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Original article

Complete denture replacement: a 20-year retrospective study of adults receiving publicly funded dental care

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Abstract

Purpose: There is little evidence as to what is the appropriate replacement interval for complete dentures. The aim of this study was to determine the longevity of complete dentures in a population of publicly insured adults across a 20 year observation period.

Methods: The records of 187,227 Australian adults who accessed complete denture treatment through public clinics between 2000-2019 were assessed. Time to denture replacement was modelled using a Weibull regression and a competing risk regression to adjust for the competing risk of mortality.

Results: Over a 20-year period, 27.7% of dentures were replaced, with a mean longevity of 6.06 (SD: 3.93) years. Pairs of complete dentures had greater mean longevity than single dentures ($p<0.001$). Approximately 4.6% of dentures provided were replaced within 2 years; 18.4% were replaced between 2 and 10 years and 4.6% of replacements occurred after 10 years.

Over 70% of adults who received a complete denture did not replace it during the observation period. Dentures provided by denturists had higher levels of replacement than those made by dentists. Participants over 80 years of age had lower rates of denture replacement. Low socio-economic status and living outside a major city were associated with reduced rates of replacement for dentures under 10 years of age.

Conclusion: Complete dentures were commonly replaced after 6 years of service. Pairs of dentures lasted longer than single dentures.

Keywords: Edentulous/edentulism, Epidemiology, Prognosis, Removable prosthodontics

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1. Introduction

Complete dentures deteriorate with use. Denture teeth wear away[1], affecting the occlusion and vertical dimension[2] of the patient, negatively impacting masticatory function and appearance. Resorption of the alveolar ridges[3] affects the retention and fit of the denture, which also impacts on function and contributes to the development of soft tissue pathology[4]. Accidental damage can occur[5].

Replacing worn dentures at appropriate intervals has been shown to improve OHRQoL[6], and is important to maintain the health and function of the wearer[7,8]. However, there is little evidence as to what the appropriate replacement interval should be. Denture longevity is defined as the length of time between the issue of a complete denture and the replacement of that denture with a new denture[9]. Two studies have examined complete denture longevity, identifying a mean of 6.5 years[10] and "longer than 15 years."[9] A systematic review found the weighted mean longevity to be 10.1 years, reporting that maxillary dentures lasted longer than mandibular dentures and longevity was reduced when complete dentures were opposed to natural teeth[11].

The effects of variables such as age, sex, socio economic status, proximity to a major city, or country of birth on complete denture longevity, have not been established. There is some evidence that complete dentures provided by denturists differ from those provided by dentists. The literature reports patients are less satisfied with mandibular dentures made by denturists[12] and that denture replacement rates for denturists are higher than for dentists[10]. Denturists provide a large proportion of complete dentures in Australia and are nationally registered clinicians. In addition to a dental technician qualification, candidates must complete a 2-year part time advanced diploma of dental prosthetics prior to registering as

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a denturist.

Existing studies most commonly report on dentures made in a university setting, by dentists or students under supervision which are "likely to have been provided to a high standard and under idealized conditions".[11] As such, the results may not be representative of those achieved in general practice. Assessing denture longevity using a public dental database provide a means of directly measuring outcomes from general practice[13] and limiting participation bias[14].

It is important to know how long complete dentures last. Patients require evidence-based information on the longevity of complete dentures as part of informed consent. Existing complete denture patients are often unaware of the deterioration in quality and status of their prosthesis over time[7,8]. Worn and deficient dentures reduce the function and OHRQoL of the wearer. Edentulous adults visit the dentist significantly less than dentate adults[15], and miss the opportunity for a clinician to review their prosthesis and advise on replacement.

The aims of this retrospective longitudinal cohort study were to assess the longevity of complete dentures in a population of publicly insured adults and to examine the effects of age, sex, denture type, socio economic status, type of clinician, clinic setting and geographic location on the replacement of different types of complete dentures.

2. Materials and Methods

2.1. Data Source

The study protocol received ethics approval by the Trobe University Human Ethics committee (HEC19112) and followed STROBE guidelines. Anonymized data, obtained from the electronic dental records of all adults who accessed complete denture treatment through the public dental service in Victoria, Australia, were provided by Dental Health Services Victoria (DHSV). To account the competing risk of death, the date of death was obtained and linked from the Victorian Registry of Births, Deaths and Marriages dataset.

2.2. Population Description

Eligible patients were adults (≥ 18 years) who received a complete denture (maxillary or mandibular or pair) between 01/01/2000 and 31/12/2019. (**Appendix Fig. 1**) Patients with implant supported dentures were excluded. Participants were low-income adults receiving government income support, who were eligible for dental care through the Victorian public dental service. Seventy seven per cent of Australians over the age of 65 are eligible for public dental care as are 17 per cent of Australians aged 16–64 years[16]. Eighty two percent of eligible patients live within 10 kilometres of a public dental clinic, and another eight percent live within 20 kilometres[17]. There is a waitlist for public denture treatment which averaged 19 months in 2019, and there is a co-payment fee, which represents approximately 7% of the full private cost of a CD. Up to half of public dentures provided are to 'priority' patients (Aboriginal or Torres Strait Islander, mental health clients, homeless, refugee or asylum seekers) who are not subject to this wait time, and who are not subject to the co-payment[18].

Complete denture treatment is provided by salaried dentists, denturists, specialist prosthodontists and students, working within more than 50 public clinics located in metropolitan, regional and rural areas in Victoria. Not all public clinics employ denturists. Dentures are also provided by private practitioners, working in private clinics, who are reimbursed on a fee-for-service basis by the relevant public dental agency. Patients who receive a voucher are free to select any clinician of their choice to provide the CD. The fee paid does not vary by clinician type, and the materials used by both dentists and denturists are expected to be the same.

2.3. Outcome Measures

Study participants were followed from the date of provision of a complete denture until the first occurrence of its replacement with another complete denture or till death, whichever occurred first. Dentures of survivors not replaced during the observation period were right censored. For patients who experienced multiple events, the interval up to the first event was considered.

The decision to replace a denture, in this population, is commonly made by the patient. A patient can contact any public clinic and, providing they are eligible for public care, can request new complete dentures and place their name on the denture wait list without examination. The Victorian public dental service places no restrictions on the reason or how frequently an edentulous person may seek dentures, stating "These (edentulous) clients usually require new dentures if they are requesting them."[19] In addition, patients who present to a public clinic with denture concerns may be placed on the denture waiting list by their treating clinician.

A pair of complete dentures was deemed to have been replaced if a new pair of complete dentures, or either a new maxillary denture or a new mandibular denture was provided. A maxillary complete denture was deemed to have been replaced if a new maxillary complete denture or a pair of complete dentures was provided. A mandibular complete denture was deemed to have been replaced if a new mandibular denture or a pair of complete dentures was provided. If a maxillary and mandibular complete denture were issued on the same day, they were recoded as a pair of dentures.

A Weibull regression model was developed across the 20-year observation period. The length of time to denture replacement was stratified into 3 periods as informed by the best fitting Weibull models. The early replacement period included dentures replaced within 2 years of issue. The mid replacement period included those dentures replaced within 2 to 10 years of issue and the late replacement period included those dentures replaced more than 10 years after issue. The factors which affect denture longevity differ across the different segments in the lifespan of a denture, and do not remain constant across time. As such, the model fit improved when time to replacement was stratified, and the periods were determined by best Weibull regression model fit[20].

2.4. Covariates

The date of treatment, patient age at the time of denture provision, sex, indigenous status, country of birth, residential postcode, type of clinician who provided treatment (dentist or denturist), registration status (student or qualified clinician) and location of care provision (in a public clinic or private clinic) were collected. Geographic location[21] and Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD)[22] was determined by residential postcode.

2.5. Statistical analyses

Demographic and covariate summaries were stratified by denture type. In this study, single complete dentures (i.e., mandibular or maxillary) were grouped together and were analysed as single complete dentures as opposed to pairs. The number of mandibular dentures was relatively small underpowering separate analyses by type of denture. Combining all single dentures and comparing them to pairs improved the model fit. The associations of the covariates with the study outcome were examined using univariate and multivariate analyses. Mean longevity of complete dentures replaced during the observation period were calculated as well as overall median time at risk. Survival proportions at 1, 5, 10, 15, and 20 years were estimated for each denture type.

Violation of the proportional hazard assumption prevented the use of Cox regression modelling to assess denture survival[23]. The Weibull, Gompertz, log-logistic, and exponential distributions were assessed as candidate parametric distributions[20,24]. Of these, the Weibull distribution provided the best fit and was used to construct the parametric survival models. Since the study population was elderly and death represented a competing risk that reduced the number of individuals at risk of complete denture failure, we also modelled the study outcome using competing risk regressions (CRRs) as defined by Fine and Gray[25]. This model assessed the effect of the predictors on the hazard of the subdistribution for time to denture replacement (the "subhazard") while accounting for the competing risk of death. The goodness of fit of the regression was tested using Akaike's information criterion (AIC)[26].

The statistical analyses were conducted using Stata SE/15.1; reported *p* values were 2 sided and a *p* value of 0.05 was considered statistically significant.

3. Results

A total of 266,206 complete dentures were provided to 187,227 participants between 01/01/2000 and 31/12/2019. Women comprised 55.4% of participants, and the mean age (standard deviation; SD) when receiving the first denture was 67.2 years (SD: 13.0).

A pair of complete dentures was the most common prosthesis issued (58.4%). (**Table 1**) Two thirds of all dentures were provided by denturists (63.8%) while the remaining third were provided by dentists (36.2%). Approximately half of the dentures issued (48.1%) were supplied by salaried clinicians working in public clinics and the remainder (51.9%) were prepared by private clinicians in private clinics, who were reimbursed by the public dental agency on completion of treatment.

The mean longevity of complete dentures which were replaced during the observation period was 6.06 (SD: 3.9) years with 27.7% of participants experiencing at least one denture replacement during the observation period. **(Fig. 1)** The mean time at risk was 7.6 years (SD: 5.2).

The 5- and 10-year survival proportions were 0.86 (95% CI: 0.86 to 0.86) and 0.67 (95% CI: 0.67 to 0.68), respectively. (**Appendix Table 1**)

A total of 51 936 dentures were replaced within the observation period. Weibull survival curves by denture type (**Fig. 2**) show that pairs of dentures have a greater survival proportion than single dentures, and the proportion of denture replacements increase with time. Pairs of complete dentures had greater mean longevity than single dentures. (**Table 2**) The results of the multivariate regression are shown in **Table 3**. Competing risk regression, which accounted for the competing risk of mortality in this cohort, produced similar results to those of the Weibull regression for each replacement group. (**Appendix Table 2**)

Table 1. Characteristics of study participants at time of first complete denture.

(n=187,227)	n	proportion
Gender		
Female	102,683	0.554
Male	82,686	0.446
Age (years)		
<65	67,398	0.360
65-79	92,613	0.495
80+	27,146	0.145
Denture Type		
Pair CD	109,388	0.584
Maxillary CD	70,685	0.378
Mandibular CD	7,154	0.038
Indigenous Status		
Non-Indigenous	182,651	0.990
Indigenous	1,783	0.097
Geographic Location		
Major City	100,378	0.537
Inner Regional	57,569	0.308
Outer Regional	27,829	0.149
Remote & Very Remote	1075	0.006
Provider Type		
Dentist or Specialist	62,928	0.362
Denturist	110,987	0.638
Service Setting		
Public Clinic	90,120	0.481
Private Clinic	97,107	0.519
Clinician Status		
Fully Qualified Clinician	171,492	0.982
Student Clinician	3,078	0.018
Country of Birth		
Australia & New Zealand	122,676	0.685
Europe & Americas	41,997	0.235
Asia	6,791	0.038
Middle East & Africa	7,600	0.042
IRSAD Tertile		
(Wealthiest) 3	55,462	0.297
2	63,847	0.342
1	67,544	0.362

CD= Complete Denture
IRSAD= Index of Relative Socio-economic Advantage and Disadvantage (Indicator of socio-economic status based on postcode of residence)

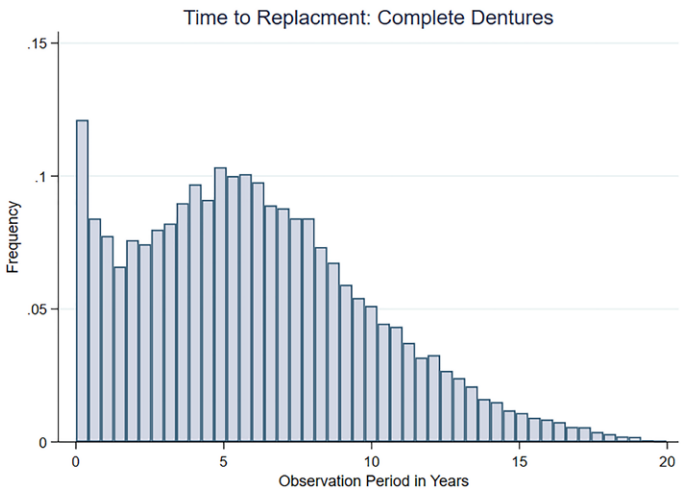

Fig. 1. Frequency distribution for complete denture longevity in years.

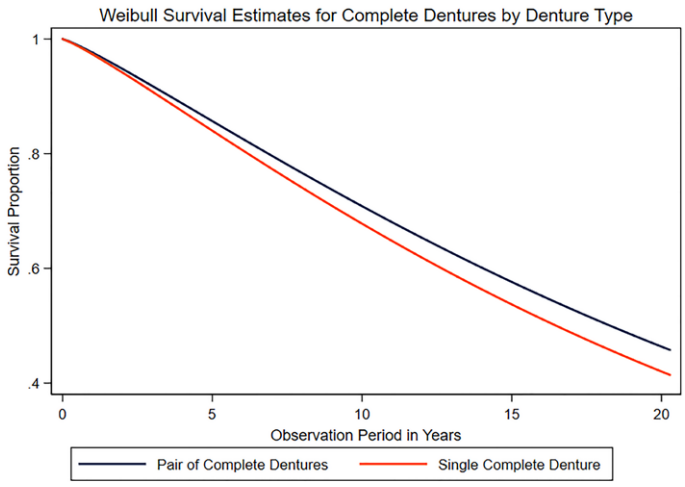

Fig. 2. Weibull Survival Estimates for complete dentures by denture type.

Table 2. Mean longevity, failure range and time at risk by denture type.

	Pair CD	Maxillary CD	Mandibular CD	All
Dentures Issued (n)	109 388	70 685	7 154	187 227
Denture Replacements (^)	28 750 (26.28%)	21 173 (29.95%)	2 013 (3.88%)	51 936 (27.74%)
Mean Longevity of dentures which were replaced, years (SD)	6.19 (4.00)	5.96 (3.83)	5.35 (3.82)	6.06 (3.93)
Mean time at risk for all participants~ years (SD)	7.84 (5.24)	7.22 (5.03)	6.87 (5.22)	7.57 (5.17)
Early Replacement <2yrs				
Denture Replacements (n)	4 976 (4.55%)	3 480 (4.92%)	409 (5.71%)	8 665 (4.63%)
Mean Longevity of dentures which were replaced years (SD)	0.87 (0.60)	0.91 (0.61)	0.89 (0.60)	0.88 (0.60)
Mid Replacement 2-10yrs				
Denture Replacements (n)	18 730 (17.12%)	14 426 (20.41%)	1 363 (19.05%)	34 519 (18.44%)
Mean Longevity of dentures which were replaced years (SD)	5.88 (2.15)	5.67 (2.13)	5.38 (2.18)	5.78 (2.14)
Late Replacement 10-20yrs				
Denture Replacements (n)	5 044 (4.61%)	3 267 (4.62%)	241 (3.37%)	8 552 (4.57%)
Mean Longevity of dentures which were replaced years (SD)	12.58 (2.09)	12.53 (2.07)	12.81 (2.22)	12.56 (2.08)

CD= Complete Denture
^ Proportion of dentures issued which were replaced during the observation period.
~ Time at risk for participants who did experience denture replacement and those who did not experience denture replacement.

3.1. Dentures replaced within 2 Years

Of the dentures provided, 4.6% were replaced within the first 2 years of issue, (**Table 2**) with no significant differences observed by sex or denture type. Dentures made by student clinicians, (HR: 2.07, 95% CI: 1.84 to 2.33) dentures made in public clinics, (HR: 1.77, 95% CI: 1.68 to 1.86) those made by dentists, (HR: 1.47, 95% CI: 1.40 to 1.54) and those provided to participants born overseas (HR: 1.19, 95% CI: 1.14 to 1.26) were more likely to experience early replacement. Participants aged 65 to 79 years, (HR: 0.84, 95% CI: 0.80 to 0.89), aged over 80 years, (HR: 0.81, 95% CI: 0.75 to 0.87) those of the lowest socio-economic strata, (HR: 0.92, 95% CI: 0.86 to 0.97) and those residing in regional and remote areas (HR: 0.86, 95% CI: 0.81 to 0.90) were less likely to experience early denture replacement. (**Table 3**)

3.2. Dentures replaced between 2-10 Years

Of dentures provided, 18.4% were replaced within 2 to 10 years of issue. (**Table 2**) Receiving a single denture, (HR: 1.19, 95% CI; 1.16 to 1.22) receiving dentures in a private clinic, (HR: 1.34, 95% CI: 1.31 to 1.38) and receiving dentures from a denturist, (HR: 1.06, 95% CI: 1.03 to 1.08) was associated with a higher risk of denture replacement. (**Table 3**) Residing in a regional and remote area (HR: 0.95, 95% CI: 0.93 to 0.98), participants aged over 80 years (HR: 0.72, 95% CI: 0.69 to 0.75), and belonging to the lowest socio-economic strata, (HR: 0.96, 95% CI: 0.93 to 0.99) were associated with a reduced risk of denture replacement.

3.3. Dentures replaced between >10 Years

Of dentures provided, 4.6% were replaced after 10 years of issue. (**Table 2**) Being female, (HR: 1.12, 95% CI: 1.07 to 1.18) having dentures made in a private clinic, (HR: 1.47, 95% CI: 1.39 to 1.56) receiving dentures from a denturist, (HR: 1.16, 95% CI: 1.11 to 1.22) residing in a regional and remote area (HR: 1.16, 95% CI: 1.10 to 1.23) was associated with an increased likelihood of denture replacement. Aged 65 to 79 years (HR: 0.78, 95% CI: 0.75 to 0.82) or aged over 80 years (HR: 0.38, 95% CI: 0.33 to 0.43) was associated with a reduced risk of denture

Table 3. Failure of complete dentures: Multivariate ~ hazard ratios utilizing the Weibull regression. (n=164,977)

	Multivariate <2yrs				Multivariate 2-10yrs				Multivariate 10-20yrs			
Covariate	HR	95%	CI	p	HR	95%	CI	p	HR	95%	CI	p
Sex												
Female	1				1				1			
Male	0.967	0.925	1.012	0.147	0.993	0.971	1.017	0.570	0.893	0.850	0.937	<0.001
Service Setting												
Private Clinic	1				1				1			
Public Clinic	1.765	1.677	1.858	<0.001	0.745	0.726	0.765	<0.001	0.679	0.643	0.717	<0.001
Type of Clinician												
Denturist	1				1				1			
Dentist or Specialist	1.468	1.403	1.535	<0.001	0.944	0.923	0.967	<0.001	0.862	0.820	0.905	<0.001
Status of Clinician												
Qualified Clinician	1				1				1			
Student Clinician	2.070	1.841	2.327	<0.001	1.014	0.908	1.131	0.810	0.871	0.618	1.227	0.429
Denture Type												
Pair CD	1				1				1			
Single CD*	1.015	0.970	1.063	0.507	1.188	1.160	1.216	<0.001	1.014	0.966	1.065	0.566
Country of Birth												
Australia & NZ	1				1				1			
Born Overseas	1.194	1.135	1.256	<0.001	1.089	1.061	1.118	<0.001	0.957	0.904	1.012	0.126
Age Category												
18-64 years	1				1				1			
65-79 years	0.844	0.804	0.886	<0.001	0.985	0.961	1.009	0.223	0.782	0.745	0.821	<0.001
80 or more years	0.806	0.750	0.865	<0.001	0.720	0.689	0.753	<0.001	0.375	0.330	0.426	<0.001
Geographic Location												
Major City	1				1				1			
Regional & Remote	0.857	0.813	0.904	<0.001	0.954	0.928	0.981	0.001	1.162	1.098	1.230	<0.001
IRSAD Tertile												
(Wealthiest) 3rd Tertile	1				1				1			
2nd Tertile	0.964	0.910	1.021	0.207	0.982	0.953	1.012	0.227	1.059	0.992	1.130	0.084
1st Tertile	0.916	0.863	0.971	0.003	0.958	0.930	0.988	0.006	1.039	0.975	1.108	0.234

~ Also adjusted for relines, tooth repairs, base fractures, denture adjustment visits.
CD= Complete Denture * Maxillary or mandibular complete denture CI=Confidence Interval HR=Hazard Ratio

replacement. (**Table 3**) The effect of country of birth, denture type and socio-economic status on replacement was not significant.

4. Discussion

This large-scale study was designed to investigate complete denture longevity in a publicly insured population using fee codes from electronic dental records. Of the 187,227 participants who received complete dentures, approximately 30% replaced their denture at least once, with a mean time to replacement of 6.06 years (SD: 3.9). The proportion of denture replacements increased as dentures increased in age. Pairs of complete dentures had greater mean longevity and greater survival proportion than single complete dentures. Participants residing outside a major city were less likely to experience denture replacement in the first 10 years of service than those in major cities, and those older than 80 years were less likely to experience denture replacement across the 20-year observation period.

The mean longevity of dentures in this study reflects published results. Lewis examined 55,000 CD replacements in a publicly insured Canadian population across 14 years and found the mean longevity to be 6.5 years[10]. In the Lewis study, insurance rules prevented participants from replacing their CDs for 5 years from issue. The similarity in longevity gives strength to our findings, given both studies occurred in different hemispheres, with different public insurance rules, and occurred some 22 years apart.

Our detected early denture replacement proportion of 4.63%, observed within 2 years of denture issue was similar to that reported in the literature[10,11]. Early denture replacement may be due to loss of the denture or irreparable damage but may also be due to a lack of patient satisfaction with the device. Some 15% of patients have been found to be dissatisfied with well-made and technically sound dentures[27]. Further investigation into the causes of early denture replacement is warranted.

For dentures under 10 years of age, the risk of replacement was lower for participants residing outside a major city and for those of the lowest socio-economic status. For dentures over 10 years of age, males were less likely to experience replacement, as were participants over 65 years of age. This result persisted after adjusting for the competing risk of death. Male sex, increasing age, regional and remote locality and low socio economic status are associated with

a lower self-perceived need for dental care[28], and lower rates of dental service utilisation[29]. As such, the reduced rates of denture replacement observed are likely to reflect reduced access to dental services[30,31] either physically or financially, and the lack of opportunity for appropriate denture replacement, rather than increased denture survival.

Dentures provided by dentists had a higher risk of early replacement than those provided by denturists, but a lower risk of replacement at subsequent periods. Dentists perform a wide range of clinical tasks including dentures, and practice surveys have shown a decrease in the proportion of clinical time dentists in Australia spent undertaking removable prosthodontics over the last 20 years[32]. In contrast, denturists' clinical tasks are limited solely to removable prosthodontics so a level of expertise from repetition may be expected.

Pairs of complete dentures had a longer mean longevity than single dentures. Single dentures were 19% more likely to be replaced at 2 to 10 years, but there was no difference at other time intervals. It is assumed that most single dentures were opposed by natural teeth. The increased masticatory force generated by natural teeth places greater stress on the denture resulting in more wear of denture teeth[33]. Higher replacement rates of single dentures may also reflect the failure of remaining natural dentition rather than of the denture itself. One third of maxillary complete dentures which failed in this study were replaced with a pair of complete dentures. (**Appendix Table 3**)

The hazard ratio for early failure of dentures provided by students was more than twice that of qualified clinicians. (**Table 3**) Notwithstanding, there was no difference at other time intervals. Students are fully supervised by qualified clinicians in all situations; however, students have been found to have a higher rate of clinical errors than experienced clinicians[34]. The high rate of early denture replacements by students in this study may reflect the replacement of dentures in which procedural errors were identified and corrected by replacement of the dentures.

4.1. Strengths and Limitations

The strengths of this study lie in the large number of dentures and the prolonged observation period. Every individual under treatment was captured, including the "marginalized and vulnerable", who are often less likely to participate in mainstream research projects[35]. The availability of routinely collected data, and the completeness of follow-up may have eliminated the effects of recall bias and low response rates[36], and the treatment outcomes identified reflect 'real world' dental care provided over many years by many different clinicians[37].

The data utilized in this study were not collected for the purpose of research. They were based on fee codes rather than clinical documentation and, as such, information on covariates was limited[37]. There was no information on denture fabrication methods, occlusal schemes, or the reason for denture replacement. Prognostic factors for denture success such as previous history of denture use, period of edentulism and number of previous dentures, were unknown[38]. It is also possible that participants sought denture treatment outside the Victorian public dental system and that treatment would not be recorded in the dataset. However, the edentulous are almost 6 times more likely to be eligible for public dental services and one third less likely to have private health insurance[39], thus the prevalence of denture care outside the public dental system in this population is likely to be low. More than three quarters of Australians over 65 years are eligible for public dental care, however the results may not be generalizable to privately insured or uninsured patients. Differences in public dental insurance schemes in other countries may also affect the generalizability of the results.

5. Conclusion

Complete dentures were most commonly replaced after approximately 6 years of service. Single dentures had a shorter longevity and lower survival than pairs of dentures. Excluding the early failure period, dentures made in private clinics, and dentures made by denturists had higher replacement rates than those made in public clinics, and by dentists, respectively.

Evidence on denture longevity will assist clinicians to inform patients regarding the appropriate lifespan for dentures, both at the treatment planning stage and at review appointments. It will assist third party providers to appropriately plan for and fund denture services and enable them to focus on improving service access for the elderly and socially disadvantaged.

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Conflicts of Interest

The authors report no conflicts of interest.

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