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The long shadow of adverse childhood events: 2. physical health outcomes in an adult community sample

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ABSTRACT

Background: The studies continue to investigate the relationship between adverse childhood experiences (ACEs) and their negative mental and physical health outcomes in adulthood. This paper replicated the landmark ACE study previously done in the United States, with an adult primary care population within Canada (*n* = 3,924).

Methods: Measures were completed by the participants to identify their ACE history and a range of physical health diagnoses. To determine the effects of ACEs on adult physical health outcomes, odds ratios were calculated with multivariate logistic regression separately for both males and females.

Results: Results indicated that the risk of many physical health problems generally increased in a dose-response pattern. The dose-response relationship was, especially, strong for physiological conditions such as irritable bowel syndrome, chronic bronchitis, gastroesophageal reflux, intestinal and abdominal discomfort, fibromyalgia, and behavior problems. These results were generally consistent in both males and females and comparatively stronger for females. The association between ACEs and cardiovascular disorders was generally not significant.

Discussion: These results contribute to the conceptualization of factors that predict a higher risk for adulthood physical disorders, which is a key to the development of intervention and prevention strategies. The implications for ACE screening and interventions within the primary care population are discussed.

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Adverse childhood experiences; primary care; adult health; physical disorders

Introduction

Adverse childhood experiences (ACEs) are generally defined as exposure to one or more negative events during the first 18 years of life [1], including abuse (sexual, physical, or emotional), neglect (physical or emotional), and household dysfunction (e.g., living with a parent who has a mental disorder or substance problem, experiencing parental separation/divorce, interparental violence, and crime in the household). The original landmark ACE study [1] identified ACEs as a critical risk factor for a variety of health conditions in adulthood. In a sample of over 17,000 American patients, the results indicated that more than half of the samples had experienced at least one ACE and that individuals with a history of increased ACEs reported more pronounced physical health problems in adulthood than those who had no ACEs. Furthermore, analyses revealed that physical disorders generally rose in concordance with the number of ACEs reported.

Considerable research has examined the "dose-response" relationship between a history of ACEs and later health problems, through the establishment of an increasing likelihood of health problems with exposure to an increased number of ACEs. The common convention, which this paper

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follows, is to sum the types of ACEs reported and to create a composite "ACE score" of 0–10, indicating the cumulative exposure to ACEs. Using this convention, childhood adversity has been associated with a wide range of long-lasting health implications in adults although much of the extant research has focused on mental disorders. Felitti et al. [1] documented that increased ACEs were associated with an increased risk for substance use disorders and depression and anxiety disorders, which also concur in less responsivity to treatment [2–4]. The relationship between ACEs and mental disorders has been well documented in considerable other research as well [5–10].

Although research has implicated ACEs as a precursor for physical illness, there is less research in this area than for mental disorders. For example, Felitti et al. [1] demonstrated a relationship between ACEs and ischemic cardiac conditions [11]. Other researchers have reported associations between ACEs and cardiovascular and chronic lung disease [12,13]. In addition, increased exposure to ACEs has been related to unhealthy behaviors such as smoking, substance abuse, and lack of physical activity [14,15].

To date, no other large-scale study has adequately replicated findings from Felitti et al. [1] or comprehensively compared the risk for a variety of adult physical health problems as a function of childhood adversity. Such a study is made difficult by the need to assess many health conditions simultaneously, and the fact that some health problems have relatively low base rates. As such, a large sample size is necessary to assess the relative risks of various health problems. Further, it is impractical to provide physician-based diagnoses for a large range of potential health problems. One practical strategy to address this concern, which is used in this study, is to ask participants to identify physician-diagnosed health disorders but without independent chart review or physician verification of these diagnoses.

This study involved adult primary care patients, who completed a measure of ACEs and indicated the presence or absence of a large series of health-related diagnoses as described below. As such, this study offers an inclusive picture of the relative risk of different medical and physical health conditions among adults who had varying degrees of exposure to ACEs. It was hypothesized that participants who had higher exposure to ACEs would also report an increased incidence of medical diagnoses, for both males and females. While it was not possible to generate precise predictions for the relationships between ACEs and the entire range of medical diagnoses that were examined, it was generally hypothesized that the associations would be the strongest for those medical conditions that clearly have a stress component in their idiopathic course. These conditions included cardiac conditions and disorders of the digestive tract [12,16].

Materials and Methods

Participants

The current study was part of a community-based study that examined the relationship between ACEs and a wide variety of mental and physical health disorders (see [14] for the study of ACEs and mental disorders). The larger EMBRACE study took place in primary care clinics throughout the city of Calgary in Canada and sought to enlist the participation of a large sample of adult primary care patients. The EMBRACE study received the ethics approval from the University of Calgary's Human Research Ethics Board (REB16- 2159).

Procedure

The study was advertised to primary care physicians who worked in several primary care networks in the city of Calgary and surrounding areas. Interested physicians were informed about the study, and if they agreed to participate, their clinic received a $1,000 honorarium as compensation for clinic disruption and staff time. The approximate time spent to recruit participants at each clinic was roughly 6 weeks. The data were collected during the period of October 2014–July 2015. During this period of time, research assistants visited the clinic to recruit participants. Signs were displayed in the clinics to indicate that a study was under the way, and when the patients checked in for their appointment, they were asked if they wanted to learn more about the study. Interested patients took a card which indicated that they were willing to be approached. Following a verbal description of the study, interested participants were given preliminary information, and if they agreed, informed consent and contact information were obtained. Each participant was then assigned a unique participant identification number and was offered to complete a questionnaire package electronically or in paper and pencil format. Participants who opted for the electronic version of the study were given a card that gave them the details of how to log onto a secure website, whereas participants who chose the paper and pencil format were given a self-addressed prestamped envelope to send their

materials back to the investigator once completed. A total of 2,737 (68.3%) participants opted for the electronic method and 1,269 (31.7%) opted for the paper and pencil format. Following the completion of the questionnaire package, each participant received a $20.00 gift card.

Measures

Demographic information

Participants provided personal information regarding their age, gender, and ethnicity (see Table 1). Other factors such as employment status, marital status, and annual household income were also collected by self-report. All nominal and ordinal values (e.g., gender, income, and marital status) were dummy coded for the purposes of covariate analyses.

Adverse childhood experiences (ACEs).

ACEs were assessed using the ACE Questionnaire [1]. The questionnaire assessed the 10 most commonly evaluated types of ACEs, including emotional, physical, and sexual abuse (three items), emotional and physical neglect (two items), and household dysfunction (interparental violence, household substance use, parental separation or divorce, mental illness in household, and crime in household; five items). Participants indicated the frequency of any of these experiences prior to the age of 18, on a scale, which ranged from "never," "once or twice," "sometimes," "often," to "very often." Responses were recoded using a standardized protocol into binary form and then summed to yield a total ACE score that ranged from 0 to 10 (Felitti et al. [1]; access to the scale and scoring instructions are available from the first author on request).

Physical health conditions

As part of the assessment package, participants were presented with a list of common physical health conditions which are often seen in primary care settings. Participants were instructed: "please check 'yes' if you have had or currently have any of the following chronic health conditions. The

Table 1. Demographic characteristics of the sample.

Variable	Males		Females	
	n	%/ M (SD)	*N*	%/ M (SD)
Age	1,241	46.13 *(17.16)*	2,673	43.29 (*16.86*)
Education				
Less than high school	74	6.0%	125	4.7%
High school or equiv.	203	16.4%	398	14.9%
Some post-secondary	271	21.8%	600	22.4%
Post-secondary	549	44.2%	1,291	48.4%
Graduate degree	142	11.4%	255	9.5%
Annual household income				
Less than 20,000	95	7.7%	287	10.7%
20,000–39,999	138	11.1%	335	12.5%
40,000–59,999	162	13.1%	401	15.0%
60,000–79,999	184	14.8%	352	13.2%
Greater than 80,000	651	52.5%	1,232	46.1%
Marital status				
Married/Cohabitating	834	67.2%	1,672	62.5%
Never married	297	23.9%	594	22.2%
Widowed	13	1.0%	94	3.5%
Separated/Divorced	92	7.5%	308	11.5%
Employment				
Full-time	751	60.5%	1,070	40.0%
Part-time	137	11.0%	694	26.0%
Unemployed	131	10.6%	472	17.7%
Retired	218	17.6%	429	16.0%
Ethnicity				
Caucasian	1,749	79.3%	2,251	84.2%
Black/African American	20	1.6%	18	0.7%
Asian	100	8.1%	184	6.9%
First Nations	12	1.0%	22	0.8%
Other	122	6.3%	189	7.1%

condition must have been diagnosed by a health-care professional and has lasted or be expected to last at least 6 months. Check "no" if you have not been diagnosed with the condition." The list of health conditions (Tables 2–6) included allergies, sensitivity and autoimmune disorders, cardiovascular-related disorders, gastrointestinal disorders, respiratory-related disorders, and pain-related disorders.

Statistical analyses

Data screening and management

Of the 4,006 participants who provided informed consent and received the questionnaire, 3,932 (98.2%) participants completed it. Participants who indicated "other" as their gender were eliminated from the analysis as their representation in the sample was minimal (n = 8). The rates of missing data were extremely low, and none of the cases seceded 2% of responses. As such, missing data were not estimated, and analyses were based on completer data sets. The analyses, therefore, included a sample of 3,924 (97.9%) of the original set of participants.

Main analyses

Analyses were performed using IBM SPSS version 24. Participants were classified by their ACE score, ranging from 0, 1, 2, 3, and 4+ (the latter group was chosen as the highest ACE score group as the percentage of participants in that group was sufficient for analyses). The group of participants with an ACE score of 0 was set as the referent group, and their rates of various health disorders were calculated (Tables 2–6). Odds ratios (ORs) were then calculated by performing multivariate logistic regressions to assess the increased risk for physical health problems as a function of ACE exposure, comparing each participant group with one or more ACEs to the referent group. Family income and age were used as covariates in this analysis to eliminate the possibility that the effects of ACEs on physical health problems were explained by these factors. Adjusted ORs and confidence intervals (CIs) were computed for every type of health problems with a minimum of 15 participants. As there was a sufficient sample size and several of the disorders of interest have known gender differences, all the analyses were conducted separately for males (n = 1241; 31.6%) and females (n = 2673, 68.4%."

Results

Participant characteristics

As shown in Table 1, participants ranged from 18 to 92 years of age (M = 44.13, SD = 17.01). Most of the participants were women (68%) and a committed relationship (married or cohabitating: 63.8%). The sample was predominantly Caucasian (82.5%), 7.2% Asian, 1% African American or Black, 0.9% First Nation, and 7.9% "other." About one-fifth of the sample (20.4%) had completed high school or less, 69.3% had completed some college or university, and the remainder (10.1%) had obtained a graduate degree. A large portion of the sample had relatively high socioeconomic status as 48% of the

Table 2. Numbers and types of ACES experienced, as a function of gender.

Variable	Males (n = 1,241)		Females (n = 2,672)	
	n	%	*N*	%
Number of ACEs				
0	420	33.8	771	28.8
1	309	24.9	594	22.2
2	198	16.0	442	16.5
3	129	10.4	278	10.4
4+	160	12.9	546	20.5
Types of ACEs Experienced				
- Emotional abuse	77	6.2	175	6.5
- Physical abuse	55	4.4	99	3.7
- Sexual abuse	64	5.2	172	6.4
- Emotional neglect	37	3.0	109	4.1
- Physical neglect	10	0.6	15	.01
- Household drugs	112	9.0	242	9.1
- Household mental illness	162	13.1	394	14.7
- Household violence	56	4.5	109	4.1
- Household criminality	36	2.9	69	2.6
- Household divorce	14	1.1	35	.01

Table 3. Adjusted odds ratios for allergies, sensitivities, and autoimmune disorders by gender, controlling for age, and household income.

Diagnostic Category/ACE score	Male			Female		
	Adjusted odds ratio	95% CI	*p*	Adjusted odds ratio	95% CI	*p*
Food Allergies						
0- Basal percentage	9.5%			15.8%		
1	1.31	0.81–2.11	0.27	1.18	0.88–1.58	0.26
2	1.33	0.77–2.32	0.30	1.33	0.97–1.81	0.07
3	1.70	0.95–3.05	0.07	1.20	0.83–1.74	0.32
4+	1.34	0.75–2.38	0.32	1.78	1.30–2.36	0.001***
Other Allergies						
0- Basal percentage	30.2%			33.6%		
1	1.04	0.75–1.44	0.80	1.36	1.09–1.72	0.007**
2	0.94	0.64–1.38	0.76	1.47	1.14–1.88	0.002**
3	1.03	0.67–1.59	0.88	1.51	1.13–2.01	0.005**
4+	0.95	0.64–1.43	0.82	1.60	1.27–2.01	0.001***
Multiple Chemical Sensitivities						
0- Basal percentage	0.3%			0.8%		
1	1.003	0.99–1.01	0.38	1.92	0.68–5.43	0.21
2	8.69	0.94–12.92	0.02*	1.14	0.32–4.08	0.83
3	3.079	0.19–9.58	0.40	0.91	0.18–4.54	0.91
4+	5.045	0.45–14.04	0.14	2.24	0.81–6.21	0.11
Other Autoimmune Disorders						
0- Basal Percentage	2.8%			5.6%		
1	0.83	0.32–2.18	0.71	1.40	0.90–2.17	0.13
2	2.90**	1.29–6.51	0.007**	1.70	1.06–2.64	0.027*
3	2.30	0.90–5.86	0.072	1.90	1.14–3.16	0.012*
4+	2.84*	1.23–6.58	0.011*	2.26	1.51–3.41	0.001***

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

participants had an annual household income of over $80,000 CAD per year.

Table 1 shows information on the rates of ACEs in the current sample. Notwithstanding the relatively well-educated and affluent nature of the sample, the rates of ACE exposure were high. Almost one-third of the samples (n = 1191; 30.3%) reported no history of ACEs (scores of 0), but 903 participants (23.1%) had scores of 1,640 (16.4%) had scores of 2,407 (10.5%) of 3, and 706 (12.9%) of 4 or more ACEs. The exposure to ACEs was higher in females than males and in particular in the 4+ ACEs group.

Relationship between ACEs and diagnosed health disorders

Tables 2–6 present the adjusted ORs and CIs for all of the health conditions inquired about in this study, broken down into logically similar groups. As shown in those tables, there was a significant association between ACE scores and a wide range of physical disorders. As the detailed results present in Tables 2–6, the broader patterns are reviewed here.

Increased odds were generally observed for many disorders with increased ACE exposure. This pattern held true for allergies and other autoimmune disorders for females (Table 2) and gastrointestinal-related disorders for both the genders (Table 4). Indeed, two of the strongest relationships between ACEs and physical health disorders were irritable bowel syndrome and intestinal/abdominal bloating, suggesting a strong association between ACEs and gut-related dysfunction. One of the patterns, which was clear for females but not for males, was related to respiratory disorders (see Table 5). Thus, ACEs were associated with chronic bronchitis, emphysema/Chronic obstructive pulmonary disease (COPD), and asthma for females, but, for males, only chronic bronchitis was associated with ACEs only for the high levels of exposure (4+). These patterns reflect differences in the increased odds of respiratory disorders across the genders, which in general were about twice as high for each level of ACE exposure for females, as compared to males.

In contrast to those disorders, where there was an increasing likelihood of disorder with increased ACEs, it was observed that cardiovascular conditions, including heart disease, congestive heart failure, stroke, angina, and high blood pressure, were

Table 4. Adjusted odds ratios for cardiovascular and related disorders by gender, controlling for age and household income.

Diagnostic category/ACE score	Male			Female		
	Adjusted odds ratio	95% CI	*p*	Adjusted odds ratio	95% CI	*p*
Heart disease						
1- Basal percentage	7.3%			2.8%		
1	0.99	0.56–1.76	0.99	1.08	0.56–2.08	0.82
2	0.89	0.44–1.78	0.73	1.40	0.72–2.74	0.32
3	0.82	0.40–1.85	0.64	1.66	0.80–3.44	0.17
4+	0.94	0.46–1.93	0.87	1.63	0.89–2.98	0.11
Congestive Heart Failure						
0- Basal percentage	2.8%			1.1%		
1	0.35	0.10–1.26	0.09	0.32	0.07–1.49	0.12
2	0.97	0.33–2.83	0.95	1.29	0.44–3.73	0.64
3	0.27	0.03–2.10	0.18	1.02	0.27–3.89	0.97
4+	1.14	0.39–3.33	0.81	2.02	0.82–4.97	0.12
Stroke						
0- Basal percentage	1.8%			0.8%		
1	1.13	0.38–3.39	0.83	0.42	0.08–2.11	0.28
2	0.61	0.13–2.98	0.54	0.86	0.21–3.46	0.83
3	1.80	0.50–6.08	0.37	1.85	0.52–6.59	0.34
4+	0.71	0.14–3.44	0.67	1.79	0.62–5.19	0.28
Angina						
0- Basal Percentage	6.5%			2.3%		
1	0.54	0.26–1.10	0.09	0.74	0.34–1.64	0.46
2	1.16	0.59–2.28	0.67	1.64	0.82- 3.27	0.16
3	1.43	0.70–2.93	0.32	1.13	0.46–2.76	0.78
4+	1.37	0.70–2.70	0.36	1.75	0.92–3.34	0.08
High Blood Pressure						
0- Basal percentage	26.6%			16.8%		
1	1.05	0.75–1.47	0.76	0.81	0.60–1.10	0.17
2	0.92	0.62–1.38	0.69	1.25	0.92–1.70	0.16
3	0.95	0.60–1.49	0.82	0.85	0.58–1.26	0.42
4+	1.18	0.79–1.77	0.42	1.00	0.74–1.35	0.98
Migraine Headaches						
0- Basal percentage	8.5%			21.1%		
1	0.96	0.56–1.65	0.89	1.04	0.79–1.35	0.80
2	1.85	1.08–3.18	0.02*	1.35	1.02–1.80	0.04*
3	1.51	0.80–2.84	0.12	1.19	0.85–1.66	0.30
4+	3.14	1.88–5.24	0.001***	1.69	1.31–2.18	0.001***

not associated with ACEs for either males or females and at even the highest levels of ACE exposure (see Table 3). The only condition that was significantly associated with ACEs in this table was migraine headaches, which emerged as significantly associated with higher levels of ACEs.

Discussion

The present study examined the relationships between self-reported ACEs and physical disorders in a Canadian primary care population. Consistent with the dose-response theory and the landmark ACEs study [1], it was hypothesized that the rates of medical diagnoses would increase as ACE scores increased. Results confirmed that, relative to those with no ACEs, the risk of autoimmune disorders, migraines/headaches, or digestive system disorders (i.e., abdominal discomfort, irritable bowel syndrome, and esophageal reflux) was higher among both males and females who endorsed a history of ACEs. Similar results were observed for intestinal ulcers and allergies among females and for multiple chemical sensitivities among males. Although this study cannot elucidate the mechanisms by which ACEs might exert differential effects for one gender or the other or for specific disorders, it is quite possible that biological variations between genders, differential exposures to ACEs, patterns of socialization associated with the

Table 5. Adjusted odds ratios for gastrointestinal and related disorders by gender, controlling for age and household income.

Diagnostic category/ACE score	Male			Female		
	Adjusted odds ratio	95% CI	*P*	Adjusted odds ratio	95% CI	*p*
Stomach, intestinal ulcers						
0- Basal percentage	6.5%			4.8%		
1	1.05	0.58–1.90	0.87	1.22	0.75–1.98	0.43
2	1.15	0.59–2.26	0.68	1.68	1.03–2.75	0.036*
3	1.17	0.55–2.49	0.69	2.34	1.39–3.93	0.001***
4+	1.46	0.75–2.83	0.26	2.44	1.58–3.76	0.001***
Crohn's Disease/ colitis						
0- Basal percentage	1.8%			2.3%		
1	0.93	0.29–2.97	0.90	0.52	0.21–1.26	0.14
2	1.54	0.48–4.91	0.46	1.01	0.46–2.22	0.98
3	0.43	0.05–3.50	0.41	0.96	0.38–2.47	0.94
4+	2.17	0.72–6.56	0.16	0.93	0.44–1.97	0.86
Irritable bowel syndrome						
0- Basal percentage	2.3%			7.7%		
1	1.92	0.81–4.56	0.13	1.14	1.02–2.17	0039*
2	3.49	1.48–8.23	0.002**	1.28	1.57–3.33	0.001***
3	4.76	1.98–11.41	0.001***	1.11	1.42–3.37	0.001***
4+	4.48	2.05–10.99	0.001***	1.42	2.02–4.03	0.001***
Gastro-esophageal reflux						
0- Basal percentage	9.3%			10.3%		
1	1.26	0.77–2.05	0.36	1.64	0.80–1.62	0.47
2	1.11	0.62–1.99	0.73	3.09	0.88–1.86	0.19
3	1.84	1.04–3.28	0.036*	3.87	0.71–1.74	0.64
4+	1.97	1.16–3.37	0.012*	5.20	1.01–1.99	0.044*
Intestinal, abdominal discomfort, bloating						
0- Basal percentage						
1	14.8%			27.3%		
2	1.15	0.76–1.73	0.46	1.43	1.13– 1.82)	0.003**
3	1.72	1.11–2.67	0.015*	2.23	1.73–2.87	0.001***
4+	1.69	1.03–2.77	0.035*	2.29	1.71–3.07	0.001***
	3.13	2.04–4.80	0.001***	3.14	2.48–3.97	0.001***

expression or repression of emotional and physical symptoms, patterns of emotion regulation, and other factors play a part in the complex patterns of associations reported in this manuscript. This study represents an effort to describe differences between males and females, which can stimulate further inquiry.It is clear that ACEs are associated with many physical health concerns and particularly in stress-prone areas such as the digestive system [16]. It is possible that early stressors condition the physical body in a way that highly sensitive areas are affected more than other parts of the body [16]. Furthermore, childhood neglect has been shown to increase the rates of chemical sensitivities and digestive system problems in adulthood, both of which were shown here to have higher frequency rates for males and females. Other autoimmune diseases have also been previously studied and closely linked to early childhood stressors [17]. The failure to find an association between ACEs and cardiovascular conditions was surprising, in part, as the previous research has found this relationship to be significant [11,12]. It is possible that the current sample size or the relatively small percentage of the sample which reported some cardiovascular issues (for example, 2.8% of males and 1.1% of females reported congestive health failure) made the discovery of effects more difficult. On the other hand, even conditions that had large percentages of the sample who reported positive diagnoses (e.g., 26.6% of males and 16.8% of females reported high blood pressure) failed to demonstrate an ACE effect. Overall, these results certainly warrant replication, before further consideration of the reasons for this lack of association is explored.

The precise mechanisms between exposure to ACEs and adult health problems remain a matter of conjecture. Early adversity does increase the

Table 6. Adjusted odds ratios for respiratory and related disorders by gender, controlling for age and household income.

Diagnostic category/ACE score	Male			Female		
	Adjusted odds ratio	95% CI	*p*	Adjusted odds ratio	95% CI	*p*
Chronic bronchitis						
0- Basal percentage	3.3%			2.1%		
1	1.22	0.55–2.72	0.62	1.99	1.03–3.84	0.038*
2	1.71	0.74–3.97	0.21	2.51	1.28–4.92	0.006**
3	1.43	0.53–3.83	0.48	2.04	0.92–4.50	0.07
4+	2.62	1.19–5.79	0.014*	4.58	2.54–8.27	0.001***
Emphysema/ COPD						
0- Basal percentage	2.3%			1.0%		
1	1.17	0.45–3.08	0.75	1.83	0.69–4.84	0.22
2	0.96	0.29–3.17	0.95	2.26	0.84–6.11	0.10
3	2.43	0.89–6.66	0.08	3.58	1.32–9.72	0.008**
4+	1.70	0.59–4.84	0.32	3.31	1.36–8.03	0.005**
Asthma						
0- Basal percentage	12.6%			15.3%		
1	1.58*	1.04–2.39	0.03*	1.34	1.00–1.79	0.047*
2	1.30	0.79–2.14	0.29	1.66	1.23–2.26	0.001***
3	1.65	0.98–2.80	0.06	1.56	1.09–2.22	0.014*
4+	1.34	0.80–2.25	0.26	1.87	1.41–2.48	0.001***

Table 7. Adjusted odds ratios for pain- related and other disorders by gender, controlling for age, and household income.

Diagnostic category/ACE score	Male			Female		
	Adjusted odds ratio	95% CI	*p*	Adjusted odds ratio	95% CI	*p*
Fibromyalgia						
0- Basal percentage	0.3%			2.1%		
1	3.98	0.41–38.42	0.20	1.20	1.02–3.85	0.04*
2	11.30	1.31–97.45	0.006**	1.64	0.78–3.44	0.18
3	6.21	0.56–69.02	0.09	1.48	0.62–3.52	0.38
4+	7.52	0.78–72.84	0.04*	3.85	2.11–7.03	0.001***
Arthritis/ Rheumatism						
0- Basal percentage	18.1%			20.8%		
1	1.05	0.72–1.55	0.79	0.98	0.75–1.29	0.89
2	1.03	0.65–1.61	0.91	1.31	0.98–1.74	0.06
3	1.20	0.76–2.02	0.39	1.25	0.89–1.74	0.19
4+	1.00	0.62–1.62	0.98	1.21	0.92–1.58	0.16
Chronic fatigue						
0- Basal percentage	0.3%			1.0%		
1	1.31	0.08–21.06	0.86	1.89	0.69–4.86	0.21
2	6.52	0.67–63.08	0.06	2.75	1.06–7.14	0.03*
3	1.00	0.99–1.01	0.56	1.97	0.62–6.27	0.24
4+	5.01	0.45–55.68	0.14	4.12	1.74–9.77	0.001***
Urinary incontinence						
0- Basal percentage	3.5%			6.5%		
1	1.23	0.57–2.66	0.59	1.71	1.15–2.54	0.008**
2	0.94	0.35–2.48	0.89	2.03	1.34–3.08	0.001***
3	1.31	0.49–3.48	0.59	2.80	1.80–4.36	0.001***
4+	1.82	0.79–4.18	0.15	2.53	1.73–3.69	0.001***

risk of inflammatory reactivity [18,19], and there is even evidence of epigenetic change associated with ACEs [20]. Some literature has suggested that ACEs have permanent effects that lead to early telomere shrinkage; therefore, there were early physiological health disturbances and shorter life span [17]. A recent review of potential biomarkers associated with ACEs [21] implicates particular factors associated with stress reactivity such as cortisol. Accumulated stress may induce a greater amount

of inflammation in the gut compared to an individual with lower stress rates [16]. As such, it may be expected that childhood adversity is directly associated with adult health problems that have their basis in stress reactivity.

This study demonstrated a dose-response relationship between ACEs and many physical health outcomes among a large adult primary care population, in which an increased number of ACEs generally were associated with increased reports of medical conditions. Approximately, two-third of the participants reported at least one ACE and 13% reported exposure to four or more types of childhood adversities. These rates are consistent with the original ACE study [1] despite the relatively younger average age of the current sample (44 years vs. 56 years). Furthermore, the results were consistent with two Canadian population-based studies [22,23]. The previous research [24] suggests that women are likely to experience higher levels of ACEs. For example, in this study, 20.5% of women had experienced 4+ ACEs, compared to 12.9% of males.

Strengths and limitations

One of the strengths of this study is the use of a relatively large primary care sample. Not only does this sample help to estimate ACEs prevalence rates within clinical populations but also it provides attention to the biopsychosocial context of individuals who experience childhood adversity. Further, this study used a well-validated ACE questionnaire equipped with multiple categories of childhood adversity [5]

This study is not exempt from limitations. Although large samples generally are associated with stronger research results, there were approximately twice as many females than males in this study. Thus, the ability to find effects was greater in the female group and is reflected in some results that were significant for females but not males (e.g., allergies, stomach /intestine ulcers). It is possible that with a larger sample of males, the patterns observed for females would have been fully replicated. In general, larger samples are associated with reduced measurement error, and some of the CI observed in this study. In particular for males, the patterns observed would likely have also been attenuated by a larger sample.

Although the current participants were similar to the participants of the original ACEs study, differences such as education, employment, and diversity may limit the generalizability of the current findings. Most of the participants were well-educated, employed, and Caucasian, and, as a result, they may not generalize to more diverse populations. The current sample was also a group that self-selected from patients who happened to be in their general physician's office during the study and so it is possible that self-section affected who took part in the study may have reduced or inflated the resultant relationships among the observed variables. Future research should examine samples from diverse backgrounds and the influence of sociodemographic characteristics on the rates and types of physical disorders associated with ACEs.

While some previous research [25] has attempted to associate specific forms of childhood maltreatment (e.g., emotional or sexual abuse) with adult health consequences, this study did not attempt to find these links. Rather, to remain consistent with the previous research findings (Felitti et al., [1]), cumulative ACE scores were used. This study also did not examine either the severity or duration of the physical disorders that participants reported. Medical history was taken at face value, without independent verification of medical diagnoses. Although the retrospective recall of ACEs and medical history is likely reliable and valid [26], future research could examine information about patient history, intensity of physical problems, and possibly the associations between ACEs and medically confirmed chronic health disorders.

Clinical implications

Consistent with previous literature, the present study found that one-third of adults in primary care reported exposure to at least one type of ACE. This level of the report suggests that ACEs should be considered broadly within primary care settings. The current study further contributes to a developing knowledge base regarding the associations between cumulative ACE scores and a range of physical health outcomes in adulthood. Specifically, the current results enhance the understanding of these issues within an urban primary care setting. Research is needed to examine the mechanisms by which ACEs contribute to latter life physical health outcomes. A better understanding of patients' ACEs in primary care settings holds the potential for both prevention efforts and improved service delivery [27,28] for affected individuals.

Although it has been argued that widespread ACE screening is premature in primary care until effective interventions and responses are available for those who screen positively [29], combining

patient's mental and physical health history through ACE screening may provide insight about possible intervention targets. While the minimization of childhood adversity, abuse, and neglect is certainly recommended as the most powerful way to prevent negative health consequences, future interventions may benefit from a focus on developmental factors for those individuals who are unfortunately suffered under the long shadow of ACEs.

This study contributes to a developing knowledge base regarding the associations between cumulative ACE scores and a range of physical health outcomes in adulthood. Specifically, the current results facilitate the understanding of these issues within an urban primary care setting. Research is needed to examine the mechanisms by which ACEs contribute to latter life physical health outcomes. A better understanding of patients' ACEs in primary care settings holds the potential for both prevention efforts and improved service delivery for affected individuals.

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