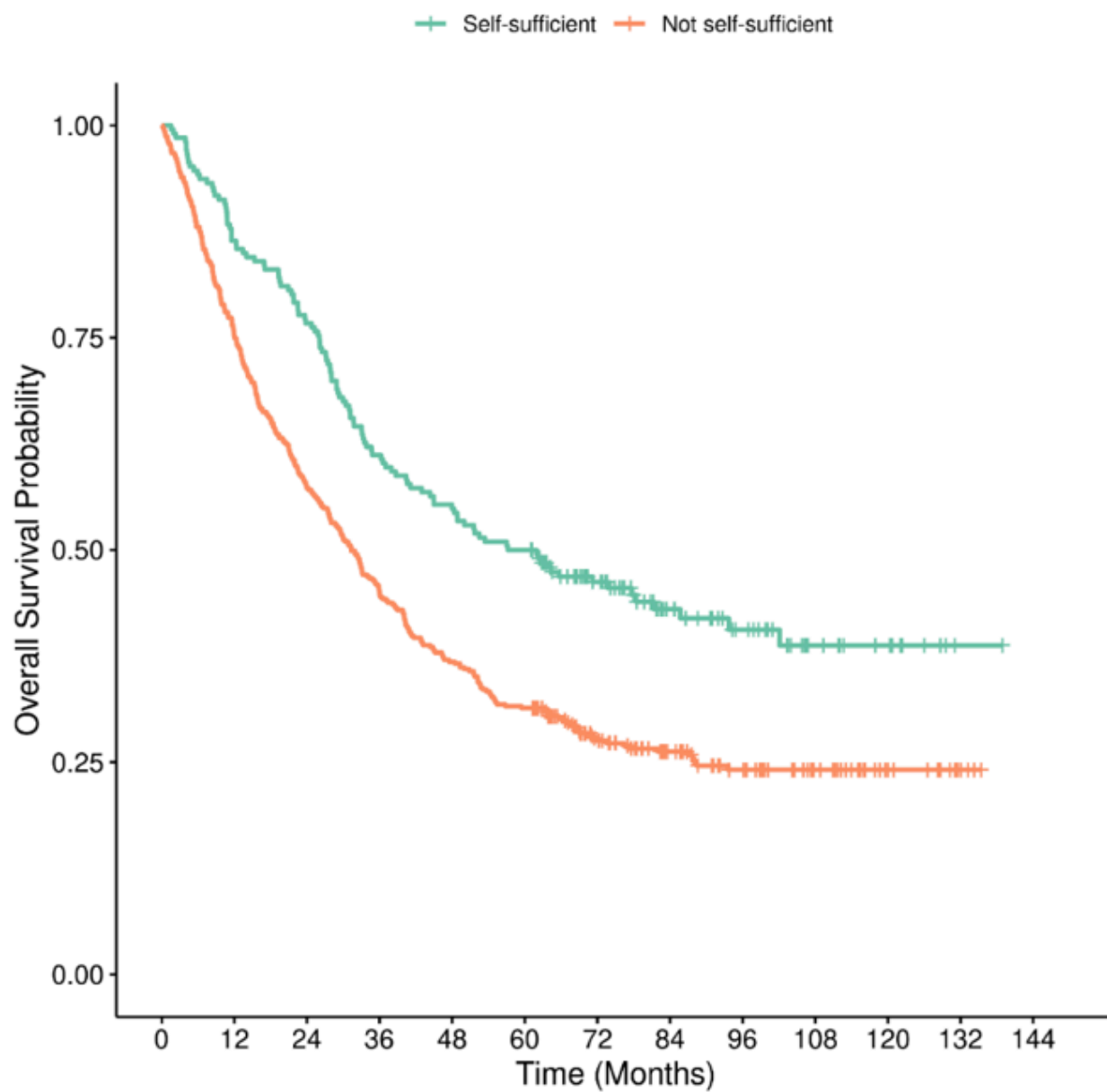


Figure 3

Overall Survival Probability and Capability to Perform Oral Self-Care

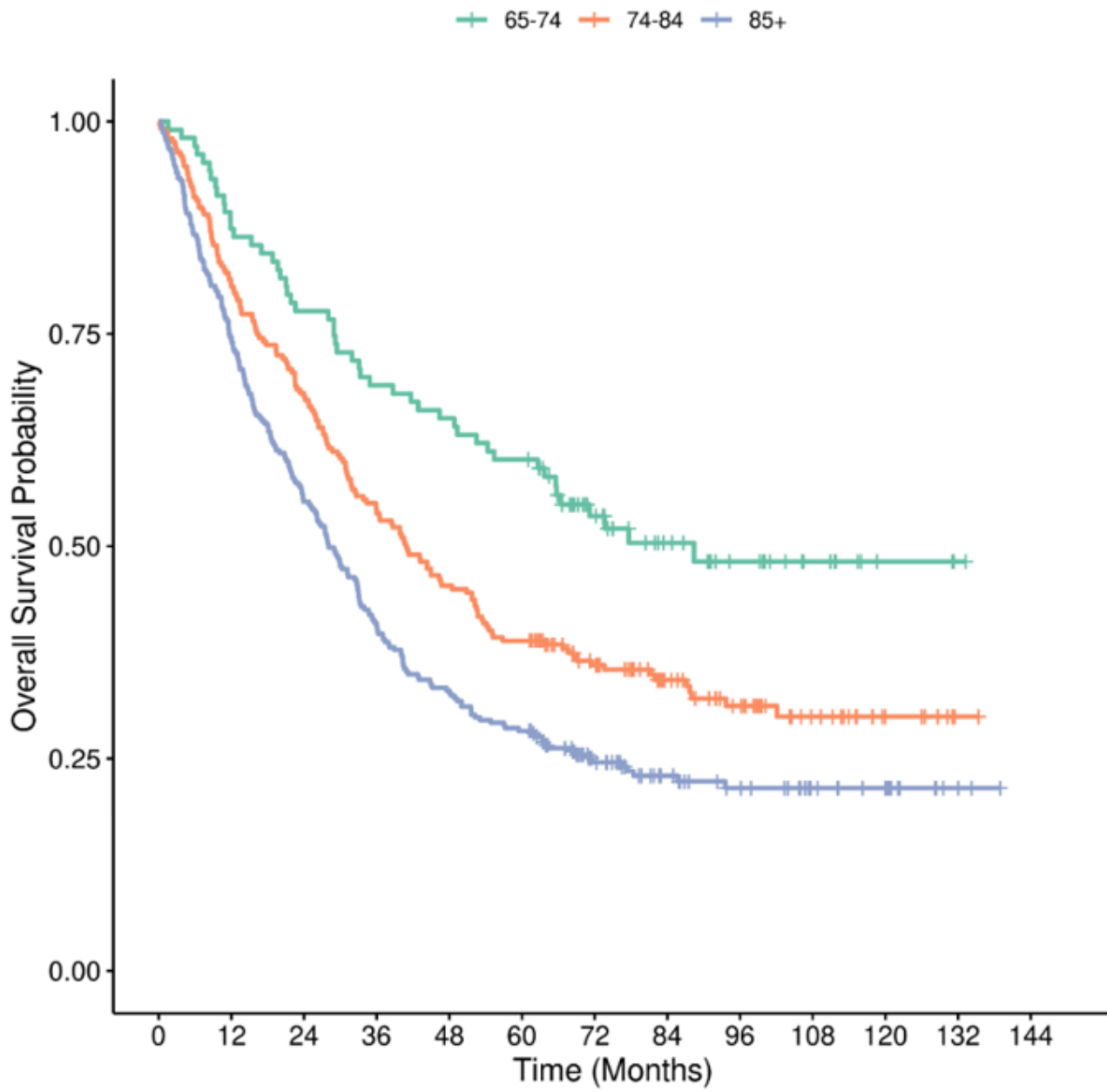


Figure 4

Overall Survival Probability and Age Categories

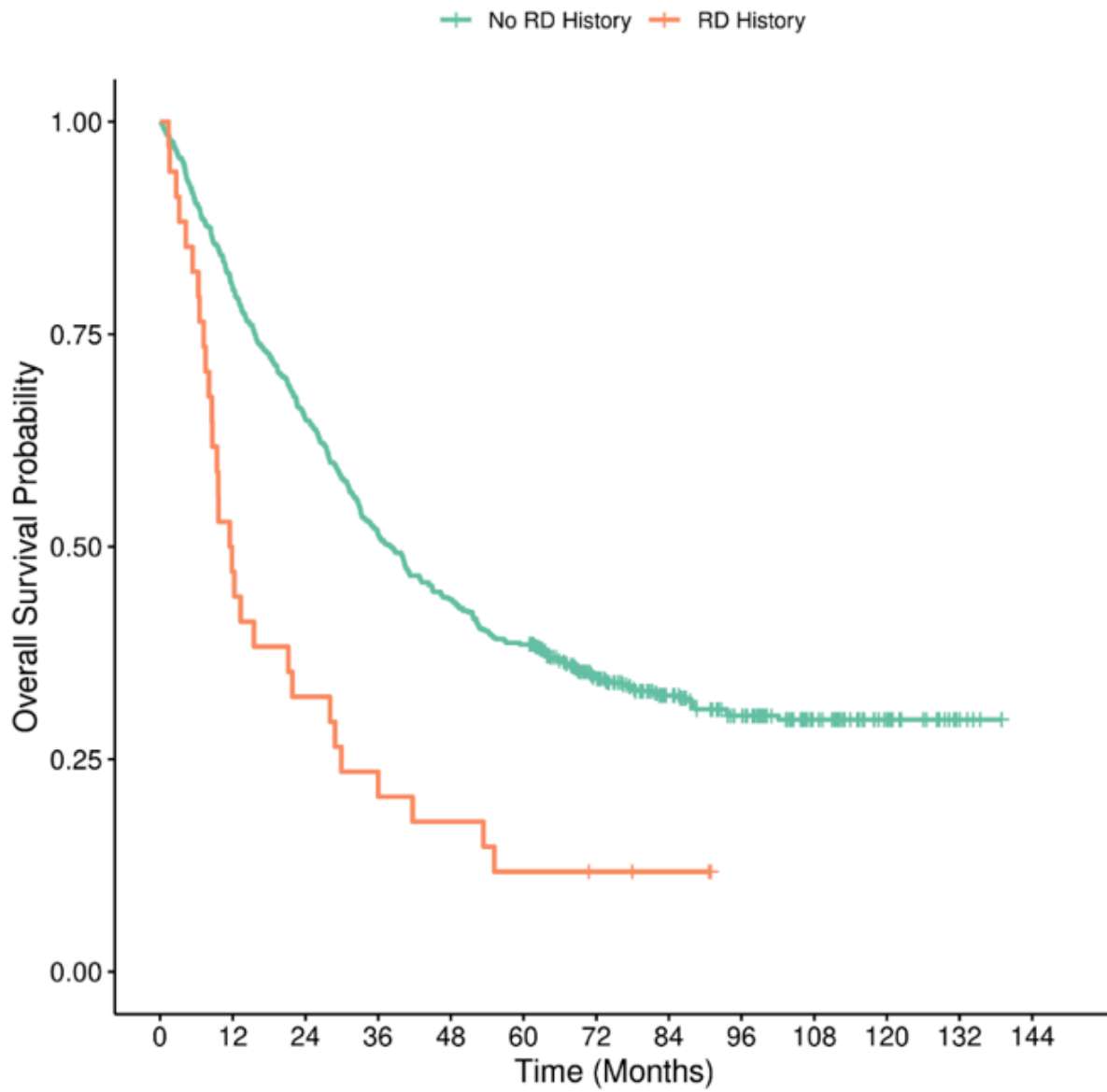


Figure 5

Overall Survival Probability and Renal Disease