Associations Between Acculturation and Oral Health Among Older Chinese Immigrants in the United States

Shaoqing Ge, MPH¹, Bei Wu, PhD², and XinQi Dong, MD, MPH³

Abstract

Background: The aim of this study was to understand the associations between acculturation and oral health among older Chinese immigrants in the United States. Method: We used data from the PINE study, which included the foreign-born older Chinese immigrants (N = 3,128). We measured acculturation by measuring participants’ length of stay and behavioral acculturation. Participants’ tooth and gum symptoms were the outcome variables. Results: Longer stay in the United States was significantly associated with fewer gum symptoms but not with tooth symptoms. Behavioral acculturation was not significantly associated with either tooth or gum symptoms. The middle tertile of behavioral acculturation, compared with its upper and lower tertiles, deemed to be a more significant risk factor of tooth/gum symptoms. In addition, older immigrants with more social interactions with the Americans were more likely to have tooth symptoms. Discussion: In the future, we will conduct a study using longitudinal data to help us better understand the relationship between acculturation and oral health in Chinese American population.

Keywords
acculturation, oral health, older Chinese immigrants, health disparities

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Oral health is an important component of health among older adults (Petersen, Kandelman, Arpin, & Ogawa, 2010). Older adults who have poor oral health are more likely to experience lower quality of life, poor nutritional intake, chewing difficulties, and lower level of physical function (Griffin, Jones, Brunson, Griffin, & Bailey, 2012; Kandelman, Petersen, & Ueda, 2008; Zhang, Wu, & Wu, 2017). Poor oral health among older adults is also associated with multiple health conditions such as diabetes (Ou & Li, 2011), hypertension (Rivas-Tumanyan, Campos, Zevallos, & Joshipura, 2013), declined kidney function (Chen et al., 2015), cognitive impairment (Wu, Fillenbaum, Plassman, & Guo, 2016), and depression (Hybels et al., 2016). Older adults face greater challenges in maintaining good oral health due to increased difficulties in self-care, as well as oral comorbidities from other chronic conditions and medicine intake (Griffin et al., 2012). Unfortunately, however, older adults, especially immigrants or racial and ethnic minorities, lack adequate access to dental care due to multiple barriers including low English language proficiency, insufficient insurance coverage, and the lack of awareness of the importance of dental care in later life (Ramsay et al., 2015).

Acculturation is an important factor affecting immigrants’ health behaviors and health outcomes (Lee, Chen, He, Miller, & Juon, 2013). It defines the process in which foreign-born individuals gradually adopt the values, customs, norms, attitudes, and behaviors of the mainstream host culture (Redfield, Linton, & Herskovits, 1936). Acculturation is a concept comprising multiple components such as context (e.g., the origin and host country), demographics (e.g., length of stay in the host country), and behavioral acculturation (e.g., language preference; Schwartz, Unger, Zamboanga, & Szapocznik, 2010). Previous studies suggested that acculturation can be associated with health outcomes due to changes of health norm and behaviors (Abraído-Lanza, Echeverría, & Flórez, 2016; Geltman et al., 2013). Yet, one major drawback of previous research on
The associations between acculturation and oral health have been found in empirical studies in immigrant populations (Cruz, Shore, Le Geros, & Tavares, 2004).

Chinese immigrants are the largest Asian immigrant population in the United States (Pew Research Center, 2012). In 2010, the number of Chinese immigrants (including Hong Kong and Taiwan) in the United States reached about 2.2 million (Camarota, 2011). Among them, the number of Chinese immigrants aged 65 years and above has increased by 55% in the past decade, which far exceeded the growth rate of 15% among general U.S. older adults (U.S. Census Bureau, 2010). Racial disparities in adults’ oral health and difficulties in accessing dental care have been an increasing public concern (Wu, Liang, Luo, & Furter, 2013).

Studies on oral health among Chinese immigrants had mixed findings. Some studies found that Chinese immigrants, compared with other racial/ethnic groups, had the lowest oral health service utilization rate and higher decay-missing-filled (DMF) index score (Cruz et al., 2001; Luo & Wu, 2016); whereas others found Chinese Americans had better oral health, measured by edentulism, than other ethnic groups (Wu, Liang, Landerman, & Plassman, 2013). These discrepancies were due to sampling biases in different studies, indicating a need of more valid analyses conducted with a larger and more representative sample. Despite that, prevailing evidence has suggested that due to a lack of oral health knowledge and presence of financial difficulties, many Chinese immigrants do not practice preventive dental visits on a regular basis (Dong, Levine, Loignon, & Bedos, 2011; Kwan & Holmes, 1999). Chinese immigrants who have lower level of acculturation are subjected to limited access to health care due to language and financial barriers as well as the unfamiliarity with the health care system in the Western world that focuses on the health and aging of U.S. Chinese older adults. Given that teeth and gums represent the two major but distinctive dimensions of oral health, the objectives of our study are to examine (a) the associations between acculturation (including “length of stay” and “behavioral acculturation”) and tooth/gum symptoms; (b) the relationship between tertiles of behavioral acculturation and tooth/gum symptoms; and (c) the associations between domains of behavioral acculturation (e.g., “language use,” “media,” and “ethnic social relations”) and tooth/gum symptoms. This study will contribute to our understanding of this population’s oral health status, as well as its associations with specific immigration-related factors. The findings would provide insight for policy makers and health care providers to design intervention strategies to improve oral health status among immigrant populations.

Method

Parent Study Overview and Data Source

The purpose of the PINE study is to collect data from community-dwelling U.S. Chinese older adults and, ultimately, examine the relationship between key cultural determinants and health as well as well-being (Dong, Wong, & Simon, 2014). Built on the strengths of a community-based participatory research (CBPR) approach, the PINE study team established, designed, and implemented culturally and linguistically sensitive community recruitment strategies (Dong et al., 2014). Face-to-face home interviews were conducted by trained multilingual interviewers. The PINE study has been demonstrated to be representative of the Chinese elderly population in the Greater Chicago area in regard to key demographic properties including age, sex, income, education, number of children, and country of origin (Simon, Chang, Rajan, Welch, & Dong, 2014).

Data for this current study are from the baseline data of the PINE study. In this current analysis, we included only those Chinese older adults who were foreign born immigrants who were more acculturated had lower rates of development of caries. Yet, previous studies on the associations between acculturation and oral health among older Chinese immigrants are very limited: (a) they only used length of stay in the United States as the surrogate for acculturation; (b) they had a narrowed focus on unmet oral health needs (Cruz, Chen, Salazar, & Le Geros, 2009) and oral health utilization behavior using convenient sampling with limited sample sizes (Cruz, Chen, Salazar, Karloopia, & LeGeros, 2010; Dong et al., 2011; Wu, Tran, & Khatutsky, 2005); (c) previous studies suggest that acculturation may be associated with oral health status, the relative associations between different levels of acculturation and oral health have not been explored. To fill the knowledge gaps, we used data from the Population Study of Chinese Elderly in Chicago (PINE), which is the largest study in the Western world that focuses on the health and aging of U.S. Chinese older adults. Studies on oral health among Chinese immigrants had mixed findings. Some studies found that Chinese immigrants, compared with other racial/ethnic groups, had the lowest oral health service utilization rate and higher decay-missing-filled (DMF) index score (Cruz et al., 2001; Luo & Wu, 2016); whereas others found Chinese Americans had better oral health, measured by edentulism, than other ethnic groups (Wu, Liang, Landerman, & Plassman, 2013). These discrepancies were due to sampling biases in different studies, indicating a need of more valid analyses conducted with a larger and more representative sample. Despite that, prevailing evidence has suggested that due to a lack of oral health knowledge and presence of financial difficulties, many Chinese immigrants do not practice preventive dental visits on a regular basis (Dong, Levine, Loignon, & Bedos, 2011; Kwan & Holmes, 1999). Chinese immigrants who have lower level of acculturation are subjected to limited access to health care due to language and financial barriers as well as the unfamiliarity with the health care system in the United States (Mao, Wu, & Chi, 2015; Mariño, Stuart, Wright, Minas, & Klimidis, 2001; Zhang et al., 2017). When oral health problems occur, Chinese older immigrants tend to apply traditional remedies such as drinking tea and taking Vitamine C instead of seeking treatment from dental providers to design intervention strategies to improve oral health status among immigrant populations.

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Covariates. This study was approved by Duke University’s Institutional Review Board (IRB).

Measures

Oral health. Self-reported oral (tooth and gum) symptoms were the primary outcome variables. At the time of interview, participants were asked, “Have you had these oral symptoms in the past?” We defined “teeth symptoms” if the participant selected “teeth” in their answers, and we defined “gum symptoms” if the participant selected “gums” in their answers.

Acculturation. Acculturation was estimated from two perspectives: length of stay in the United States and behavioral acculturation. Length of stay in the United States was estimated by asking a question, “How many years have you been living in US?” Behavioral acculturation was measured by using the 12-item short acculturation scale developed by Marin, Sabogal, Marin, Otero-Sabogal, and Perez-Stable (1987). This questionnaire measured behavioral acculturation from three domains: language use (α = .90), media use (α = .86), and ethnic social relations (α = .78; Marin et al., 1987). Responses to each of the questions were recorded on a 5-point range from 1 (“all Chinese”) to 5 (“all Americans”). The level of behavioral acculturation was evaluated by summing up the scores of each question, yielding a total score range from 12 to 60, with a higher score representing a higher acculturation level. Score for each domain of behavioral acculturation (language preference, media use, and ethnic social relations) were also calculated. The instrument has shown good reliability in the Chinese population (Wong, Yoo, & Stewart, 2007). The previous literature on the PINE study showed the Cronbach’s alpha of .88 (Dong, Bergren, & Chang, 2015).

Covariates. Covariates included age (in years), gender, living arrangements (living alone or not), education (in years), number of chronic conditions, smoking status (current smoker, former smoker, or never smoker), income (log-transformed), geographical origins, and language preferences. Based on the previous literature, we selected these variables that are potentially associated with oral health (Cruz et al., 2001; Eke et al., 2016; Mao et al., 2015; Wu et al., 2005), and they were used in both sets of models with tooth symptoms and gum symptoms as the dependent variable.

Data Analysis

Descriptive statistics were calculated for all variables (means, standard deviations, frequency, and percentage). Hierarchical logistic regression analyses were conducted. Prior to performance of all statistical tests, model assumptions including linearity, normality, homoscedasticity, and multicollinearity were examined. No high correlation was found between years in the United States and behavioral acculturation (r = .13), language preference and behavioral acculturation (r = .26), or any of the variables included in the analyses (r < .4). Sets of sequential logistic regression analyses were performed to assess the contributions of acculturation, demographic factors, socioeconomic factors, medical conditions, and smoking behaviors to tooth symptoms and gum symptoms. That is, Model 1 included acculturation (years in the United States and behavioral acculturation). Model 2 added demographic variables (age, gender, education, and living arrangement). Model 3 added socioeconomic factors (income and education). Model 4 added number of medical conditions and smoking behaviors. Model 5 added risk behaviors represented by smoking. Similar hierarchical logistic regression approach for tertiles of acculturation and domains of acculturation. Specifically, given the high correlation between domains “language use” and “media” (p = .54), we conducted three sets of hierarchical logistic regressions, each with a single domain of behavioral acculturation in the model. All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC). Statistical tests were conducted with the level of significance set at 0.05.

Results

Detailed descriptive statistics have been described elsewhere (Dong et al., 2015; Ge, Wu, Bailey, & Dong, 2017). Participants resided in the United States for an average of 19.8 years (SD = 12.7). Of the 3,128 participants, 1,497 of them reported having tooth symptoms in the past, yielding a prevalence of 47.9%; 586 of the participants reported having any gum symptoms, yielding a prevalence of 18.7%.

Acculturation

In the fully adjusted model, length of stay and behavioral acculturation deemed to have nonsignificant associations with tooth symptoms. Living arrangement (odds ratio [OR] = 0.802, 95% CI [0.663, 0.969], p < .05), income (OR = 0.853, 95% CI [0.792, 0.919], p < .001), and being a current smoker (OR = 1.436, 95% CI [1.079, 1.912], p < .05) were significantly associated with tooth symptoms, indicating that older Chinese immigrants who lived alone, had higher income, and were current smokers reported less oral symptoms (see Table 1). In terms of gum symptoms, length of stay remained a significant factor on the happening of any gum symptoms (OR = 0.982, 95% CI [0.972, 0.991], p < .001). Age (OR = 0.969, 95% CI [0.956, 0.983], p < .001) and medical conditions (OR = 1.157, 95% CI [1.085, 1.234], p < .001) also remained significant, indicating that older Chinese immigrants who were younger and had more medical conditions reported more oral symptoms (see Table 1).
### Table 1. Associations Between Acculturation and Tooth/Gum Symptoms.

| Variables         | Tooth Symptoms |                        | Gum Symptoms |                        |
|-------------------|----------------|-------------------------|--------------|-------------------------|
|                   | Model 1        | Model 2                 | Model 3      | Model 4                 | Model 5 |
|                   | OR [95% CI]    | OR [95% CI]             | OR [95% CI]  | OR [95% CI]             | OR [95% CI] |
|                   | Model 1        | Model 2                 | Model 3      | Model 4                 | Model 5 |
|                   | OR [95% CI]    | OR [95% CI]             | OR [95% CI]  | OR [95% CI]             | OR [95% CI] |
| Acculturation     |                |                         |              |                         |          |
| Length of stay    | 0.990*** [0.984, 0.995] | 0.997* [0.984, 0.999] | 0.996 [0.988, 1.003] | 0.994 [0.988, 1.003] | 0.978*** [0.970, 0.985] |
| Behavioral acculturation | 1.000 [0.981, 1.021] | 1.000 [0.981, 1.021] | 1.000 [0.981, 1.021] | 1.000 [0.981, 1.021] | 1.000 [0.981, 1.021] |
| Demographics      |                |                         |              |                         |          |
| Age               | 0.997 [0.988, 1.007] | 0.995 [0.986, 1.005] | 0.994 [0.984, 1.005] | 0.995 [0.984, 1.005] | 0.975*** [0.962, 0.990] |
| Females           | 0.923 [0.794, 1.065] | 0.906 [0.778, 1.054] | 0.900 [0.772, 1.045] | 0.905 [0.777, 1.049] | 0.974*** [0.854, 1.008] |
| Living alone      | 0.794* [0.639, 0.977] | 0.802* [0.664, 0.970] | 0.801* [0.662, 0.967] | 0.802* [0.663, 0.969] | 0.970*** [0.849, 1.001] |
| Non-Jewish/Chinese| 0.949 [0.730, 1.237] | 0.966 [0.763, 1.221] | 0.966 [0.762, 1.221] | 0.966 [0.762, 1.221] | 0.970*** [0.849, 1.001] |
| Socioeconomic factors |                |                         |              |                         |          |
| Income            | 0.853*** [0.792, 0.919] | 0.854*** [0.792, 0.919] | 0.853*** [0.792, 0.919] | 0.853*** [0.792, 0.919] | 0.870 [0.777, 0.961] |
| Education         | 0.993 [0.975, 1.012] | 0.993 [0.975, 1.012] | 0.995 [0.977, 1.014] | 0.995 [0.977, 1.014] | 0.972 [0.877, 1.062] |
| Health factor     |                |                         |              |                         |          |
| Medical conditions | 1.017 [0.944, 1.094] | 1.019 [0.946, 1.094] | 1.019 [0.946, 1.094] | 1.019 [0.946, 1.094] | 1.017 [0.946, 1.094] |
| Behavioral status |                |                         |              |                         |          |
| Current smoker    | 1.436* [1.079, 1.912] | 1.436* [1.079, 1.912] | 1.436* [1.079, 1.912] | 1.436* [1.079, 1.912] | 1.436* [1.079, 1.912] |
| Former smoker     | 1.160 [0.904, 1.493] | 1.160 [0.904, 1.493] | 1.160 [0.904, 1.493] | 1.160 [0.904, 1.493] | 1.160 [0.904, 1.493] |

Note. OR = odds ratio; CI = confidence interval.
*p < .05. **p < .01. ***p < .001.
Cruz et al., 2009 studied the associations between acculturation and oral health status. Our finding was consistent with previous studies. The length of stay in the United States was associated with better oral health, fewer oral health symptoms, suggesting that longer stay for those within the middle tertile of behavioral acculturation was 1.652 times more likely to have any tooth symptoms (OR = 1.652, 95% CI [1.381, 1.976], p < .001). Length of stay deemed to have a significant association with gum symptoms. As for gum symptoms, the fully adjusted model, older adults within the middle tertile of behavioral acculturation was 1.639 times more likely to have gum symptoms than those within the bottom tertile (OR = 1.639, 95% CI [1.311, 2.050], p < .001). Length of stay deemed to have a significant association with gum symptoms (OR = 0.981, 95% CI [0.971, 0.990], p < .001).

As for domains of behavioral acculturation (see Table 3), only “ethnic social relations” deemed significant association with tooth symptoms. In the fully adjusted models, people who scored higher in “ethnic social relations,” referring to that they had more interactions with the general American population than Chinese population, were more likely to have tooth symptoms (OR = 1.106, 95% CI [1.052, 1.163], p < .001). Length of stay had no significant associations with tooth symptoms. None of the domains of behavioral acculturation was significantly associated with gum symptoms. Length of stay was a significant indicator of gum symptoms.

Discussion

This study found that length of stay was related to the reported oral symptoms among older Chinese immigrants. Length of stay was significantly associated with both tooth and gum symptoms after adjusting for partial or all the covariates. However, behavioral acculturation showed no significant associations with neither dental nor gum symptoms. Our study was the first to investigate the associations between acculturation and oral symptoms using a large population-based sample (N = 3,159) of older Chinese immigrants. This study contributes to our understanding of the relationship between acculturation and oral health status among older Chinese immigrants and is informative of the cross-racial oral health disparity between Chinese immigrants and other ethnic groups.

We found length of stay was a significant factor related to tooth symptoms and gum symptoms. Our binary regression analyses results indicated that people who have lived longer in the United States would have fewer oral health symptoms, suggesting that longer stay in the United States was associated with better oral health status. Our finding was consistent with previous studies. Cruz et al., 2009 studied the associations between immigration and acculturation attributes with oral health among the top seven immigrant groups in New York City. Without distinguishing the country of origins of the immigrants, this study found an inverse relationship between length of stay in the United States and unmet oral health needs, which was measured by the ratio of decayed surfaces to decayed and filled surfaces (DS: DFS). However, there are insufficient explanations on the mechanisms of how length of stay associates to oral health. A possible reason for the associations between longer stay and fewer oral symptoms could be due to adequate oral service utilization (Gao & McGrath, 2011). Older adults who have lived in the United States for a longer time are more likely to be acculturated into the U.S. society. They may have better access to oral health service, are more familiar with the health care system, and use dental services more often. All of these could result in an increased oral health literacy and better oral health outcomes. This assumption is supported by the previous literature (Luo & Wu, 2016; Mao et al., 2015; Wu et al., 2005). For examples, Luo and Wu (2016) found that the length of stay had a significant association with having a dental visit in the previous 12 months; Wu et al. (2005) also found that the length of stay in the United States was a significant indicator of utilization of dental services for older Chinese immigrants. However, the associations between length of stay and tooth symptoms was gone after adjusting for socioeconomic factors. This indicated the important role of financial affordability on oral health outcomes. We found income was significantly associated with tooth but not gum symptoms. This difference regarding the importance of socioeconomic status may be related to different severities of symptoms of tooth and gum, as well as the specific patterns of coping behaviors among older Chinese immigrants. In a previous study, Chinese immigrants were mostly motivated to consult a dental professional when they encountered acute oral problems such as toothache (Dong et al., 2011). Given this need, older Chinese immigrants who are financially capable would be able to seek professional treatment and promote dental health. However, gum symptoms were mostly chronic, such as swollen and bleeding gums, that do not require timely attention. Also, due to a lack of oral health literacy and cultural believes, Chinese immigrants usually attribute gum symptoms to insufficient Vitamin C intake and “internal fire” (i.e., excessive internal body heat). Thus, they tended to rely on self-treatment such as taking Vitamin C supplements, drinking tea, and rinsing with salt water, but not seeking for timely professional help (Dong et al., 2007). That being said, older Chinese immigrants lacked the awareness and motivation to promote gum health regardless of their income level. Future qualitative studies should be conducted to understand the nature of these associations.

We found no significant associations between behavioral acculturation level and tooth symptoms or gum

Tertiles and Domains of Behavioral Acculturation

As for tertiles of behavioral acculturation, as shown in Table 2, in the fully adjusted model, the top tertile of behavioral acculturation was 1.52 times more likely to have any tooth symptoms than the lowest tertile of behavioral acculturation (OR = 1.521, 95% CI [1.246, 1.857], p < .001), whereas the middle tertile of behavioral acculturation was 1.652 times more likely to have any tooth symptoms (OR = 1.652, 95% CI [1.381, 1.976], p < .001). Length of stay deemed to be not a significant indicator of tooth symptoms. As for gum symptoms, in the fully adjusted model, older adults within the middle tertile of behavioral acculturation was 1.639 times more likely to have gum symptoms than those within the bottom tertile (OR = 1.639, 95% CI [1.311, 2.050], p < .001). Length of stay deemed to have a significant association with gum symptoms (OR = 0.981, 95% CI [0.971, 0.990], p < .001).

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| Variables                  | Tooth symptoms | Gum symptoms |
|----------------------------|----------------|--------------|
|                            | Model 1        | Model 2      | Model 3    | Model 4     | Model 5     | Model 1        | Model 2      | Model 3    | Model 4     | Model 5     |
|                            | OR [95% CI]    | OR [95% CI]  | OR [95% CI]| OR [95% CI]| OR [95% CI]| OR [95% CI]    | OR [95% CI]  | OR [95% CI]| OR [95% CI]| OR [95% CI]|
| Acculturation              |                |              |            |            |            |                |              |            |            |            |
| Length of stay             | 0.990*** [0.984, 0.996] | 0.990*** [0.984, 0.997] | 0.994 [0.987, 1.001] | 0.994 [0.987, 1.001] | 0.994 [0.987, 1.001] | 0.978*** [0.974, 0.992] | 0.983*** [0.974, 0.993] | 0.983*** [0.974, 0.993] | 0.984*** [0.971, 0.996] | 0.982*** [0.971, 0.996] |
| BA_high                    | 1.420*** [1.198, 1.684] | 1.416*** [1.186, 1.740] | 1.507*** [1.232, 1.834] | 1.521*** [1.246, 1.857] | 1.521*** [1.246, 1.857] | 1.168 [0.931, 1.466] | 1.139 [0.885, 1.466] | 1.165 [0.898, 1.512] | 1.191 [0.917, 1.547] | 1.200 [0.924, 1.561] |
| BA_mid                     | 1.684*** [1.462, 2.004] | 1.679*** [1.406, 2.004] | 1.646*** [1.377, 1.969] | 1.646*** [1.376, 1.968] | 1.652*** [1.381, 1.974] | 1.657*** [1.336, 2.057] | 1.641*** [1.294, 2.013] | 1.628*** [1.303, 2.034] | 1.639*** [1.311, 2.050] |        |
| Demographics               |                |              |            |            |            |                |              |            |            |            |
| Age                        | 1.002 [0.992, 1.012] | 0.999 [0.989, 1.009] | 0.998 [0.988, 1.009] | 0.999 [0.989, 1.010] | 0.978*** [0.965, 0.991] | 0.978*** [0.964, 0.991] | 0.973*** [0.959, 0.986] | 0.972*** [0.959, 0.986] |            |            |
| Females                    | 0.937 [0.809, 1.080] | 0.912 [0.783, 1.062] | 0.906 [0.777, 1.057] | 1.067 [0.857, 1.328] | 1.081 [0.895, 1.304] | 1.062 [0.874, 1.292] | 1.002 [0.802, 1.221] | 1.111 [0.831, 1.484] |            |            |
| Living alone               | 0.812* [0.674, 0.980] | 0.820* [0.678, 0.991] | 0.818* [0.676, 0.989] | 0.820* [0.678, 0.992] | 1.188 [0.931, 1.517] | 1.210 [0.946, 1.548] | 1.181 [0.923, 1.512] | 1.192 [0.931, 1.527] |            |            |
| Not from China             | 0.983 [0.788, 1.309] | 0.922 [0.687, 1.236] | 0.921 [0.687, 1.235] | 0.919 [0.685, 1.232] | 1.283 [0.854, 1.928] | 1.209 [0.802, 1.822] | 1.203 [0.797, 1.815] | 1.193 [0.790, 1.800] |            |            |
| Cantonese or Toisanese     | 1.068 [0.884, 1.289] | 0.960 [0.785, 1.226] | 0.964 [0.788, 1.230] | 0.969 [0.775, 1.211] | 0.998 [0.786, 1.267] | 0.974 [0.735, 1.321] | 1.012 [0.763, 1.342] | 1.008 [0.760, 1.338] |            |            |
| Socioeconomic factors      |                |              |            |            |            |                |              |            |            |            |
| Income                     | 0.857*** [0.796, 0.923] | 0.858*** [0.796, 0.924] | 0.857*** [0.795, 0.923] | 0.963 [0.876, 1.059] | 0.971 [0.883, 1.068] | 0.970 [0.888, 1.067] |            |            |            |            |
| Education                  | 0.989 [0.970, 1.007] | 0.988 [0.970, 1.007] | 0.991 [0.972, 1.010] | 0.995 [0.971, 1.019] | 0.995 [0.971, 1.016] | 0.992 [0.968, 1.017] |            |            |            |            |
| Health factor              |                |              |            |            |            |                |              |            |            |            |
| Medical conditions         | 1.017 [0.967, 1.071] | 1.020 [0.969, 1.073] | 1.157*** [1.085, 1.234] | 1.156*** [1.084, 1.233] |            |            |            |            |            |            |
| Behavioral status          |                |              |            |            |            |                |              |            |            |            |
| Current smoker             | 1.448 [1.086, 1.932] | 1.055 [0.724, 1.538] |            |            |            |            |            |            |            |            |
| Former smoker              | 1.184 [0.921, 1.523] | 1.240 [0.989, 1.274] |            |            |            |            |            |            |            |            |

Note: OR = odds ratio; CI = confidence interval; BA = behavioral acculturation.
*p < .05, **p < .01, ***p < .001.
Table 3. Associations Between Domains of Acculturation and Tooth/Gum Symptoms.

| Variables                  | Tooth symptoms          | Gum symptoms          |
|----------------------------|-------------------------|-----------------------|
|                            | Unadjusted | Adjusted | Unadjusted | Adjusted | Unadjusted | Adjusted | Unadjusted | Adjusted | Unadjusted | Adjusted | Unadjusted | Adjusted |
|                            | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] | OR [95% CI] |
| Acculturation              |             |           |             |           |             |           |             |           |             |           |             |             |
| Length of stay            | 0.991***    | [0.985, 0.997] | 0.997     | [0.99, 1.01] | 0.999***    | [0.993, 0.995] | 0.993     | [0.984, 1.000] | 0.979*** | [0.971, 0.987] | 0.983*** | [0.973, 0.993] | 0.978*** | [0.969, 0.986] |
| BA_language               | 0.974*      | [0.929, 1.021] | 0.975     | [0.923, 1.029] | 0.962*      | [0.894, 1.021] | 0.949     | [0.873, 1.021] | 0.962*    | [0.894, 1.025] | 0.962*    | [0.894, 1.029] |
| BA_media                  | 0.984       | [0.954, 1.015] | 0.989     | [0.956, 1.024] | 1.008***    | [1.049, 1.107] | 1.106***  | [1.053, 1.171] | 1.008*** | [1.047, 1.073] | 1.008*** | [1.047, 1.073] |
| BA_ethnic_social_relations|             |           |             |           |             |           |             |           |             |           |             |             |
| Age                       | 0.994       | [0.984, 1.004] | 0.994     | [0.984, 1.005] | 0.997      | [0.987, 1.008] | 0.969***  | [0.956, 0.982] | 0.969*** | [0.956, 0.983] | 0.971*** | [0.957, 0.986] |
| Females                   | 1.041       | [0.987, 1.095] | 1.045     | [0.984, 1.005] | 1.051      | [0.984, 1.018] | 1.084     | [1.042, 1.129] | 1.091     | [1.053, 1.130] | 1.092     | [1.053, 1.130] |
| Living-alone              | 0.886*      | [0.847, 0.937] | 0.887*    | [0.846, 0.932] | 0.869*     | [0.827, 0.913] | 0.917*    | [0.873, 0.964] | 0.917*    | [0.873, 0.964] | 0.917*    | [0.873, 0.964] |
| Not from China            | 0.889       | [0.830, 0.954] | 0.881     | [0.845, 0.927] | 0.938      | [0.874, 1.011] | 1.134     | [1.074, 1.205] | 1.171     | [1.091, 1.257] | 1.251     | [1.097, 1.422] |
| Cantonese or Toisanese     | 0.860       | [0.801, 1.070] | 0.864     | [0.804, 1.075] | 0.977      | [0.799, 1.223] | 0.939     | [0.711, 1.239] | 0.947     | [0.718, 1.250] | 1.008     | [0.752, 1.329] |
| Socioeconomic factors      |             |           |             |           |             |           |             |           |             |           |             |             |
| Income                    | 0.863***    | [0.801, 0.930] | 0.860***  | [0.799, 0.927] | 0.846***   | [0.786, 0.911] | 0.972     | [0.883, 1.071] | 0.966     | [0.878, 1.064] | 0.958     | [0.871, 1.054] |
| Education                 | 0.999       | [0.980, 1.017] | 0.998     | [0.980, 1.017] | 0.991      | [0.973, 1.010] | 0.996     | [0.972, 1.020] | 0.994     | [0.971, 1.019] | 0.991     | [0.967, 1.015] |
| Health status             |             |           |             |           |             |           |             |           |             |           |             |             |
| Medical conditions        | 1.018       | [0.947, 1.071] | 1.018     | [0.948, 1.071] | 1.019      | [0.948, 1.072] | 1.156***  | [1.084, 1.233] | 1.154*** | [1.084, 1.234] | 1.157*** | [1.085, 1.234] |
| Behavioral status         |             |           |             |           |             |           |             |           |             |           |             |             |
| Current smoker            | 1.242*      | [1.096, 1.397] | 1.431     | [1.107, 1.903] | 1.430      | [1.073, 1.905] | 1.054     | [0.724, 1.534] | 1.063     | [0.731, 1.546] | 1.061     | [0.729, 1.543] |
| Former smoker             | 1.151       | [0.986, 1.349] | 1.154     | [1.089, 1.262] | 1.148      | [1.090, 1.201] | 1.214     | [1.087, 1.368] | 1.221     | [1.089, 1.366] | 1.227     | [1.088, 1.370] |

Note. OR = odds ratio; CI = confidence interval; BA = behavioral acculturation.

*p < .05, **p < .01, ***p < .001.
symptoms among older Chinese immigrants. We used a validated short behavioral acculturation scale, which included three major concepts including “language use,” “media,” and “ethnic social relations” to measure behavioral acculturation. Our study is the first that specifically investigate the relationship between behavioral acculturation measured by a multidimensional scale and oral health status among this specific population. However, previous studies of the similar topic in other minority population produced mixed findings. Cruz and colleagues (2004) found that behavioral acculturation was significantly associated with better dental and gum health among Haitian immigrants in New York City. Similarly, Mariño et al. (2001) found that behavioral acculturation was significantly associated with decayed, missing, and filled surface (DMFS) scores among Vietnamese living in Melbourne, Australia. However, Ismail and Szpunar (1990) found that behavioral acculturation was significantly associated with gum health status (gingivitis and periodontal pocketing) but not the number of missing and decayed teeth. The inconsistencies in previous findings may be due to different samples and different instruments applied, as well as different oral health status among diverse populations. Sufficient understanding of how behavioral acculturation affects oral health status is still lacking. Future comparative studies between different ethnic groups using congruent measures are needed. Also, we need to apply an acculturation measure that is more sensitive to capture health behaviors, so that we can better understand the potential mechanisms that account for the association between behavioral acculturation and oral health status.

To our knowledge, our study is the first to look at the associations between tertiles of acculturation and oral health symptoms among an immigrated population in the United States. We found that upper tertile in behavioral acculturation were more likely to have tooth/gum symptoms than the lower tertile of acculturation. We also found that the middle tertile of behavioral acculturation was the group that most likely to have any teeth symptoms. Our study findings are consistent with the cultural marginality model (Geltman et al., 2013), which reveals the possibility that the group of moderate acculturation are likely to have more oral health challenges due to the interactions of adopting to the host nation’s lifestyles (which typically includes more sweet food) and lacking sufficient oral health services. The top tertile of acculturation group had slightly better oral health than the middle tertile, which may be due to their greater familiarity with the U.S. health care system and greater likelihood to access local dental care. Similar non-linear relationship between acculturation and oral health were also found by Mariño and colleagues (2001). In the future, a study using longitudinal data and analytical method will help to better delineate the relationship between acculturation and oral health in Chinese American population.

Furthermore, our study is the first to look at the associations between each of the three different domains of behavioral acculturation and oral health outcomes. Previous studies have only examined the relationship between overall behavioral acculturation, without looking further into the different associations of distinguished domains of behavioral acculturation with oral health status (Cruz et al., 2004; Mariño et al., 2001). Our findings are consistent with the previous literature in that no significant associations were found between language and oral health outcomes (Cruz et al., 2009; Luo & Wu, 2016). Media use, from our analyses, was deemed not to be significantly associated with oral health. These nonsignificant associations may be due to (a) language constituting less of an obstacle to oral health information exchange and care access while living in a multicultural context such as Chicago (Cruz et al., 2009) or (b) not much oral health information were exchanged through these channels. In addition, and importantly, we found that more social interaction with Americans were significantly associated with more tooth symptoms. This demonstrates the possibility that Chinese immigrants who are more socially engaged with Americans might have also adopted the lifestyle that has negatively affected their oral health. Future studies are still needed to investigate the nature of as well as the potential mediators between the associations of ethnic social relations and oral health outcomes.

**Limitations**

The findings of our study should be interpreted with awareness of its limitations. First, the parent study included only very general oral symptoms. Future studies can learn more by including more detailed oral symptoms such as toothache, tooth decay, and swollen gums. Second, the timing of the happening of oral symptoms was uncertain given that the question did not ask for a specific timeframe. Future studies should have a justifiable timeframe included when asking for the happening of any oral symptoms (e.g., “within the last 12 months”). Third, the generalizability of current findings might be limited by the fact that this is a regional representative data. However, our study is the first step toward gaining a better understanding of the relationship between acculturation and oral symptoms among this particular population. Fourth, oral symptoms in this study were based on self-reported data. Future studies should have more rigorous clinical examinations to measure oral health status among older Chinese immigrants. Fifth, the cross-sectional nature of this study forbade us from referring any causal relationship. Further studies using longitudinal analytical methods should be conducted to examine the relationship between length of stay, acculturation, and the trajectory of oral health status among the older Chinese immigrants. Last but not least, we did not include dental insurance in the current...
analysis given that this information was not collected in the parent study. Future research must consider the potential influence of dental insurance on oral health-seeking behaviors and outcomes.

Despite these limitations, this study has important implications for researchers, community social workers, and nurses. Researchers should consider conducting qualitative studies to better examine the nature of the associations between acculturation and oral health symptoms. Community social workers and nurses should pay more attention to those who are newly immigrated, have more medical conditions, are current smokers, and are not properly insured. Policy makers should always keep in mind the necessity of developing well-targeted and culturally competent policies for older Chinese immigrants.

Conclusion

Our study is the first to examine the associations between acculturation and oral health among older Chinese immigrants. Oral health is an important component of systematic health. We found that longer length of stay in the host country, but not behavioral acculturation, was significantly associated with better oral health status, but not was behavioral acculturation. Future studies should be carried out to illicit the underlying mechanisms and potential mediators that contributes to the associations between acculturation and oral health status. It is also of merit for future studies to understand why behavioral acculturation was not associated with oral health status among this specific population from a cultural competent perspective.

Declaration of Conflicting Interests

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