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# Factors Associated with Tooth Loss in Older Adults in Rural Colorado

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## Abstract

The purpose of this paper is to examine factors that are associated with tooth loss in older adults living in the San Luis Valley (SLV), Colorado, which is a rural and large geographical area (roughly the size of Connecticut) that has a large population age 60 years or older. Data used in this manuscript were collected as a part of the SLV Community Health Survey. The analyzed sample included 308 adults over the age of 65 years who completed the survey. Basic descriptive statistics and a series of step-wise binary logistic regression analyses were conducted; the dependent variable was the number of permanent teeth removed because of tooth decay or gum disease. Fifty-two percent of the participants were male, Hispanic participants made up 40 % of the sample and 76 % of the participants had at least a high school education. Tooth loss was significantly associated with older age (*OR* = 1.09; *p* = 0.02), lower income (*OR* = 0.01; *p* = 0.00), less than high school education (*OR* = 0.32; *p* = 0.01), being Hispanic (*OR* = 2.15; *p* = 0.05), self-reported fair-poor health status (OR 2.94; *p* = 0.02), consumption of one or more than one sweet beverage per day (*OR* = 4.52*; p* = 0.00), no dental insurance (*OR* = 4.70; *p* = 0.01) and length of time since last dental visit (*OR* = 0.21; *p* = 0.01). The findings of the present study suggest possible causes for tooth loss in rural adults and underscore the need for in-depth research to study the overall oral health of rural older adults living in SLV.

### Keywords

Older adults; Tooth loss; Sam Luis valley; Rural communities

## Introduction

Tooth loss or ‘dental mortality’ is one of the most important indicators of oral health status in older adults; it reflects the lifelong cumulative effects of both disease and social factors [4,

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24]. According to the National Health and Nutrition Examination Survey, 57 % of adults aged 65 years or older report poor or fair oral health [22]. A recent study reported that poverty and minority race/ethnicity were significantly associated with poor oral health outcomes in OHQOL and number of permanent teeth [12]. Studies suggest that tooth loss in older adults affects food choices due to pain or discomfort, is associated with both weight loss and obesity, and can have a substantial negative impact on quality of life [17, 21].

Tooth loss is a multi-factorial process involving dental caries; periodontal disease; and a variety of socio-environmental factors such as socio-economic status (SES), educational levels, access to care, and insurance status; and general health status [1, 4]. A recent study reported that less educated, and lower incomes increased the odds of edentulism and more missing teeth in older adults [23]. A significant proportion of older adults (age 65 or older) do not view oral healthcare as an important part of their overall health and well-being [15]. Older adults with low income and less education have been found to have lower expectations of good health in their old age [21].

Older adults living in rural areas have less favorable oral health than their counterparts in urban areas [22]. Older rural adults who belong to racial and ethnic minority groups and those who have less than high-school education have fewer teeth than their urban counterparts and are consequently more likely to be edentulous later in life [14, 22]. Older rural adults are more likely to be uninsured and report fewer dental visits in the past year and poorer dental status than their urban counterparts [22]. Kiyak et al. [15] reported that older adults residing in rural areas have more unmet dental needs and lower utilization of dental services.

This paper examines the factors that are associated with tooth loss in older adults in the San Luis Valley (SLV), Colorado, which is rural, geographically isolated and an economically disadvantaged area is covering roughly the size of Connecticut that has a large population age 60 years or older. SLV not only has a high proportion of older adults but a high density of ethnic minority older adults as well. Data used in this manuscript were collected as a part of the SLV Community Health Survey (SLVCHS), which describes the health status of this population.

## Methods

### Study Design

The study was approved by the Colorado Multiple Institutional Review Board. Participants in the SLVCHS were randomly selected using a stratified, multistage cluster design. The target sample size was 1100 completed health surveys (~175 adults in each of six rural counties) SLV in Colorado. A cluster design was chosen over a simple random sample to increase efficiency by eliminating the need to create a sampling frame of all occupied households in the SLV and by reducing the travel of data collectors. The stratified design assured a defined sample size in each stratum.

Sampling frame strata included: (1) county and (2) population density. “Low” density was defined as Census blocks having fewer than 50 people per square mile based on 2009

estimated population and “high” density was defined as those Census blocks having at least 50 people per square mile. In the first stage of sampling, a proportionate random sample of clusters of Census blocks (Primary Sampling Units—PSUs) was selected [11, 16]. In the second stage of sampling, a sample of housing units (the Secondary Sampling Unit; SSU) within PSUs was selected so that each household within a county had an equal probability of being selected. Maps of each sampled PSU including (1) an aerial photograph, (2) a street data layer, and (3) house numbers from the SLV GIS/GPS Authority database for mapping a route and identifying the randomly selected starting household. A total of 16 Community Liaisons (CLs), who were familiar with the communities, then followed pre-determined routes drawn on the maps. In the third stage of sampling, one adult was randomly selected to participate in the health survey from each household selected in stage 2. This was accomplished by conducting a brief interview at each selected household that included an enumeration of all adults (18 years of age or older) and their birthdates. The adult with the next closest birthday to the date of the interviewer’s visit was selected to complete the health survey.

## Data Collection Procedure

A trained Data Collector was assigned to complete the survey with the selected adult as soon as the Community Liaison called the respondent’s contact information into the office. All surveys were completed within 1 month of the enumeration visit. In most cases, that survey was completed over the phone within a week of the enumeration visit and audio recorded for quality control. On participant request, surveys were conducted in person at the home (8 % of respondents). Interviews were completed for 90 % of participants who agreed to the enumeration visit.

## Survey Instrument

**San Luis Valley Community Health Survey—**Most of the survey questions were based on the Behavioral Risk Factors Surveillance System, a national survey conducted by the Centers for Disease Control and Prevention on a random sample of US adults every year and the Colorado Health Access Survey conducted by the Colorado Health Institute every 2 years since 2008. There were a total of 222 questions, and the survey took 45 min to 1 h to complete. Eligibility to be in the survey included adults (over the age of 18 years) who had resided in the SLV more than 6 months out of the prior year.

## Data Analyses

Basic descriptive statistics (frequencies) and a series of step-wise binary logistic regression analyses were conducted using procsurvey logistic in SAS 9.3. The weighting variable took into account survey design, age, ethnicity and gender. In every logistic regression model, the dependent variable was the number of permanent teeth removed because of tooth decay or gum disease (6 or more = 1; 5 or fewer = 0). The demographic covariates were age, ethnicity, gender, level of education, and family income. A series of logistic regression models were run to test the main effects and some interaction effects of variables with a known association with tooth loss, including various chronic diseases, health risk behaviors and other social determinants of health (Table 1).

## Results

A total of 1187 respondents completed the survey; however, only 308 were over the age of 65, which is the sub-sample whose data were analyzed for this study. Table 1 provides the weighted distribution of the demographic characteristics of this study's sample, unweighted measures are presented for comparison. The majority of the respondents were male (52 %) and Hispanic respondents were 40 %. More than half of the respondents had an annual income of less than $25,000, and 76 % respondents had at least a high school education. Twenty- nine percent of the participants (n = 308) were edentulous, 37 % had lost 1–5 teeth, and 20 % had lost 6 or more but not all teeth. Edentulism increased with age; 15 % of participants between 65 and 75 years, 25 % between 75 and 85 years and 58 % above the age of 85 years were edentulous.

In a multivariate regression model adjusted for demographics (Table 2), loss of 6 or more teeth (compared with fewer than 6) was significantly associated with older age (*OR* = 1.09; *p* = 0.02), lower income (*OR* = 0.01; *p* = 0.00), less than high school education (*OR* = 0.32; *p* = 0.01), being Hispanic (*OR* = 2.15; *p* = 0.05), self-reported fair-poor health status (OR 2.94; *p* = 0.02), consumption of one or more than one sweet beverage per day (*OR* = 4.52; *p* = 0.00), no dental insurance (*OR* = 4.70; *p* = 0.01) and length of time since last dental visit (*OR* = 0.21; *p* = 0.01).

Having diabetes did not have a statistically significant association with loss of 6 or more teeth in our sample (*OR* = 1.30; *p* = 0.69), but the interaction between income and diabetes was significantly associated with tooth loss in the older adults (*p* value = 0.00). Table 3 presents data on the number of teeth lost in participants who had an annual income of less than $25,000 and more than or equal to $25,000 depending on their diabetic status as informed to them by their physician. A higher percent of respondents who had an income higher than $25,000 and were diabetic had lost 6 or more teeth (71.4 %) than those who had an income lower than $25,000 and were diabetic (65.5 %).

Not having dental insurance was highly associated with tooth loss (*OR* = 4.70, *p* = 0.01). Regular dental visits were protective of teeth retention in older adults. Participants who visited the dentist within 1–2 years had lower odds of tooth loss (OR = 0.21 *p* = 0.01). Participants who visited the dentist in last 2–5 years as compared to 1 year had higher odds of tooth loss (OR = 7.76 *p* = 0.01).

## Discussion

In this study we found that tooth loss was significantly associated with lower income and daily consumption of sweet beverages. The other factors that were significantly associated with tooth loss in older adults were not having dental insurance; the length of time since last dental visit; older age; poor or fair general health status and belonging to Hispanic community. The age-related effect on tooth loss can be attributed to the accumulation of oral disease over the life span.

Dental caries is the major reason for tooth extraction in the elderly, [3, 7] and diet containing high sugars is a major cause of dental caries at any age. Sheiham and James [20], in a latest

study emphasized on the role of sugar in dental caries saying… “the only critical factor that determines the caries process in practice is sugar”; they also reported that the majority of caries in permanent teeth occurs in adults, not children, indicating that sugar-induced dental caries progresses throughout life [20]. Though dental caries was not measured as an outcome of this study, daily consumption of sweet beverages was significantly associated with tooth loss suggesting that the older adults may have suffered from higher dental caries, especially root caries, which is the most common cause of extraction of teeth [19].

Our findings are related to tooth loss associated with income, not having dental insurance and last visit to the dentist were similar to the other studies in the literature. Income has been identified as a risk factor for tooth loss in older adults. Seniors with less income were most likely to be edentulous, as reported in the National Survey of Oral Health in US Employed adults and seniors [5]. According to a CDC report (2003), tooth retention was less in individuals whose annual household income was less than $15,000 than among those with higher income [2]. Low income was associated with an increase in complete tooth loss from 19 % of older adults (aged 65–74 years) in 1988–1994 to 23 % in 1999–2004 [5]. Gilbert et al. [8], conducted a study to see if social disparities and belonging to ethnic minority played a role in tooth loss and access to dental care and reported that tooth loss was common in older adults with fewer financial resources and those who sought care on a problem-oriented basis.

In the United States, it is more common for older adults to pay for dental services themselves without the benefit of insurance [9, 18]. Medicare does not cover routine services, and Medicaid provides only limited coverage in certain states; the majority of older adults lose their dental insurance when they retire [9]. Data show that poor, low-income, and ethnic minority older adults are less likely to have dental coverage than wealthier older adults [6, 18]. The older adults living in SLV have low SES with more than 50 % having an income of less than $25,000; this could lead to low dental care use rates as they might not be able to afford dental insurance or pay for transportation to reach the dental office. Similar outcomes were seen in the Florida Dental Care Study, where ethnic and low SES adults endured the disease and its burden until treatment could not be delayed any longer [8]. Also, according to the literature, when older adults who have lower SES and lack dental insurance do seek care, there are greater chances that they are offered tooth extraction as a treatment modality rather than other alternative treatments, thus increasing the risk of tooth loss even with access to the dental care system [8, 13, 25].

Strengths of the study include the strong study design, which allowed for the collection of data from a representative sample of older adults in the SLV, and the collection of many variables about demographic, behavioral, and disease status characteristics. This is also one of the few studies that have examined correlates of tooth loss in older adults in a rural setting. One weakness of the study is the lower sample of size of older adults. Despite the fact the study collected data from 1,187 adults in the SLV, only 308 were over the age of 65. That being said, this did allow for sufficient statistical power to detect some effects.

## Conclusion

Older adults in rural communities have disparately poor oral health outcomes. Tooth loss can have a profound effect on the quality of life of older individuals by restricting food choices, impairing chewing ability, affecting speech, limiting social interaction and lowing the self-esteem [10]. This study has provided initial data on factors related to tooth loss in older adults living in a rural and economically disadvantaged area in Colorado. However, more research is warranted to examine the effect of social, cultural and economic factors related to the overall oral health of older adults in the SLV that can inform policy makers to develop preventive interventions for this population.

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**Table 1**

Demographics and potential risk factors affecting oral health of survey respondents 65 years or older (n = 308)

| Characteristics | Weighted | Unweighted |
|---|---|---|
| Age median (range) | 72.4 (65–93) | 73.0 (65–93) |
| Ethnicity (%) | | |
| Hispanic | 39.7 | 47.1 |
| Non-hispanic white | 60.0 | 51.6 |
| Other | 0.3 | 1.3 |
| Gender (%) | | |
| Male | 52.3 | 42.2 |
| Female | 47.7 | 57.8 |
| Education (%) | | |
| Less than high school | 24.4 | 25.6 |
| High school graduate | 35.3 | 32.8 |
| Some college | 19.7 | 20.0 |
| College graduate | 20.5 | 21.6 |
| Income (%) | | |
| Less than $25,000 | 53.9 | 61.6 |
| $25,000 to <$50,000 | 31.9 | 26.9 |
| $50,000 to <$75,000 | 10.6 | 8.1 |
| $75,000 or greater | 3.6 | 3.3 |
| Diabetes (%) | | |
| Yes | 17.4 | 18.2 |
| No | 82.6 | 81.8 |
| Cardiovascular disease (%) | | |
| Yes | 16.1 | 17.9 |
| No | 83.9 | 82.1 |
| Hypertension | | |
| Yes | 59.0 | 57.5 |
| No | 41.0 | 42.5 |
| Smoking status (%) | | |
| Currently smoke every day | 5.7 | 5.9 |
| Currently smoke some days | 2.1 | 2.3 |
| Ex-smoker | 42.8 | 41.5 |
| Never smoked | 49.4 | 50.3 |
| Health status (%) | | |
| Poor | 12.8 | 11.1 |
| Fair | 17.6 | 22.6 |
| Good | 27.7 | 28.8 |
| Very good | 28.6 | 25.8 |
| Excellent | 13.3 | 11.8 |
| Consumption of 1 or more sweet drinks per day | | |

| Characteristics | Weighted | Unweighted |
|---|---|---|
| Yes | 32.3 | 33.7 |
| No | 67.7 | 66.3 |
| Often get the social and emotional support they need | | |
| Never | 8.2 | 10.0 |
| Rarely | 2.8 | 5.5 |
| Sometimes | 16.3 | 14.8 |
| Usually | 25.5 | 25.8 |
| Always | 47.1 | 44.0 |
| Number of teeth removed due to decay or gum disease (%) | | |
| None | 14.8 | 16.2 |
| 1–5 | 36.5 | 26.6 |
| 6 or more, but not all | 20.1 | 22.6 |
| All | 28.6 | 34.7 |
| Dental insurance (%) | | |
| Yes | 17.5 | 19.9 |
| No | 82.5 | 80.1 |
| Time since last dental visit (%) | | |
| Less than a year ago | 55.6 | 48.3 |
| 1–2 years ago | 11.9 | 12.7 |
| 2–5 years ago | 11.0 | 11.0 |
| 5 or more years ago | 21.5 | 28.0 |

Percentages may not add up to 100 % because they are rounded to the nearest percent

## Table 2

Model of association between participant characteristics and tooth loss (6 or more teeth lost vs. fewer) (n = 308)

| Variable | Odds ratio* | *p* value |
|---|---|---|
| Age | 1.09 | 0.02 |
| Hispanic versus non-hispanic white | 2.15 | **0.05** |
| HS or greater versus less than HS | 0.32 | **0.01** |
| $25,000– < $50,000 versus < $25,000 | 0.10 | 0.00 |
| Diabetes | 1.30 | 0.69 |
| Income* diabetes | | **0.01** |
| Cardiovascular disease | 1.40 | 0.54 |
| Hypertension | 1.42 | 0.38 |
| Health status: fair-poor versus good–excellent | 2.94 | 0.02 |
| Currently smoke every day versus never | 1.76 | 0.56 |
| Currently smoke some days versus never | 3.68 | 0.24 |
| Ex-smoker versus never | 1.72 | 0.18 |
| Ever smoke 100 cig versus never | 1.80 | 0.16 |
| 1 drink last 30 days: no versus yes | 1.19 | 0.65 |
| Drink 1+ sweet drink/day yes versus no | 4.52 | **0.00** |
| Fat snack sometimes—always versus never, rare | 1.89 | 0.12 |
| Social support: never, rare versus sometimes-always | 1.58 | 0.50 |
| Life sat: sat-very s versus very dissatisfied | 1.24 | 0.80 |
| Dental Insurance: no versus yes | 4.70 | **0.01** |
| Last seen dentist: 1–2 years ago versus <1 year | 0.21 | **0.01** |
| Last seen dentist: 2–5 years ago versus <1 year | 7.76 | **0.01** |
| Last seen dentist: 5+ years ago versus <1 year | 5.40 | **0.05** |

Odds ratio and *p* value of variable in logistic regression model adjusted for age, ethnicity, gender and education

Bold values are statistically significant ($p < 0.05$)

**Table 3**

Frequencies of interactions between Income, Diabetes and number of teeth lost

| | Income Level | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <$25,000 | | | | ≥$25,000 | | | |
| | Diabetes no | | Diabetes yes | | Diabetes no | | Diabetes yes | |
| | N | % | N | % | N | % | N | % |
| Number of teeth lost | | | | | | | | |
| 0–5 teeth lost | 41 | 31.5 | 10 | 34.5 | 59 | 66.3 | 4 | 28.6 |
| 6 or more teeth lost | 89 | 68.5 | 19 | 65.5 | 30 | 33.7 | 10 | 71.4 |
| All | 130 | 100 | 29 | 100 | 89 | 100 | 14 | 100 |

DM: Diabetes Mellitus interaction with income using logistic regression. $p = 0.01$