ORIGINAL REPORT: EPIDEMIOLOGIC RESEARCH

Exposure to Adverse Childhood Experiences and Oral Health Measures in Adulthood: Findings from the 2010 Behavioral Risk Factor Surveillance System

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Abstract: Introduction: Adverse childhood experiences (ACEs) are negative life events occurring before the age of 18 y. ACEs are risk factors for heart disease and diabetes in adult life. Furthermore, individuals who experience ACEs are more likely to smoke and become obese—factors associated with poor oral health.

Objective: This study investigated likely associations between ACEs and the oral health measures of the 2010 Behavioral Risk Factor Surveillance System (BRFSS).

Methods: Data from 16,354 participants of the 2010 BRFSS were analyzed with SAS 9.4. ACE scores were calculated in 2 domains: abuse (emotional, physical, or sexual) and household challenges (parental separation or divorce, intimate

partner violence, household substance abuse, household mental illness, and incarceration). ACE scores, ranging from 0 to 8, were categorized into 0, 1, 2, 3, and ≥ 4 . The 2010 BRFSS oral health measures included >1 y since last dental visit, ≥ 6 teeth extracted, and ≥ 2 y since last dental cleaning. Survey logistic regression estimated prevalence odds ratios and 95% CIs, adjusted for age, sex, race/ethnicity, and educational attainment.

Results: The weighted mean ACE score was 1.74 (95% CI = 1.68 to 1.81), and the weighted and age-standardized percentages of study participants with ACE scores of 0, 1, 2, 3, and ≥ 4 were 33.1%, 24.3%, 14.9%, 9.69%, and 18.1%, respectively. There appeared to be a dose-response association between categories of ACE scores and the oral health measures.

Specifically, when compared with participants with an ACE score of 0, participants with ACE scores of 1, 2, 3, and ≥ 4 had adjusted prevalence odds ratios (95% CIs) of 1.10 (0.82 to 1.47), 1.20 (0.90 to 1.60), 1.35 (0.98 to 1.85), and 1.72 (1.31 to 2.26), respectively, for reporting ≥ 2 y since last dental cleaning.

Conclusions: Findings suggest that ACEs may be associated with poor oral health measures in adulthood, even after adjusting for important oral diseases risk factors. Longitudinal follow-up studies are needed to delineate pathways by which this relationship occurs.

Knowledge Transfer Statement:

Our findings indicate that exposure to childhood trauma may have negative impacts on oral health in adulthood.

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Oral health practitioners need to be aware of the potential impacts of childhood trauma on health behaviors that ultimately affect oral health outcomes.

Keywords: epidemiology, public health, trauma informed care, adult, childhood exposure, trauma

Introduction

Adverse childhood experiences (ACEs), defined as negative life events occurring before the age of 18 y, are associated with important medical and public health problems (Felitti et al. 1998; Hughes et al. 2017). ACEs negatively affect health and well-being and are associated with significant morbidity and mortality (Fang et al. 2012). Domains of ACEs, including physical, sexual, and emotional abuse or neglect, cumulatively affect lifelong health and function (Kimple and Kansagra 2018). Indeed, stress from these sources of abuse is posited to disrupt early brain development, resulting in more chronic stress that ultimately disrupts the development of the nervous and immune systems (Anda et al. 2006). This suggests that individuals exposed to ACEs are likely more susceptible to disease development by way of differences in physiologic development and engagement in health-damaging behaviors (Hughes et al. 2017). An estimated 1 in 5 US adolescents experience some form of maltreatment during childhood (Finkelhor et al. 2009; Finkelhor et al. 2013), and approximately 32% of women and 22% of men experienced sexual and physical abuse, respectively, as children (Briere and Elliott 2003). The long-term economic impacts of exposure to ACEs are enormous. For instance, the average per-victim lifetime cost (in 2010 dollars) of nonfatal child maltreatment in the United States was estimated at \$210,012, and with a reported 579,000 nonfatal and 1,740 fatal child maltreatment cases in 2008 alone, the aggregated lifetime economic burden of childhood maltreatment was estimated at over \$124 billion in 2010 dollars (Fang et al. 2012).

ACEs are associated with chronic health conditions, such as chronic obstructive pulmonary disease (Anda et al. 2008; Cunningham et al. 2014), heart disease (Dong, Giles, et al. 2004), and poor ratings on quality of life (Corso et al. 2008), including poor oral health–related quality of life (Kabani et al. 2018). Furthermore, mental distress, depressive symptoms (Kessler and Magee 1993; Chapman et al. 2004), and psychological dysfunction (Briere and Elliott 2003) are reported to be associated with exposure to ACEs. Moreover, other studies reported that individuals who experienced adverse childhood events are more likely to engage in risky health behaviors, such as smoking (Anda et al. 2006; Edwards et al. 2007; Hughes et al. 2017) and excessive alcohol consumption (Anda et al. 2006; Dube et al. 2006; Hughes et al. 2017)—behaviors that are known risk factors for poor oral health outcomes (Do et al. 2008; Akinkugbe et al. 2015).

Although theoretical and conceptual models, such as the life course perspectives (Braveman and Barclay 2009), social ecological model (Vélez-Agosto et al. 2017), and the oral health conceptual model (Fisher-Owens et al. 2007), depict and describe sociobiological interactions in oral disease occurrence, only a handful of studies have directly examined how ACEs affect oral health. These studies have been limited to dental decay among children and adolescents (Bright et al. 2015; Duda et al. 2017), tooth loss in the elderly (Matsuyama et al. 2016), resilience factors in children's oral health status (Crouch et al. 2018), and oral health–related quality of life (Kabani et al. 2018), or they investigated certain ACE domains, such as the dental treatment experience of adults with a history of childhood sexual abuse (Willumsen 2001; Stalker et al. 2005; Larijani and Guggisberg 2015). The current investigation seeks to elucidate exposure to ACEs (separately and in combination) on oral health measures (dental visit; missing teeth and dental cleaning) among a representative sample

of US adults. To our knowledge, only 1 study had previously investigated exposure to ACEs and tooth loss among older adults (Matsuyama et al. 2016), but none has examined history of ACE exposure with dental care–seeking or preventative behaviors among adults.

Methods

Data Source and Study Population

The Behavioral Risk Factor Surveillance System (BRFSS) is a collaborative project between the US Centers for Disease Control and Prevention (CDC) and US states and territories. It uses telephone surveys to collect health-related risk behaviors, chronic health conditions, and utilization of preventive services among adults ≥ 18 y (CDC 2010a). The BRFSS questionnaire consists of 3 sections: a core survey used by all states, optional modules, and state-added questions. A total of 16,354 participants from ten US States (Hawaii, Maine, Nebraska, Nevada, Ohio, Pennsylvania, Utah, Vermont, Washington, Wisconsin) and the District of Columbia, that collected information (using an optional module) on Adverse Childhood Experiences (ACEs) in the 2010 survey year were included in this study. The 2010 BRFSS survey underwent poststratification weighting to known proportions of age, race/ethnicity, sex, and geographic region within populations, thus allowing for estimates that are representative of the adult US population (CDC 2010b). Given that the data used for this investigation came from a select number of US states, weights (Lee and Chen 2017) were applied during data analysis to allow for findings that are representative of the 10 US states (and the District of Columbia) that collected information on exposure to ACEs in 2010.

Exposure: ACEs

ACEs were obtained in the following domains:

- *Abuse:* emotional (1 question), physical (1 question), sexual (3 questions)
- *Household challenges:* parental separation/divorce (1 question), parental

intimate partner violence (1 question), household substance abuse (2 questions), mental illness in the household (1 question), and incarcerated household member (1 question)

For ACE questions and responses, see the online Appendix. A response of “yes” to each question in the household challenges domain and “at least once” to questions in the abuse domain indicated exposure to an ACE. Given that these experiences tend to cluster as opposed to occurring independently (Dong, Anda, et al. 2004), we summed the number of ACEs that each participant reported to form an ordinal variable ranging from 0 (lowest score) to 8 (maximum possible score). ACE scores were then analyzed as continuous values and categorized into 0, 1, 2, 3, and ≥ 4 for the purpose of dose-response assessment. In addition, each of the 8 ACE sub domain questions were analyzed as independent exposures to assess their relationship with the oral health measures.

Covariates

Covariates included age, sex (male or female), race/ethnicity (non-Hispanic White, non-Hispanic Black, other non-Hispanic, multiracial non-Hispanic, Hispanic), and educational attainment ($\leq$ high school, $>$ high school). US state was also included as a covariate because it potentially represents a confounder. Risk factors for poor oral health, including diabetes and smoking, were also included as covariates. Diabetes was based on the question “Have you ever been told by a doctor that you have diabetes?” Responses were yes/no. Individuals who reported prediabetes or borderline diabetes ($n = 211$) were categorized as having diabetes for the purposes of this investigation because of the few number of respondents in this category in order to attain statistically reliable estimates. Smoking was based on report of having smoked 100 lifetime cigarettes. Those who additionally reported current daily or occasional smoking irrespective of

whether they had smoked 100 lifetime cigarettes were categorized as current smokers; those who reported that they no longer smoke were categorized as former smokers; and participants who had not smoked 100 cigarettes in their lifetime were categorized as never smokers. While these covariates (diabetes and smoking) are associated with experiencing ACEs (Edwards et al. 2007; Ford et al. 2011)—hence, potential intermediaries on a pathway between ACEs and poor oral health—we adjusted for them to determine whether any association between ACEs and poor oral health is independent of these factors. In other words, do ACEs affect oral health through pathways that do not involve diabetes and smoking?

Outcome: 2010 BRFSS Oral Health Measures

Last Dental Visit

Information on last dental visit was based on the question “How long has it been since you last visited a dentist or a dental clinic for any reason? Include specialists, such as orthodontists?” (<https://www.cdc.gov/brfss/questionnaires/pdf-ques/2010brfss.pdf>). Responses of within the past year, within the past 2 y, within the past 5 y, and ≥ 5 y ago were dichotomized into ≤ 12 mo and > 1 y ago.

Number of Teeth Extracted

Number of teeth extracted was based on the question “How many of your permanent teeth have been removed because of tooth decay or gum disease? Include teeth lost to infection, but do not include teeth lost for other reasons such as injury or orthodontics. (If wisdom teeth are removed because of tooth decay or gum disease, they should be included in the count for lost teeth).” Responses included none, 1 to 5 teeth, ≥ 6 but not all teeth, and all teeth. Given the low percentage of edentulous individuals (2.1%) that produced statistically unreliable estimates, we dichotomized responses into ≥ 6 versus < 6 teeth missing.

Last Dental Cleaning

Last dental cleaning was based on the question “How long has it been since you had your teeth cleaned by a dentist or dental hygienist?” Responses of within the past year, 2 y, 5 y, and ≥ 5 y ago were categorized into ≥ 2 y versus < 2 y ago.

Based on the premise that more health-conscious individuals (in this case, oral health) will visit the dentist at regularly scheduled intervals, be more likely to keep their teeth clean, and have routine dental examinations—and thus have better oral health status—these factors represent proxies for the condition of the mouth.

Statistical Analysis

The proportion of study participants (overall and according to sex) exposed to ACEs were estimated, with differences evaluated with survey-adjusted large-sample Wald chi-square tests. Next, the distribution of demographic factors and the 2010 BRFSS oral health measures—age standardized to the 2010 US census distribution—were estimated according to categories of ACE score (0, 1, 2, 3, ≥ 4). Likely independent associations between each ACE and the 2010 BRFSS oral health measures were evaluated with survey logistic regression, which estimated prevalence odds ratios (PORs) and 95% CIs. Finally, associations between total ACE score (categorical and continuous) across all domains and each 2010 BRFSS oral health measure were likewise estimated, adjusting for sociodemographic factors (age, sex, education and race/ethnicity). A second logistic model additionally adjusted for smoking and diabetes status (risk factors for poor oral health) to determine if any association between ACEs and the 2010 BRFSS oral health measures were independent of these factors. Adjustment for US state did not meaningfully affect the results and was thus excluded in favor of a more parsimonious model. Given differential reporting in oral health care utilization as well as differences in oral disease status among men and women (Dye et al. 2007), potential

statistical interaction between each ACE and the 2010 BRFSS oral health measures were assessed at an a priori alpha of 0.1. In the presence of significant statistical interaction, results stratified according to sex will be presented. Data analyses were conducted in SAS 9.4 (SAS Institute Inc) and accounted for the BRFSS complex survey design. Reporting adhered to the STROBE guidelines (Strengthening the Reporting of Observational Studies in Epidemiology).

Results

The overall weighted mean ACE score for all study participants was 1.74 (95% CI = 1.68 to 1.81), and the corresponding weighted percentages (SE) of study participants with 0, 1, 2, 3, and ≥ 4 ACE scores were 33.1% (0.79), 24.3% (0.77), 14.9% (0.62), 9.69% (0.50), and 18.1% (0.68), respectively. The overall percentages (SE) of study participants who experienced emotional abuse and physical abuse were 43% (0.87) and 19% (0.67), respectively; however, there were no meaningful differences in the proportion of men and women who experienced emotional ($P = .5$) and physical ($P = .9$) abuse. There was a significant difference between the proportion of women and men who experienced sexual abuse, with women more likely than men to have experienced sexual abuse (18% vs. 7%; $P < .0001$). More women than men reported growing up in households with a household member who abused alcohol (28% vs. 23%, $P = .001$) and living in households with a history of mental illness/suicidal attempt (22% vs. 15%, $P < .0001$) (Table 1).

Participants ≥ 60 y were least likely to have an ACE score ≥ 4 . Likewise, those with more than a high school education (3%) and men (14%) were less likely than participants with at most a high school education (5%) and women (20%) to have an ACE score ≥ 4 . In contrast, participants who were diabetic and current smokers were more likely to have an ACE score ≥ 4 . Non-Hispanic Blacks (22.7%) and multiracial non-

Hispanics (26.8%) were also more likely to have an ACE score ≥ 4 as compared with the other racial/ethnic groups (Table 2).

About a quarter (27%) of study participants reported >1 y since last dental visit; 6.4% reported missing ≥ 6 teeth; and 18% reported ≥ 2 y since last dental cleaning. Each ACE question appeared to be associated with an increased adjusted prevalence odds of reporting >1 y since last dental visit, ≥ 2 y since last dental cleaning, and ≥ 6 teeth extracted (Fig.). We found no significant ACE $\times$ sex or ACE score $\times$ sex interaction with the 2010 BRFSS oral health measures. For instance, the ACE $\times$ sex interaction P values with >1 y since last dental visit for the household challenges questions were as follows: parental separation/divorce (0.8), intimate partner violence (0.1), household substance abuse (0.7), mental illness in the household (0.9), and incarcerated household member (0.9). The corresponding interaction P values for the abuse questions (emotional, physical, sexual) were 0.2, 0.2, and 0.2. Likewise, the ACE score $\times$ sex interaction P values for last dental visit and last dental cleaning were, respectively, 0.3 and 0.2. Sex was therefore analyzed as a confounder, as opposed to an effect measure modifier; hence, regression analysis results stratified by sex are not presented.

There appears to be an unadjusted dose-response (graded) association between the number of ACE score estimated for each participant and the 2010 BRFSS oral health measures (Table 3). This graded association persisted upon covariate adjustment. Specifically, as compared with participants with an ACE score of 0, those with scores of 1, 2, 3, and ≥ 4 had the following adjusted PORs (95% CIs) for reporting ≥ 2 y since last dental cleaning: 1.10 (0.82 to 1.47), 1.20 (0.90 to 1.60), 1.35 (0.98 to 1.85), and 1.72 (1.31 to 2.26). Furthermore, each additional increase in ACE score was associated with an 11% (1.05 to 1.16) increased prevalence odds of reporting ≥ 2 y since last dental visit. These estimates, while following

a similar trend, were attenuated upon adjusting for smoking and diabetes status (Table 4). Similarly, as compared with participants with an ACE score of 0, those with scores of 1, 2, 3 and ≥ 4 had the following adjusted PORs (95% CIs) for reporting ≥ 6 teeth extracted: 1.10 (0.83 to 1.45), 1.57 (1.12 to 2.20), 1.75 (1.24 to 2.47), and 2.23 (1.69 to 2.95). Likewise, each additional ACE score was associated with an 18% (1.12 to 1.25) increased prevalence odds of having lost ≥ 6 teeth. Similar to the findings for last dental cleaning, these estimates were attenuated toward the null upon adjustment for smoking and diabetes status, although the graded association persisted (Table 4).

Discussion

Findings from this investigation were consistent with positive associations between exposure to ACEs and the 2010 BRFSS oral health measures. Specifically, each ACE factor was associated with an increase in the prevalence odds of the oral health measures (Fig.). Furthermore, we found a dose-response (i.e., graded) association between the number of ACEs and the prevalence odds of missing ≥ 6 teeth and ≥ 2 y since last dental cleaning even after adjusting for oral diseases risk factors such as smoking and diabetes. This suggests an association between ACEs and the oral health measures that is likely independent of these oral diseases risk factors. Our finding that 67% of the study sample experienced ≥ 1 ACE is similar to previous national survey reports that found that 61% of 0- to 17-y-olds had directly experienced or witnessed past-year victimization (Briere and Elliott 2003; Finkelhor et al. 2013). Also similar to a previous report (Finkelhor et al. 2009), our study found that an experience of physical abuse was greater among boys than girls, while sexual abuse was greater among girls.

Previous reports indicate that individuals who were victimized as children are less likely to utilize preventive health care at recommended intervals due to psychosocial barriers

Table 1.

Prevalence of Childhood Exposure to Abuse and Household Dysfunction: BRFSS 2010.

Domains of Adverse Childhood Experiences	Weighted Percentage (SE)			P Value ^a
	All (N = 16,354)	Women (n = 9,580)	Men (n = 6,774)	
Abuse ^b				
1. Emotional abuse (Before age 18, how often did a parent or adult in your home ever . . .)				
Swear at, insult, or put you down?	43.0 (0.87)	42.3 (1.11)	43.6 (1.35)	0.5
2. Physical abuse (Before age 18, how often did a parent or adult in your home ever . . .)				
Hit, beat, kick or physically hurt you in any way? (never vs. ≥1)	18.9 (0.67)	18.7 (0.86)	19.0 (1.03)	0.9
3. Sexual abuse (How often did anyone at least 5 years older than you . . .)	12.5 (0.57)	17.7 (0.81)	7.4 (0.79)	<0.0001
Touch you sexually?	10.8 (0.52)	16.1 (0.78)	5.8 (0.69)	<0.0001
Try to make you touch them sexually?	7.8 (0.46)	10.6 (0.59)	5.0 (0.70)	<0.0001
Force you to have sex?	4.5 (0.32)	6.9 (0.52)	2.1 (0.37)	<0.0001
Household challenges ^c				
4. Parental separation or divorce				
Were your parents ever separated or divorced?	26.4 (0.78)	26.9 (1.01)	25.9 (1.18)	0.5
5. Intimate partner violence				
How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up? (never vs. ≥1)	18.4 (0.69)	19.1 (0.88)	17.7 (1.05)	0.3
6. Household substance abuse	30.1 (0.81)	32.0 (1.07)	28.2 (1.20)	0.02
Did you live with anyone who was a problem drinker or alcoholic?	25.7 (0.76)	28.4 (1.01)	23.1 (1.13)	0.001
Did you live with anyone who used illegal street drugs or abused prescription medications?	13.0 (0.63)	12.6 (0.82)	13.4 (0.95)	0.5
7. Household mental illness				
Was a household member depressed, mentally ill, or attempt suicide?	18.4 (0.69)	21.9 (0.97)	15.0 (0.97)	<0.0001
8. Incarcerated household member				
Did you live with anyone who served time in prison, jail or other correctional facility?	7.9 (0.50)	7.1 (0.63)	8.6 (0.77)	0.1
Adverse childhood experience score category				
0 (none)	33.1 (0.79)	32.9 (1.03)	33.2 (1.20)	
1	24.3 (0.77)	22.4 (0.90)	26.1 (1.22)	0.012
2	14.9 (0.62)	14.5 (0.80)	15.3 (0.94)	
3	9.7 (0.50)	9.4 (0.60)	9.9 (0.79)	
≥4	18.1 (0.68)	20.8 (0.94)	15.5 (0.99)	

Data came from 10 US States (Hawaii, Maine, Nebraska, Nevada, Ohio, Pennsylvania, Utah, Vermont, Washington, Wisconsin) and the District of Columbia. Sample sizes are unweighted.

BRFSS, Behavioral Risk Factor Surveillance System.

^aBased on the modified Rao-Scott chi square test.

^bNever vs. at least once.

^cNo vs. yes.

Table 2.

Age-Standardized Distribution of Demographic Factors according to Categories of ACE Score: BRFSS 2010.

	<i>n</i> ^b (%)	ACE Score Category, Weighted % (SE) ^a				
		0	1	2	3	≥4
Age, y						
18 to 29	1,495 (22.1)	26.5 (2.20)	25.8 (2.31)	16.7 (1.92)	10.4 (1.45)	20.6 (1.95)
30 to 39	2,527 (24.0)	29.6 (1.74)	24.3 (1.79)	15.4 (1.37)	9.3 (1.16)	21.4 (1.71)
40 to 49	3,876 (22.7)	34.9 (1.39)	23.3 (1.17)	12.7 (0.85)	10.8 (0.88)	18.3 (1.12)
50 to 59	5,517 (22.1)	37.4 (1.26)	24.3 (1.07)	14.8 (0.90)	9.5 (0.71)	14.1 (0.87)
60 to 64	2,939 (9.13)	43.0 (1.71)	23.3 (1.45)	14.6 (1.23)	6.6 (0.73)	12.6 (1.08)
Sex						
Female	9,580 (49.1)	34.4 (0.95)	22.5 (0.82)	14.5 (0.70)	9.2 (0.53)	19.5 (0.81)
Male	6,774 (50.9)	35.5 (1.10)	25.7 (1.05)	15.2 (0.85)	9.5 (0.68)	14.1 (0.81)
Race/ethnicity						
NH White	11,070 (72.9)	35.3 (0.89)	24.5 (0.80)	14.8 (0.66)	9.0 (0.53)	16.4 (0.69)
NH Black	1,367 (5.58)	26.6 (1.96)	21.5 (1.72)	16.8 (1.70)	12.3 (1.42)	22.7 (2.21)
Hispanic	723 (6.84)	30.7 (3.30)	23.1 (3.02)	13.9 (2.40)	12.0 (2.24)	20.2 (2.64)
Other NH	1,790 (9.65)	46.3 (2.17)	25.6 (2.11)	11.1 (1.51)	7.0 (1.00)	9.9 (1.21)
Multiracial NH	1,222 (5.00)	23.2 (1.88)	18.7 (1.63)	17.9 (2.42)	13.5 (1.63)	26.8 (2.65)
Missing	182					
Education						
≤High school	4,762 (32.9)	9.0 (4.74)	21.8 (4.66)	19.1 (4.31)	14.9 (3.73)	34.2 (5.09)
>High school	11,574 (67.1)	22.6 (3.93)	29.8 (4.07)	15.6 (3.11)	9.8 (2.24)	22.3 (3.31)
Missing	18					
Smoking						
Never	8,896 (57.4)	41.3 (1.01)	24.8 (0.89)	13.6 (0.70)	8.4 (0.55)	11.9 (0.67)
Former	4,549 (22.0)	29.7 (1.34)	22.4 (1.36)	16.5 (1.09)	11.0 (0.96)	20.5 (1.26)
Current	2,870 (20.6)	23.2 (1.47)	24.2 (1.66)	15.9 (1.41)	11.1 (1.10)	25.5 (1.53)
Missing	39					
Diabetes						
No	14,809 (93.2)	35.2 (0.77)	24.3 (0.71)	14.8 (0.58)	9.2 (0.45)	16.6 (0.61)
Yes	1,535 (6.76)	32.6 (2.43)	22.5 (2.11)	15.4 (2.02)	10.2 (1.44)	19.3 (2.09)
Missing	10					
All participants	16,354 (100)	33.1 (0.79)	24.3 (0.77)	14.9 (0.62)	9.7 (0.50)	35.2 (4.59)

Data came from 10 US States (Hawaii, Maine, Nebraska, Nevada, Ohio, Pennsylvania, Utah, Vermont, Washington, Wisconsin) and the District of Columbia. Direct standardization to the 2010 US census distribution.

ACE, adverse childhood experience; BRFSS, Behavioral Risk Factor Surveillance System; NH, non-Hispanic.

^aPercentages are weighted and adjusted for age.

^bUnweighted N.

^cSurvey-weighted percentage.

Figure. Adjusted prevalence odds ratio (95% CI) between each adverse childhood experience (ACE) sub domain and the 2010 Behavioral Risk Factor Surveillance System oral health measures. Figure is plotted on the natural log scale. Emotional, physical, and sexual abuse refer to study participants having these experiences at any time before the age of 18 y. Violence at home refers to violence among adults in the household in which the study participant grew up. Mental illness, substance abuse, and incarceration refer to growing up in a household with a member who had mental illness, abused substances, or was incarcerated.

that prohibit access. Furthermore, when compared with their nonvictimized peers, these individuals are less likely to have health insurance, a factor that promotes health care access. This lends itself to a vicious cycle whereby psychosocial barriers, including dental fear and anxiety, result in avoidance of dental care, leading to a deterioration of the teeth, to feelings of guilt and shame about the appearance of the teeth, and to avoiding dental care utilization due to fear of dental care and fear of been judged (Larijani and Guggisberg 2015).

With respect to specific ACEs, a systematic review focused on dental fear and history of sexual violence victimization with respect to dental care utilization (Larijani and Guggisberg 2015) reported a common trend of dental fear among individuals with a history of sexual violence victimization, whereby presence in the dental chair and proximity of the dental care provider elicit feelings of embarrassment, flashbacks, and a lack of control.

Our results indicated that a history of childhood sexual abuse was associated with delaying dental visit, having ≥ 6 teeth extracted, and reporting ≥ 2 y since last dental cleaning. Low oral health self-efficacy among survivors of sexual abuse likely also results in avoidance of dental care altogether and a corresponding domino effect of worse oral health outcomes (Hays and Stanley 1997).

Prior findings including ours suggest that ACEs likely represent upstream risk indicators for poor oral health, specifically by facilitating engagement in negative health behaviors such as smoking and alcohol consumption (Anda et al. 2006; Edwards et al. 2007; Hughes et al. 2017), which are more proximal risk factors for poor oral health conditions such as dental caries and periodontal diseases. Given that the association between ACEs and the 2010 BRFSS oral health measures reported in this study persisted after adjusting for smoking and diabetes, a more complex biopsychosociological framework may

be at play whereby the negative effects of exposure to ACEs extend across the life course. Based on previous findings that ACEs are associated with chronic health conditions like heart disease (Dong, Giles, et al. 2004) and obesity (Hughes et al. 2017), which are in turn associated with poor oral health, this further implies that risk factors for oral diseases do not occur in isolation and that intervention strategies to improve oral health will likely benefit from inter- and transdisciplinary teams working in concert to implement, in this case, trauma (i.e., ACEs) informed approaches (i.e., ACEs) to oral health care and oral diseases prevention strategies.

Trauma-Informed Care

Trauma-informed care refers to an organizational structure and treatment perspective that involves an understanding, recognition, and response to the effects of all types of trauma (Earls 2018). A trauma-informed practice recognizes the broad health impacts of

Table 3.

Unadjusted Association between Categories of ACE Scores and the 2010 BRFSS Oral Health Measures.

ACE Score	Last Dental Visit, >1 y Ago		≥6 Teeth Removed		Dental Cleaning, ≥2 y Ago	
	<i>n</i>	POR (95% CI)	<i>n</i>	POR (95% CI)	<i>n</i>	POR (95% CI)
0	5,621	Reference	5,564	Reference	5,460	Reference
1	3,803	1.19 (0.86 to 1.65)	3,781	1.04 (0.73 to 1.48)	3,700	0.97 (0.64 to 1.47)
2	2,446	1.17 (0.83 to 1.63)	2,430	1.67 (1.10 to 2.53)	2,373	1.24 (0.82 to 1.87)
3	1,632	1.65 (1.15 to 2.37)	1,628	2.55 (1.69 to 3.85)	1,583	1.30 (0.85 to 1.99)
≥4	2,830	2.35 (1.70 to 3.25)	2,805	2.73 (1.91 to 3.91)	2,720	2.61 (1.80 to 3.77)
Trend estimate		1.17 (1.10 to 1.24)		1.22 (1.15 to 1.30)		1.19 (1.11 to 1.26)

Data came from 10 US States (Hawaii, Maine, Nebraska, Nevada, Ohio, Pennsylvania, Utah, Vermont, Washington, Wisconsin) and the District of Columbia. Trend estimate is for each additional unit increase in ACE score. Unweighted sample sizes for all participants with corresponding ACE score. Sample sizes vary due to incomplete or missing information on oral health measures.

ACE, adverse childhood experience; BRFSS, Behavioral Risk Factor Surveillance System; POR, prevalence odds ratio.

Table 4.

Categories of ACE Scores and the Adjusted Odds of the 2010 BRFSS Oral Health Measures.

ACE Score	Last Dental Visit, >1 y Ago			≥6 Teeth Removed			Dental Cleaning, ≥2 y Ago		
	<i>n</i>	aPOR (95% CI) ^a	aPOR (95% CI) ^b	<i>n</i>	aPOR (95% CI) ^a	aPOR (95% CI) ^b	<i>n</i>	aPOR (95% CI) ^a	aPOR (95% CI) ^b
0	5,621	Reference	Reference	5,564	Reference	Reference	5,460	Reference	Reference
1	3,803	1.28 (1.00 to 1.63)	1.21 (0.96 to 1.54)	3,781	1.10 (0.83 to 1.45)	1.00 (0.75 to 1.33)	3,700	1.10 (0.82 to 1.47)	1.03 (0.77 to 1.37)
2	2,446	1.15 (0.89 to 1.47)	1.08 (0.84 to 1.39)	2,430	1.57 (1.12 to 2.20)	1.39 (0.96 to 2.00)	2,373	1.20 (0.90 to 1.60)	1.12 (0.83 to 1.51)
3	1,632	1.56 (1.18 to 2.06)	1.45 (1.08 to 1.93)	1,628	1.75 (1.24 to 2.47)	1.49 (1.05 to 2.12)	1,583	1.35 (0.98 to 1.85)	1.21 (0.86 to 1.70)
≥4	2,830	1.54 (1.20 to 1.97)	1.35 (1.05 to 1.75)	2,805	2.23 (1.69 to 2.95)	1.78 (1.34 to 2.35)	2,720	1.72 (1.31 to 2.26)	1.47 (1.12 to 1.94)
Trend estimate		1.08 (1.03, 1.13)	1.05 (1.00 to 1.10)		1.18 (1.12 to 1.25)	1.13 (1.07 to 1.19)		1.11 (1.05 to 1.16)	1.07 (1.02 to 1.13)

Data came from 10 US States (Hawaii, Maine, Nebraska, Nevada, Ohio, Pennsylvania, Utah, Vermont, Washington, Wisconsin) and the District of Columbia. Trend estimate is for each additional unit increase in ACE score. Unweighted sample sizes for all participants with corresponding ACE score. Sample sizes vary due to incomplete or missing information on oral health measures.

ACE, adverse childhood experience; aPOR, adjusted prevalence odds ratio; BRFSS, Behavioral Risk Factor Surveillance System.

^aAdjusts for age, sex, race/ethnicity, and educational attainment.

^bAdjusts for age, sex, race/ethnicity, and educational attainment and for smoking and diabetes.

trauma on children and families and recognizes that trauma survivors can be retraumatized by well-meaning caregivers and community service providers. Services need not be trauma specific to be trauma informed. Trauma-specific services are geared directly to the needs of trauma survivors, whereas trauma-

informed services can be put into place on an organizational level to ensure that all patients feel more comfortable and do not require that a person disclose or discuss their particular trauma histories (Reeves 2015).

Previous research with trauma survivors suggested that experiencing

a provider-patient relationship that fostered a sense of empathy, safety, and connection benefited patients and increased engagement in treatment and prevention services (Gallo-Silver and Weiner 2006; Reeves 2015). Furthermore, trauma survivors reported that dental care experiences would be improved if

dental care providers understood trauma symptoms and responded sensitively by adapting the environment to help meet the patient's needs. Suggestions for addressing aspects of the dental environment that could be triggers for trauma survivors include the following: avoiding placing blame for the patient's unhealthy behaviors (smoking, alcohol use); discussing and obtaining consent before procedures; allowing for more upright body positioning, with "tell-show-do" desensitization to explain to patients how, when, and why certain tools will be used (e.g., mouth props and saliva ejectors); asking the patient what may make them more comfortable; and utilizing signals for the patient to alert the dentist of needing a break (Stalker et al. 2005; Raja, Hoersch, et al. 2014; Reeves 2015). Raja and colleagues provided a framework called the trauma-informed care pyramid to help dental care providers integrate the general principles of trauma-informed care into daily practice (Raja, Hoersch, et al. 2014). This framework includes examples of behavioral and patient-centered communication modifications (e.g., reflective listening, open-ended questions) that can improve the dental experiences of all patients, including those who choose not to disclose their trauma history in the context of oral health care (Raja, Hoersch, et al. 2014; Raja, Rajagopalan, et al. 2014).

Findings from this investigation, with data from 10 US states and the District of Columbia, indicated that 67% of respondents have at least 1 ACE; suffice it to say, dental care providers likely come into contact with and/or treat patients who have been victimized as children. Thus, the need for trauma-informed care in the dental treatment of these patients, indeed all patients who visit the dentist, cannot be overemphasized. Findings such as ours seek to encourage provider training on trauma-informed care and inform interventions in dental and health curriculum to train future providers in the proper treatment of adults who were exposed to ACEs as minors.

Strengths and Limitations

This is the first study to our knowledge to investigate likely associations between exposure to ACEs and various oral health measures in a large representative population-based sample. While exposure to ACEs occurred in childhood and adolescent years and because data on these exposures were elicited by self-report at a later time, they are likely subject to recall issues or misreporting resulting from memory lapses, repression of memories, or refusal to disclose sensitive information. Moreover, exposure to ACEs was elicited per responses to a limited number of survey questions and thus may not capture the extent of the abuse actually experienced. Given that the age in which exposure to ACEs occurred was also not available in the BRFSS data, we relied on cross-sectional methods to analyze these data. Therefore, our findings are subject to the limitations of cross-sectional data, thus making us unable to delineate and/or quantify the actual causal pathways through which early life conditions influence oral health in later life. Our outcome measures (missing ≥ 6 teeth, >1 y since last dental visit, and ≥ 2 y since last dental cleaning), while important, were used as proxies for the condition of the teeth and gums. In light of this, availability of objective oral health status determined by oral assessment and examination would have allowed for a more comprehensive evaluation of the influence of early life conditions on oral health in later life. Lastly, our study sample came from 10 US states and the District of Columbia; thus, these findings may not be applicable broadly.

Conclusions

While additional studies, specifically longitudinal follow-up studies, are required to delineate the contribution of ACEs to oral diseases occurrence later in life, oral health practitioners need to be aware of the potential impacts that these traumas have on health behaviors that ultimately result in poor oral health outcomes. Efforts should be created to incorporate trauma-informed care into oral health promotion

and oral health provider training curriculum, given its potential impacts in mitigating the burden of oral diseases that disproportionately affect segments of the population.

Author Contributions

A.A. Akinkugbe, contributed to conception, design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript; K.B. Hood, contributed to data interpretation, drafted and critically revised the manuscript; T.H. Brickhouse, contributed to conception and data interpretation, critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of the work.

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