ORIGINAL ARTICLE

International Dental Journal 2014; 64: 260–268

doi: 10.1111/idj.12118

Caries experience and use of dental services in rural and urban adults and older adults from central Chile

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Objective: To determine whether there is a relationship between the use of dental services and caries experience in adults and older adults from central Chile. **Materials and methods:** A sample of 453 adults, 35–44 years of age, and 438 older adults, 65–74 years of age, was interviewed and examined using World Health Organisation (WHO) methods. Sociodemographic variables were also registered. Caries experience was assessed using the Decayed, Missing and Filled teeth (DMFT) index. Multiple linear regression models were used to determine whether there was an association between the independent variables and caries experience. **Results:** Caries prevalence was 99.6% for adults [DMFT score = 14.89 (±6.16)] and 99.8% for older adults [DMFT score = 25.68 (±6.49)]. Less than half of the population – 41.7% of adults and 31.5% of older adults – received dental care. Regardless of the age group, there were no differences in the DMFT score between those who received and those who did not receive attention ($P > 0.05$). When the DMFT findings were analysed in greater detail, people who received dental care and urban participants had more fillings ($P < 0.05$) than did those who were not provided with attention or lived in rural areas, who, in turn, had more missing teeth ($P < 0.05$). A higher educational level was associated with a decrease of 1.15 DMFT points ($P = 0.003$) in the group of older adults. **Conclusions:** Adults and older adults from the Maule Region showed severe dental damage from caries. Although rurality and use of services do not seem to affect caries experience, they are associated with differences in fillings and missing teeth.

Key words: *Dental caries, dental services, oral health, geriatrics, adults, disparities*

INTRODUCTION

Untreated dental caries is the most prevalent oral condition worldwide, affecting 35% of the population of all ages[1]. Although scarce information is available in Chile, the most reliable data indicate that caries prevalence ranges from 16.8% at 2 years of age to nearly 100% in the adult population nationwide[2]. Among all oral conditions, dental caries ranks first as a cause of disability-adjusted life years (DALYs). In Chile, oral conditions represent 1.4% of all DALYs, with dental caries comprising the highest proportion of the total burden of disease in adults[3].

Within the multifactorial aetiology of dental caries, various biological factors have been documented and studied for many years, including diet, oral bacteria, saliva and fluoride exposure[4]. More recently, some non-biological factors have expanded the way that caries is conceived, with caries development being associated with socio-economic factors and access to dental care[5]. The concept of access to health services is complex and comprises the perception of health needs with the demand and effective use of services. Therefore, the use of health services is influenced by individual factors, by characteristics of the health system, the social context and the past experience of using the services[6]. Some of these factors may be related to rurality. Whether rural life represents a risk factor for caries is largely unclear. This is especially interesting in the Maule Region, the most rural in the country, with 37.4% *versus* 13.4% of rural population for the rest of the country. Furthermore, the rural population of the Region has the lowest schooling level in Chile, of only 5.9 years[7].

It is widely acknowledged that gathering information about the status and the use of dental services is

a key component for producing efficient policies on prevention and treatment at the community level. Yet, available information on oral health is globally scarce and therefore it remains unclear whether a lack of access implies poor oral health indicators, particularly increased caries experience. In Chile, no information has been published on the situation of the use of dental services or on whether lack of care is associated with a higher burden of disease. The EpiMaule study, described here, was the first research project that analysed this subject at the regional level. This report is part of a larger study on oral health in the Maule Region in central Chile, with the primary aim being to determine whether sociodemographic characteristics and the use of dental services impact caries experience in adults and older adults.

Chile is facing an accelerated growth of the elderly population[7], which is usually impoverished and not covered by dental care provision. Hence, information about a potential relationship between the use of dental services and increased caries experience will provide support to raise awareness on the need of improving assistance to the increasingly larger population of elderly people.

MATERIALS AND METHODS

This cross-sectional study used data gathered from a major International Association for Dental Research (IADR) Regional Development Program (RDP) grant; 'RDP for training in research methods and oral health surveys and the assessment of oral health in the Chilean Division of the IADR'. The IADR RDP grant was awarded to the IADR Chilean and Australian divisions and the study was conducted by investigators from the University of Talca, Chile, in cooperation with the University of Melbourne, Australia, in 2011. The main goal of this study was to assess the oral health of different ages of people living in the Maule Region, in central Chile. The present study only reports on adults and older adults. Data on other age groups are in the process of publication elsewhere. Briefly, 453 volunteers, 35–44 years of age, and 438 volunteers, 65–74 years of age, were probabilistically selected for the study from educational institutions (in the case of adults) and from older adult's clubs (in the case of the older adults). Individuals with cognitive or verbal impairment were excluded from the study.

A multistage probability sampling design stratified by age was used to estimate proportions, ensuring the inclusion of participants with the presence or absence of fluoride in their drinking water as a surrogate indicator of rurality. Fluoridated drinking water is available for 98.22% of the population in the Maule Region, at the recommended dose of fluoride of 0.6–1.0 mg/L (WHO). Only 50.85% of the rural areas, however, are covered by the water fluoridation programme[7]. The reported prevalence of periodontal pockets deeper than 3 mm in adults 35–44 years of age and in older adults 65–74 years of age[2] was used to calculate sample size with a 95% confidence level and a 3% estimation error. Hence, a sample of 453 adults and 438 older adults was necessary. Data on periodontal status of this population forms part of a larger study and are being prepared for a separate report. Sample selection for the 35–44 years' age group was carried out by simple random sampling. Thus, participant schools were randomly chosen by random number software from the official list of schools in the Maule Region provided by the Ministry of Education. In the case of the 65–74 years' age group, older adult clubs were randomly selected from the official list of clubs provided by the National Service for the Elderly (SENAMA) in the Region.

The research protocol and the informed consent form were approved by the Bioethics Committee of the University of Talca. The study was conducted in full accordance with the World Medical Association Declaration of Helsinki. Data were collected through an interview and oral examination, using WHO recommendations and criteria[8], without the use of radiographs. Examinations were performed using a CPI (WHO) probe and mirrors, following standard infection-control procedures. Four examiners were trained in the application of the interview and were calibrated in caries detection. Intra- and interexaminer reliability was checked using Cohen's kappa statistics by the repetition of examinations on 28 individuals by each examiner. In both cases, kappa statistics were higher than 0.90, indicating almost complete agreement. The time required for each examination and survey was about 30 minutes.

The independent sociodemographic variables included were age, sex, marital status, education, residence, health insurance and occupation[9]. Data used to determine the use of dental services were the frequency and the type of provider, either public or private[10]. The dependent variable was caries status, as measured by the Decayed, Missing and Filled teeth (DMFT) index, which considers fillings and decayed and missing teeth[8].

Data were descriptively analysed for caries prevalence distribution according to the selected independent variables: age (years), sex (female or male), health insurance (public, private or other), educational level (no formal studies, primary, secondary or higher), occupation (employed, self-employed, housewife, retired or other) and dental visits during the 12 months preceding the survey (yes, no). Normal distribution of the data was verified using the Kolmogorov–Smirnov test. To determine the differences between groups for continuous dependent variables, the Student's *t*-test, analysis of variance (ANOVA)

and the chi-square test were used. A multiple linear regression model was fitted to determine the relative importance of each independent variable when predicting DMFT scores as the continuous dependent variable and the associated 95% confidence intervals (CIs) from the parameters estimated by the model. Data processing and management were performed using the SPSS v15 (IBM Corporation, Somers, NY, USA) statistical package.

RESULTS

Data missing owing to a lack of response or to the inability to answer the questions was lower than 2%.

Sociodemographic characteristics

Women comprised 85% of the sample of 35- to 44-year-old adults. Mean age of the participants in that group was 39.48 (±3.41) years, and 46.8% were living in urban areas (*Table 1*). Of the adult participants, 59.6% were married, 51.2% had completed secondary education and 47.5% reported being employed. Almost all of the participants (87.2%) were covered by public health insurance (*Table 1*). Most of the participants (77.4%) from the 65–74 years' age group were women with a mean age of 69.73 (±3.44) years. Of those, 52.1% lived in rural areas, 48.4% were married, 61% had primary education, 58% were retired and 91.1% were covered by public health insurance (*Table 2*).

Use of dental care services

In the 35–44 years' age group, 41.7% of the individuals reported that their last dental visit was <1 year ago and 60.3% were treated under the public health system. On the other hand, a lower population of

Table 1 Characterisation and bivariate analysis of the population, 35–44 years of age, according to the decayed, missing and filled teeth (DMFT) score, in the Maule Region, Chile

	n (%) (CI)	DMFT, mean (SD)	*D*, mean (SD)	*F*, mean (SD)	*M*, mean (SD)
Gender*					
Female	387 (85.4) (0.82–0.88)	15.29 (6.14)	2.84 (3.30)	5.64 (4.61)	6.81 (5.82)
Male	66 (14.6) (0.11–0.18)	12.56 (5.76)	2.88 (3.44)	4.41 (4.00)	5.27 (4.24)
		0.001	0.939	0.42	**0.012**
Residence*					
Urban	212 (46.8) (0.44–0.51)	14.63 (5.84)	2.44 (2.76)	4.95 (4.51)	6.01 (5.41)
Rural	241 (53.2) (0.49–0.58)	15.08 (6.37)	3.14 (3.64)	6.18 (4.50)	6.99 (5.76)
		0.448	0.21	**0.004**	0.069
Status†					
Single	105 (23.2) (0.19–0.27)	13.70 (5.75)	2.81 (3.07)	5.77 (4.48)	5.12 (4.17)
Married	270 (59.6) (0.55–0.64)	15.04 (6.27)	2.72 (3.28)	5.12 (4.35)	7.20 (5.77)
Divorced	39 (8.6) (0.06–0.11)	16.18 (4.80)	3.03 (3.41)	7.18 (5.38)	5.97 (5.93)
Widowed	7 (1.5) (0.00–0.03)	16.29 (8.849	3.71 (3.77)	2.14 (2.26)	10.43 (6.63)
Other, mean	29 (6.4) (0.06–0.04)	15.83 (7.07)	3.76 (4.13)	5.72 (4.97)	6.34 (7.32)
		0.147	0.525	**0.022**	**0.007**
Education†					
No formal studies	4 (0.8) (0.00–0.02)	13.50 (4.79)	3.75 (3.50)	2.00 (3.36)	7.75 (3.30)
Primary	145 (32) (0.28–0.36)	15.51 (6.73)	3.23 (3.59)	3.78 (3.75)	8.50 (6.66)
Secondary	232 (51.2) (0.47–0.56)	14.67 (5.78)	2.78 (3.25)	5.89 (4.58)	6.00 (5.01)
Higher	70 (15.5) (0.12–0.19)	14.46 (6.20)	2.31 (2.92)	7.63 (4.65)	4.51 (4.19)
		0.51	0.252	**<0.0001**	**<0.0001**
Occupation†					
Employed	215 (47.5) (0.43–0.52)	14.80 (5.82)	2.64 (3.11)	6.20 (4.75)	5.96 (5.20)
Self-employed	32 (7.1) (0.05–0.09)	12.56 (6.13)	2.41 (2.12)	4.97 (4.29)	5.19 (5.35)
Housewife	175 (38.6) (0.34–0.43)	15.50 (6.44)	3.23 (3.79)	4.59 (4.26)	7.69 (6.04)
Retired	4 (0.9) (0.00–0.02)	21.50 (5.91)	3.25 (2.75)	3.50 (4.12)	14.75 (7.67)
Other	24 (5.3) (0.03–0.07)	13.25 (6.08)	2.38 (2.60)	5.96 (3.87)	4.92 (4.49)
		0.013	0.374	**0.008**	**<0.0001**
Health Insurance†					
Public	395 (87.2) (0.84–0.90)	14.80 (6.15)	2.84 (3.31)	5.32 (4.47)	6.63 (5.62)
Private	15 (3.3) (0.02–0.05)	13.13 (4.03)	1.80 (1.97)	7.87 (3.75)	3.47 (2.58)
Other	34 (7.5) (0.05–0.01)	17.67 (9.26)	5.00 (4.38)	3.17 (4.53)	9.50 (8.80)
		0.086	0.244	0.035	0.085
Dental visits (last 12 months)*					
Yes	189 (41.7) (0.37–0.46)	15.23 (6.61)	3.19 (3.57)	6.58 (4.52)	6.29 (5.02)
No	264 (58.3) (0.53–0.62)	14.65 (6.51)	2.37 (2.86)	4.66 (4.39)	6.80 (6.04)
		0.32	**<0.0001**	**<0.0001**	0.329

SD, standard deviation.
*The Student's *t*-test was used for the association between variables.
†Analysis of variance was used between variables.
P-values in bold indicate statistically significant differences ($P < 0.05$).

Table 2 Characterisation and bivariate analysis of the population, 65–74 years of age, according to the decayed, missing and filled teeth (DMFT) score, in the Maule Region, Chile

	n (%) (CI)	DMFT, mean (SD)	D, mean (SD)	F, mean (SD)	M, mean (SD)
Gender*					
Female	339 (77.4) (0.74–0.81)	26.05 (6.40)	1.10 (1.88)	2.07 (3.53)	22.88 (8.97)
Male	99 (22.6) (0.19–0.27)	24.39 (6.66)	1.92 (2.85)	1.88 (3.18)	20.60 (8.81)
		0.025	**0.008**	0.627	**0.026**
Residence*					
Urban	210 (47.9) (0.43–0.53)	25.26 (6.36)	1.11 (1.71)	2.87 (4.12)	21.28 (9.19)
Rural	228 (52.1) (0.47–0.57)	25.99 (6.57)	1.42 (2.44)	1.40 (2.70)	23.17 (8.74)
		0.241	0.113	**<0.0001**	**0.03**
Status†					
Single	52 (11.9) (0.09–0.15)	22.63 (7.67)	1.17 (2.17)	3.13 (4.01)	17.79 (9.88)
Married	212 (48.4) (0.44–0.53)	25.41 (6.17)	1.39 (2.31)	2.23 (3.56)	21.79 (8.75)
Divorced	26 (5.9) (0.04–0.08)	24.27 (6.73)	1.81 (2.63)	3.04 (4.46)	19.42 (8.98)
Widowed	142 (32.4) (0.28–0.37)	27.35 (6.04)	0.93 (1.80)	1.22 (2.66)	25.20 (8.11)
Other	2 (0.5) (−0.00 to 0.01)	25.00 (1.41)	0.50 (0.70)	0.00 (0.00)	24.50 (0.70)
		<0.0001	0.089	**0.002**	**<0.0001**
Education†					
No formal studies	53 (12.1) (0.09–0.15)	26.34 (7.25)	1.06 (1.77)	0.72 (1.65)	24.57 (8.19)
Primary	267 (61) (0.56–0.66)	26.34 (5.81)	1.39 (2.27)	1.30 (2.43)	23.64 (7.72)
Secondary	96 (21.9) (0.18–0.26)	24.15 (7.10)	1.26 (2.10)	3.76 (4.51)	19.13 (10.22)
Higher	22 (5) (0.03–0.07)	22.73 (7.94)	0.68 (1.93)	6.41 (5.47)	15.64 (12.46)
		0.004	0.397	**<0.0001**	**<0.0001**
Occupation†					
Employed	11 (2.5) (0.01–0.04)	21.00 (6.89)	1.91 (2.30)	2.45 (3.47)	16.64 (7.65)
Self-employed	17 (3.9) (0.02–0.06)	22.94 (5.27)	2.76 (3.49)	3.41 (4.52)	16.76 (8.05)
Housewife	145 (33.1) (0.29–0.38)	25.92 (6.55)	1.34 (1.97)	1.79 (3.13)	22.79 (8.68)
Retired	254 (58) (0.53–0.63)	26.06 (6.37)	1.13 (2.14)	2.05 (3.58)	22.88 (9.09)
Other	8 (1.8) (0.01–0.03)	19.50 (5.39)	1.75 (1.75)	2.50 (2.44)	15.25 (6.08)
		0.002	**0.032**	0.444	**0.002**
Health insurance†					
Public	399 (91.1) (0.88–0.94)	25.79 (6.47)	1.32 (2.22)	2.01 (3.44)	22.46 (8.97)
Private	8 (1.8) (0.05–0.03)	24.75 (7.97)	0.50 (1.06)	2.75 (3.88)	21.50 (9.08)
Other	3 (0.7) (−0.00 to 0.02)	26.00 (8.48)	0.00 (0.00)	1.50 (2.12)	24.50 (10.60)
		0.442	0.609	0.928	0.619
Dental visits (last 12 months)*					
Yes	138 (31.7) (0.27–0.36)	25.01 (6.21)	1.16 (1.95)	3.22 (4.24)	20.62 (8.72)
No	296 (68.3) (0.59–1.23)	26.00 (6.62)	1.34 (2.26)	1.50 (2.88)	23.16 (9.04)
		0.138	0.409	**<0.0001**	**0.006**

SD, standard deviation.
*The Student's t-test was used for the association between variables.
†Analysis of variance was used between variables.
P-values in bold indicate statistically significant differences ($P < 0.05$).

older adults (31.5%) had received dental care in the previous year and also a lower proportion (50.5%) were treated under the public health system (*Table 3*).

Caries status

Caries prevalence in the 35–44 years' and 65–74 years' age groups was 99.6% (95% CI: 0.98–1.001) and 99.8% (95% CI: 0.98–1.002), respectively. The average DMFT values were 14.89 (±6.16) and 25.68 (±6.49) for the 35–44 years' and 65–74 years' age groups, respectively (*Table 4*).

Association of DMFT with sociodemographic variables

When a potential association between caries (DMFT) and the study variables was tested (*Table 1*), 35- to 44-year-old women showed a significantly higher DMFT value ($P = 0.001$) compared with men [15.29 (±6.14) *vs* 12.56 (±5.76), respectively]. Likewise, women of this age group had more missing teeth than did men ($P = 0.012$). Single people and those living in rural areas had more fillings than did subjects with other marital status ($P = 0.022$) and urban adults ($P = 0.004$). With regard to missing teeth, widowers had higher scores than did participants with other marital status ($P = 0.007$). Regarding education, a direct relationship between fillings and higher level of education was observed ($P = 0.0001$). Conversely, more missing teeth were observed in subjects with a lower education level ($P = 0.0001$). Housewives had a higher DMFT score ($P = 0.013$) and retirees showed more missing teeth than did subjects in other occupations ($P = 0.0001$). Most of the fillings had been performed in the private health care system ($P = 0.035$). In the 65- to 74-year-old group (*Table 2*), women had higher DMFT scores ($P = 0.025$) and more missing

Table 3 Use of dental care services in the Maule Region, Chile

Variable	Age group (years), n (%) (95% CI)	
	35–44 (n = 453)	65–74 (n = 438)
Last visit*		
<1 year	189 (41.7) (0.37–0.46)	138 (31.5) (0.27–0.36)
1–2 years	84 (18.5) (0.14–0.22)	75 (17.1) (0.14–0.21)
2–5 years	88 (19.4) (0.16–0.23)	92 (21) (0.18–0.25)
5–10 years	44 (9.7) (0.07–0.12)	52 (11.9) (0.09–0.15)
More than 10 years	34 (7.5) (0.05–0.09)	73 (16.7) (0.13–0.20)
Never	7 (1.5) (0.00–0.03)	4 (0.9) (0.00–0.02)
Do not know/ No answer	7 (1.5) (0.00–0.03)	4 (0.9) (0.00–0.02)
Provider*		
Public	273 (60.3) (0.58–0.65)	221 (50.5) (0.46–0.55)
Private	167 (36.9) (0.33–0.41)	187 (42.7) (0.38–0.47)
Dental laboratory	7 (1.5) (0.00–0.03)	25 (5.7) (0.04–0.08)
Do not know/ No answer	6 (1.3) (0.00–0.02)	5 (12) (0.09–0.15)

95% CI, 95% confidence interval.
*Analysis of variance was used between variables.

teeth ($P = 0.026$) than did men. Regarding the place of residence, people in urban areas had more fillings compared with their rural counterparts ($P = 0.0001$). Widowers showed a higher DMFT score ($P = 0.0001$) and more missing teeth ($P = 0.0001$) than did single, married or divorced people. An inverse relationship was observed between DMFT and education level ($P = 0.004$). Specifically, higher educational level was related to more fillings ($P = 0.0001$). Retirees or housewives had a higher DMFT score than did subjects in employment ($P = 0.002$).

Relation of caries experience and the use of dental service

No significant associations were observed in the group of adults when relating caries experience as a whole (DMFT) with the use of any dental service during the last 12 months ($P = 0.32$). However, people who had received dental care in the past year had more carious lesions ($P < 0.0001$) and more fillings ($P < 0.0001$) than did individuals who did not receive dental care during the previous year (*Table 1*). Likewise, older adults showed no significant associations between use of service and DMFT ($P = 0.138$). When DMFT components are individually considered, however, people receiving dental care in this age group had more fillings ($P = 0.0001$) and missing teeth ($P = 0.006$) than did individuals who had not received dental care in the year prior to the oral examination (*Table 2*). In 35- to 44-year-old adults (*Table 5*), age and gender were associated with the DMFT score. Thus, the DMFT score increased by 0.57 units for each year of age ($P = 0.0001$). Being male implied a decrease of 2.94 points in the DMFT score compared with being

Table 4 Caries experience index (DMFT) according to study group

	DMFT Index							
	35–44 years				65–74 years			
	Mean	SD	Min–max	95% CI	Mean	SD	Min–max	95% CI
DMFT	14.89	6.16	0–32	14.33–15.46	25.68	6.49	0–32	25.07–26.29
D	2.85	3.32	0–20	2.54–3.16	1.29	2.17	0–15	1.08–1.49
F	5.46	4.54	0–21	5.04–5.88	2.03	3.46	0–16	1.70–2.35
M	6.58	5.64	0–32	6.06–7.10	22.36	8.98	0–32	21.52–23.21

95% CI, 95% confidence interval; D, decayed; DMFT, decayed, missing and filled teeth; F, filled; M, missing.

Table 5 Association between decayed, missing and filled teeth (DMFT) index and independent variables: multivariate analysis of populations 35–44 and 65–74 years of age

Variable	35–44 years				65–74 years			
	β	*P*-value	95% CI		β	*P*-value	95% CI	
			Lower	Upper			Lower	Upper
Access	0.775	0.164	−0.319	1.869	−0.877	0.173	−2.14	0.385
Age	0.570	<0.001	0.411	0.729	0.455	<0.001	0.283	0.627
Sex	−2.944	<0.001	−4.476	−1.412	−2.131	0.004	−3.562	−0.701
Education	−0.072	0.861	−0.875	0.731	−1.155	0.009	−2.020	−0.290
Residence	0.488	0.386	−0.616	1.591	0.645	0.303	−0.585	1.875
Constant	−5.116	0.174	−12.508	2.276	−1.590	0.803	−14.135	10.995

95% CI, 95% confidence interval.
Linear regression.

female ($P = 0.0001$). Likewise, in older adults (*Table 5*), age and gender were also associated with the DMFT score. In this age group, for every year of age the DMFT score increased by 0.45 units ($P = 0.001$) and being male implied a decrease of 2.13 points in the DMFT score ($P = 0.005$). Additionally, higher level of education implied a decrease of 1.15 points in the DMFT score ($P = 0.003$).

DISCUSSION

Consistent with other national reports[2], the present study indicated a high burden of disease in the population studied. In fact, the prevalence of caries in the 35–44 years' and 65–74 years' age groups was 99.6% and 99.8%, respectively. Additionally, both groups showed a high caries experience, as measured by the DMFT index, with scores of 14.89 (±6.16) and 25.68 (±6.49) for the 35–44 years' and 65–74 years' age groups, respectively. Epidemiological studies in Chile[2] and Brazil[11,12] have shown similar results for the adult population. Adults and older adults in Chile did not benefit, during childhood, from the oral health promotion and prevention activities that are currently available. This lack of intervention could explain the high severity of caries reported in this study. Historical and social events and various health policies over time have had an effect on these cohorts, which have benefited from measures such as water fluoridation, the development of anaesthetics, fluoride supplementation and the widespread use of toothpastes[13]. Similarly to other countries[14], a more detailed analysis of caries experience in this population shows that women in both age groups had higher DMFT scores and more missing teeth compared with men (*Tables 1* and *2*). This result could be attributed to the fact that pregnant women experience several extrinsic and intrinsic changes that make them vulnerable to dental caries, such as changes in salivary production and oral microbiota, social changes influencing lifestyle, an increasingly cariogenic diet and poor brushing techniques, because of nausea and symptoms related to pregnancy. All of these factors may act as risk factors for the onset of caries[15]. However, the precise mechanisms associated with these differences in susceptibility to dental caries according to gender are still unknown.

With a higher percentage of women than of men (*Tables 1* and *2*), the population under study was unevenly distributed and differed from the true population distribution of the country and of the Maule Region[7]. The higher number of female participants can be explained by the nature of the sample, which included parents and/or guardians of school-age children for the 35–44 years' age group. In general, women tend to take responsibility for their children in relation to schooling. In the case of the other group under study, they were organised in clubs for older adults, in which most of the participants are women[16]. Regardless of the gender differences in the participants in this study, it has been reported that women have a higher caries experience compared with men[17–19], as pointed out above. This situation may make women more prone to have an interest in participating in this type of study. Furthermore, there may be an underlying selection bias because of a higher demand by women for receiving oral health services compared with men.

Data from this study showed that rural adults had more fillings on average than their urban counterparts (*Table 1*). Although this may seem unusual, the difference could be the result of a higher quantity of health-care centres in rural areas in the Maule Region than in other regions in Chile, as a result of its high rurality (33.6%), the highest in the country[20]. Unlike the results for adults, older adults living in urban environments had more fillings than did older adults in rural areas (*Table 2*). This may be the result of easier access to dental care services in cities than in rural areas. In rural areas, people usually live dispersed in a large territory, making the use of dental care services complicated for the older population, especially when they are fragile, poor and/or dependent.

In both age groups, there were more fillings as the educational level rose. In contrast, there were more missing teeth in participants with lower educational levels. This finding suggests that education is associated with higher use of dental services. These data are consistent with information from the National Health Survey 2009–2010, which found that people with higher educational levels had increased use of dental services[21]. In this context, the results of low use of dental services observed in this study are in line with the low literacy rate in the region (92.6%), which is the lowest in the country[20] and even lower in rural areas. Moreover, educational coverage in the Maule Region is 70.8%, which is also the lowest in Chile. Thus, it is possible to explain the lack of use of dental services and the poor oral health status in the population by these educational, socio-economic[22] and cultural[23] factors.

Less than half (41.7%) of the population of adults from the Maule Region received dental care in the past year. Our data are consistent with national information from the National Health Survey 2009–2010, which showed that approximately 41.3% of adults had visited a dentist during the last year[21]. Against expectation, there was no difference in the use of services either between age groups or between urban or rural areas (data not shown). Previous data from Chile[20] showed that urban populations used more dental services compared with their rural counterparts. Discrepancy between the data shown here and

the national information might be explained by the high rurality in the Maule Region. In fact, in this region, 72.6% of primary care facilities are located in rural areas. In the case of the elderly population, only 31.7% had received dental care in the past year. These data were higher than the previous national reports of 21.5%[2], but are still lower than the most recent information, at the country level, of over 40.4%[21]. According to studies on the use, unmet needs and satisfaction with oral health services in the USA, only around 50% of the population had access to a dental visit in the past year, with 34.7% receiving attention within the last 6 months[9]. The inability to access dental care in the previous year was significantly associated with insurance coverage, health status and gender. Similar results were reported in Belgium, where 49.7% of the participants had not visited a dentist in the year prior to the survey, which was associated with a low educational level, male gender and low family income[8]. Residence location can also explain differences in oral health status. For example, people living in rural areas in Australia have a higher DMFT score (with more decayed and lost teeth and fewer fillings) compared with people living in urban areas[10]. Although the differences observed in caries experience between urban and rural areas may be explained by limitations in accessing dental services, other causes were argued, including age and low socio-economic status. A striking finding of the present study is the fact that people who received dental care had more carious lesions and fillings than did those who did not receive dental care in the preceding year (*Tables 1* and *2*). A potential explanation for that situation may be derived from the low access to oral health care in the Chilean adult population. Adults have no coverage in the Chilean dental public system, and coverage for older adults in Chile is limited to only one dental care programme restricted to be used when that person is 60 years old. As no state subsidy for dental coverage applies for the adult population, access to the private health system is unaffordable for most people, whose pensions are usually very low. Hence, people who used the services during the last 12 months are most likely to be those who have the worst oral situation. Thus, it is totally possible that these individuals have more missing teeth as a result of caries and more fillings. Chile has established priorities in the provision of dental services[24]. Thus, children, adolescents and pregnant women are defined as the priority populations. In this context, adults and older adults are excluded from coverage by the state, except for dental emergencies and some few restorative programmes with low coverage, nonetheless. Although rational from a financial standpoint, prioritising dental services for young people could lead to dramatic social consequences for the country. Given that a higher life expectancy is anticipated for the coming years in Chile and worldwide, this underserved growing population will increase the complexity of the problem. Life expectancy in Chile has reached 78 years in recent decades[20]. The oral health situation of older adults will depend on the strategies adopted in the country for those populations that today are children, teenagers and adults. Cultural patterns, nonetheless, help little to cope with the situation affecting the adult population. As a matter of fact, adults often accept poor oral health status with the belief that oral health damage is a normal part of the ageing process[25]. Elderly subjects have more oral diseases and poorer access to dental care, especially individuals with lower socio-economic status[26], than do the rest of the population, as shown here (*Tables 1* and *2*).

In addition to health implications, oral diseases have a strong impact on socio-economic factors as a result of the high costs associated with their treatment. In fact, only 45% of the participants had access to private dental care (*Table 3*). Data showed that people who had private insurance had more fillings and fewer extracted teeth compared with participants with public insurance, without differences in the DMFT as a whole. It seems reasonable to speculate that caries experience does not change when the use of dental care services improves. Some components of the index, however, are directly related to the use of dental care facilities. This represents a challenge for the Chilean health system because it has been reported that having dental insurance facilitates service utilisation[27]. In fact, older adults with insurance visit the dentist 2.5 times more and are more likely to retain teeth and to maintain more favourable attitudes toward oral health[28] than are those who are uninsured. Given the lack of information, further studies relating the type of health insurance or coverage with oral health status are suggested.

A limitation of this study is the cross-sectional nature of the research. These studies cannot assess causality, directionality of the association or determine the exposure time. It is important to recognise that this study is not representative of all 65- to 74-year-old adults in the Maule Region because, for logistical reasons and available resources, our sampling strategy only considered older adults organised in clubs. Therefore, selection bias is expected because subjects who did not participate in senior centres were excluded from the study. Likewise, a similar source of bias is expected in the adult group, as the study designs did not consider those who were not guardians or who did not have school-age children.

In summary, the results indicate that 41.7% and 31.5% of adults and older adults in central Chile,

respectively, received dental care, especially in the public health system. A high prevalence of dental caries was found, affecting nearly all of the participants in both groups. People who received dental care had more fillings, and those who did not receive dental care had more missing teeth. Rurality does not appear to have a significant effect on caries experience, but it does condition differences in the number of fillings. Higher use of dental services seems to relate to more fillings and fewer missing teeth as a result of caries, regardless of age of the subject. These data urge policymakers to increase coverage and the use of dental services and to promote cost-effective oral health measures for the growing population of older adults.

Acknowledgements

The authors thank the students from the Dental School of the University of Talca who participated in registering the data during the field stage of the project. This study was partially funded by an RDP of the IADR awarded by the Australian and Chilean Divisions of the IADR to RAG and RJM and by a grant awarded by the University of Talca to RAG.

Competing Interest

The authors declare no conflict of interest.

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