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Examination of the Factorial Structure of Adverse Childhood Experiences and Recommendations for Three Subscale Scores

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Abstract

Objective—The purpose of the current investigation is to assess and validate the factor structure of the Behavioral Risk Factor Surveillance System's (BRFSS) Adverse Childhood Experience (ACE) module.

Method—ACE data available from the 2009 BRFSS survey were fit using exploratory factor analysis (EFA) to estimate an initial factorial structure. The exploratory solution was then validated using confirmatory factor analysis (CFA) with data from the 2010 BRFSS survey. Lastly, ACE factors were tested for measurement invariance using multiple group factor analysis.

Results—EFA results suggested that a 3-factor solution adequately fit the data. Examination of factor loadings and item content suggested the factors represented the following construct areas: Household Dysfunction, Emotional/Physical Abuse, and Sexual Abuse. Subsequent CFA results confirmed the 3-factor solution and provided preliminary support for estimation of an overall latent ACE score summarizing the responses to all available items. Measurement invariance was supported across both gender and age.

Conclusions—Results of this study provides support for the use of the current ACE module scoring algorithm, which uses the sum of the number of items endorsed to estimate exposure. However, the results also suggest potential benefits to estimating 3 separate composite scores to estimate the specific effects of exposure to Household Dysfunction, Emotional/Physical Abuse, and Sexual Abuse.

Keywords

ACEs; adverse childhood experiences; child abuse; child maltreatment; factor analysis

Child maltreatment and other adverse childhood experiences (ACEs) represent extreme environmental hazards to psychosocial and cognitive development (Rogosch, Dackis, & Cicchetti, 2011; Leeb, Lewis, & Zolotor, 2011). Previous studies have consistently replicated the findings that ACEs predict a wide range of long-term health outcomes and behaviors among adults including smoking, substance abuse, Post Traumatic Stress Disorder, heart disease, diabetes, lung cancer, psychopathology, and premature death (Anda et al., 2002; Edwards, Holden, Anda, & Felitti, 2003). ACEs include both unhealthy home environments, such as living with a substance abusing parent, as well as harmful behaviors directed toward the child, such as emotional, physical, and sexual abuse.

Assessing the impact of stressful life events has typically included examination of single stressors. Examples of these stressors range from exposure to combat, to childhood stressful life events such as abuse, as well as to adult stressful events such as the death of a loved-one. The manner in which these stressful life events are summarized has been debated since the 1970s, and often these items are simply summed into a single composite (Cleary, 1980; Bynum et al., 2010; Dohrenwend & Dohrenwend, 1978; Felitti et al., 1998; Kessler, 1980; Newcomb, Huba, & Bentler, 1981). A more sophisticated way to summarize these events is to weight certain events more based on the relationship to psychological outcomes and psychopathology (Newcomb et al., 1981). Such studies often incorporate more advanced

measurement techniques such as exploratory and confirmatory factor analyses to derive domain specific scales.

More recently, the U.S. Centers for Disease Control and Prevention (CDC) has implemented public health surveillance for ACEs. Initially, the CDC collaborated with colleagues from the Southern California region of the HMO, Kaiser Permanente, and selected 17 items assessing exposure to various types of ACEs to be administered to samples of adults who were members of the HMO (Felitti et al., 1998). These questions were selected from 3 different sources; the Conflicts Tactics Scale (Straus & Gelles, 1990), a previous study examining sexual abuse among adult women (Wyatt, 1985), and the National Health Interview Survey (National Center for Health Statistics, 1991). In 2009, the CDC began annually administering 11 items adapted from this questionnaire to large samples of adults that participated in the Behavioral Risk Factor Surveillance System (BRFSS) survey. The items cover nine different types of childhood exposures such as emotional abuse, physical abuse, sexual abuse, household-member mental illness, household-member substance abuse, witnessing domestic violence, parental separation/divorce, and incarcerated family members (see Table 1). The BRFSS is the largest and longest running state-based random digit dialed health survey in the United States. Currently, the survey is administered via telephone annually to more than 500,000 individuals. Twenty-two states administered the ACE questions on the BRFSS between 2009 through 2012. As a result, the CDC has now collected the largest sample of adults that have ever responded to these 11 questions (n = 186,423; CDC, 2009a, 2010a, 2011, 2012).

In previous studies, ACEs have typically been summed into a single index to estimate the overall impact on subsequent physical and mental health. Although the literature has demonstrated that some of the ACE constructs can be measured appropriately with valid and reliable items (Straus, Hamby, Boney-McCoy, & Sugarman, 1996; Newcomb et al., 1981), the 11 items adapted from the original Kaiser/CDC ACE studies have never been examined together in terms of understanding their psychometric properties in an adult sample. There are several potential advantages to examining the psychometric properties of the ACE questionnaire items, particularly for surveillance purposes. First, if the items are associated with several different factors, the manner in which they are summarized could impact how those different factors interact and predict long-term health outcomes among adults. In addition, if several items measure the same factor, then single items could be selected from each factor to represent that construct in studies that do not have the financial or other resources to support use of the entire ACE questionnaire. This scenario is often the case when administering large national health surveys for surveillance purposes and has been demonstrated for assessment of the prevalence of depression and major depression using the Patient Health Questionnaire in the U.S. (PHQ-9 [Kroenke & Spitzer, 2002], PHQ-8 [Kroenke et al., 2009], and PHQ-2 [Löwe, Kroenke, & Grafe, 2005]). Lastly, in most studies, the psychological measures are administered to individuals that vary in terms of sociodemographic characteristics such as age and gender. To support the validity and reliability of group comparisons using latent constructs, a common metric must be used across groups. This is typically referred to as measurement invariance (Vandenberg, 2002; Widaman & Reise, 1997). The purpose of the current study is to examine the factorial

structure of the 11 ACE items that have been administered on the BRFSS. Specifically, the authors aim to demonstrate the following:

1. A set of latent domains can be derived from the 11 items of the BRFSS ACE Module using exploratory analysis.
2. The latent structure derived from the exploratory analysis will be reproduced using a confirmatory modeling approach in a different sample.
3. The latent factors will maintain aspects of configural and metric invariance across age groups and gender.

Method

Participants

We used data from the Adverse Childhood Experiences module administered to participants on 2009 and 2010 (CDC, 2009a, 2010a) Behavioral Risk Factor Surveillance System annual surveys.

Sample 1—This sample consisted of 27,545 noninstitutionalized adults surveyed during the 2009 Behavioral Risk Factor Surveillance System data collection period (CDC, 2009a). Participants were residents of one of the following five states: Arkansas, Louisiana, New Mexico, Tennessee, or Washington. The final weighted sample comprised 75.9% white, 10.3% black, 8.5% Hispanic, 1.4% multiracial, and 3.9% other ethnicities. The gender distribution of the sample consisted of 52.3% females and the respondent ages ranged from 18 to 98 years with a mean age of 47.1 (*SE* = 0.18).

Sample 2—This sample consisted of 57,703 noninstitutionalized adults surveyed during the 2010 Behavioral Risk Factor Surveillance System data collection year (CDC, 2010a). Participants were residents of the District of Columbia or one of the following 10 states: Hawaii, Maine, Nebraska, Nevada, Ohio, Pennsylvania, Utah, Washington, Wisconsin, or Vermont. The final weighted sample comprised 81.1% white, 5.1% black, 3.5% Hispanic, 3.8% multiracial, and 6.5% other ethnicities. Ages of the respondents ranged from 18 to 98 years, with a mean age of 47.5 (*SE* = 0.16) with 50.9% of sample being female.

Measures: Adverse Childhood Experiences

The ACE module (CDC, 2009b, 2010b) consists of 11 items that assess exposure to nine types of ACEs, including verbal abuse, physical abuse, sexual abuse, household mental illness, household alcohol abuse, household drug abuse, domestic violence, parental separation/divorce, and incarcerated family members (see Table 1). Details about the psychometrics of the ACE module are included in the Results section.

Procedure

ACE data were collected as part of the annually administered BRFSS questionnaire. The goal of the BRFSS, coordinated by the CDC, is to track state-specific behavioral health risks in the United States. Information from the survey is used to improve preventative health practices for chronic diseases, injuries, and infectious diseases. The survey is conducted

monthly in each state during a two-week period using a random-digit dialing sampling protocol to contact respondents. Once contacted, BRFSS interviewers ask respondents a series of questions regarding their health and health behaviors. Whereas many of these health-related questions are included in the questionnaire across every state, several items comprising additional modules are optional, and it is at the discretion of each state whether or not they will be included during a given data collection year. The ACE items are among these optional modules and therefore were not administered in every state each year.

Before analysis, the responses to the ACE items from the 2009 and 2010 samples were dichotomized to convey exposure to a given type of experience. For example, the response options for the intimate partner violence item, *How often did your parents of adults in your home ever slap, hit, kick, punch, or beat each other up?*, consist of several categories, including (a) *Never*, (b) *Once*, and (c) *More than once*. The response options for this item and similar items were collapsed into (a) *Never* and (b) *One or more times*, reflecting exposure status. Several items, such as *Did you live with anyone who was a problem drinker or alcoholic?*, were already dichotomous (Yes/No) and therefore did not require further collapsing of response categories to correspond with ACE exposure status.

Statistical Procedures

The BRFSS uses a complex sampling design that employs survey weights to adjust for non-response and noncoverage biases. This weight along with stratum and primary sampling unit variables were included in all analyses. Data analyses were conducted in R version 3.01 (R Core Team, 2013) and Mplus Version 7.0 (Muthén & Muthén, 2012).

Exploratory Factor Analysis (EFA)—As an initial data analytic step, responses to the ACE module from the 2009 BRFSS sample (Sample 1) were submitted to EFA in Mplus 7.0 (Muthén & Muthén, 2012), using mean- and variance-adjusted weighted least squares estimation (WLSMV) on the tetrachoric correlations of categorical responses. Solutions using geomin (oblique) rotation and varimax (orthogonal) rotation were estimated and compared producing very similar, often identical, loading patterns for both factor solutions. The best factorial solution was chosen based on Satorra-Bentler chi-square statistics, a model fit statistic robust to non-normally distributed variables (Satorra & Bentler, 2001), Root Mean Squared Error of Approximation (RMSEA), Tucker-Lewis Index, (TLI), and Comparative Fit Index (CFI). Commonly implemented guidelines of 0.06 and 0.95 for RMSEA and TLI/CFI, respectively were used to assess model fit (Bentler, 1990; Browne & Cudeck, 1992; Hu & Bentler, 1999).

Confirmatory Factor Analysis (CFA)—To validate the EFA results, a subsequent CFA was completed by specifying a structural equation model that corresponded with the factor loadings that emerged from the EFA. Given the degree to which each of the three factors were intercorrelated in the previous analysis and the common ACE module scoring algorithm found in the literature (Felitti et al., 1998), inclusion of a 2nd order factor structure in the confirmatory model was preferred. However, although this higher order domain would theoretically constitute an overarching or summary measure of ACE exposure, it is important to note that a 2nd order factor specified in a CFA model with three

indicators (*Household Dysfunction*, *Physical/Emotional Abuse*, and *Sexual Abuse*) is just identified, meaning that model fit describing the addition of the 2nd order factor cannot be assessed. As a result, fit indices for this model are identical to those fit indices of a model without the inclusion of this overarching factor. Therefore, a model consistent with the EFA model containing three correlated first order factors was estimated. A schematic depicting this structure is displayed in Figure 1. This model was fit to the ACE module responses in the 2010 BRFSS sample (Sample 2) using tetrachoric correlations (Table 2) and WLSMV estimation in MPlus (Muthén & Muthén, 2012) to handle categorical data (Muthén, 1984; Muthén & Muthén, 2012).

Cronbach's alpha—Cronbach's alpha (Cronbach, 1951) was employed to estimate the internal consistency of the dimensions validated by the CFA. It provided an overall measure of the interrelatedness among the items comprising each dimension. The magnitude of alpha coefficients can range from 0 to 1, where higher values reflect greater reliability. Values of Cronbach's alpha greater than 0.6 were considered to reflect an acceptable level of reliability (Streiner, 2003).

Multiple group confirmatory factor analysis (MGCFA)—Configural and metric measurement invariance was examined by estimating a series of nested MGCFA models using the 2010 BRFSS ACE Module data (Sample 2). These analyses compared CFA models that allowed the factor loadings to be freely estimated across groups to a model that constrained these loadings to be equal across groups (Meredith, 1993; Widaman & Reise, 1997). Configural invariance is established when the factor loading pattern and item thresholds are similar and the overall model fits well for both groups when estimated simultaneously (Gregorich, 2006; Horn, McArdle, & Mason, 1983; Vandenberg, 2002). Metric invariance is substantiated when the factor loadings and item thresholds constrained to be equal across two groups are found to be statistically equivalent, suggesting that the factors measure identical constructs using the same measurement scale for both groups (Gregorich, 2006; Horn, McArdle, & Mason, 1983; Vandenberg, 2002). Measurement invariance was investigated using analytic procedures suggested by Muthén and Muthén (2012, p. 485). We evaluated both the factor loadings and changes in the fit statistics to determine whether they measured similar constructs in both groups and permitted the examination of latent mean differences (Sass, 2011). Configural and metric measurement invariance were first tested by gender and then by age using four groups (18 –34 years, 35–49 years, 50 – 64 years, and >65 years).

Results

Exploratory Factor Analysis

Examination of the model fit statistics suggested that a geomin rotated 3-factor model adequately fit the data (RMSEA = 0.01; CFI = 0.997; TLI = 0.994). A summary of this model is presented in Table 3. Rotated factor loadings and item content for each extracted factor were subsequently inspected for interpretability using a loading of 0.40 as a cut point for inclusion of an item on a given dimension. Factor 1 consists of 5 items describing disturbances in the childhood home environment such as family member substance use,

parental separation or divorce, and parental incarceration. As a result, this factor was labeled *Household Dysfunction*. Factor 2, labeled *Physical/Emotional Abuse*, consisted of 3 items assessing violent behavior and emotional abuse. Finally, the remaining 3 items, all pertaining to inappropriate childhood sexual experiences, loaded highly onto a *Sexual Abuse* factor. Examination of the interfactor correlations suggested that all three factors are moderately related to one another with coefficients ranging from 0.40 (*Household Dysfunction* and *Sexual Abuse*) to 0.56 (*Sexual Abuse* and *Physical/Emotional Abuse*) in magnitude.

Confirmatory Factor Analysis

Examination of the fit statistics and geomin rotated factor loadings shown in Figure 1 suggested adequate fit of the model to the data (RMSEA = 0.02; CFI = 0.99; TLI = 0.99). The previously described *Household Dysfunction*, *Physical/Emotional Abuse*, and *Sexual Abuse* domains informed by the EFA results were replicated in Sample 2. Moderate to high correlations were found among the 3 domains. This pattern of relatedness among the factors was consistent with the EFA results, further suggesting that a higher-order ACE factor may exist.

Factor Means and Reliabilities

Results for this analysis are presented in Table 4. Composite scores for each of the ACE scales were then computed for every participant in the sample by summing the responses for each of the items comprising the scale. Considering the magnitude of the correlations among the 3 factors in the CFA results, an *Overall ACE* score was also created for each participant by summing the responses of all of the ACE items. The means of the three subscale scores ranged from 0.21 (*Sexual Abuse*) to 0.77 (*Household Dysfunction*) with a mean of 1.61 for the *Overall ACE* score. Overall, the items comprising each of the scales were found to be related to one another with alphas ranging from 0.61 (*Household Dysfunction*) to 0.80 (*Sexual Abuse* and *Overall ACE*).

Measurement Invariance

A summary of the estimated fit statistics for all MGCFA models appears in Table 5. CFAs were conducted separately for males and females to establish a good fitting measurement model for each group. Factor loading patterns for both the male and female models (1 and 2) were consistent with those found in the 3 lower order factors emerging from the previous CFA model. Examination of the fit statistics suggested that the models for both males and females adequately fit the data, indicating that further invariance testing was appropriate. Next, configural invariance was established by estimating a model simultaneously including the ACE data for both genders with the item scale factors fixed to 1 and without parameter constraints on either the factor loadings or the item thresholds (Model 3). Results of this model suggest that the factor structure of the ACE module is the same for both men and women. Lastly, a model constraining both the factor loadings and item thresholds to be equivalent across groups with the scale factors fixed to 1 for males and unconstrained for females was estimated to investigate metric invariance. Comparing Model 4 with Model 3 indicated only trivial changes in the fit statistics as indicated by a change in RMSEA of

0.001 and no change in CFI or TLI from Model 3 to Model 4. Such small changes in these fit indices constitute metric equivalence across the groups (Chen, 2007; Cheung & Rensvold, 2002). Although the chi-square difference test is frequently used to facilitate comparisons among such models, it been shown to be sensitive to large sample sizes and therefore prone to reject the null (less constrained) model (Cheung & Rensvold, 2002). Chi-square statistics have been included among the fit indices in Table 5, however they were deemed to have little interpretive value for these analyses.

Having established that the BRFSS ACE module has the same factor structure and measurement scale across men and women, measurement invariance across age groups were then tested using the same statistical modeling procedure. Separate models (Models 1, 2, 3, and 4 in Table 5) for each of the 4 age groups (18–34 years, 35–49 years, 50–64 years, >65 years) were found to have similar factor loading patterns consistent with the 3 factors identified in the previous EFA and CFAs. Continuing the measurement invariance testing, a configural invariance model with the same constraints described above in the gender model was estimated and achieved adequate model fit (RMSEA = 0.016, CFI = 0.99, TFI = 0.99). Finally, a fully constrained model was estimated to investigate metric invariance. Similarly to the results found in the gender analyses, comparing Model 6 with Model 5 indicated no change in RMSEA, CFI, or TLI. As a result, both configural and metric invariance were established, indicating the factor structure and measurement scale are consistent across the 4 age groups. Therefore, correlational and mean comparisons between the BRFSS ACE module factors by age group and gender can be directly interpreted.

Discussion

The BRFSS ACE module was developed in response to the growing need to assess and further understand the prevalence and impact of child abuse and household environmental factors on public health outcomes in the United States. In the initial exploratory analysis, we sought to empirically determine the number of lower order scales that could be constructed from the BRFSS ACE module items. A confirmatory analysis followed to validate the initial factor structure of the BRFSS ACE module as well as to determine whether it may be appropriate to combine these lower order scales to create an overall composite score. Taken together, the results of these analyses suggest that (a) these items can be used to generate three composite scores estimating levels of exposure to *Household Dysfunction*, *Emotional/Physical Abuse*, and *Sexual Abuse*; (b) there is support that these three lower order factors effectively map onto a higher order general factor of child maltreatment, *Overall ACE*; and (c) measurement equivalence has been demonstrated across both age and gender.

Limitations

Our study—like many lines of child maltreatment research—relied exclusively on self-report data, with its obvious limitations. Childhood abuse and related injuries are often sensitive and potentially anxiety-provoking for a respondent to report. As a result, the individual's willingness to respond in a forthcoming manner is potentially influenced (Tourangeau & Yan, 2007). Also, respondents were asked to retrospectively report on their ACE exposure. Memory bias or other coping developed as a result of enduring abuse may

impact the accuracy of the individual's self-report (Edwards, Fivush, Anda, Felitti, & Nordenberg, 2001). In fact, longitudinal studies of adults who suffered documented adolescent abuse have shown that their retrospective reports of the abuse often underestimate the actual occurrence (Della Femina, Yeager, & Lewis, 1990; Williams, 1994).

The sample of items assessing the currently measured domains of adverse childhood experiences may be incomplete, omitting such areas as bullying and peer victimization, exposure to community violence, parental death, and childhood neglect. Other aspects, such as parental involvement, childhood socioeconomic status, the quality of peer relations, and the presence of disease as a child are also not presently included and thus cannot be evaluated as potential markers or buffers for ACEs.

Lastly, the current study only developed and investigated the internal structure of the inventory. Future research should continue to examine the predictive relationships of these ACE dimensions with important physical and mental health outcomes. However, most importantly, future studies should demonstrate the utility of these domain-specific scales in identifying protective processes that may help prevent ACEs altogether or foster resilience when ACEs do occur. Such research is fundamental to gaining insight into the effects and importance of safe, stable, nurturing familial and community relationships and environments on the promotion of healthy development throughout the life course.

Research Implications

Three composite scores—Traditionally, the limitations of the total ACE score outlined above have been addressed using frequency analysis or regression modeling to examine each item in the module individually. Understanding the relation between each of the ACE items—frequently referred to as ACE types—and deleterious outcomes in adulthood constitutes a necessary and worthwhile endeavor. Nevertheless, a researcher heeding the warnings of classical test theorists is mindful that such granular analysis comes with the potential for increased measurement error introduced by relying on a single item to assess what may in fact be a multifaceted construct (McDonald, 1999; Nunnally, 1978).

Fortunately, the three composite scores from our findings—*Household Dysfunction*, *Emotional/Physical Abuse*, and *Sexual Abuse*—offer a more psychometrically favorable avenue for conducting lower-level analyses in that they are more content specific, internally consistent, and also reflect exposure intensity. Further, composite scores are more stable than a single item score insofar as each item used in the scale accounts for only a portion of the total score. Thus, unless responses change for all the items that comprise the score, the likelihood of the score changing dramatically is less than when a single score is used to measure a particular aspect of ACEs. As a result, these more comprehensive measures of the ACE domains are ideal for use in quantitative ACE investigations by providing a better chance of obtaining more robust and reproducible analytic results compared to item level analysis.

Measurement invariance for gender and age—Substantiating measurement equivalence across groups such as age and gender is a frequently overlooked step. It is often

the case that group comparisons on measurement instruments are made without having checked whether such comparisons are appropriate. Considering that means and correlational-based research constitutes the most common type of ACE investigations, failure to know how a measure performs across groups of interest is not without consequence. Specifically, the researcher does not know with any degree of certainty whether his or her correlational findings or mean differences at the latent level reflects the true magnitude of the relationship among ACE domains and selected outcomes or the true differences in ACE exposure in the population. The researcher's findings are confounded by unknown amounts of measurement bias in the instrument. Testing for measurement equivalence across group serves to reduce the potential for this bias. Therefore, establishing the configural and metric invariance of the BRFSS ACE Module factors across gender and age groups was an important and necessary step toward demonstrating the measure's applicability to survey ACEs in the population in a more robust and less biased manner.

Also, this study tested for configural and metric invariance across age groups in an adult only population. However, it is worth noting that a similar set of 3 ACE domains obtained through factor analysis of a larger set of ACE items administered to a sample of children and adolescents has been previously reported (Scott, Burke, Weems, Hellman, & Carrión, 2013). This finding when coupled with the factor analytic results in our study suggest that the factor configuration of ACEs may be consistent across the entire developmental range.

Total ACE Score—Although we were unable to directly test the fit of a higher-order factor in our CFA model, the 3 lower order factors were found to be moderately intercorrelated with one another. Further, the 11 ACE items taken together as a set were found to have an acceptable degree of internal consistency. Together, these findings suggest that it is plausible that the ACE items may be totaled to represent an overall or global ACE score which is consistent with and lends support to the common practice of expressing ACE exposure as a single score (Anda, Butchart, Felitti, & Brown, 2010; Dong et al., 2004; Felitti et al., 1998). This score is frequently grouped into ranges representing intensity of ACE exposure and subsequently used to investigate the presence of dose-response patterns in poor mental and physical health outcomes, such as depression (Anda et al., 2002; Chapman et al., 2004; Edwards et al., 2003), substance abuse (Dube et al., 2006), and obesity (Williamson, Thompson, Anda, Dietz, & Felitti, 2002), as well as to estimate the general prevalence of ACE exposure (Bynum et al., 2010). Whereas our findings indicate that this is likely an appropriate and psychometrically reliable usage of the scale, it is important to recognize that such a score has limitations as well. Particularly, it may be prone to convey an overly simplified representation of respondents' childhood experiences both at the individual level and in the aggregate. The overall ACE score does not provide necessary details about the nature and context of the adverse childhood experiences encountered by the individual respondent or in the population at large. Therefore, we cannot discern what types of experiences are driving the magnitude of the overall ACE index; and we cannot understand important characteristics of early adverse experiences, such as chronicity, age of onset, and severity.

Clinical and Policy Implications

Adverse Childhood Experiences are common in the population (Anda, 2006). ACE prevalence studies and data from public health surveillance systems have consistently estimated that more than half of the U.S. population reports having experienced at least one ACE (Bynum et al., 2010; Felitti et al., 1998; Finkelhor et al., 1990). Data from the 2009 BRFSS suggest that approximately 8.7% or about 1 of 10 individuals report having experienced 5 or more ACEs (Bynum et al., 2010). Such significant exposure to ACEs in the population coupled with their profound and long term effects on health outcomes and general quality of life underscores the need for reliable measures of child abuse and household dysfunction.

Our results suggest that the BRFSS ACE Module represents an efficient and empirically derived way to assess household dysfunction, emotional and physical abuse, and sexual abuse for public health surveillance purposes. Public Health surveillance systems such as the BRFSS serve to actively and directly measure what is going on in a population (Thacker & Berkelman, 1988). Inclusion of reliable measures of ACE exposure on these data collection systems help to identify the prevalence of these experiences across a wide range of demographic, cultural, and socioeconomic groups. The ability to assess cross-sections of the population on a set specific ACE domains adds further granularity to the data, improving our ability to identify and monitor increases in exposure to specific ACE types which not only quantifies their occurrence, but also. Armed with this information, the need for interventions and the effect of interventions already in place can be evaluated in an empirical fashion (Nsubuga et al., 2006). Therefore, application of the an ACE measurement framework such the BRFSS ACE module helps to both reduce measurement error and improve the utility of the data which in turn allows policymakers to make better informed decisions.

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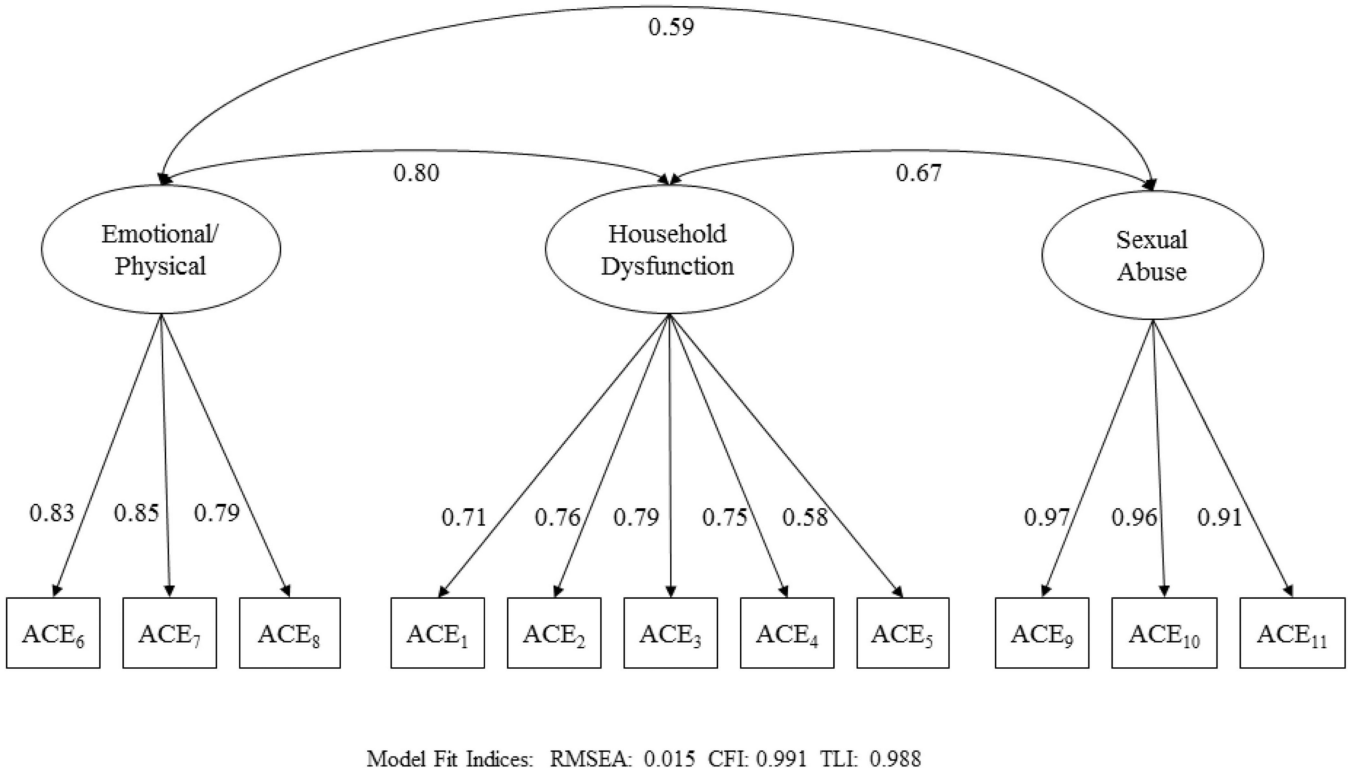

Figure 1.
Diagram of the confirmatory three-factor model.

Table 1

Behavioral Risk Factor Surveillance System Adverse Childhood Experiences Module Items

Item	Content	ACE type
Looking back before you were 18 years of age …		
1	Did you live with anyone who was depressed, mentally ill, or suicidal?	Household mental illness
2	Did you live with anyone who was a problem drinker or alcoholic?	Household alcohol abuse
3	Did you live with anyone who used illegal street drugs or who abused prescription medications?	Household substance abuse
4	Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Incarcerated family member
5	Were your parents separated or divorced?	Parental separation/divorce
6	How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up?	Household physical violence
7	Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way?	Physical abuse
8	How often did a parent or adult in your home ever swear at you, insult you, or put you down?	Emotional abuse
9	How often did anyone at least 5 years older than you or an adult ever touch you sexually?	Sexual abuse
10	How often did anyone at least 5 years older than you or an adult try to make you touch them sexually?	Sexual abuse
11	How often did anyone at least 5 years older than you or an adult force you to have sex?	Sexual abuse

Table 2

Tetrachoric Correlations Among the 11 Items of the 2010 BRFSS ACE Module

Item	1	2	3	4	5	6	7	8	9	10	11
1	—										
2	0.48	—									
3	0.56	0.56	—								
4	0.39	0.51	0.70	—							
5	0.34	0.43	0.41	0.44	—						
6	0.44	0.59	0.45	0.46	0.48	—					
7	0.48	0.45	0.43	0.37	0.35	0.68	—				
8	0.51	0.48	0.44	0.36	0.34	0.60	0.73	—			
9	0.43	0.38	0.37	0.33	0.30	0.40	0.47	0.44	—		
10	0.42	0.37	0.39	0.34	0.31	0.40	0.47	0.43	0.92	—	
11	0.43	0.39	0.41	0.37	0.33	0.43	0.52	0.46	0.88	0.86	—

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Table 3

Geomin Rotated Factor Loadings and Factor Inter-Correlations From the EFA of the 2009 BRFSS ACE Data

Item	Household dysfunction	Emotional/physical abuse	Sexual abuse
1	**0.41**	0.28	0.07
2	**0.62**	0.27	−0.08
3	**0.84**	0.00	0.06
4	**0.86**	−0.07	0.02
5	**0.54**	0.07	0.00
6	0.33	**0.57**	−0.01
7	−0.01	**0.93**	0.01
8	0.11	**0.76**	0.02
9	0.03	0.01	**0.95**
10	0.04	−0.01	**0.97**
11	−0.02	0.13	**0.85**
Factor Inter-correlations			
Household dysfunction	—		
Emotional/physical abuse	0.52	—	
Sexual abuse	0.40	0.56	—
Model fit indices: RMSEA, 0.012; CFI, 0.997; TLI, 0.994			

* Factor loadings greater than 0.40 appear in bold.

Table 4

Range of Descriptive Statistics and Internal Consistency of Responses for Each of the Composite Scores of the 2010 BRFSS ACE Module

Scale name	# Items	Scale mean	Scale *SD*	Range of mean item score	Range of item *SD*	Range of $r_{item\text{-}total}$	Cronbach's α
Household dysfunction	5	0.77	1.12	0.04–0.24	0.20–0.42	0.58–0.68	0.61
Emotional/physical abuse	3	0.67	0.94	0.15–0.34	0.36–0.47	0.76–0.80	0.70
Sexual abuse	3	0.21	0.64	0.04–0.11	0.20–0.31	0.62–0.79	0.80
Overall ACE	11	1.61	2.07	0.04–0.34	0.20–0.47	0.45–0.61	0.78

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Table 5

Summary of Fit Statistics of Measurement Invariance Models Across Gender and Age

Model description	Comparison	χ^2	*df*	Δ*p*	CFI	TLI	RMSEA	RMSEA 90% CI
Gender								
1. Men	—	162.30	41	—	0.99	0.99	0.011	0.010, 0.013
2. Women	—	471.75	41	—	0.99	0.99	0.017	0.016, 0.019
3. Configural invariance	—	605.13	82	—	0.99	0.99	0.015	0.014, 0.016
4. Strict invariance	4 to 3	603.82	87	0.00	0.99	0.99	0.014	0.013, 0.016
Age								
1. 18–34 years	—	122.77	41	—	0.99	0.99	0.018	0.015, 0.022
2. 35–49 years	—	212.27	41	—	0.99	0.99	0.018	0.016, 0.021
3. 50–64 years	—	299.14	41	—	0.99	0.98	0.018	0.016, 0.020
4. 65 years or older	—	145.47	41	—	0.99	0.98	0.012	0.010, 0.014
5. Configural invariance	—	776.47	164	—	0.99	0.99	0.016	0.015, 0.017
6. Strict invariance	6 to 5	829.93	179	0.00	0.99	0.99	0.016	0.015, 0.017

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