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Adverse childhood experiences and the onset of chronic disease in young adulthood☆

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ABSTRACT

This study examined the association of adverse childhood experiences (ACEs) with early-onset chronic conditions.

We analyzed data from the 2011–2012 Behavioral Risk Factor Surveillance System (BRFSS), which included 86,968 respondents representing a nine-state adult population of 32 million. ACE questions included physical, emotional, and sexual abuse; substance use, mental illness or incarceration of a household member; domestic violence, and parental separation. Outcomes included chronic conditions (cardiovascular disease, chronic obstructive pulmonary disease, cancer, depression, diabetes, and prediabetes); overall health status; and days of poor mental or physical health in the past month. We estimated Poisson regression models of the likelihood of chronic conditions and poor health status comparing adults reporting ≥4 ACEs to respondents with no ACEs within three age strata: 18–34, 35–54 and ≥55 years.

The prevalence of ≥4 ACEs was highest among youngest respondents (19%). There was a dose-response gradient between ACE scores and outcomes except for cancer in older adults. Among younger respondents, those reporting ≥4 ACEs had two to four times the risk for each chronic condition and poor health status compared to respondents reporting no ACEs. With few exceptions (depression, poor mental and physical health in the past month), incidence rate ratios were highest in young adults and successively decreased among older adults.

This study is among the first to analyze patterns of association between ACEs and adult health disaggregated by age. Young adults with high ACE scores are at increased risk of early-onset chronic disease. Trauma-informed care and ACEs prevention are crucial public health priorities.

1. Introduction

There is mounting evidence that maltreatment and psychosocial stress in childhood are important determinants of adult disease and disability (American Academy of Pediatrics, 2014a; Teicher & Samson, 2016; Gilbert et al., 2015; Centers for Disease Control, 2010; Felitti et al., 1998). The seminal Adverse Childhood Experiences Study, which surveyed over 17,000 non-institutionalized and insured adults, observed a strong dose-dependent association between the cumulative number of adverse childhood experiences (ACEs) and an array of poor health and behavioral outcomes in adulthood (Felitti et al., 1998). Subsequent reports, in addition to the original ACEs Study, found that a higher burden of ACEs was associated with a higher risk of many adverse health, behavioral, psychological, and social outcomes, including smoking, heavy alcohol consumption, substance use, high-risk sexual behavior (Felitti et al., 1998; Ford et al., 2011; Anda et al., 1999; Edwards et al., 2007; Anda et al., 2002; Dube et al., 2001a; Dube et al., 2002; Rothman et al., 2008), mental health problems (depression, anxiety, suicidality, hallucinations) (Anda et al., 2007; Benjet et al., 2010; Chapman et al., 2004; Dube et al., 2001b), and chronic diseases (ischemic heart disease, cancer, lung disease, diabetes, chronic headaches, HIV, liver disease, and autoimmune disease) (Felitti et al., 1998; Dube et al., 2009; Brown et al., 2010; Anda et al., 2008; Cunningham et al., 2014; Huang et al., 2015; Huffhines et al., 2016; Anda et al., 2010; Fang et al., 2016; Dong et al., 2004; Dong et al., 2003). ACEs are also associated with premature mortality (Brown et al., 2009), poor self-reported health (Thompson et al., 2015), increased utilization of health services (Chartier et al., 2010), unemployment (Liu et al., 2013), and poor

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Table 1
Percent of self-reported exposure to adverse childhood experiences (ACEs) by age.[a]

	18–34	35–54	55+	Total
Weighted sample size (n)	9,697,850	11,543,207	11,311,135	32,552,191
Unweighted number of respondents (n)	12,745	26,739	47,483	86,968
Demographics				
Gender				
Men	51.0	49.7	45.9	48.8
Female	49.0	50.3	54.1	51.2
Race/ethnicity				
White	69.0	76.7	85.5	77.5
African American	11.2	10.1	7.3	9.5
Hispanic	9.8	5.8	2.1	5.7
Other	10.0	7.4	5.1	7.3
Education				
High school or less	42.5	37.3	43.5	41.0
Some college or more	57.5	62.7	56.5	59.0
Annual household income				
< $15,000	14.7	10.1	12.5	12.3
$15,000–$24,999	32.0	18.4	26.8	25.4
$25,000–$34,999	25.3	23.7	29.3	26.1
$35,000–$49,999	11.6	16.4	14.2	14.2
> $50,000	16.4	31.4	17.2	22.0
ACE items				
Maltreatment				
Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way?[b]	14.1	16.1	10.9	13.7
How often did a parent or adult in your home ever swear at you, insult you, or put you down?[b]	32.0	32.5	21.2	28.4
How often did anyone at least 5 years older than you or an adult, ever touch you sexually?[b]	7.0	10.9	6.9	8.3
How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?[b]	5.7	8.3	4.4	6.2
How often did anyone at least 5 years older than you or an adult, force you to have sex?[b]	4.0	4.7	2.3	3.7
Household stressors				
Did you live with anyone who was depressed, mentally ill, or suicidal?	19.2	15.4	9.3	14.4
Did you live with anyone who was a problem drinker or alcoholic?	20.4	23.6	18.6	20.9
Did you live with anyone who used illegal street drugs or who abused prescription medications?	14.6	10.4	3.0	9.1
Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	11.5	6.5	2.8	6.7
Were your parents separated or divorced?	30.4	25.4	12.6	22.4
How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?	14.1	16.9	11.34	14.1
ACE score				
0 ACEs reported	44.64	42.63	55.98	47.87
1 ACE reported	17.78	19.84	19.41	19.08
2 to 3 ACEs reported	18.49	19.25	15.67	17.78
4 or more ACEs reported	19.09	18.28	8.93	15.27

All age comparisons $p < 0.001$.

[a] Values represent population-weighted percentages (%) from the 2011–2012 Behavioral Risk Factor Surveillance System in Nine States (2011 BRFSS from Minnesota, Montana, Vermont, Washington; 2012 BRFSS from Iowa, North Carolina, Oklahoma, Tennessee, Wisconsin), with 86,968 observations from a population of 32,552,191.

[b] Affirmative answer defined as "Once" or "More than once."

academic and social well-being outcomes (Bright et al., 2016; Brown et al., 2017; Jimenez et al., 2017; Hunt et al., n.d.; Jimenez et al., 2016; Bethell et al., 2014; Quach et al., 2017; Burke et al., 2011).

In recent decades, increasing attention has been focused on elucidating the mechanisms that underlie associations between childhood adversity and poor health outcomes in adulthood. From birth to six years, the brain undergoes its most rapid period of growth and development (Gao et al., 2009), and thus the early childhood years are a highly sensitive stage for the detrimental effects of adversity (American Academy of Pediatrics, 2014b; Felitti & Anda, 2010; National Research C, 2000). In the absence of secure attachment and key buffering relationships with caregivers, ACEs and other types of childhood adversity such as poverty, food insecurity, poor educational opportunities, and community violence can promote a type of stress response known as toxic stress (Bucci et al., 2016; National Scientific Council on the Developing Child, 2012; National Scientific Council on the Developing Child, n.d.). Toxic stress is differentiated from other types of stress in two notable ways: (1) its sources are either severe, prolonged, unpredictable, and/or unrelenting; and (2) toxic stress represents a hijacking of the normal stress response mechanisms mediated by the brain. Sustained over-activity of the stress response disrupts normal brain development, architecture, and function; dysregulates endocrine and immune system physiology; and has even been observed to promote heritable changes within the epigenome (National Research C, 2000; National Scientific Council on the Developing Child, 2012; National Scientific Council on the Developing Child, n.d.; Perry & Pollard, 1997; Hart & Rubia, 2012; Shonkoff et al., 2009; McEwen & Gianaros, 2010; Kubota et al., 2017; Luby et al., 2017). The life course implications of childhood adversity and maltreatment are multifaceted, affecting cognitive, physical, emotional, and social domains.

Thus, childhood adversity contributes to chronic conditions and disability via two interrelated pathways: (1) dysregulation of centrally-mediated stress-response processes, potentially leading to a state of persistent low-grade inflammation; and (2) promoting behaviors such as impulsivity, poor social ties, and future discounting, which stem from structural and neurodevelopmental changes in the brain and in turn promote adoption of health-risk behaviors (i.e. smoking and illicit substance use) (Miller et al., 2011). Over time, these processes can have a wear-and-tear effect (Geronimus et al., 2006) on the body and increase risk of future chronic conditions, such as metabolic syndrome (Eckel et al., n.d.), atherosclerosis, ischemic heart condition, diabetes, chronic obstructive pulmonary condition (COPD), and cancer (Bucci et al., 2016; Hotamisligil, 2006; Libby & Theroux, 2005; Vasto et al., 2009; Wolf & Morrison, 2017; McEwen, 2005).

Currently, what is less well documented is the extent to which childhood adversity increases risk of chronic disease and poor self-rated

Table 2
Percent chronic conditions and health-related quality of life by age.

	18–34	35–54	55 +	Total
Weighted sample size (n)	9,697,850	11,543,207	11,311,135	32,552,191
Chronic conditions				
Cardiovascular disease[a]	1.12	5.34	18.89	8.79
COPD	2.27	5.23	10.43	6.16
Cancer (other than skin cancer)	1.66	4.19	13.38	6.63
Depression	17.11	20.12	17.20	18.21
Diabetes	1.87	7.79	18.24	9.66
Prediabetes[b]	2.45	5.97	9.15	6.02
Health-related quality of life				
Would you say that in general your health is:				
Excellent	23.43	18.82	13.01	18.17
Very good	37.52	34.29	29.41	33.56
Good	30.01	30.64	33.23	31.35
Fair	7.70	11.45	1.61	11.95
Poor	1.34	4.79	8.25	4.96
Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?				
Any days (one or more)	32.86	34.44	35.36	34.29
No days	66.37	64.48	62.19	64.25
1 to 12 days	26.57	22.96	19.09	22.70
13 or more days	7.06	12.57	18.72	13.05
Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?				
Any days (one or more)	40.79	35.39	23.48	32.86
No days	58.41	63.72	75.08	66.08
1 to 12 days	28.49	22.60	14.59	21.58
13 or more days	13.10	13.68	10.33	12.34

All age comparisons $p < 0.001$.

[a] Cardiovascular disease prevalence includes affirmative responses to questions asking if respondent had ever been told they had: heart attack/myocardial infarction, angina/coronary heart disease, or stroke (Questions 5.1, 5.2, and 5.3 in 2012 BRFSS; 6.1, 6.2, and 6.3 in 2011 BRFSS).

[b] Prediabetes prevalence is reported in an optional BRFSS module not used by all states. Data for prediabetes above is from the following states that used both the optional ACEs module and the optional Prediabetes Module: Minnesota, Montana, Washington State in 2011; Iowa, North Carolina, Oklahoma, Tennessee, Wisconsin in 2012 with 79,872 observations from a population of 32,053,696.

health status across different ages of adulthood, and in particular, among young adults. Indeed, we did not find any studies specifically assessing the association of ACEs and chronic disease or poor self-rated health among young adults. The effect of ACEs on health in this age group is of growing interest, however, as recent advances in chronic disease epidemiology have deepened understanding of the relationship between risk factors for chronic disease and onset of disease. Studies in cardiovascular disease (CVD) epidemiology have found that the duration of risk factors among older individuals is a key factor in the lifetime risk of developing CVD (Berry et al., 2012). That is, the high prevalence of CVD in advanced age may in part reflect the prolonged length of time individuals have lived with risk factors of CVD (i.e. obesity, smoking, high cholesterol, diabetes, hypertension, etc). This claim is supported by large cohort data analyzing lifetime risks of CVD; individuals in the Framingham cohort who had an optimal CVD risk factor profile at age 55 were found to have a markedly lower absolute risk of CVD at age 80 (5–8%) compared to similarly aged individuals who had ≥2 risk factors at age 55 (50–68%) (Berry et al., 2012; Kannel & Vasan, 2009). Consistent with these developments in CVD epidemiology, a recent American Heart Association scientific statement calls for additional research on adolescent adversity and cardiometabolic outcomes across the lifecourse (Suglia et al., 2017).

This study investigates the extent to which childhood adversity is associated with a greater prevalence of self-reported chronic conditions and worse health-related quality of life (HRQOL) in young adulthood. We hypothesize that, in young adulthood – a period when the absolute prevalence of chronic disease is stereotypically low – the risk of chronic disease among respondents with high ACE scores is greater compared to similarly aged adults reporting no ACEs. Understanding the risk of ACEs on the health of young adults is important because it could potentially help identify individuals at higher risk for earlier development of chronic disease and disability. As health systems increasingly focus on trauma-informed care and ways to mitigate the effects of trauma among their patients, a critical piece of this effort will be to understand the unique ways trauma disadvantages exposed individuals beyond what is already known. Additionally, our secondary hypothesis is that the effects of childhood adversity become increasingly attenuated with aging, as the effect of other chronic disease risk factors increases. Using data from what is (to our knowledge) one of the largest studies of ACEs to date, we compare the association between ACE scores and the risk of self-reported chronic disease and lower HRQOL within different periods of the adult lifespan.

2. Methods

This study presents a cross-sectional analysis of Center for Disease Control Behavioral Risk Factor Surveillance System (BRFSS), a telephone interview survey from nine states that adopted the 8-item ACEs questionnaire in 2011–2012 (2011: MN, MT, VT, WA; 2012: IA, NC, OK, TN, WI). In early 2018, we analyzed the most recent publicly-available ACEs data with valid weights representative of the adult population of each state. This study, which utilized open access de-identified data, was exempt from institutional review board approval.

2.1. ACEs questions

The 2011–2012 BRFSS ACEs module contained was based on eight child abuse and household stressor questions asked in the original ACEs study (Felitti et al., 1998). Physical abuse was based on the question, "*Before the age of 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.*" Emotional/verbal abuse was based on, "*How often did a parent or adult in your home ever swear at you, insult you, or put you down?*" Sexual abuse was determined by a positive response any of the following three

Table 3
Percent reported chronic condition prevalence and health-related quality of life by ACE score by age.

	18–34				35–54				55+			
ACE score	0	1	2–3	4+	0	1	2–3	4+	0	1	2–3	4+
Weighted *n* (in millions)	4.33	1.72	1.79	1.85	4.92	2.29	2.22	2.11	6.33	2.19	1.77	1.01
Chronic disease												
Cardiovascular disease[a]	0.84	0.77	0.99	2.24	4.33	4.59	5.60	8.22	18.36	19.05	19.80	20.27
COPD	1.44	1.52	2.10	5.10	4.25	3.83	4.98	9.32	8.94	10.32	11.73	17.68
Cancer[b]	1.19	1.31	1.18	3.56	3.40	2.87	4.60	7.02	13.25	13.57	13.66	13.31
Depression	11.24	12.59	18.76	33.44	13.67	14.46	22.82	38.48	12.02	15.38	24.78	40.25
Diabetes	1.06	0.96	2.42	4.09	6.82	7.35	8.44	9.87	17.48	17.36	21.10	19.82
Prediabetes[c]	1.35	2.66	2.59	4.71	4.75	5.57	7.15	8.04	8.22	9.98	9.86	11.91
Self-reported general health												
Excellent	28.30	24.00	19.79	15.02	21.29	19.43	17.80	13.44	13.97	12.95	11.47	9.81
Very good	36.51	40.07	38.92	36.16	35.38	36.28	34.77	29.11	30.04	30.28	28.51	25.12
Good	28.89	29.22	30.29	33.09	29.78	31.39	30.42	32.08	33.33	34.66	32.94	30.19
Fair	5.16	5.97	9.26	13.75	9.96	9.34	11.81	16.86	15.36	15.04	16.88	21.71
Poor	1.14	0.74	1.74	1.98	3.59	3.56	5.20	8.50	7.33	7.07	10.20	13.17
Physical health rated "not good" in last 30 days												
Any days	28.37	29.79	34.82	44.33	28.43	31.39	37.95	48.08	31.73	35.51	39.44	50.61
None	70.82	69.69	64.01	55.15	70.24	67.79	61.18	50.91	65.59	62.16	58.95	49.39
1 to 12 days	23.71	25.71	28.26	32.42	19.70	22.22	25.81	28.35	17.18	19.81	22.03	24.35
13 or more days	5.47	4.60	7.73	12.43	10.06	9.98	13.01	20.75	17.23	18.02	19.03	28.95
Mental health rated "not good" in last 30 days												
Any days	32.96	37.73	46.01	46.01	27.74	31.83	40.41	51.79	18.37	23.66	30.63	42.61
None	66.55	61.84	52.82	41.56	71.52	67.27	58.41	47.27	80.17	75.08	67.90	55.74
1 to 12 days	24.54	30.05	31.57	33.33	18.93	22.19	27.54	26.40	11.56	15.73	19.70	22.19
13 or more days	8.91	8.10	15.61	25.12	9.55	10.54	14.05	26.33	8.27	9.19	12.40	22.07

[a] Cardiovascular disease prevalence includes affirmative responses to questions asking if respondent had ever been told they had: heart attack/myocardial infarction, angina/coronary heart disease, or stroke (Questions 5.1, 5.2, and 5.3 in 2012 BRFSS; 6.1, 6.2, and 6.3 in 2011 BRFSS).
[b] Excluding skin cancer.
[c] Prediabetes prevalence is reported in an optional BRFSS module not used by all states. Data for prediabetes above is from the following states that used both the optional ACEs module and the optional Prediabetes Module: Minnesota, Montana, Washington State in 2011; Iowa, North Carolina, Oklahoma, Tennessee, Wisconsin in 2012 with 79,872 observations from a population of 32,053,696.

Table 4
Adjusted incidence rate ratios[a] for chronic conditions and health-related quality of life for ACE score of four or more compared to zero ACEs, by age.

Outcome	18–34	35–54	55+
	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Cardiovascular disease[b]	2.57 (1.44–4.60)	1.59 (1.31–1.93)	1.15 (1.04–1.27)
COPD	2.99 (1.94–4.60)	1.61 (1.33–1.94)	1.97 (1.73–2.24)
Cancer[c]	2.58 (1.69–3.93)	1.76 (1.40–2.20)	0.99 (0.87–1.12)
Depression	2.69 (2.35–3.08)	2.35 (2.14–2.57)	3.28 (3.02–3.55)
Diabetes	3.45 (2.28–5.22)	1.28 (1.08–1.51)	1.16 (1.04–1.29)
Prediabetes[d]	3.05 (2.10–4.43)	1.49 (1.22–1.81)	1.39 (1.17–1.67)
Self-reported general health as "fair" or "poor"[e]	2.22 (1.84–2.68)	1.45 (1.31–1.61)	1.53 (1.42–1.65)
Reported that *any* days in the past 30 the respondent's physical health was not good[f]	1.50 (1.37–1.64)	1.54 (1.44–1.64)	1.57 (1.48–1.66)
Reported that *any* days in the past 30 the respondent's mental health was not good[g]	1.64 (1.52–1.77)	1.72 (1.62–1.83)	2.25 (2.10–2.41)

[a] All incidence rate ratios were adjusted for sex, race, income, education, and state-level variation in ACEs and outcomes.
[b] Cardiovascular disease prevalence includes affirmative responses to questions asking if respondent had ever been told they had: heart attack/myocardial infarction, angina/coronary heart disease, or stroke (Questions 5.1, 5.2, and 5.3 in 2012 BRFSS; 6.1, 6.2, and 6.3 in 2011 BRFSS).
[c] Excluding skin cancer.
[d] Prediabetes prevalence is reported in an optional BRFSS module not used by all states. Data for prediabetes above is from the following states that used both the optional ACEs module and the optional Prediabetes Module: Minnesota, Montana, Washington State in 2011; Iowa, North Carolina, Oklahoma, Tennessee, Wisconsin in 2012 with 79,872 observations from a population of 32,053,696.
[e] Self-reported General Health rated on a 5-point scale: Excellent, Very Good, Good, Fair, Poor.
[f] BRFSS Question 2.1: "Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?".
[g] BRFSS Question 2.2: "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?".

questions: (1) "H*ow often did anyone at least 5 years older than you or an adult, ever touch you sexually?*" (2) "*How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?*" (3) "*How often did anyone at least 5 years older than you or an adult, force you to have sex?*" Substance use in the household was assessed by an affirmative response to either: "*Did you live with anyone who was a problem drinker or alcoholic?*" or "*Did you live with anyone who used illegal street drugs or who abused prescription medications?*" Mental illness in the household member was assessed by the question, "*Did you live with anyone who was depressed, mentally ill, or suicidal?*" Having lived with an

incarcerated household member was defined by, "*Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?*" Domestic violence was assessed by the question, "*How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up?*" Parental separation was based on, "*Were your parents separated or divorced?*" The cumulative ACE score ranged from zero to eight categories; comparable with previous studies, scores of four or more were categorized as the highest exposure.

2.2. Chronic conditions health-related quality of life (HRQOL) outcomes

Chronic conditions were determined by responses to "*Has a doctor, nurse, or other health professional EVER told you that you had any of the following?*" including cardiovascular disease (CVD), which includes heart attack/myocardial infarction, angina/coronary heart disease, and stroke; chronic obstructive pulmonary disease (COPD); non-skin cancers; depression; diabetes; and prediabetes, available for all states except Vermont. We also analyzed three questions on HRQOL: (1) "*Would you say that in general your health is excellent, very good, good, fair, or poor?*" with responses dichotomized as excellent, very good or good, versus fair or poor; (2) "*Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?*" with responses were dichotomized as any days versus none; and (3) "*Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?*" also dichotomized as any days versus none.

2.3. Respondent characteristics and statistical analysis

We classified the age of respondents into three birth cohort strata: 18–34 years, 35–54 years, and ≥55 years. We performed Poisson regression within each age stratum to assess age differences in the association between ACE score and chronic condition and health status, focusing on comparisons between four or more ACEs and zero ACEs (Poisson regression incidence rate ratios better reflect relative risk given differences in prevalence across ages (Zhang & Yu, 1998; Zou, 2004). Analyses were adjusted for sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, other), annual income (< $15,000 per year, $15,000–$24,999 per year, $25,000–$34,999 per year, $35,000–$49,999 per year, and > $50,000 per year) highest education obtained (less than high school education, high school graduate, some college attended, college graduate), and state-level variations in ACEs, chronic conditions, and poor self-rated health. All analyses are based on population-weighted data using the STATA version 14 complex survey design module (College Station, TX).

3. Results

A total of 86,968 respondents completed the ACEs module representing a nine-state population of 32,552,191. Table 1 shows weighted proportions for ACE items and ACE score by age strata. The prevalence of multiple household stressors, such as mental illness, illegal substance use, parental separation, and incarcerated household member was highest in the youngest group (18–34 years) and was successively lower in each older stratum. Physical, verbal, and sexual abuse was highest among middle-aged adults (35–44 years old). The prevalence of high ACE scores decreased across age strata from 19.1% of 18–34 year-olds reporting four or more ACEs, to 18.3% of 35–54 year-olds, and only 8.9% in the 55 and older group.

Table 2 shows self-reported chronic conditions and HRQOL responses among adults, by age. As expected, the prevalence of chronic conditions was lowest among 18–34 year-olds. Responses for HRQOL exhibited varying patterns: the proportion of adults reporting general health as "poor" or "fair" was highest in the middle age group (16.2%), followed next by the oldest group (9.9%), and was lowest in the youngest group (9.0%). The proportion of adults reporting having "any days" of poor physical health in the past 30 days was lowest in the youngest group, and successively increased slightly across the two older strata. In contrast, the proportion of adults reporting having "any days" of poor mental health in the past 30 days was highest in the youngest group.

The prevalence of chronic conditions and worse HRQOL according to ACE score and age is shown in Table 3. A dose-dependent gradient was generally observed between ACE score and prevalence of almost every condition. Individuals who reported four or more ACEs had the highest prevalence of each condition compared to those who reported fewer ACEs; the sole exception was non-skin cancer in adults aged 55 and older. A dose-dependent gradient was also observed between ACE score and proportion of adults reporting fair or poor health and days of poor physical or mental health.

Table 4 shows adjusted incidence rate ratios (IRRs) for four or more ACEs compared to no ACEs within each age stratum. Comparisons of the prevalence of chronic conditions between respondents reporting four or more ACEs and respondents with no ACEs were statistically significant except for cancer in the 55-year and older stratum. IRRs for each chronic disease were largest in the youngest stratum with the exception of depression, which was highest among the oldest adults. IRRs for fair or poor overall health status were also highest among younger respondents, but IRRs for having any days of poor physical health in the past month were about equal across age groups. Further, similar to what was observed for depression, IRRs for having any days of poor mental health in the past month were highest among older respondents.

4. Discussion

This study found that the risk of multiple chronic conditions and poorer self-reported general health among adults with four or more ACEs compared to those without ACEs differs across the life-course. Incidence rate ratios for all but one chronic condition (depression) and self-reported general health were highest among the youngest respondents. In young adulthood, when the absolute prevalence of chronic conditions is low, individuals exposed to a high burden of ACEs are at much greater risk of chronic disease and are more likely to assess their health as fair or poor compared to age-matched counterparts. IRRs for CVD, non-skin cancer, diabetes, and prediabetes were successively lower in the two older age groups, presumably as the clinical significance of other risk factors increases among adults with or without a history of childhood trauma. Another reason for the lower prevalence of higher ACE scores and attenuated IRRs among the oldest respondents is survival bias. Brown et al. observed a 20-year decrease in life expectancy based on ACE scores, in which individuals with no ACEs lived, on average, to 80 years, whereas those with six or more ACEs lived to an average of 60 years (Brown et al., 2009).

That individuals with high burden of ACEs are at increased risk of developing chronic disease in early adulthood adds to growing concerns about the life-course implications of childhood adversity. Adults diagnosed with a chronic disease in young adulthood are disadvantaged compared to adults who do not develop chronic disease until their elderly years. Chronic diseases are well-known to decrease quality of life in several ways, including: additional complications or comorbidities that arise over time (e.g. congestive heart failure from a prolonged history of hypertension); disabilities and physical activity limitations that impact other domains beyond health (e.g. employment, leisurely activities); and the plethora of economic costs associated with management of chronic conditions (e.g. medications, procedures, physician or hospital visits). Thus, in addition to enduring the psychological and social tolls of trauma and adversity in youth, high ACE-burden adults are faced with the compounding challenge of being at increased risk of developing chronic diseases in young adulthood.

4.1. Limitations

Our cross-sectional study has several limitations. First, our study design precluded assessment of causation between ACEs and chronic conditions or self-rated health. Our analysis highlights associations between ACEs and health outcomes, which may or may not be indicative of a causal relationship. However, examination of this association under the scrutiny of the Bradford-Hill Criteria by the original ACE Study researchers (Anda et al., 2006) as well as a growing body of longitudinal research (Brown et al., 2010; Bethell et al., 2014; Luby et al., 2017; Copeland et al., 2018; Exley et al., 2015) suggests a potential causal relationship. More prospective, longitudinal studies further assessing the relationship between ACEs and chronic conditions in adulthood are needed. A second limitation is that BRFSS data are self-reported, and it is unknown to what extent ACEs items may suffer from recall bias (McKinney et al., 2009). Yet in this setting, recall bias is more likely to reflect false negatives and thus would bias our results conservatively (Hardt & Rutter, 2004). Same-source bias, a type of measurement error due to both exposure and outcomes being reported by the same individual, is also a limitation related to recall bias that could bias results in either direction. Third, our multivariable analyses did not adjust for health-risk behaviors (e.g. smoking, obesity) or other behavioral health conditions known to be directly associated with ACEs. However, behavioral risk factors for chronic disease are likely in the pathway between ACEs and poor health outcomes (Bucci et al., 2016; Miller et al., 2011). Thus, adjusting for these factors would spuriously dilute the association between ACEs and health outcomes. In fact, controlling for income and education (which was done in this study) may somewhat underestimate the association of ACEs with health outcomes to the extent that ACEs are associated with socioeconomic status. A fourth limitation is survival bias, which could potentially account for the much lower prevalence of reported ACEs among the oldest respondents, as those with high ACE scores are more likely to die at younger ages. Nonetheless, survival bias would not particularly distort the primary findings of this study, which are that even in young adulthood, ACEs are strongly associated with the likelihood of multiple chronic diseases and poor self-rated health.

5. Conclusions

Two key clinical and public health implications arise from this analysis. First, these data support the practice of adopting a life-course perspective (Lynch & Smith, 2004) in the delivery of health services for individuals and populations. This approach has been endorsed by the American Academy of Pediatrics and American Academy of Family Practice through encouraging health providers to consider ecological, biological, and developmental factors when synthesizing assessments on the health and health trajectories of all patients (American Academy of Pediatrics, 2014a; American Academy of Pediatrics, 2014c; Forkey et al., 2014; Daaleman & Elder, 2007). Studies piloting universal screening of ACEs for early detection and mitigation of the toxic stress response in children are currently underway in multiple health systems across the U.S. (Flynn et al., 2015; Gottlieb et al., 2016; Wade et al., 2017) Even so, in primary care, particularly for adults, such systematic responses to the long-term effects of childhood adversity are largely absent (Weinreb et al., 2010). Identification of ACEs in adults can help primary care providers promote a deeper contextual understanding of intense bouts of anxiety or depression that underlie health-compromising behaviors, and could increase adoption of self-regulation skills (Leitch, 2017; Cameron et al., 2018).

A second key implication from this study relates to broader efforts in prevention, advancing health equity, and the need for health systems to engage and invest meaningfully in this work. ACEs are known to be common in the general public; however, recent data have shown how certain groups – such as African Americans and Hispanics; individuals identifying as gay, lesbian, bisexual, or transgender; and individuals who did not complete high school or who make less than $15,000 per year – are at greater risk for higher ACE scores (Merrick et al., 2018). Coupled with our findings, which suggest the effect of ACEs may manifest in young adulthood via earlier development of chronic conditions and poor self-rated health, an overarching implication is that childhood adversity is likely a driver of health disparities and escalating economic burden on the U.S. health system. Indeed, ACEs prevention and trauma-informed care can have a profound impact on controlling rising healthcare costs (Anda & Brown, 2010; Afifi et al., 2008) and should considered as part of a comprehensive effort in advancing health equity (Metzler et al., 2017; Bancks et al., 2017). Promising interventions include perinatal home visits, evidence-based parenting and youth mentoring programs, expanding behavioral health services for adolescents, expanding access to evidence-based substance use treatment programs, addressing unmet social needs in a medical home framework, and integration of self-regulation skill building and emerging neuromodulatory therapies (van der Kolk et al., 2016) into medical practice. Addressing the burden of ACEs will inevitably require cross-sector partnerships with the public health sector, health systems, schools, police departments, correctional facilities, and community organizations to streamline and coordinate access to social services and promote trauma-informed, empathetic care. Trauma-informed initiatives – such as the Community Safety Approach in First 5 Alameda County (Erickson & Keener, 2016), which connects early childhood programming with employment opportunities for parents and housing support, and Peace4Tarpon (Sharrow, 2013), a multi-sector effort to transform the city of Tarpon Springs into a trauma-sensitive community – are useful examples for how human service organizations can partner together across sectors to advance trauma-informed principles.

In summary, our study found that ACEs are associated with many chronic conditions and poor self-rated health in young adulthood. Health systems and providers – including adult providers – should strongly consider expanding behavioral and mental health services, adopting trauma-informed practices, and engaging in opportunities for cross-sector collaboration in response to mounting data on the long-term effects of childhood adversity.

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