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Adverse Childhood Events Are Related to the Prevalence of Asthma and Chronic Obstructive Pulmonary Disorder Among Adult Women In Hawaii

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Abstract

PURPOSE—In the US, women surpass men in the prevalence of lung diseases. Limited studies exist on the association of adverse childhood events (ACEs) to asthma and COPD particularly among women and cohorts of understudied populations (e.g. Pacific Islanders). This study evaluated the ACEs-asthma and ACEs-COPD relationships among women in Hawaii and the contribution of poor health factors (smoking, binge drinking and obesity) in these associations.

METHODS—Using data from 3,363 women in the Behavioral Risk Factor Surveillance System-Hawaii, we assessed how self-reported ACEs (count and type [household dysfunction, and physical, verbal and sexual abuse]) relate to asthma and COPD. Multivariable log-binomial regression, accounting for the sampling design, and model adjustments for socio-demographics, healthcare access, emotional support, current smoking, binge drinking and BMI status were used to generate prevalence ratios.

RESULTS—For every increase in ACE count, the likelihood for asthma increased by 7% (CI=1.02–1.13), and for COPD, by 21% (CI=1.12–1.31) accounting for socio-demographics, healthcare access and emotional support. Verbal abuse was also associated with greater likelihood for asthma independent of these covariates (PR=1.43, CI=1.14–1.79). Household dysfunction

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Disclaimer: The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the University of California-San Diego or the Hawaii Department of Health.

CONFLICT OF INTEREST

None.

ETHICAL APPROVAL

"All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethnical standards."

This study consists of secondary analyses of publically available, de-identified data, and was determined to be IRB exempt. "For this type of study formal consent is not required."

(PR=1.82, CI=1.15–2.82) and physical (PR=2.01, CI=1.20–3.37), verbal (PR=2.24, CI=1.38–3.65) and sexual (PR=1.81, CI=1.10–2.97) abuse were all associated with COPD using similar adjustments. Additional adjustment for smoking, binge drinking and BMI status did not impact the ACE-asthma associations and only modestly attenuated the ACE-COPD relationships.

CONCLUSIONS—Primary and secondary prevention of ACEs may optimize the health of young girls in Hawaii, and reduce the burden of asthma and COPD among women in the state.

Keywords

Adverse Childhood Events; Asthma; COPD; BRFSS; Hawaii; Women's Health

INTRODUCTION

Asthma and chronic obstructive pulmonary disorder (COPD) is more common in women than men. In Hawaii, the prevalence of adults currently affected by asthma exceeds that of the national average across sex (e.g. 11.4% versus 10.4%), and age groups (e.g. 15.1% in Hawaii versus 10.2% in the US, age 18–24 years) [1]. Nationally, COPD has increased overtime (1999–2011), and women consistently have higher rates compared to men, almost double for chronic bronchitis (56.7% vs. 29.6%) [2]. Women were also more likely to be hospitalized due to complications of COPD compared to men (discharge rate per 10,000 was 26.2 for women and 20.2 for men) [2].

Asthma and COPD have been shown in some studies to be associated with traumatic events during childhood. Puerto Rican children with physical and sexual abuse had twice the likelihood of asthma [3]. In the Kaiser Health Plan in California, patients with at least 5 adverse childhood events (ACEs) had significantly greater prevalence of COPD compared to those reporting no ACEs [4]. Little is known whether these findings translate to populations consisting of diverse populations found in Hawaii which includes large Asian, Native Hawaiian and Other Pacific Islander populations.

ACEs have been shown associated with poor health factors, which may lead to lung diseases. For example, smoking is associated with the development of asthma [5–8]. Despite potential exacerbation of respiratory symptoms, comparable smoking prevalence between asthmatics and non-asthmatics has been demonstrated [9]. Smoking is also a major contributor to COPD, accounting for 9 out of 10 of COPD-related deaths [10]. In Hawaii, 15.4% of adults currently smoke, ranking the state 5th nationwide [11]. Among youths (age 12–17 years), Hawaii ranks 2nd in smoking prevalence [11]. The presence of ACEs is associated with greater smoking prevalence [12, 13] and may account, at least in part, for the rate of asthma and COPD in Hawaii. Other poor health factors (e.g. excessive alcohol consumption, obesity) are also potential pathways through which ACEs may lead to the subsequent onset or exacerbation of lung diseases [14–16]. Although the prevalence of obesity in Hawaii is lower than that of the US [17], the prevalence of 'heavy alcohol use' (2+ drinks for men and 1+ drinks for women per day) in Hawaii is reported to be about 30% higher [18]. Interventions that target these poor health factors associated with ACEs may likely decrease the prevalence of lung diseases in Hawaii.

The current study aimed to examine the relationships between ACEs and asthma and COPD among women in Hawaii, and assess the contribution of smoking, binge drinking and obesity in adulthood which may potentially mediate these associations.

METHODS

This study utilized data from the 2010 Hawaii Behavioral Risk Factor Surveillance System (BRFSS) survey, coordinated and partially funded by the Centers for Disease Control and Prevention (CDC). In 2010, the BRFSS used a multistage probability sample method of the non-institutionalized/non-hospitalized US adults in households with a landline telephone. The Council of American Survey Research Organizations response rate, which reflects both telephone sampling efficiency and the degree of participation among eligible respondents contacted [19], was 49.1%, which was similar to other states where BRFSS ACEs module was conducted [20]. Detailed information on the sampling methodology, survey weighting procedures, quality assurance of the survey, and other aspects of this survey is available online at http://www.cdc.gov/brfss/index.htm. This secondary analyses of publically available, de-identified data and was determined to be IRB exempt.

ACEs

Eleven questions/items were used to define adverse events during childhood (before age 18 years), adapted from validated instruments [21]. In the current study, ACE count was based on the number of ACEs reported and ranged from 0–11. These items were also grouped into 4 standard categories as in previous studies: household dysfunction, physical abuse, verbal abuse and sexual abuse [20, 21]. A list of specific questions/items by ACE categories is provided (Table 1). The response for each item of household dysfunction, with the exception of the item, ‘Witness domestic violence’, was ‘Yes’ or ‘No’. For the household item, ‘Witness domestic violence’, and the categories of physical, verbal and sexual abuse, responses included “Once”, “More than once” or “Never”. A response of “more than once” was necessary for verbal abuse to be considered present [20]. For ACE categories with multiple items, at least one item had to be present.

Asthma and COPD

The primary outcomes of this study were reports of asthma and COPD, emphysema or chronic bronchitis. To assess asthma, participants were asked: ‘Have you ever been told by a doctor, nurse, or other health professional that you had asthma?’. For COPD, emphysema or chronic bronchitis, individuals were asked: ‘Have you ever been told by a doctor or another health professional that you have chronic obstructive pulmonary disease, also called COPD, emphysema or chronic bronchitis?’ For the remainder of this report, COPD, emphysema or chronic bronchitis will be termed as COPD. Both outcomes were classified as “Yes” or “No,” with the exclusion of ‘don’t know/not sure’ or ‘refused’ responses.

Covariates

Covariates selection was based on previous studies and a conceptual model determined a priori. Adjustments included socio-demographics such as age, race/ethnicity with which participants report best represent them (White, Hawaiian, Filipino, Japanese, Other), and

education status (below high school, high school graduate, attended college/technical school, graduated college/technical school); healthcare access (yes, no); meeting emotional support needs (always/usually, sometimes, rarely/never); current smoking status; binge drinking; and BMI. Access to healthcare (yes/no) was determined using the question: 'Do you have any kind of health care coverage, including health insurance, prepaid plans such as health management organizations (HMOs), or government plans such as Medicare?'. Current smoking status was defined as reporting both having smoked at least 100 cigarettes in a lifetime and still smoking at the time of the survey. Binge drinking was defined as reporting the consumption of 4+ alcoholic drinks on at least one occasion during the past 30 days. Self-reported weight and height were used to calculate BMI (kg/m^2). Normal weight, overweight and obesity were defined as a BMI of less than 25, 25–30, and 30 or greater, respectively.

Statistical Analyses

Of the 3,868 women in the survey, 347 were excluded due to missing values for ACE count or any of the ACE types (consistent with previous literature [20]), as were 45 participants with missing values for asthma or COPD (n=3,476). An additional 113 observations were excluded due to missing covariates resulting in a final sample size of 3,363.

The population characteristics were compared overall and by asthma and COPD status (i.e. presence vs. absence) using Student's 't' and chi-square tests for continuous and categorical variables, respectively. Multivariable log-binomial regression was utilized to obtain prevalence ratios and 95% confidence intervals to evaluate ACE (count and type) against asthma and COPD. Statistical evaluations included unadjusted models and adjustment for covariates. Analyses were performed using STATA (StataCorp. 2012. *Stata Statistical Software: Release 12.* College Station, TX) taking into account the complex sampling design with significant associations at the $p<0.05$ level.

RESULTS

Over half of the participants had at least 1 ACE (55.2%) with 1 ACE in 20.1%, 2 ACEs in 11.5%, 3 ACEs in 8.1%, 4 ACEs in 5.4%, and 5+ ACEs in 10.0%. Overall, the population had a mean age of 48.5 years (median=48 years), was mostly White (26%) or Japanese (26%) and 69% had at least some college education (Table 2). Most had access to healthcare and had emotional support. Those with asthma were younger and more likely to report receiving emotional support than those without asthma. Those with asthma were more likely to be obese compared to those without asthma. COPD was associated with older age and greater smoking prevalence.

For every increase in ACE count, asthma was 8% more likely and COPD 18% more likely to occur after adjustment for socio-demographics, healthcare access and emotional support (Table 3). Additional adjustment for poor health factors negligibly changed in estimates (Table 3). Verbal abuse were also significantly associated with asthma adjusted for socio-demographics, healthcare access and emotional support. Additional adjustment for poor health factors negligibly changed the results. Household dysfunction and physical, verbal and sexual abuse were all associated with 58%, 72%, 84% and 74% greater likelihood,

respectively, for COPD. These estimates increased following adjustment for socio-demographics, healthcare access and emotional support, and attenuated following additional adjustment for poor health factors. The highest magnitude of association was that between verbal abuse and COPD.

DISCUSSION

Among women residing in Hawaii, an increase in the number of ACEs was associated with greater prevalence for asthma and COPD independent of socio-demographics, healthcare access, emotional support, current smoking, binge drinking, and BMI status. Additionally, participants who reported verbal abuse during childhood were more likely to have asthma (compared to those who did not report verbal abuse), while all ACE measures were all significantly related to COPD. Verbal abuse had the greatest magnitude of association, relative to other ACE types, with both asthma and COPD. While adjustment for poor health factors negligibly impacted the ACE-asthma association, it attenuated the magnitude of associations between all measures of ACE and COPD, although maintaining significance.

In a sample of women in New Zealand, sexual abuse before age 16 years was found associated with asthma [22]. This study, however, considered the severity of sexual abuse capturing not only the specific nature of event, but also, the frequency of occurrence, which was not captured in our study. Non-contact sexual abuse was also considered which, in addition to accounting for the gravity of abuse, might have unveiled an association not found in our study. Physical abuse was not found associated with asthma during adulthood, similar to our results [22]. In a study of international populations, childhood adversities which included “physical abuse, sexual abuse, neglect, parental death, parent divorce, other parental loss, parental mental disorder, parental substance use, parental criminal behavior, family violence, and family economic adversity” predicted adult-onset (age ≥ 21 years) asthma [23]. It is possible that a combination of these factors rather than one aspect of ACEs may increase the risk for adult asthma, and thus differentiate from the null findings from our individual assessment of physical and sexual abuse against asthma. In a 16-year longitudinal study of Black women, physical and sexual abuse during childhood (up to age 11), but not during adolescence (12–18 years of age), was significantly associated with the development of asthma as an adult [24]. Since we did not differentiate timing in the experience of physical or sexual abuse (i.e. during childhood versus adolescence), it is possible that our null finding was weighted towards individuals who report the occurrence of these ACEs types during adolescence. Another study evaluating physical and sexual abuse among Puerto Rican children, an ethnic group with the highest prevalence for asthma when considered against US states/territories, also revealed a significant association with asthma [3]. The results, however, included males in whom physical abuse has been previously shown more prevalent compared to women in Hawaii (although not significantly different) [25]. As physical and sexual abuse were not assessed separately in this study of Puerto Ricans, it is possible that the association may be driven by the positive physical abuse-asthma relationship among males. Cultural factors may differentiate Puerto Ricans from women in Hawaii and explain the difference in results. Verbal abuse was not investigated in any of these other studies.

Using data from a HMO in California of multi-ethnic men and women at least 19 years of age, individuals with a higher frequency of ACEs were reported to have greater odds for chronic bronchitis or emphysema and COPD [21, 26], which was consistent with our findings. Categories of ACEs, to our knowledge, have not been assessed against COPD.

Despite adjustment for poor health factors through which ACEs may lead to either asthma or COPD, there remains a significant association suggesting other pathways may be at play. One such mechanism is suppression of the hypothalamus-pituitary-adrenal (HPA) axis due to chronic stress such as ACEs leading to low concentration of cortisol [27]. Low levels of cortisol has been shown associated with lung diseases [28, 29], possibly due to the decrease in anti-inflammatory effects of cortisol that would otherwise be protective [30]. In a prior study of the same population, however, ACEs were found associated with depression [31] which have been shown associated with increased cortisol [32]. Greater levels of inflammation due to stress (and/or decreased cortisol) are also associated with greater vulnerability to respiratory infections that may damage lung tissue and impair lung capacity [33]. Further studies are needed to delineate the relationship between stress induced by the presence of ACEs and changes in cortisol level, and how this, in turn, may influence the prevalence of asthma or COPD.

Of the significant associations between ACEs and COPD, verbal abuse produced the strongest association and was also the only ACE found significantly related to asthma. Attempts to stop or remove oneself from situations of household dysfunction, physical abuse and sexual abuse may be better monitored compared to verbal abuse in which the definition of what constitutes as verbal abuse may not be quite as clear as for other types of ACEs. Further, therapy to address issues from verbal abuse may less likely occur as it does not leave any ‘visible’ evidence of trauma. Thus, the frequency as well as duration of verbal abuse may perhaps exceed that of other ACE types and translate into greater impact on health. In situations where verbal abuse and other ACE types are equally frequent during childhood, verbal abuse may perhaps have a stronger influence on psychological wellbeing, triggering physiological anomalies that can lead to adverse health. Future evaluations that assess the frequency and duration of ACEs, as well as the comparative psychological impact of these exposures, may help explain the greater impact of verbal abuse on lung diseases found in the current study.

There were some noteworthy limitations to this study. First, the design of our analyses could not determine a temporal relationship between ACEs and respiratory outcomes that longitudinal data would have supported. The age of onset of asthma in the survey, for example, was not specified, and could have occurred during childhood, even perhaps prior to the occurrence of ACEs. Second, the survey excluded institutionalized or hospitalized individuals who may be more likely than others to have had ACEs. Inclusion of these individuals, therefore, would have likely strengthened the findings in this study. Third, data collection for BRFSS, Hawaii only sampled individuals with landlines. There may be socio-economic differences between individuals who use landlines versus those who prefer cell phones as the primary household contact. Fourth, the presence of asthma and COPD was determined by self-report. Potential misclassification, however, may likely be non-differential. Lastly, the presence of asthma or COPD may increase the likelihood to recall

ACEs (i.e. recall bias). However, as questions on asthma and COPD were only a small part of the survey, recall bias of ACEs may occur in general for individuals with existing health outcomes.

The strengths of this study include the use of a large cohort of multi-racial/ethnic women, particularly of Asians, Native Hawaiian and Pacific Islander background who are typically not represented in studies. The BRFSS dataset also provides data on health factors and multiple measures of ACEs. In addition, it includes verbal abuse as one of the ACE categories not found in many other studies.

In conclusion, the findings of this study suggest that interventions that prevent or assist individuals to cope with ACEs may not only optimize the health of young girls in Hawaii, but also potentially lower the prevalence of asthma and COPD among women in the state. Individuals being treated for either asthma or COPD may also benefit from assessment for the presence of ACEs and implementation of interventions that help address issues borne from ACEs.

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TABLE 1

Adverse Childhood Events (ACEs) Question Items and Corresponding Responses (BRFSS, 2010, Hawaii)

ACE Type	Items: "Now, looking back before you were 18 years of age…"	Response
Household Dysfunction	1. Did you live with anyone who was depressed, mentally ill, or suicidal?	Yes, No
	2. Did you live with anyone who was a problem drinker or alcoholic?	Yes, No
	3. Did you live with anyone who used illegal street drugs or who abused prescription medications?	Yes, No
	4. Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Yes, No
	5. Were your parents separated or divorced?	Yes, No
	6. How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?	Never, Once, More than Once
Physical Abuse	1. Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Do not include spanking. Would you say…	Never, Once, More than Once
Verbal Abuse[b]	1. How often did a parent or adult in your home ever swear at you, insult you, or put you down?	Never, Once, More than Once
Sexual Abuse	1. How often did anyone at least 5 years older than you or an adult ever touch you sexually?	Never, Once, More than Once
	2. How often did anyone at least 5 years older than you or an adult try to make you touch them sexually?	Never, Once, More than Once
	3. How often did anyone at least 5 years older than you or an adult force you to have sex?	Never, Once, More than Once

[a] Responses of 'Don't know/not sure' and refusal to answer (not included in this table) were coded as missing values.

[b] The occurrence of verbal abuse was defined by a "more than once" response versus "once" or "never".

TABLE 2

Weighted estimates of characteristics of women in Hawaii, overall and by asthma and COPD (BRFSS 2010, Sample N=3,363)

	Overall		Asthma			COPD		
	n[a]	Mean or %[b]	No	Yes	p	No	Yes	p
Demographics								
Mean Age (in years)	3,363	48.5	49.3	45.3	0.002*	48.2	58.8	<0.001*
Median Age (in years)	3,363	48.0	48.0	46.0	---	47.0	60.0	---
Race/ethnicity (%)					0.035*			0.178
White	1,216	26.3	26.4	25.9		26.2	32.0	
Hawaiian	402	13.0	12.4	15.5		12.8	20.4	
Filipino	399	16.0	17.3	10.7		16.1	10.9	
Japanese	822	26.1	26.2	25.9		26.3	20.9	
Other	524	18.5	17.7	22.1		18.6	15.8	
Education Status (%)					0.110			0.171
Less than high school	157	4.2	4.7	2.3		4.2	6.1	
High school graduate	867	26.6	26.7	26.4		26.7	25.0	
Attended college/technical school	997	30.2	29.2	34.2		30.0	39.1	
Graduated from college/technical school	1,342	38.9	39.4	37.1		39.2	29.7	
Health Factors								
Current Smoking (% Yes)	410	12.8	12.7	13.1	0.077	12.4	24.9	0.002*
Binge Drinking (% Yes)	298	10.5	9.8	13.6	0.087	10.6	8.3	0.506
Body Mass Index (%)					<0.001*			0.191
Normal	1,752	53.2	55.7	42.4		53.4	47.1	
Overweight	956	26.3	25.8	28.1		26.3	24.2	
Obese	655	20.6	18.4	29.5		20.3	28.8	
Healthcare Access (% Yes)	3,222	95.6	95.2	97.1	0.154	95.6	97.3	0.397
Emotional Support (%)					0.003*			0.765
Rarely/never	353	10.1	11.2	5.3		10.0	12.2	
Sometimes	363	10.2	10.4	9.6		10.2	10.9	
Always/usually	2,647	79.7	78.4	85.1		79.8	76.9	

	Overall		Asthma			COPD		
	n[a]	Mean or %[b]	No	Yes	p	No	Yes	p
Adverse Childhood Events								
Mean	3,439	1.6	1.5	2.0	0.001*	1.6	2.3	0.002*
Categories (% Yes)								
Household Dysfunction	1,369	41.8	40.2	48.6	0.010*	41.5	53.2	0.035*
Physical Abuse	490	14.9	14.9	14.9	0.985	14.7	23.2	0.031*
Verbal Abuse	845	24.9	22.8	33.9	<0.001*	24.6	37.9	0.007*
Sexual Abuse	487	13.2	12.6	16.0	0.120	13.0	21.0	0.028*

p=p-value; BRFSS=Behavioral Risk Factor Surveillance System; SE=Standard Error; kg=Kilogram; m=Meter

[a]Unweighted number of women in Hawaii who participated in the BRFSS, 2010 with complete data

[b]Weighted percentages

*Significant p-value < 0.05

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TABLE 3

Crude and Adjusted Prevalence Ratios (PR) and 95% Confidence Interval for the Adverse Childhood Events (ACEs)-Asthma and ACEs-COPD Associations

Outcome[a]	ACE Count[a]	ACE Type			
		Household Dysfunction PR (CI)	Physical Abuse PR (CI)	Verbal Abuse PR (CI)	Sexual Abuse PR (CI)
Asthma					
Model 1	1.08 (1.04, 1.13)*	1.31 (1.07, 1.62)*	1.00 (0.75, 1.32)	1.54 (1.25, 1.91)*	1.25 (0.95, 1.65)
Model 2	1.07 (1.02, 1.13)*	1.23 (0.98, 1.53)	97.1 (0.72, 1.31)	1.43 (1.14, 1.79)*	1.18 (0.89, 1.58)
Model 3	1.06 (1.01, 1.12)*	1.22 (0.98, 1.51)	95.5 (0.71, 1.29)	1.40 (1.12, 1.76)*	1.13 (0.84, 1.52)
COPD					
Model 1	1.15 (1.07, 1.24)*	1.58 (1.03, 2.43)*	1.72 (1.05, 2.84)*	1.84 (1.18, 2.87)*	1.74 (1.06, 2.87)*
Model 2	1.21 (1.12, 1.31)*	1.82 (1.17, 2.82)*	2.01 (1.20, 3.37)*	2.24 (1.38, 3.65)*	1.81 (1.10, 2.97)*
Model 3	1.18 (1.08, 1.29)*	1.69 (1.08, 2.65)*	1.74 (1.03, 2.96)*	2.07 (1.25, 3.44)*	1.69 (1.02, 2.78)*

ACEs = Adverse Childhood Events; COPD = Chronic Obstructive Pulmonary Disease; PR = Prevalence Ratio; CI = 95% Confidence Interval

[a]Model 1: Unadjusted; Model 2: Adjusted for socio-demographics (age, race/ethnicity, education), healthcare access and emotional support; Model 3: Adjusted for Model 2 and current smoking status, binge drinking and BMI status.

*Significant p-value < 0.05