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## RESEARCH ARTICLE

# Oral health among the elderly in 7 Latin American and Caribbean cities, 1999-2000: a cross-sectional study

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## Abstract

**Background:** To describe the prevalence of missing teeth, use of bridges and dentures and unmet dental needs among those aged 60 years and above. The associations of these conditions with socio-demographics, type 2 diabetes mellitus and depression were also studied. The work was carried out in 7 Latin American and Caribbean (LAC) cities in 1999-2000.

**Methods:** A secondary analysis was conducted on the Survey of Health and Well-Being of Elders (SABE) dataset. The 7 cities were Buenos Aires, Bridgetown, São Paulo, Santiago, Havana, Mexico City and Montevideo. This survey did not employ any oral examinations. Descriptive statistics, chi-square and regression analysis were used to test for associations.

**Results:** Data for 10 902 persons were analyzed. Females made up 62% of the population. Across the SABE population, between 93.7% (Mexico City) to 99.9% (Santiago) reported missing teeth, with an average of 97.5%. Of those with missing teeth, between 55.1% (Mexico City) and 82.4% (São Paulo) reported having bridges or dentures, with an average of 70.1% across all SABE cities. The proportion of the SABE population with 'unmet dental needs' ranged from 85.8% (Santiago) to 98.4% (Havana), with an average of 94.5%. Bridgetown, São Paulo and Mexico City demonstrated a statistically significant association between aging and tooth loss. Generally a greater proportion of females (97.6%) reported tooth loss compared with males (96.8%), but in only São Paulo and Montevideo was there a statistically significant association between sex and tooth loss. Generally those with higher education reported less tooth loss, primary education (97.6% had tooth loss), secondary (96.8%) and tertiary (94.7%). All the SABE cities except Buenos Aires demonstrated a statistically significant association between tooth loss and education.

**Conclusions:** The prevalence of missing teeth, use of bridges and dentures and unmet dental needs were high in the SABE cities in 1999-2000. In general across the SABE cities, the elderly with the most missing teeth were less educated or less likely to be a professional. They tended to be not working and were receiving a pension. Additionally they were less likely to report their health as 'excellent', were diabetic and were more likely to give responses suggestive of depression.

**Keywords:** Public health dentistry, Dental health survey, Elderly, Latin America, Caribbean

## Background

The Latin America and the Caribbean (LAC) population is ageing at unprecedented rates. The UN Database reports that by 2025 the elderly will increase by 300% in developing countries, especially in Latin America [1,2]. As life expectancy increases, so too does the desire for improved quality of life (QoL). QoL is dependent upon

many factors including nutrition and enjoyment of food which involves adequate mastication and oral health [1].

Older people have more complex oral health needs. Oro-facial and dental pain or missing, discoloured and broken teeth can adversely affect people's health, confidence and well-being. The resultant facial shape change which occurs may lead to an unwillingness to carry out everyday activities [1,3-5]. Many elderly also suffer from non-communicable diseases (NCDs) that can affect general and oral health. The required medications for these NCDs often cause reduced quantity and quality of saliva,

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thereby increasing the risk for tooth decay and other oral diseases [6]. Additionally, ill-fitting dentures affect patients' QoL by making certain foods difficult to chew. Finally, oral cancer is also common in this age group and may develop after years of tobacco and alcohol abuse [7].

Whilst oral health care services are available in developed countries, utilisation is low among the elderly [8]. In low income countries where access to health care is poor especially in rural areas, elderly people experience high levels of oral health problems. In addition to socio-economic factors, issues of limited availability and access to oral care make the elderly more vulnerable to developing oral diseases. The problem is further compounded in developing countries with diets rich in refined carbohydrates, and little allocation of health budgets to the prevention of oral diseases. Dental health resources cost developed countries 5-10% of health care expenditure per year [7] and oral disease is the fourth most expensive disease to treat [7]. Research in Latin America reveal that 60-70% of Mexicans over age 65 years have few or no teeth and gum disease and untreated caries are highly prevalent [7]. In South Brazil, poorer QoL are associated with depression and difficulty to chew food [9]. Aging populations therefore pose a significant challenge to healthcare systems. Appropriate oral health policies and strategies are needed to address these challenges.

This paper employed a secondary analysis of the Survey on Health, Well-Being, and Aging in Latin America and the Caribbean (SABE) dataset [10] to achieve the following objectives:

1. To describe the prevalence of oral health issues in the elderly population in 7 Latin American and Caribbean cities in 1999-2000.
2. To investigate associations between demographic variables, oral health and NCDs in this population.

Although dated, the information can provide a background of past oral health in preparation for future policies, strategies and research.

## Method
The Survey on Health, Well-Being, and Aging in Latin America and the Caribbean (SABE) [10] was a cross-sectional study conducted between October 1999 and December 2000. It set out to examine health (including oral health) conditions and limitations of persons aged 60 years and above, and living in private households. The surveys were undertaken in seven cities: Buenos Aires (Argentina), Bridgetown (Barbados), São Paulo (Brazil), Santiago (Chile), Havana (Cuba), Mexico City (Mexico) and Montevideo (Uruguay). SABE was funded by the Pan American Health Organisation (PAHO/WHO) [10]. The data base is to be used only for statistical reporting and analysis and is publicly available from: http://www.icpsr.umich.edu/icpsrweb/NACDA/studies/3546?archive=NACDA&q=SABE.

Demographic variables such as age, sex, race, education, birthplace, religion, ethnicity, marital status, and income were collected along with cognitive, health (including dental), functional and nutritional status, and use and accessibility of services. Dental health was measured by self-reporting rather than oral examination [11].

### Sampling target populations
The sampling target population from the SABE dataset were the sixty years (60) and older population living at home in urban areas of the respective cities [10].

### Sample design
Eligible participants were selected through a multistage clustered sample with stratification of the units. The sample was chosen in three selection stages of primary, secondary and tertiary sampling units; with two stages employed in Barbados and Brazil [10].

### Questionnaire
The SABE questionnaire was designed to produce information and to compare unique ageing processes in the LAC cities with other populations [10]. The modules extracted and included in this current paper are demographics, work history and income, self-reported overall health, oral health, diabetes and depression.

### SABE and Oral Health
The dentition aspects investigated in SABE are -

➢ The prevalence of oral disease in the elderly, ascertained from the question: Are you missing any teeth?
➢ Access to dental care: Do you have any bridges/dentures/false teeth?
➢ Unmet Dental Needs: In the SABE, the Geriatric Oral Health Assessment Index (GOHAI) scale was used to quantify the 'Unmet needs for oral health services' of older adults [12,13]. If a participant had a score of 57 or less out of 60, they were regarded as having an 'unmet dental need'.

Other information collected included self-reported overall assessment of health where responses ranged from 'Excellent' and 'Very Good' to 'Bad'. Also collected was information on depression, the Yesavage Geriatric Depression Scale (GDS) Short form was used [14].

### Ethical issues
Ethical approval was granted for the conduct of the survey by the Pan American Health Organization Ethical

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**Table 1 Age and dentition for the SABE population**

| Row % | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? | | |
|---|---|---|---|---|---|---|---|---|---|
| | N (%) | | | N (%) | | | N (%) | | |
| Age groups | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | N = 1474 | | | N = 1417 | | | N = 1477 | | |
| 60 yrs and > | 291 (96.4) | 11 (3.6) | 0.038 | 177 (61.9) | 109 (38.1) | 0.104 | 285 (94.1) | 18 (5.9) | |
| 61 - 65 yrs. | 310 (97.8) | 7 (2.2) | | 171 (56.4) | 132 (44.6) | | 307 (96.2) | 12 (3.8) | 0.182 |
| 66 - 70 yrs. | 298 (99.3) | 2 (0.7) | | 180 (62.5) | 108 (37.5) | | 276 (93.9) | 18 (6.1) | |
| 71 - 75 yrs. | 248 (99.2) | 2 (0.8) | | 161 (66.0) | 83 (34.0) | | 230 (92.0) | 20 (8.0) | |
| 76 - 80 yrs. | 175 (99.4) | 1 (0.6) | | 95 (56.2) | 74 (43.8) | | 163 (92.6) | 13(7.4) | |
| 81 yrs. and up | 133 (98.5) | 2 (1.5) | | 69 (54.3) | 58 (45.7) | | 131 (97.0) | 4 (3.0) | |
| Buenos Aires | N = 1027 | | | N = 998 | | | N = 1028 | | |
| 60 yrs and > | 46 (95.8) | 2 (4.2) | 0.441 | 30 (66.7) | 15 (33.3) | 0.164 | 47 (97.8) | 1 (2.1) | 0.423 |
| 61 - 65 yrs. | 241 (98.0) | 5 (2.0) | | 178 (73.6) | 64 (26.4) | | 237 (96.3) | 9 (3.7) | |
| 66 - 70 yrs. | 252 (98.4) | 4 (1.6) | | 185 (73.4) | 67 (26.6 ) | | 243 (94.9) | 13 (5.1) | |
| 71 - 75 yrs. | 233 (97.1) | 7 (2.9) | | 176 (76.5) | 54 (23.5) | | 235 (97.9) | 5 (2.1) | |
| 76 - 80 yrs. | 134 (98.5) | 2 (1.5) | | 97 (74.0) | 34 (26.0) | | 134 (97.8) | 3 (2.2) | |
| 81 yrs. and up | 101 (100) | 0 (0.0) | | 79 (80.6) | 19 (19.4) | | 96 (95.0) | 5 (5.0) | |
| São Paulo | N = 2143 | | | N = 2129 | | | N = 2143 | | |
| 60 yrs and > | 76 (100) | 0 (0.0) | 0.045 | 66 (86.8) | 10 (13.2) | 0.022 | 73 (96.1) | 3 (3.9) | 0.747 |
| 61 - 65 yrs. | 429 (98.8) | 5 (1.2) | | 331 (77.2) | 98 (22.8) | | 413 (95.2) | 21 (4.8) | |
| 66 - 70 yrs. | 366 (99.2) | 3 (0.8) | | 308 (84.2) | 58 (15.8) | | 356 (96.5) | 13 (3.5) | |
| 71 - 75 yrs. | 379 (98.7) | 5 (1.3) | | 311 (82.3) | 67 (17.7) | | 373 (97.1) | 11 (2.9) | |
| 76 - 80 yrs. | 421 (100) | 0 (0.0) | | 352 (83.6) | 69 (16.4) | | 404 (96.0) | 17 (4.0) | |
| 81 yrs. and up | 459 (100) | 0 (0.0) | | 358 (78.0) | 101 (22.0) | | 438 (95.6) | 21 (4.6) | |
| Santiago | N = 1299 | | | N = 1281 | | | N = 1301 | | |
| 60 yrs and > | 63 (100) | 0 (0.0) | 0.365 | 41 (67.2) | 20 (32.8) | 0.017 | 55 (87.3) | 8 (12.7) | 0.108 |
| 61 - 65 yrs. | 278 (100) | 0 (0.0) | | 180 (65.7) | 94 (34.3) | | 244 (87.1) | 36 (12.9) | |
| 66 - 70 yrs. | 327 (100) | 0 (0.0) | | 202 (72.5) | 121 (27.5) | | 290 (88.7) | 37 (11.3) | |
| 71 - 75 yrs. | 247 (100) | 0 (0.0) | | 178 (72.7) | 67 (27.3) | | 216 (87.4) | 31 (12.6) | |
| 76 - 80 yrs. | 182 (100) | 0 (0.0) | | 133 (73.9) | 47 (26.1) | | 153 (84.1) | 29 (15.9) | |
| 81 yrs. and up | 201 (99.5) | 1 (0.5) | | 147 (74.2) | 51 (25.8) | | 162 (80.2) | 40 (19.8) | |
| Havana | N = 1905 | | | N = 1877 | | | N = 1905 | | |
| 60 yrs and > | 112 (99.1) | 1 (0.9) | 0.838 | 69 (61.6) | 43 (38.4) | 0.007 | 113 (100) | 0 (0.0) | 0.452 |
| 61 - 65 yrs. | 438 (98.0) | 9 (2.0) | | 293 (66.9) | 145 (33.1) | | 440 (98.4) | 7 (1.6) | |
| 66 - 70 yrs. | 389 (98.7) | 5 (1.3) | | 285 (73.3) | 104 (26.7) | | 384 (97.5) | 10 (2.5) | |
| 71 - 75 yrs. | 326 (99.1) | 3 (0.9) | | 226 (69.3) | 100 (30.7) | | 321 (97.6) | 8 (2.4) | |
| 76 - 80 yrs. | 251 (98.4) | 4 (1.6) | | 192 (76.5) | 59 (23.5) | | 252 (98.8) | 3 (1.2) | |
| 81 yrs. and up | 361 (98.4) | 6 (1.6) | | 270 (74.8) | 91 (25.2) | | 329 (97.8) | 8 (2.2) | |
| Mexico City | N = 1873 | | | N = 1717 | | | N = 1876 | | |
| 60 yrs and > | 628 (89.0) | 78 (11.0) | 0.000 | 339 (54.1) | 288(45.9) | 0.620 | 662 (93.5) | 46 (6.5) | 0.255 |
| 61 - 65 yrs. | 337 (90.8) | 34 (9.2) | | 171 (51.0) | 164 (49.0) | | 352 (94.9) | 19 (5.1) | |
| 66 - 70 yrs. | 280 (93.6) | 19 (6.4) | | 155 (55.6) | 124 (44.4) | | 282 (94.3) | 17 (5.7) | |
| 71 - 75 yrs. | 201 (95.7) | 9 (4.3) | | 109 (54.5) | 91 (45.5) | | 190 (94.5) | 20 (9.5) | |
| 76 - 80 yrs. | 150 (95.5) | 7 (4.5) | | 89 (59.7) | 60 (41.3) | | 150 (95.5) | 7 (4.5) | |

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**Table 1 Age and dentition for the SABE population** (Continued)

| | Yes | No | p value | Yes | No | p value | Yes | No | p value |
|---|---|---|---|---|---|---|---|---|---|
| 81 yrs. and up | 127 (97.7) | 3 (2.3) | | 71 (55.9) | 56 (45.1) | | 120 (94.5) | 7 (5.5) | |
| Montevideo | N = 1450 | | | N = 1365 | | | N = 1450 | | |
| 60 yrs and > | 64 (91.4) | 6 (9.6) | 0.166 | 52 (79.7) | 13 (21.3) | 0.078 | 66 (94.3) | 4 (5.7) | 0.259 |
| 61 - 65 yrs. | 291 (92.7) | 23 (7.2) | | 209 (72.8) | 78 (27.2) | | 301 (95.9) | 13 (4.1) | |
| 66 - 70 yrs. | 366 (94.8) | 20 (5.2) | | 289 (79.2) | 76 (20.8) | | 376 (97.4) | 10 (2.6) | |
| 71 - 75 yrs. | 282 (96.2) | 11 (3.8) | | 214 (76.4) | 66 (23.6) | | 277 (94.5) | 16 (5.5) | |
| 76 - 80 yrs. | 220 (96.5) | 8 (3.5) | | 163 (75.1) | 54 (24.9) | | 217 (95.2) | 11 (4.8) | |
| 81 yrs. and up | 153 (96.2) | 6 (3.8) | | 129 (84.9) | 23 (15.1) | | 156 (98.1) | 3 (1.9) | |

Review Committee and the appropriate institutional review board in each city.

### Analysis

Descriptive statistics was used to compare proportions of affected elderly between the various cities and chi-square analysis was done to investigate whether any associations exist between demographic and disease variables and dentition in the elderly. Regression analysis for the 'Unmet needs' oral health variable against the demographic and disease variables was conducted to determine possible predictors of 'Unmet dental health needs' in the various cities. Statistical Package for the Social Sciences (SPSS) v. 12 was used. Statistical significance was set at $p < 0.05$.

### Results

The overall sample size of the SABE population was 10,902, females comprised 62%. The response rate ranged from 62.5% in Buenos Aires to 95.3% in Havana [10]. Across the SABE population, between 93.7% (Mexico City) to 99.9% (Santiago) reported missing teeth, with an average for all countries of 97.5%. See Tables 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

**Table 2 Gender and dentition for the SABE population**

| Row N % | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? | | |
|---|---|---|---|---|---|---|---|---|---|
| | N (%) | | | N (%) | | | N (%) | | |
| Sex | Yes | No | p value | Yes | No | p value | Yes | No | p value |
| Bridgetown | N = 1474 | | | N = 1417 | | | N = 1477 | | |
| Male | 887 (97.9) | 13 (2.1) | 0.349 | 515 (61.9) | 356 (38.1) | 0.299 | 843 (93.5) | 59 (6.5) | 0.104 |
| Female | 562( 98.6) | 12 (1.4) | | 338 (59.1) | 208 (41.9) | | 549 (95.5) | 26 (4.5) | |
| Buenos Aires | N = 1027 | | | N = 998 | | | N = 1028 | | |
| Male | 370 (97.9) | 12 (2.1) | 0.765 | 268 (73.2) | 98 (26.8) | 0.143 | 368 (97.4) | 10 (2.6) | 0.255 |
| Female | 637 (98.2) | 8 (1.8) | | 477 (75.5) | 155 (25.5) | | 624 (96.0) | 26 (4.0) | |
| São Paulo | N = 2143 | | | N = 2129 | | | N = 2143 | | |
| Male | 872 (99.0) | 9 (1.0) | 0.039 | 634 (72.7) | 238 (27.3) | 0.000 | 846 (96.0) | 35 (4.0) | 0.937 |
| Female | 1258 (99.7) | 4 (0.3) | | 1092 (86.9) | 165 (13.1) | | 1211 (96.0) | 51 (4.0) | |
| Santiago | N = 1299 | | | N = 1281 | | | N = 1301 | | |
| Male | 445 (99.8) | 1 (0.2) | 0.167 | 236 (53.8) | 203 (46.2) | 0.000 | 376 (84.3) | 70 (15.7) | 0.180 |
| Female | 853 (100) | 0 (0.0) | | 645 (76.7) | 197 (23.3) | | 744 (87.0) | 111 (13.0) | |
| Havana | N = 1905 | | | N = 1877 | | | N = 1905 | | |
| Male | 700 (98.9) | 8 (1.1) | 0.343 | 454 (64.9) | 246 (35.1) | 0.000 | 698 (98.6) | 10 (1.4) | 0.239 |
| Female | 1177 (98.3) | 20 (1.7) | | 881 (74.9) | 296 (25.1) | | 1171 (97.8) | 26 (2.2) | |
| Mexico City | N = 1873 | | | N = 1717 | | | N = 1876 | | |
| Male | 465 (91.7) | 42 (8.3) | 0.789 | 216 (46.8) | 246 (53.2) | 0.000 | 481 (94.9) | 26 (5.1) | 0.172 |
| Female | 1258 (92.1) | 108 (7.9) | | 718 (57.2) | 537 (42.8) | | 1275 (93.1) | 94 (6.9) | |
| Montevideo | N = 1450 | | | N = 1365 | | | N = 1450 | | |
| Male | 490 (92.5) | 40 (7.5) | 0.001 | 318 (65.4) | 168 (34.6) | 0.000 | 514 (97.0) | 16 (3.0) | 0.175 |
| Female | 886 (96.3) | 34 (3.7) | | 737 (83.8) | 142 (16.2) | | 879 (95.4) | 41 (4.5) | |

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**Table 3 Education level and dentition for the SABE population**

| Row N (%) | Are you missing any teeth? N (%) | | | Do you have bridges/dentures? N (%) | | | Unmet dental needs? N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Education level | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | N = 1456 | | | N = 1399 | | | N = 1459 | | |
| Primary | 1119 (98.7) | 15 (1.3) | 0.049 | 665 (60.9) | 427 (39.1) | 0.281 | 1071 (94.2) | 66 (5.8) | 0.843 |
| Secondary | 217 (96.4) | 8 (1.6) | | 126 (59.4) | 86 (41.6) | | 214 (95.1) | 11 (4.9) | |
| Higher/oth | 96 (99.0) | 1 (1.0) | | 50 (52.6) | 45 (47.4) | | 91 (93.8) | 6 (6.2) | |
| Buenos Aires | N = 989 | | | N = 960 | | | N = 990 | | |
| Primary | 690 (98.4) | 11 (1.6) | 0.209 | 505 (74.5) | 173 (25.6) | 0.301 | 677 (96.6) | 24 (3.4) | 0.838 |
| Secondary | 184 (97.4) | 5 (2.6) | | 136 (73.5) | 49 (26.5) | | 182 (95.8) | 8 (4.2) | |
| Higher/oth | 95 (96.0) | 4 (4.0) | | 78 (80.4) | 19 (19.6) | | 96 (97.0) | 3 (3.0) | |
| São Paulo | N = 1600 | | | N = 1586 | | | N = 1600 | | |
| Primary | 1347 (99.6) | 6 (0.4) | 0.001 | 1140 (84.7) | 206 (15.3) | 0.729 | 1293 (95.6) | 60 (4.4) | 0.622 |
| Secondary | 70 (97.2) | 2 (2.8) | | 59 (84.3) | 11 (15.7) | | 69 (95.8) | 3 (4.2) | |
| Higher/oth | 170 (97.1) | 5 (2.9) | | 140 (82.4) | 30 (17.6) | | 170 (96.1) | 5 (3.9) | |
| Santiago | N = 1138 | | | N = 1126 | | | N = 1139 | | |
| Primary | 90 (100) | 0 (0.0) | * | 62 (68.9) | 28 (31.1) | 0.936 | 77 (85.6) | 13 (14.4) | 0.877 |
| Secondary | 143 (100) | 0 (0.0) | | 96 (67.6) | 46 (32.4) | | 125 (87.4) | 18 (12.6) | |
| Higher/oth | 905 (100) | 0 (0.0) | | 618 (69.1) | 276 (31.9) | | 778 (85.9) | 128 (14.1) | |
| Havana | N = 1901 | | | N = 1873 | | | N = 1901 | | |
| Yes | 1793 (98.7) | 23 (1.3) | 0.001 | 1270 (70.8) | 523 (29.2) | 0.126 | 1782 (98.1) | 34 (1.9) | 0.751 |
| No | 80 (94.1) | 5 (5.9) | | 63 (78.8) | 17 (21.2) | | 83 (97.6) | 2 (2.4) | |
| Mexico City | N = 1553 | | | N = 1415 | | | N = 1554 | | |
| Primary | 1014 (92.1) | 87 (7.9) | 0.020 | 531 (52.5) | 480 (47.5) | 0.000 | 1033 (93.7) | 69 (6.3) | 0.276 |
| Secondary | 115 (95.0) | 6 (5.0) | | 77 (67.0) | 38 (33.0) | | 115 (95.0) | 6 (5.0) | |
| Higher/oth | 291 (87.9) | 40(22.1) | | 210 (72.7) | 79 (27.3) | | 303 (91.5) | 28 (8.5) | |
| Montevideo | N = 1382 | | | N = 1300 | | | N = 1382 | | |
| Primary | 859 (96.5) | 31 (3.5) | 0.000 | 656 (76.7) | 199 (23.3) | 0.239 | 858 | 32 (3.6) | 0.886 |
| Secondary | 221 (94.8) | 12 (5.2) | | 177 (81.6) | 40 (19.4) | | 224 | 9 (3.9) | |
| Higher/oth | 231 (89.2) | 28(11.8) | | 172 (75.4) | 56 (24.5) | | 248 | 11 (4.2) | |

*Santiago has 100% missing teeth for this variable unable to determine an association.
Havana has no education level variable, so "Did you attend school - yes/no" was used.

## Socio-demographics (Age, education, marital status, occupational status) and prevalence of missing teeth

Across the SABE cities 2.5% of the population aged 60 years and above reported no missing teeth. A notable exception was the 60-65 years age groups in Mexico City and Montevideo where 8-11% reported having complete dentition. Bridgetown, São Paulo and Mexico City demonstrated a statistically significant association between aging and tooth loss. In all cities except Havana (M:F = 1.01:1), a greater proportion of females (97.6%) reported tooth loss compared with males (96.8%). In only São Paulo and Montevideo was there a statistically significant association between sex and tooth loss.

Generally those with higher education reported less tooth loss, among those with primary education, 97.6% reported tooth loss, secondary (96.8%) and tertiary (94.7%). All the SABE cities except Buenos Aires demonstrated a statistically significant association between tooth loss and education.

Greater proportions of manual and unskilled (92.5%), service workers and office employees (92.3%) reported having missing teeth compared with professionals (88.8%). São Paulo, Havana, Mexico City and Montevideo all demonstrated a statistically significant association between tooth loss and past employment. Across all SABE cities, among those with missing teeth, there were higher proportions currently not working (97.9%) than currently working (96.1%). Whilst among those with no missing teeth, there were more persons working (3.9%) than not (2.1%). This achieved statistical significance in Mexico City and Montevideo. Across the entire SABE population, among those with missing teeth, greater proportions were receiving a pension (97.5%) than not (95.2%); and among those with no missing teeth, greater proportions were not

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**Table 4 Marital status and dentition for the SABE population**

| Row % | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Marital status | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | N = 1459 | | | N = 1402 | | | N = 1462 | | |
| Unmarried | 292 (98.7) | 4 (1.3) | 0.373 | 186 (63.9) | 105 (36.1) | 0.368 | 284 (94.4) | 17 (5.6) | |
| Married | 499 (97.7) | 12 (2.3) | | 292 (59.8) | 196 (40.2) | | 488 (95.1) | 25 (4.9) | |
| Widow/er | 407 (99.3) | 3 (0.7) | | 232 (58.1) | 167 (41.9) | | 382 (93.2) | 28 (6.8) | 0.164 |
| Separated | 151 (98.1) | 3 (1.9) | | 94 (63.9) | 53 (36.1) | | 149 (96.1) | 6 (3.9) | |
| Divorced | 81 (97.6) | 2 (2.4) | | 42 (54.5) | 35 (45.5) | | 74 (89.2) | 9 (10.8) | |
| Buenos Aires | N = 1025 | | | N = 996 | | | N = 1026 | | |
| Unmarried | 54 (94.7) | 3 (5.3) | * | 46 (82.1) | 10 (17.9) | 0.212 | 56 (98.2) | 1 (1.8) | |
| Married | 432 (97.7) | 10 (2.3) | | 315 (72.7) | 118 (27.3) | | 426 (96.4) | 16 (3.6) | |
| Widow/er | 42 (98.6) | 6 (1.4) | | 313 (76.3) | 97 (23.7) | | 413 (96.5) | 15 (3.5) | 0.886 |
| Separated | 88 (98.9) | 1 (1.1) | | 60 (69.0) | 27 (31.0) | | 85 (95.5) | 4 (4.5) | |
| Divorced | 10 (100) | 0 (0.0) | | 9 (90.0) | 1 (10.0) | | 10 (100) | 0 (0.0) | |
| São Paulo | N = 2142 | | | N = 2128 | | | N = 2142 | | |
| Unmarried | 103 (100) | 0 (0.0) | * | 80 (77.7) | 23 (22.7) | 0.139 | 95 (92.2) | 8 (7.8) | |
| Married | 1112 (99.2) | 9 (0.8) | | 899 (80.9) | 12 (19.1) | | 1082 (95.5) | 39 (3.5) | |
| Widow/er | 757 (99.6) | 3 (0.4) | | 626 (82.7) | 131 (17.3) | | 728 (95.8) | 32 (4.2) | 0.035 |
| Separated | 135 (99.3) | 1 (0.7) | | 101 (74.8) | 34 (25.2) | | 132 (97.1) | 4 (2.9) | |
| Divorced | 22 (100) | 0 (0.0) | | 20 (90.9) | 2 (19.1) | | 19 (86.4) | 3 (13.6) | |
| Santiago | N = 1284 | | | N = 1266 | | | N = 1286 | | |
| Unmarried | 94 (98.9) | 1 (1.1) | * | 56 (61.5) | 35 (39.5) | 0.013 | 85 (89.5) | 10 (10.5) | |
| Married | 560 (100) | 0 (0.0) | | 362 (65.3) | 192 (34.7) | | 495 (88.4) | 65 (11.6) | |
| Widow/er | 458 (100) | 0 (0.0) | | 334 (73.7) | 119 (26.3) | | 379 (82.4) | 81 (17.6) | 0.015 |
| Separated | 166 (100) | 0 (0.0) | | 113 (69.3) | 50 (31.7) | | 147 (88.6) | 19 (11.4) | |
| Divorced | 5 (100) | 0 (0.0) | | 5 (100) | 0 (0.0) | | 3 (60.0) | 2 (40.0) | |
| Havana | N = 1902 | | | N = 1874 | | | N = 1902 | | |
| Unmarried | 61 (93.8) | 4 (6.2) | * | 31 (50.8) | 30 (49.2) | 0.001 | 64 (98.5) | 1 (1.5) | |
| Married | 700 (98.5) | 11 (1.5) | | 484 (69.1) | 216 (30.9) | | 702 (98.7) | 9 (1.3) | |
| Widow/er | 658 (98.9) | 7 (1.1) | | 494 (75.1) | 164 (24.9) | | 648 (97.4) | 17 (2.6) | 0.534 |
| Separated | 247 (99.6) | 1 (0.4) | | 179 (72.5) | 68 (27.5) | | 243 (98.0) | 5 (2.0) | |
| Divorced | 208 (97.7) | 5 (2.3) | | 145 (69.7) | 63 (30.3) | | 209 (98.1) | 4 (1.9) | |
| Mexico City | N = 1868 | | | N = 1712 | | | N = 1871 | | |
| Unmarried | 89 (94.7) | 5 (5.3) | 0.002 | 52 (58.4) | 37 (41.6) | 0.063 | 92 | 2 (2.1) | |
| Married | 978 (91.1) | 95 (8.9) | | 515 (52.9) | 458 (47.1) | | 1010 | 64 (6.0 | |
| Widow/er | 457 (94.0) | 29 (6.0) | | 259 (56.6) | 199 (44.4) | | 452 | 36 (7.4) | 0.291 |
| Separated | 170 (92.9) | 13 (7.1) | | 86 (51.2) | 82 (48.8) | | 169 | 14 (7.7) | |
| Divorced | 24 (75.0) | 8 (5.0) | | 19 (79.2) | 5 (20.8) | | 29 | 3 (9.4) | |
| Montevideo | N = 1444 | | | N = 1360 | | | N = 1444 | | |
| Unmarried | 49 (94.2) | 3 (5.8) | 0.288 | 28 (57.1) | 21 (42.9) | 0.000 | 49 (94.2) | 3 (5.8) | |
| Married | 659 (93.7) | 44 (6.2) | | 495 (75.8) | 158 (24.2) | | 673 (95.7) | 30 (4.3) | 0.456 |
| Widow/er | 511 (96.4) | 19 (3.6) | | 416 (82.1) | 91 (17.9) | | 515 (97.2) | 15 (2.8) | |
| Separated | 82 (96.5) | 3 (3.5) | | 55 (67.9) | 26 (32.1) | | 80 (94.1) | 5 (5.9) | |
| Divorced | 70 (94.6) | 4 (5.4) | | 57 (81.4) | 13 (18.6) | | 70 (94.6) | 4 (5.4) | |

*Buenos Aires, São Paulo, Santiago and Havana has many cells with N < 5 for this variable therefore unable to determine an association.

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**Table 5 Past occupation and dentition for the SABE population**

| Row % | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Past occupation | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | N = 1404 | | | N = 1348 | | | N = 1407 | | |
| Professionals | 108 (54.3) | 91 (45.7) | 0.079 | 108 (54.3) | 91 (45.7) | 0.129 | 197 (93.8) | 13 (6.2) | 0.166 |
| Office workers | 371 (59.1) | 257 (41.9) | | 371 (59.1) | 257 (40.9) | | 622 (95.4) | 30 (4.6) | |
| Manual/unskill | 325 (62.4) | 196 (31.6) | | 325 (62.4) | 196 (37.6) | | 506 (92.8) | 39 (7.2) | |
| Buenos Aires | N = 925 | | | N = 898 | | | N = 883 | | |
| Professionals | 129 (97.7) | 3 (2.3) | 0.810 | 99 (78.0) | 28 (22.0) | 0.345 | 84 (93.3) | 6 (6.7) | 0.288 |
| Office workers | 248 (98.4) | 4 (1.6) | | 187 (74.8) | 63 25.2) | | 243 (96.3) | 9 (3.6) | |
| Manual/unskill | 533 (98.5) | 8 (1.5) | | 375 (72.0) | 146 (28.0) | | 525 (97.0) | 16 (3.0) | |
| São Paulo | N = 2000 | | | N = 1986 | | | N = 2000 | | |
| Professionals | 141 (97.2) | 4 (2.8) | 0.003 | 125 (88.7) | 16 (11.3) | 0.002 | 139 (95.9) | 6 (4.1) | 0.985 |
| Office workers | 535 (99.3) | 4 (0.7) | | 409 (76.6) | 125 (23.4) | | 517 (95.9) | 22 (4.1) | |
| Manual/unskill | 1311 (99.6) | 5 (0.4) | | 1075 (82.) | 236 (18) | | 1260 (95.7) | 56 (4.3) | |
| Santiago | N = 1053 | | | N = 1038 | | | N = 1055 | | |
| Professionals | 77 (100) | 0 (0.0) | * | 58 (77.3) | 17 (22.7) | 0.211 | 67 (87.0) | 10 (13.0) | 0.700 |
| Office workers | 207 (100) | 0 (0.0) | | 136 (67.3) | 66 (32.7) | | 178 (85.2) | 31 (14.8) | |
| Manual/unskill | 769 (100) | 0 (0.0) | | 514 (67.5) | 247 (32.5) | | 672 (87.4) | 97 (12.6) | |
| Havana | N = 1584 | | | N = 1561 | | | N = 1584 | | |
| Professionals | 266 (96.4) | 10 (3.6) | 0.003 | 180 (67.7) | 86 (32.3) | 0.538 | 274 (99.3) | 2 (0.7) | 0.160 |
| Office workers | 568 (99.3) | 4 (0.7) | | 405 (71.3) | 163 (28.7) | | 558 (97.6) | 14 (2.4) | |
| Manual/unskill | 727 (98.8) | 9 (1.2) | | 515 (70.8) | 212 (29.2) | | 725 (98.5) | 11 (1.5) | |
| Mexico City | N = 1532 | | | N = 1410 | | | N = 1533 | | |
| Professionals | 113 (86.9) | 17 (13.1) | 0.035 | 85 (75.2) | 28 (24.8) | 0.000 | 119 (91.5) | 11 (8.5) | 0.323 |
| Office workers | 477 (93.7) | 32 (6.3) | | 262 (55.3) | 212 (44.7) | | 469 (92.1) | 40 (7.9) | |
| Manual/unskill | 823 (92.2) | 70 (7.8) | | 404 (49.1) | 419 (50.9) | | 840 (94.0) | 54 (6.0) | |
| Montevideo | N = 1310 | | | N = 1233 | | | N = 1310 | | |
| Professionals | 183 (89.3) | 22 (10.7) | 0.000 | 140 (78.2) | 39 (21.8) | 0.019 | 196 (4.4) | 9 (95.5) | 0.470 |
| Office workers | 304 (96.5) | 11 (3.5) | | 248 (81.8) | 55 (18.2) | | 306 (2.9) | 9 (97.1) | |
| Manual/unskill | 756 (95.7) | 34 (4.3) | | 555 (73.9) | 196 (26.1) | | 755 (4.4) | 35 (95.5) | |

*Santiago has 100% missing teeth for this variable therefore no cell for a p value.

receiving a pension (4.8%) than those who were receiving a pension (2.5%). This achieved statistical significance in Bridgetown.

Throughout the SABE cities, all the categories of marital status report tooth loss range from 75% - 100%. With an average of 98.1%, Havana and Mexico City demonstrated a significant statistical association between tooth loss and marital status.

### Health conditions (depression and diabetes), self-reported overall health and prevalence of missing teeth

For all SABE cities except Montevideo, among those with missing teeth there were greater levels of depression (average 11.2%) compared with those not missing teeth (average 6.5%). This achieved statistical significance in Mexico City.

For all SABE cities except São Paulo and Montevideo, among those with missing teeth there were greater levels of diabetes (average = 16.5%) compared with those not missing teeth (average = 12.3%). This did not achieve statistical significance in any of the SABE cities.

Among those with missing teeth, 0.3% (Mexico City) to 6% (Montevideo) reported 'Excellent' health, with an average of 3.5% across 6 cities (excluding Havana which had different descriptors on the Likert scale). Among those with no missing teeth, between 0% (Montevideo) and 23.1% (São Paulo) reported 'Excellent' health, with an average of 9.3%. The association between 'self-reported' overall health and missing teeth achieved

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**Table 6 Working status and dentition for the SABE population**

| Row % | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Working status | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | N = 1409 | | | N = 1353 | | | N = 1412 | | |
| Yes | 247 (97.2) | 7 (2.8) | 0.191 | 138 (56.6) | 106 (43.4) | 0.255 | 243 (95.7) | 11 (4.3) | 0.267 |
| No | 137 (98.4) | 18 (1.6) | | 671 (60.5) | 438 (39.5) | | 1087 (93.9) | 71 (6.1) | |
| Buenos Aires | N = 929 | | | N = 902 | | | N = 929 | | |
| Yes | 246 (97.6) | 6 (2.4) | 0.258 | 186 (75.3) | 61 (24.7) | 0.508 | 239 (94.8) | 13 (5.2) | 0.138 |
| No | 668 (98.7) | 9 (1.3) | | 479 (73.1) | 176 (26.9) | | 656 (96.9) | 21 (3.1) | |
| São Paulo | N = 2004 | | | N = 1990 | | | N = 2004 | | |
| Yes | 432 (98.9) | 5 (1.1) | 0.145 | 344 (79.8) | 87 (20.2) | 0.476 | 422 (96.6) | 15 (3.4) | 0.371 |
| No | 1559 (99.5) | 8 (0.5) | | 1268 (81.3) | 291 (18.7) | | 1498 (95.6) | 69 (4.4) | |
| Santiago | | | | | | | N = 1188 | | |
| Yes | 313 (100) | 0.0 | * | 191 (61.8) | 118 (39.2) | 0.007 | 274 (87.3) | 40 (12.7) | 0.659 |
| No | 873 (100) | 0.0 | | 604 (70.2) | 257 (29.8) | | 754 (86.1) | 120 (13.7) | |
| Havana | N = 1905 | | | N = 1807 | | | N = 1905 | | |
| Yes | 346 (98.3) | 6 (1.7) | 0.685 | 236 (68.2) | 110 (31.8) | 0.185 | 346 (98.3) | 6 (1.7) | 0.777 |
| No | 1531 (98.6) | 22 (1.4) | | 1099 (71.8) | 432 (29.2) | | 1523 (98.1) | 30 (1.9) | |
| Mexico City | N = 1569 | | | N = 1443 | | | N = 1571 | | |
| Yes | 573 (88.7) | 73 (11.3) | 0.000 | 284 (49.6) | 289 (51.4) | 0.019 | 603 | 43 (6.7) | 0.904 |
| No | 873 (94.6) | 50 (5.4) | | 486 (55.9) | 383 (44.1) | | 862 | 63 (6.8) | |
| Montevideo | N = 1327 | | | N = 1250 | | | N = 1327 | | |
| Yes | 227 (91.9) | 20 (8.1) | 0.015 | 170 (75.2) | 56 (24.8) | 0.645 | 238 | 9 (3.6) | 0.661 |
| No | 1023 (95.6) | 47 (4.4) | | 785 (76.7) | 239 (23.3) | | 1034 | 46 (4.3) | |

statistical significance for São Paulo, Mexico City and Montevideo.

### Socio-demographics and reporting bridges or dentures
Of those with missing teeth, between 55.1% (Mexico City) and 82.4% (São Paulo) reported having bridges or dentures, with an average of 70.1%.

São Paulo, Santiago and Havana all demonstrated a statistically significant association between aging and reporting the use of dentures or bridges. On average more females (73.4%) have bridges and dentures than males (62.7%), except in Bridgetown where it is the reverse. São Paulo, Santiago, Havana, Mexico City and Montevideo all demonstrated a statistically significant association between sex and reporting the use of dentures or bridges. The proportions of those with bridges/dentures was distributed on average equally among those with lower (70.1%) versus those with higher educational achievement (72.1%) across all SABE cities except in Mexico City. Here there was a statistically significant association between educational achievement and reporting the use of bridges or dentures.

Santiago, Havana and Montevideo all demonstrated a statistically significant association between marital status and reporting the use of dentures or bridges.

Generally larger proportions of professionals (74.2%) reported bridges or dentures compared with office or manual and unskilled workers (68.9%). In São Paulo, Mexico City and Montevideo there was a statistically significant association between occupation and reporting the use of bridges or dentures. Among those reporting using bridges or dentures there were no consistent pattern of current employment, except in Santiago and Mexico City. In these 2 cities there was a statistically significant association with greater proportions of those wearing dentures 'not currently working'.

In 4 of the SABE cities among those reporting having bridges or dentures there were higher proportions receiving pensions. Only in Mexico City was there a statistically significant association.

### Health conditions and reporting bridges or dentures
In the SABE cities among those with missing teeth and reported wearing bridges or dentures 12.3% were ascertained to be depressed compared with 15.7% among those not wearing bridges or dentures. In Bridgetown and Mexico City this association achieved statistical significance.

Among the elderly with missing teeth and reporting use of bridges and dentures the proportion with diabetes

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**Table 7 Pension and dentition for the SABE population**

| Row % | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Pension? | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | n = 1454 | | | N = 1397 | | | N = 1457 | | |
| Yes | 995 (99.0) | 10 (1.0) | 0.003 | 581 (60.1) | 385 (39.9) | 0.884 | 944 (93.7) | 63 (6.3) | 0.229 |
| No | 435 (96.9) | 14 (3.1) | | 261 (60.6) | 170 (30.4) | | 429 (95.3) | 21 (4.7) | |
| Buenos Aires | N = 1014 | | | N = 902 | | | N = 1014 | | |
| Yes | 668 (98.2) | 12 (1.8) | 0.710 | 186 (75.3) | 61 (24.7) | 0.508 | 657 (96.5) | 24 (3.5) | 0.949 |
| No | 326 (97.9) | 7 (2.1) | | 479 (73.1) | 126 (26.9) | | 321 (96.4) | 12 (3.6) | |
| São Paulo | N = 2135 | | | N = 2121 | | | N = 2135 | | |
| Yes | 1689 (99.4) | 10 (0.6) | 0.812 | 1373 (81.3) | 316 (18.7) | 0.727 | 1631 (96.0) | 68 (4.0) | 0.905 |
| No | 433 (99.3) | 3 (0.7) | | 348 (80.6) | 84 (19.4) | | 418 (95.9) | 18 (4.1) | |
| Santiago | N = 1297 | | | N = 1279 | | | N = 1299 | | |
| Yes | 1284 (100) | 0 (0.0) | 0.000 | 868 (68.5) | 399 (61.5) | 0.085 | 1107 (86.1) | 179 (13.9) | 0.879 |
| D/K | 12 (92.3) | 1 (7.7) | | 11 (91.7) | 1 98.3) | | 11 (84.6) | 2 (15.4) | |
| Havana | N = 1448 | | | N = 1427 | | | N = 1444 | | |
| Yes No | 1427 (98.5) | 21 (1.5) | * | 1015 (71.1) | 412 (28.9) | * | 1421 (98.1) | 27 (1.9) | * |
| Mexico City | N = 1852 | | | N = 1696 | | | N = 1854 | | |
| Yes | 406 (93.1) | 30 (6.9) | 0.286 | 252 (62.5) | 151 (37.5) | 0.000 | 408 (93.6) | 28 (6.4) | 0.955 |
| No | 1296 (91.5) | 120 (8.5) | | 667 (51.6) | 626 (48.4) | | 1328 (93.7) | 90 (6.3) | |
| Montevideo | N = 1445 | | | N = 1361 | | | N = 1445 | | |
| Yes | 1108 (95.4) | 54 (4.6) | 0.155 | 859 (78.1) | 241 (21.9) | 0.117 | 1122 (96.6) | 40 (3.4) | 0.143 |
| No | 264 (93.3) | 19 (6.7) | | 192 (73.6) | 69 (26.4) | | 268 (94.7) | 15 (5.3) | |

*Havana has 100% elderly persons receiving pension therefore no cell for a p value.

was 17.9%, compared with those without bridges and dentures, diabetes was present in 20.7%. In Havana and Mexico City there was a statistically significant association among those wearing bridges and dentures and the presence of diabetes.

## Self-reported overall health
Among the SABE cities there was a consistent pattern of self-reported overall health and whether the respondents used bridges or dentures. In Santiago, Havana and Mexico City this achieved a statistically significant association.

## Socio-demographics and unmet oral health needs
The proportion of the SABE population with 'unmet dental needs' ranged from 85.8% (Santiago) to 98.4% (Havana), with an average of 94.5%. There were no statistically significant associations between unmet dental needs and age, sex, past occupation, education achievement, working status, or pension status. There were no statistically significant associations between marital status and unmet dental needs except in São Paulo and Santiago.

## Health conditions and unmet dental needs
There were no statistically significant associations between unmet dental needs and depression or self-reported health in any of the SABE cities. Similarly, there were no statistically significant associations between unmet dental needs and diabetes except for Bridgetown where more of those without diabetes have unmet dental needs. Regression analysis was conducted for each SABE city to determine which independent variables predicted having an 'Unmet dental need'. There were no such independent variables identified except in Bridgetown where the 'absence of diabetes' predicted having an Unmet dental need. See Table 11.

## Discussion
There has been a wealth of information arising from the SABE dataset, [10,12] but this paper is the first to describe the oral health of the population. Across the SABE population, in 1999-2000, 97.5% reported missing teeth, and of those with missing teeth, an average of 70.1% reported having bridges or dentures. Further, 94.5% were determined to have 'unmet dental needs', expressing difficulties with chewing, oral pain, speech and appearance, among other issues. Further analysis revealed associations with the presence of missing teeth

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**Table 8 Depression and Dentition for the SABE population**

| Row % | Are you missing any teeth? N (%) | | | Do you have bridges/dentures? N (%) | | | Unmet dental needs N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Depression | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | N = 1474 | | | N = 1445 | | | N = 1508 | | |
| No | 1403 (98.3) | 24 (1.7) | 0.816 | 834 (60.4) | 546 (39.6) | 0.041 | 1358 (94.6) | 81 (5.6) | 0.571 |
| Yes | 46 (97.9) | 1 (2.1) | | 31 (47.7) | 34 (52.3) | | 64 (92.8) | 5 (7.2) | |
| Buenos Aires | N = 1027 | | | N = 1013 | | | N = 1043 | | |
| No | 916 (97.9) | 20 (2.1) | 0.159 | 673 (74.0) | 236 (26.0) | 0.833 | 903 (96.4) | 34 (3.6) | 0.352 |
| Yes | 91 (100) | 0 (0.0) | | 76 (73.9) | 28 (26.9) | | 104 (98.1) | 2 (1.9) | |
| São Paulo | N = 2143 | | | N = 2129 | | | N = 2143 | | |
| No | 1860 (99.4) | 12 (0.6) | 0.590 | 1503 (80.8) | 356 (19.2) | 0.495 | 1797 (96.0) | 75 (4.0) | 0.967 |
| Yes | 270 (99.6) | 1 (0.4) | | 223 (82.6) | 47 (17.4) | | 260 (95.9) | 11 (4.1) | |
| Santiago | N = 1299 | | | N = 1281 | | | N = 1301 | | |
| No | 1004 (99.1) | 1 (0.1) | 0.588 | 687 (69.5) | 301 (30.5) | 0.281 | 859 (85.3) | 148 (14.7) | 0.130 |
| Yes | 294 (100) | 0 (0.0) | | 195 (66.2) | 99 (33.8) | | 261 (88.8) | 33 (11.2) | |
| Havana | N = 1905 | | | N = 1877 | | | N = 1905 | | |
| No | 1656 (98.6) | 23 (1.4) | 0.323 | 1185 (71.6) | 471 (28.4) | 0.256 | 1649 (98.2) | 30 (1.8) | 0.368 |
| Yes | 221 (97.8) | 5 (2.2) | | 150 (67.9) | 71 (32.1) | | 220 (97.3) | 6 (2.7) | |
| Mexico City | N = 1873 | | | N = 1717 | | | N = 1817 | | |
| No | 1377 (91.1) | 135 (8.9) | 0.003 | 784 (57.2) | 587 (42.8) | 0.000 | 1414 (93.3) | 101 (6.7) | 0.327 |
| Yes | 346 (95.8) | 15 (4.2) | | 150 (43.4) | 196 (56.6) | | 342 (94.7) | 19 (5.3) | |
| Montevideo | N = 1450 | | | N = 1365 | | | N = 1450 | | |
| No | 1229 (95.1) | 64 (4.9) | 0.445 | 949 (77.9) | 269 (22.1) | 0.112 | 1238 (95.7) | 55 (4.3) | 0.070 |
| Yes | 147 (93.6) | 10 (6.4) | | 106 (72.1) | 41 (27.9) | | 155 (98.7) | 2 (1.3) | |

and educational achievement or past employment across many, but not all the SABE cities.

## Social determinants of missing teeth
### Education and Past occupation
Generally in this study those with higher education and those self-reporting their occupation as professionals reported less tooth loss. Those with a primary and secondary education had more tooth loss versus those with a tertiary education. All the SABE cities except Buenos Aires demonstrated a statistically significant association between tooth loss and education. Similarly, the manual and unskilled, service workers and office employees generally reported having more missing teeth compared with professionals. São Paulo, Havana, Mexico City and Montevideo all demonstrated a statistically significant association between tooth loss and past employment. This association with education is consistent with reports from the United States (US). In the National Health and Nutrition Examination Survey (NHANES) study, 23% of those with 0-8 years of education reported pain in biting or chewing compared with 10% of those with 13 or more years of education [15].

## Other surveys of dental disease in the Americas
Successive surveys of seniors over the age of 65 years in the US has shown that overall, the prevalence of tooth loss in seniors has decreased from the 1970 until the 2000s [16]. A more recent paper from 2005-8 reported that in this population 19.9% had untreated dental caries and almost 23% of were edentulous [17]. The data from this paper cannot be compared with these results however as different oral parameters were measured. In Latin America, a 2012 report of Decayed, Missing, Filled Teeth (DMFT) index showed a mean DMFT of 21.57 in the 65–74 years group [18]. Factors related to tooth loss in the 65–74 year-old group were education level <12 years (OR 2.54) and personal income (OR 1.66). This current paper has similar findings with respect to education. Two other South American countries have carried out national surveys including an oral examination in adults: Colombia [19] with a DMFT of 19.6 in the "older than 55" group and Brazil with a mean DMFT of 27.8 for the 65–74-year-old group in 2003 and a DMFT of 27.5 for the 65–74 years adults in 2010 [20]. However both these report DMFT, which cannot be compared directly with these results. Nevertheless they suggest, as does this paper, high levels of caries prevalence in the elderly.

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**Table 9 Diabetes and Dentition for the SABE population**

| Row % | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Diabetes** | **Yes** | **No** | ***p* value** | **Yes** | **No** | ***p* value** | **Yes** | **No** | ***p* value** |
| Bridgetown | N = 1469 | | | N = 1412 | | | N = 1472 | | |
| Yes | 315 (99.10) | 3 (0.9) | 0.237 | 191 (62.4) | 115 (37.6) | 0.401 | 291 (90.9) | 29 (9.1) | |
| No | 1129 (98.1) | 22 (1.9) | | 661 (59.8) | 445 (40.2) | | 1096 (95.1) | 56 (4.9) | 0.004 |
| Buenos Aires | N = 1023 | | | N = 985 | | | N = 1024 | | |
| Yes | 128 (98.5) | 2 (1.5) | 0.713 | 494 (75.0) | 165 (25.0) | 0.649 | 125 (96.2) | 5 (3.8) | 0.827 |
| No | 875 (98.0) | 18 (2.0) | | 240 (73.6) | 86 (26.4) | | 863 (96.5) | 31 (3.5) | |
| São Paulo | N = 2126 | | | N = 2112 | | | N = 2143 | | |
| Yes | 377 (99.2) | 3 (0.6) | 0.840 | 304 (80.6) | 73 (19.4) | 0.060 | 370 (97.4) | 10 (2.6) | 0.210 |
| No | 1736 (99.4) | 10 (0.4) | | 1412 (81.4) | 323 (18.6) | | 1670 (95.6) | 76 (4.4) | |
| Santiago | N = 1283 | | | N = 1265 | | | N = 1285 | | |
| Yes | 173 (100) | 0 (0.0) | 0.693 | 126 (72.8) | 47 (27.2) | 0.224 | 153 (88.4) | 20 (11.6) | 0.333 |
| No | 1109 (99.9) | 1 (0.1) | | 745 (68.2) | 347 (31.8) | | 953 (85.7) | 159 (14.3) | |
| Havana | N = 1903 | | | N = 1876 | | | N = 1899 | | |
| Yes | 288 (99.3) | 2 (0.7) | 0.254 | 226 (78.5) | 62 (21.5) | 0.003 | 280 (96.6) | 10 (3.4) | 0.315 |
| No | 1588 (98.5) | 25 (1.5) | | 1109 (69.8) | 479 (30.2) | | 1587 (98.4) | 126 (1.6) | |
| Mexico City | N = 1862 | | | N = 1708 | | | N = 1864 | | |
| Yes | 347 (93.5) | 24 (6.5) | 0.224 | 171 (49.7) | 173 (50.3) | 0.045 | 346 (93.0) | 26 (7.0) | 0.628 |
| No | 1366 (91.6) | 125 (8.4) | | 760 (55.7) | 604 (44.3) | | 1398 (93.7) | 94 (6.3) | |
| Montevideo | N = 1445 | | | N = 1360 | | | N = 1445 | | |
| Yes | 175 (93.1) | 13 (6.9) | 0.232 | 134 (77.0) | 40 (23.0) | 0.888 | 182 (96.8) | 6 (3.2) | 0.569 |
| No | 1196 (95.1) | 61 (4.9) | | 919 (77.5) | 267 (22.5) | | 1206 (95.9) | 51 (4.1) | |

### Depression and dentition

Depression has been well linked to dentition [21]. In Santiago, this association was found for the 35-44 age group but not the 65-74 year olds [18]. Similarly, in this current paper, no association was found except in Mexico City where those with missing teeth had twice the rate of depression than those with no missing teeth (8.9% vs. 4.2%, $p < 0.003$). In general, there were more depressed among those not wearing dentures (15.7%) than among those wearing dentures (12.3%).

This provides interesting areas for debate, including whether many of those elderly with missing teeth are generally less accepting of their loss and have higher rates of depression; and whether those without bridges and dentures, either had no access to care or cannot afford the services and have the resultant increased depression rates. These are areas for future study.

### Diabetes and oral health

Recent research have widened our understanding of the relationship between oral health and diabetes [22,23]. For example, periodontal disease has been shown to be is a strong predictor of mortality from ischemic heart disease (IHD) and diabetic nephropathy among Pima Indians with type 2 diabetes (T2DM) [24]. Also individuals with poorly controlled diabetes mellitus had a significantly higher prevalence of severe periodontitis than those without diabetes [25]. Tooth loss is considered the end point for untreated periodontal disease. The prevalence of periodontal disease is increasing in most aging societies suggesting it is a public health problem [26]. One study from Germany reported that the association between T2DM and tooth loss was statistically significant only for females [27]. In this current paper we studied the relationship between the presence of diabetes and oral health. We could demonstrate no relationship between those with diabetes and those reporting missing teeth. In 5 of the 7 SABE cities we could not demonstrate a relationship between diabetes and those reporting the use of bridges or dentures, the two exceptions being Havana and Mexico City. In both these cities those with diabetes made up about 17% of the users of bridges and dentures.

### Pension systems in SABE cities and relationship with oral health

Across the entire SABE population, among those with missing teeth, greater proportions were receiving a

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**Table 10 Self-reported overall health and dentition for the SABE population**

| Row %<br>Self reported health | Are you missing any teeth? | | | Do you have bridges/dentures? | | | Unmet dental needs? N (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Yes | No | *p* value | Yes | No | *p* value | Yes | No | *p* value |
| Bridgetown | N = 1474 | | | N = 1445 | | | N = 1508 | | |
| Excellent | 56 (98.2) | 1 (1.8) | 0.218 | 33 (60.0) | 22 (40.0) | 0.391 | 57 (98.3) | 1 (1.7) | 0.368 |
| Very good | 163 (98.8) | 2 (1.2) | | 89 (56.0) | 70 (44.0) | | 164 (94.8) | 9 (5.2) | |
| Good | 501 (97.3) | 14 (2.7) | | 289 (57.5) | 214 (42.5) | | 496 (94.3) | 30 (5.7) | |
| Fair | 648 (98.8) | 8 (1.2) | | 405 (62.3) | 245 (37.7) | | 626 (93.4) | 44 (6.6) | |
| Bad | 81 (100) | 0 (0.0) | | 49 (62.8) | 29 (37.2) | | 79 (97.5) | 2 (2.5) | |
| Buenos Aires | N = 995 | | | N = 982 | | | N = 1042 | | |
| Excellent | 44 (97.8) | 1 (2.2) | 0.301 | 30 (71.4) | 12 (28.6) | 0.800 | 43 (93.5) | 3 (6.5) | 0.271 |
| Very good | 148 (100) | 0 (0.0) | | 104 (73.2) | 38 (26.8) | | 144 (97.3) | 4 (2.7) | |
| Good | 447 (97.6) | 11 (2.4) | | 334 (74.4) | 115 (25.6) | | 447 (96.3) | 17 (3.7) | |
| Fair | 284 (97.3) | 8 (2.7) | | 220 (73.8) | 78 (26.2) | | 294 (97.7) | 7 (2.3) | |
| Bad | 52 (100) | 0 (0.0) | | 35 (68.6) | 16 (31.4) | | 50 (96.2) | 2 (3.8) | |
| São Paulo | N = 2143 | | | N = 2129 | | | N = 2143 | | |
| Excellent | 90 (96.8) | 3 (3.2) | 0.001 | 79 (87.8) | 11 (12.2) | 0.171 | 90 (96.8) | 3 (3.2) | 0.927 |
| Very good | 128 (97.7) | 3 (2.3) | | 107 (83.6) | 21 (16.4) | | 125 (95.4) | 6 (4.6) | |
| Good | 730 (99.6) | 3 (0.4) | | 596 (81.8) | 133 (18.2) | | 702 (95.8) | 31 (4.2) | |
| Fair | 983 (99.7) | 3 (0.3) | | 792 (80.6) | 191 (19.4) | | 946 (95.9) | 40 (4.1) | |
| Bad | 199 (99.5) | 1 (0.5) | | 152 (76.4) | 47 (23.6) | | 194 (97.0) | 6 (3.0) | |
| Santiago | N = 1299 | | | N = 1281 | | | N =1301 | | |
| Excellent | 27 (100) | 0 (0.0) | 0.661 | 14 (51.9) | 13 (48.1) | 0.038 | 22 (81.5) | 5 (18.5) | 0.885 |
| Very good | 53 (100) | 0 (0.0) | | 38 (77.6) | 11 (22.3) | | 46 (86.8) | 7 (13.2) | |
| Good | 380 (99.7) | 1 (0.3) | | 239 (64.6) | 131 (35.4) | | 332 (87.1) | 49 (12.9) | |
| Fair | 559 (100) | 0 (0.0) | | 397 (71.4) | 159 (28.6) | | 483 (86.1) | 78 (13.9) | |
| Bad | 279 (100) | 0 (0.00 | | 103 (69.2) | 86 (30.8) | | 237 (84.9) | 42 (15.1) | |
| Havana | N = 1905 | | | N = 1877 | | | N = 1905 | | |
| Proxy | 170 (96.6) | 6 (3.4) | 0.293 | 109 (64.1) | 61 (32.9) | 0.009 | 174 (98.9) | 2 (1.1) | 0.090 |
| Excellent | 33 (100) | 0 (0.0) | | 19 (57.6) | 14 (42.4) | | 32 (97.0) | 1 (3.0) | |
| Very good | 57 (100) | 0 (0.0) | | 41 (71.9) | 16 (28.1) | | 57 (100) | 0 (0.0) | |
| Good | 547 (98.7) | 7 (1.3) | | 388 (70.9) | 159 (29.1) | | 548 (98.9) | 6 (1.1) | |
| Fair | 850 (98.6) | 12 (1.4) | | 634 (74.6) | 216 (25.4) | | 844 (97.9) | 18 (2.1) | |
| Bad | 220 (98.7) | 3 (1.3) | | 144 (65.5) | 76 (34.5) | | 214 (96.0) | 9 (4.0) | |
| Mexico City | N =1868 | | | N =1713 | | | N =1871 | | |
| Excellent | 42 (89.4) | 5 (10.6) | 0.000 | 33 (78.6) | 9 (21.4) | 0.002 | 43 (91.7) | 4 (8.3) | 0.728 |
| Very good | 67 (83.8) | 13 (16.2) | | 43 (64.2) | 24 (35.8) | | 77 (96.2) | 3 (3.8) | |
| Good | 395 (89.2) | 48 (10.8) | | 228 (57.7) | 167 (42.3) | | 415 993.7) | 28 (6.3) | |
| Fair | 900 (92.7) | 71 (7.3) | | 466 (52.0) | 431 (48.0) | | 907 (93.1) | 67 (6.9) | |
| Bad | 314 (96.0) | 13 (4.0) | | 163 (52.2) | 149 (47.8) | | 309 (94.5) | 18 (5.5) | |
| Montevideo | N = 1450 | | | N = 1365 | | | N = 1450 | | |
| Excellent | 84 (84.8) | 15 (15.2) | 0.000 | 71 (84.5) | 12 (15.5) | 0.068 | 96 | 3 (3.0) | 0.626 |
| Very good | 143 (89.9) | 16 (10.1) | | 105 (75.5) | 36 (24.5) | | 152 | 7 (4.4) | |
| Good | 663 (96.10 | 26 (3.9) | | 495 (78.6) | 135 (21.4) | | 631 | 28 (4.2) | |
| Fair | 426 (97.3) | 12 (2.7) | | 324 (76.6) | 99 (23.4) | | 420 | 18 (4.1) | |
| Bad | 90 (94.7) | 5 (5.3) | | 60 (68.2) | 28 (31.8) | | 94 | 1 (1.1) | |

**Table 11 Results of logistic regression to determine the independent variables associated with Unmet Oral health needs in the SABE population for Bridgetown**

| Bridgetown | B | S.E. | Wald | df | 95% CI | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Age | .204 | .247 | .680 | 1 | -.281 | .689 |
| Sex | -.399 | .255 | 2.452 | 1 | -.899 | .100 |
| Marital status | .195 | .302 | .418 | 1 | -.397 | .788 |
| Education level | -.068 | .316 | .047 | 1 | -.688 | .552 |
| Past occupation | .230 | .352 | .427 | 1 | -.460 | .920 |
| Current working status | -.237 | .369 | .412 | 1 | -.961 | .487 |
| Pension | .250 | .279 | .803 | 1 | -.297 | .797 |
| Depression | .270 | .478 | .318 | 1 | -.667 | 1.207 |
| Diabetes | .583 | .254 | 5.267 | 1 | .085 | 1.081 |
| Self-reported overall health | -12.307 | .729 | 284.816 | 1 | -13.736 | -10.877 |
| Constant | -15.598 | .563 | 767.698 | 1 | -16.701 | -14.494 |

pension than not. The question for future study is whether those with less missing teeth are more educated and more healthy and therefore continue to work. Further, are they less likely to be receiving a pension, more engaged in life, and are subsequently less depressed? The findings of this paper appears to suggest that this is the case. The pension systems across the SABE cities are varied but generally universal with pensions available between age 60-65 years [28].

### Limitations

There are several limitations to this study, for example, data used in the SABE study is self-reported and not actual clinical examinations. This makes the comparison of this 1999-2000 data impossible with the 3 reported surveys of the DMFT index from Latin America. The SABE surveys were conducted in urban cities, whilst the more recent Latin American surveys report using nationally representative samples. This data was also collected fourteen years ago. Therefore, one can question how comparable or generalizable is it today. Nevertheless, the information does provide a baseline for other LAC cities and countries which have not conducted any subsequent surveys.

Additionally, the SABE study used self-perceived oral health which reflects people's subjective and objective assessments of their oral health, and is highly associated with perceptions of treatment need and subsequent demand for dental services [11]. Future studies in these populations should use an oral examination to confirm participants' perceptions.

### What's next

This paper provides baselines which future studies can re-assess for change. These include the very high levels of missing teeth among all age intervals of those over 60 years, the high levels of unmet dental needs and the relatively high proportion of those requiring dental prostheses. The very high levels of 'unmet dental needs' across all the SABE cities is telling and future studies should evaluate how well this construct remains elevated as new dental interventions are introduced. There are also opportunities for extensive comparison of DMFT data across more LAC countries, with a focus on the elderly. As we saw above these are now available for 3 Latin American countries. This can assist in evaluating the different dental care models in LAC. Notably, the free health system of Havana did not particularly stand out as exemplary. Throughout the LAC there has been an epidemic of NCDs with diabetes being at the forefront. The evidence suggests that better periodontal care assists in better diabetes control [23]. In this study we could not demonstrate a link between diabetes and missing teeth. Future research in the LAC should investigate the cost-effectiveness of improving dental services to assist in combating the diabetes epidemic.

### Conclusions

The results of this secondary analysis illustrates that in 1999-2000, there was a high prevalence of missing teeth, bridge and dentures use and poorly met dental needs among the elderly in the 7 SABE cities of Latin America and the Caribbean.

In general across the SABE cities, the larger proportion of elderly reporting missing teeth were less educated or less likely to be a professional. They were also currently not working and were receiving a pension. Finally they were less likely to report their health as 'excellent', were diabetic and were more likely to give responses suggestive of depression.

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