



Research article

Using latent class analysis to empirically classify maltreatment according to the developmental timing, duration, and co-occurrence of abuse types

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ABSTRACT

Background: Individuals can have vastly different maltreatment experiences depending on the types, developmental timing, and duration of abuse. Women and men may be differentially affected by distinct abuse patterns.

Objective: To examine whether maltreatment subgroups could be identified based on the types, developmental timing, and duration of abuse, and to determine their prevalence among a large, community-based sample. We also examined sex differences in associations of maltreatment subgroups with adverse health outcomes.

Participants and Setting: Data came from 9310 women and men (95 % White) in the United States who responded to the Growing Up Today Study questionnaire in 2007 (aged 19–27 years).

Methods: Participants reported on physical, sexual, and emotional abuse occurring in childhood (before age 11 years) and adolescence (ages 11–17 years). We conducted latent class (LC) analyses using indicators for child and adolescent abuse. We examined associations of LCs with health outcomes using sex-stratified log-binomial models with generalized estimated equations.

Results: We identified five LCs characterized by: 1) no/low abuse (59 %), 2) child physical abuse (16 %), 3) adolescent emotional abuse (9%), 4) child and adolescent physical and emotional abuse (16 %), and 5) child and adolescent sexual abuse (1%). LCs were uniquely associated adult health outcomes among both women and men. Associations of LCs with eating disorder behaviors appeared stronger for men than women.

Conclusions: Individuals experience distinct patterns of maltreatment based on the types, developmental timing, and duration of abuse. These patterns are uniquely associated with adverse health outcomes in adulthood, and can be identified using LCA.

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1. Introduction

One in four children in the U.S. is estimated to experience maltreatment (Finkelhor, Turner, Shattuck, & Hamby, 2013), which includes physical, sexual, and emotional abuse, and more than 3.5 million children in the U.S. are referred to Child Protective Services for abuse or neglect each year (U.S. Department of Health & Human Services, 2020). Individuals can have vastly different maltreatment experiences depending on the combination of abuse types (Finkelhor, Ormrod, & Turner, 2007; Lau et al., 2005), as well as the developmental timing and duration of abuses (Manly, Kim, Rogosch, & Cicchetti, 2001; Thornberry, Ireland, & Smith, 2001). Since the types, developmental timing, and duration of abuse each may affect risk of adverse health outcomes (Manly et al., 2001), the heterogeneity of maltreatment experiences makes it challenging to study its effects. In order to fully apprehend the harmful consequences due to maltreatment, as well as to effectively treat and prevent maltreatment at the population level, a refined understanding of how abuse tends to cluster in the general population based on the types, developmental timing, and duration of abuse is needed. There is currently no such classification.

Researchers have taken different classification approaches to address the complex nature of maltreatment, but previous solutions still do not sufficiently address the issue. Because abuse co-occurrence is common (Felitti et al., 1998; Finkelhor et al., 2007; Lau et al., 2005; Noonan et al., 2010), one frequent classification approach is to use a “sum score”, in which the total number of abuses experienced is used as a predictor (Felitti et al., 1998; Finkelhor et al., 2007; Williamson, Thompson, Anda, Dietz, & Felitti, 2002). The main limitation to this strategy is that people can receive the same sum score but have experienced different abuse combinations and thus have disparate levels of risk. Another classification approach is to compare those who have experienced any abuse, regardless of type, to those who have not experienced any abuse (Kaplow & Widom, 2007). This approach similarly categorizes together people who may have vastly different maltreatment experiences. Another classification strategy is to include different abuse types as separate variables into the same statistical model (A.E. Duncan et al., 2015; Mason et al., 2015). However, using this approach, individual effect estimates represent the risk among individuals who experienced the specific abuse type, but not the other types, and there is strong potential for multicollinearity since individual abuse types frequently co-occur and are highly correlated (Vatcheva, Lee, McCormick, & Rahbar, 2016). Moreover, it is difficult to include and interpret all possible abuse interactions when examining numerous abuse types.

An additional limitation to previous maltreatment classifications is that abuse timing and duration are usually not considered. Experiencing abuse during sensitive developmental periods as well as abuse sustained over multiple developmental periods may put individuals at especially high risk for adverse consequences (Jaffee & Maikovich-Fong, 2011; Halfon & Hochstein, 2002; Warmingham, Handley, Rogosch, Manly, & Cicchetti, 2019). Studies have used various age cutoffs to determine what age range constitutes “childhood” maltreatment. For example, studies have categorized “childhood” maltreatment as that occurring before ages 11, 16, or 18 years (A.E. Duncan et al., 2015; Mason et al., 2015; Williamson et al., 2002). These broad age ranges span different developmental and potentially sensitive periods, making it difficult to compare results.

One statistical method that could account for the types, timing, and duration of abuse to classify maltreatment is latent class analysis (LCA). This statistical approach (under the broader category of finite mixture modeling) identifies naturalistic subgroupings of individuals in a population based on their responses to observed variables (Oberski, 2016). LCA is commonly used in psychiatric nosology research to identify subgroupings of people with similar psychiatric symptom patterns (A. E. Duncan et al., 2007; Swanson et al., 2014), and has been increasingly used to examine the co-occurrence of social and environmental exposures (Roesch, Villodas, & Villodas, 2010; Shevlin & Elklit, 2008). There is growing support that, in order to best examine the effects due to complex patterns of abuse, the unit of analysis should be the individual, rather than the separate abuse variables themselves (Roesch et al., 2010; Shevlin & Elklit, 2008; Warmingham et al., 2019). This approach is referred to as being “person-centered,” rather than “variable-centered,” and can be accomplished using LCA (Roesch et al., 2010). Several studies have illustrated the utility of LCA to identify maltreatment subgroups characterized by unique patterns of abuse co-occurrence (Rivera, Fincham, & Bray, 2018). Yet this approach is still not widely employed, and to our knowledge, no previous studies have accounted for the specific developmental periods for each type of abuse.

The main objective of this study was to examine if maltreatment subgroups could be identified based on the types, developmental timing, and duration of abuse using LCA, and to determine the prevalence of resulting maltreatment subgroups in a large, community-based sample of young adult women and men. Since previous research has demonstrated that individuals who experience maltreatment have elevated risks of developing a wide range of adverse health outcomes (Gilbert et al., 2009), we hypothesized that maltreatment subgroups characterized by distinct patterns of abuse would be uniquely associated with a several health indicators. Therefore, to assess the validity of the identified maltreatment subgroups, we examined their associations with several adverse health outcomes as a secondary aim of this study. Because the prevalence of maltreatment types and adult health outcomes varies by sex, and also because associations of maltreatment with health outcomes may be different for women and men (Afifi et al., 2017; Hyman, Garcia, & Sinha, 2006; Sacks et al., 2017), we examined sex differences in these associations.

2. Methods

2.1. Sample

The Growing Up Today Study (GUTS), an ongoing cohort study in the United States, was established in 1996 when participants were aged 8–15 years. All participants were children of women in the Nurses’ Health Study II (NHSII), a large cohort study of over 100,000 nurses across the United States followed since 1989 (A. E. Field, Manson, Taylor, Willett, & Colditz, 2004). In 1996, women

in the NHSII (then ages 25–43 years) who had children in the appropriate age range were asked for consent for their children to be invited to participate in GUTS. Children were mailed invitation letters; 9033 girls and 7843 boys agreed to participate. There have been 14 data collection waves between 1996–2016. Only the 2007 questionnaire contained questions about maltreatment. Our analytic sample was limited to those who completed the 2007 questionnaire (6168 women, 3698 men), who responded to at least one question on maltreatment (5928 women [96 % from 2007 survey], 3437 men [93 % from 2007 survey]), and who had complete information on demographic variables, for a final analytic sample size of 5905 women and 3405 men. Comparing women and men who were and were not included in this final analytic sample, there were minimal differences in the distributions of age, race/ethnicity, maternal age at birth of the participant, baseline (1996) overweight/obesity, or baseline report of ever getting drunk. There were modest differences in baseline eating disorder behavior prevalence among men who were and were not included. Women who were not included in the sample had a higher prevalence of eating disorder behaviors at baseline compared with women who were included (3.6 % vs. 2.6 %; $p = .005$). Depressive symptoms and drug use (two health outcomes we assessed in the present study) were not assessed in the baseline survey.

The Human Subjects Committee at Brigham and Women's Hospital approved the GUTS project and analyses.

2.2. Measurements

All information on maltreatment and health outcomes came from the 2007 questionnaire, which was the first year that all participants were at least 18 years of age (participants were aged 19–27 years).

2.2.1. Child and adolescent maltreatment

Participants reported on physical, sexual, and emotional abuse occurring during *childhood (before age 11 years)* and *adolescence (ages 11–17 years)*. Physical abuse was assessed using items from the Conflict Tactic Scales (Straus, Hamby, Boney-McCoy, & Sugarman, 1996). Participants reported the frequency with which an adult in the family: pushed, grabbed, or shoved them; kicked, punched, or hit them with something in a way that hurt, or physically attacked them in another way; and hit them so hard it left bruises or marks. We dichotomized physical abuse as none, or any form of physical abuse occurring at least once. Emotional abuse was measured with three items from the Childhood Trauma Questionnaire (Bernstein et al., 1994). Participants reported how often, on a five-point Likert scale from never to very often, an adult in their family: yelled and screamed at them; said hurtful or insulting things to them; and punished them in a way that seemed cruel. Likert scores were summed and emotional abuse was dichotomized as not reporting high emotional abuse levels (below 75th percentile), and reporting high emotional abuse levels (75th percentile and greater). This cut-off has been used in GUTS previously to reflect the prevalence of moderate/severe emotional abuse (Mason et al., 2015). Questions from the Sexual Experiences Survey assessed sexual abuse (Koss & Gidycz, 1985). Participants reported whether and how often 1) they had ever been touched by or been forced to touch an adult or older child in a sexual way when they did not want to, and 2) an adult or older child had ever forced or attempted to force them into any sexual activity by “threatening you, holding you down, or hurting you in some way when you did not want to?”. Those who endorsed any sexual touching and/or forced sexual activity were categorized as experiencing sexual abuse.

2.2.2. Health outcomes

Participants self-reported their height and weight. Body mass index (BMI) was calculated as weight in kilograms divided by height in squared meters. Participants with a BMI ≥ 25 kg/m² were considered to have overweight/obesity. BMI measurements based on self-reported height and weight are highly correlated with, although tend to slightly underestimate, true BMI (Goodman, Hinden, & Khandelwal, 2000; Stommel & Schoenborn, 2009).

Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CESD-10) (Radloff, 1991). Consistent with previous GUTS investigations (A.E. Field et al., 2012), participants in the top decile were considered to have high depressive symptoms.

Participants reported how many times over the past year they drank four (women) or five (men) or more alcoholic drinks over a few hours. Women and men who endorsed drinking four or five alcoholic drinks over a few hours, respectively, 12 or more times in the past year (averaging 1 time per month) were categorized as binge drinking.

Participants reported whether they had used cocaine, heroin, ecstasy, GHB, LSD, other hallucinogens, crystal meth, or other amphetamines in the past year. Participants also reported whether they had ever used prescription drugs (tranquilizers, pain killers, sleeping pills, Ritalin, and Adderall) without a prescription. Those who reported they used illicit drugs or used prescription drugs without a prescription categorized as using drugs.

Eating disorder behaviors occurring in the past 12 months were assessed using validated questions on binge eating episodes and purging (A.E. Field, Taylor, Celio, & Colditz, 2004). Participants who endorsed both eating a very large amount of food and feeling out of control while overeating met criteria for binge eating. Purging was defined as using vomiting or laxatives to keep from gaining weight in the past year. Participants who reported binge eating and/or purging at least monthly were categorized as engaging in eating disorder behaviors.

2.2.3. Covariates

Participants self-reported their race in 1996. Because the cohort is > 90 % White, participants were classified as either White or non-White. In 2001, mothers in the NHSII reported their past-year household income. We categorized household income as < \$100,000, \geq \$100,000, or missing. Mother's age in years at the birth of her GUTS child was included as a continuous variable.

2.3. Statistical analysis

We conducted a series of latent class (LC) analyses in MPlus version 8 (Muthén & Muthén, 2007) that included indicator variables for child physical abuse, child sexual abuse, child emotional abuse, adolescent physical abuse, adolescent sexual abuse, and adolescent emotional abuse. Participants missing on some but not all indicator variables contributed to the model under a missing at random assumption (Muthén & Muthén, 2007). We fit models with increasing numbers of classes, starting with a 2-class solution. To guide our selection of the optimal solution, we used model fit statistics from the sample size adjusted Bayesian Information Criterion (SS-BIC), Akaike Information Criterion (AIC), entropy value, and adjusted Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (VLMRT). Lower SS-BIC and AIC values indicate better model fits. Entropy values can range from 0 to 1, with values closer to 1 indicating better separation of classes (Celeux & Soromenho, 1996). A VLMRT p-value < 0.05 indicates that the current model is better fitting than a model with one less class. Lastly, we decided a priori that each class needed to contain at least 1 % of the sample to have sufficient stability for interpretation. Individuals were assigned to the maltreatment group they had the highest probability of membership in.

We first conducted LCAs separately among women and men. We observed that the identified maltreatment groups appeared very similar among each sex. As such, we then conducted LCAs among the total sample of women and men combined. The underlying LCs among the total sample appeared to be equivalent to those among women and men when LCAs were conducted separately by sex, as presented in sensitivity analyses below. We thus decided to conduct LCAs among the total sample of women and men combined for our main analysis. This approach also ensured that the exposure groups were equivalent across sex, which allowed us to directly compare results predicting health outcomes for women and men when stratified.

We examined associations of maltreatment LCs (identified from the total sample of women and men combined) with adverse health outcomes using log-binomial models to estimate prevalence ratios (PR) and 95 % confidence intervals (Barros & Hirakata, 2003). We used generalized estimating equations (SAS version 9.4, proc gendmod) and specified an exchangeable working correlation and empirical (robust) standard errors to account for non-independence due to sibling clusters (607 women and 329 men had at least one same-sex sibling in the sample). We stratified all analyses of maltreatment LCs with health outcomes by sex. Models adjusted for age, race, family household income, and maternal age at the participant's birth. Sample sizes varied slightly by health outcome; 1.5 %, 0.0 %, 8.3 %, 3.6 %, and 2.4 % of the analytic sample was missing data on overweight/obesity, depressive symptoms, drug use, binge drinking, and eating disorder behaviors, respectively. Since all of our analyses were hypothesis-driven (i.e., we hypothesized that maltreatment groups characterized by abuse would be associated with a range of adverse health outcomes), rather than exploratory, we did not adjust for multiple comparisons (Rothman, 1990; Savitz & Olshan, 1995). We conducted sensitivity analyses that limited our sample to individuals who had at least an 80 % probability of belonging to a LC.

Table 1

Demographic, health, and abuse characteristics of 9310 women and men in the analytic sample.

	Total (n = 9310), n (%) or mean (sd)	Women (n = 5905), n (%) or mean (sd)	Men (n = 3405), n (%) or mean (sd)	P ^a
Age (years)	22.8 (1.7)	22.7 (1.7)	23.0 (1.7)	< .001
White race	8818 (94.7)	5582 (94.5)	3236 (95.0)	.293
Household income				.102
< \$100,000	4435 (47.6)	2809 (47.6)	1626 (47.8)	
≥ \$100,000	3220 (34.6)	2011 (34.1)	1209 (35.5)	
Missing	1655 (17.8)	1085 (18.4)	570 (16.7)	
Maternal age at participant's birth (years)	29.5 (3.5)	29.4 (3.5)	29.5 (3.5)	.200
Overweight/obesity	3178 (34.7)	1684 (28.8)	1494 (45.1)	< .001
High depressive symptoms	899 (9.7)	615 (10.4)	284 (8.3)	< .001
Binge drinking	2672 (29.8)	1476 (25.8)	1196 (36.8)	< .001
Drug use	2798 (31.7)	1659 (30.4)	1049 (34.0)	.001
Eating disorder behaviors	629 (6.9)	557 (9.6)	72 (2.2)	< .001
Child Abuse (before age 11 years)				
Physical	2897 (32.0)	1695 (29.5)	1202 (36.4)	< .001
Sexual	642 (7.1)	511 (8.9)	131 (4.0)	< .001
Emotional	2122 (23.5)	1400 (24.4)	722 (21.9)	.007
Adolescent abuse (ages 11 – 17 years)				
Physical	2121 (23.4)	1228 (21.3)	893 (27.0)	< .001
Sexual	574 (6.4)	514 (9.0)	60 (1.8)	< .001
Emotional	2376 (26.0)	1638 (28.3)	738 (22.2)	< .001
Child/adolescent abuse (before age 18 years)				
Physical	3377 (37.7)	1967 (34.5)	1410 (43.3)	< .001
Sexual	1068 (11.9)	892 (15.5)	176 (5.4)	< .001
Emotional	2938 (32.6)	1965 (34.2)	973 (29.8)	< .001

^a Comparing men to women.

Table 2
The prevalence of reporting additional abuse types among individuals who reported each abuse.^a

Number of other abuse types reported	Child Physical Abuse, (n = 2758), n (%)	Child Sexual Abuse, (n = 581), n (%)	Child Emotional Abuse, (n = 2029), n (%)	Adolescent Physical Abuse, (n = 1981), n (%)	Adolescent Sexual Abuse, (n = 536), n (%)	Adolescent Emotional Abuse, (n = 2232), n (%)
0	546 (19.8)	180 (31.0)	116 (5.7)	161 (8.1)	154 (28.7)	247 (11.1)
1	635 (23.0)	97 (16.7)	445 (21.9)	434 (21.9)	93 (17.4)	454 (20.4)
2	534 (19.4)	92 (15.8)	447 (22.0)	372 (18.8)	80 (14.9)	479 (21.5)
3	833 (30.2)	74 (12.7)	814 (40.1)	806 (40.7)	75 (14.0)	842 (37.7)
4	168 (6.1)	96 (16.5)	165 (8.1)	166 (8.4)	92 (17.2)	168 (7.5)
5	42 (1.5)	42 (7.2)	42 (2.0)	42 (2.1)	42 (7.8)	42 (1.9)

^a The information presented in this table was limited to individuals who had complete information on all abuse types (n = 8599).

Table 3

Fit indices for latent class solutions among the total sample of women and men.

	SS-BIC	AIC	VLMRT	Entropy	Log likelihood
2 class	41908.5	41857.0	< .001	.828	−20915.5
3 class	41436.6	41357.4	< .001	.757	−20658.7
4 class	40982.4	40875.5	< .001	.921	−20410.7
5 class	40892.2	40757.5	< .001	.931	−20344.7
6 class	40876.4	40714.0	0.010	.925	−20316.0
7 class	40890.8	40700.6	0.139	.920	−20302.3

Abbreviations: AIC, Akaike information criteria; SS-BIC, sample-size adjusted Bayesian information criteria; VLMRT, Vuong-Lo-Mendell-Rubin adjusted likelihood test.

3. Results

The sample was majority White (95 %), and the mean age was 22.8 years in 2007 (Table 1). The prevalence of abuses and health outcomes differed substantially by sex. Each maltreatment type was correlated with each other type (minimum correlation between child physical abuse and adolescent sexual abuse [0.07], maximum correlation between child emotional abuse and adolescent emotional abuse [0.63]). The majority of individuals who experienced any abuse type also experienced at least one other abuse type, and the likelihood of experiencing multiple forms of abuse varied by abuse type (Table 2).

Among the total sample of women and men combined, we found support that a 5-class model was the best fitting LC solution (Table 3). Although the 6-class solution had the lowest SS-BIC and AIC values, two classes contained less than 1 % of the overall sample. The 5-class model had SS-BIC and AIC values that were very close to the 6-class model (and were the second lowest overall). A VLMRT value < 0.05 indicated that the 5 class solution was a better fit than the 4 class solution. The 5-class model had the highest entropy value (0.931) and was close to 1, indicating excellent class separation (Celeux & Soromenho, 1996).

The five identified maltreatment latent classes can be characterized as follows (Fig. 1): LC1 (“no/low abuse”; 59 %), very low probability of any abuse in both childhood and adolescence; LC2 (“child physical abuse”; 16 %), high probability of child physical abuse, and medium probabilities of child emotional abuse and adolescent physical abuse; LC3 (“adolescent emotional abuse”; 9%), high probability of adolescent emotional abuse, and medium probability of childhood emotional abuse; LC4 (“child and adolescent physical and emotional abuse”; 16 %), high probability of physical and emotional abuse in both childhood and adolescence; LC5 (“child and adolescent sexual abuse”; 1%), high probability of child sexual abuse and adolescent sexual abuse, and medium probability of physical and emotional abuse in both childhood and adolescence.

The prevalence of LC1 (“no/low abuse”) and LC4 (“child and adolescent physical and emotional abuse”) was similar among women and men (Table 4). A higher proportion of men were in LC2 (“child physical abuse”) compared with women. A higher proportion of women were in LC3 (“adolescent emotional abuse”) and LC5 (“child and adolescent sexual abuse”) compared with men.

When we conducted LCAs among women and men separately, we found evidence that 5-class and 4-class models were the best fitting LC solutions, respectively (Supplemental Table 1). Among women, although the 6-class model had the lowest SS-BIC value, two LCs contained 1% of the sample, and the 5-class model had the highest entropy value. Among men, although the 5-class model had the lowest SS-BIC value, one LC contained 1 % of the sample, and the 4-class model had a higher entropy value (and the second highest entropy value overall after the 3-class model, which had a substantially higher SS-BIC value). The five latent classes identified among women separately were very similar to those of LCs 1 through 5 in our main analysis (Supplemental Fig. 1), and the four latent classes identified among men separately were very similar to those of LCs 1 through 4 in our main analysis (Supplemental Fig. 2). As such, these sensitivity analyses provide evidence that the five latent classes observed in the main analysis (derived using the total sample of women and men combined) represent natural maltreatment subgroupings found among both women and men, and that the

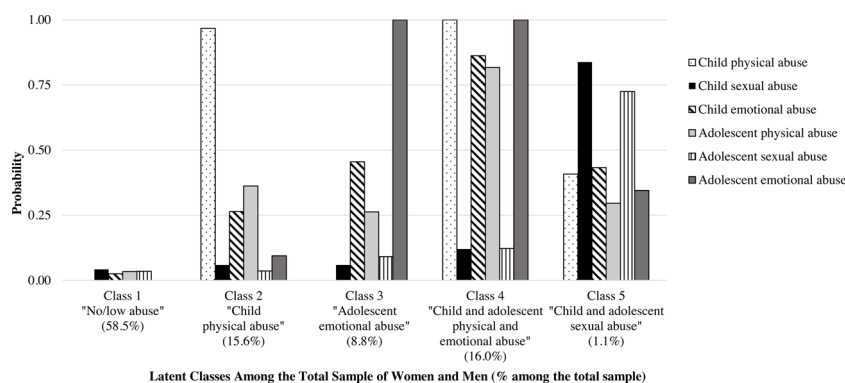


Fig. 1. Probability of reported abuses among each latent class in the best fitting 5-class solution conducted among the total sample of women and men.

Table 4
Prevalence of maltreatment latent classes among the total sample and by sex.

	Total, (n = 9310), n (%)	Women, (n = 5905), n (%)	Men, (n = 3405), n (%)	P ^a
Maltreatment latent class				< .001
LC1: "No/low abuse"	5446 (58.5)	3483 (59.0)	1963 (57.6)	
LC2: "Child physical abuse"	1454 (15.6)	748 (12.7)	706 (20.7)	
LC3: "Adolescent emotional abuse"	820 (8.8)	614 (10.4)	206 (6.1)	
LC4: "Child and adolescent physical and emotional abuse"	1492 (16.0)	974 (16.5)	518 (15.2)	
LC5: "Child and adolescent sexual abuse"	98 (1.1)	86 (1.5)	12 (0.4)	

^a Comparing men to women.

LCs from the main analysis were not driven primarily by maltreatment experiences among one sex.

When examining associations of maltreatment LCs with adverse health outcomes, we excluded men in LC5 "child and adolescent sexual abuse" since there were too few men in this group to draw meaningful inference ($n = 12$). Among both women and men, LCs characterized by abuse had greater prevalence of adverse health outcomes compared with those in LC1 ("no/low abuse") (Table 5). Among women, compared with those in LC1 ("no/low abuse"), women in LC3 ("adolescent emotional abuse"), LC4 ("child and adolescent physical and emotional abuse"), and LC5 ("child and adolescent sexual abuse") had greater prevalence of overweight/obesity (prevalence ratios [PRs] ranged 1.27–1.39), high depressive symptoms (PRs ranged 2.15–2.87), using drugs (PRs ranged 1.64–2.37), binge drinking (PRs ranged 1.16–1.25), and eating disorder symptoms (PRs ranged 1.66–2.37). Among men, compared with those in LC1 ("no/low abuse"), men in LC3 ("adolescent emotional abuse") and LC4 ("child and adolescent physical and emotional abuse") had greater prevalence of overweight/obesity (PRs ranged 1.16–1.20), high depressive symptoms (PRs ranged 2.23–2.84), using drugs (PRs ranged 1.49–1.75), and eating disorder behaviors (PRs ranged 2.86–4.21). LCs did not tend to predict binge drinking for men. Among both women and men, LC2 ("child physical abuse") was more weakly associated with all adverse health outcomes compared with other LCs characterized by abuse.

Associations of maltreatment LCs with overweight/obesity, high depressive symptoms, and drug use appeared fairly similar for women and men (although some slight differences existed). Associations of maltreatment LCs with binge drinking appeared slightly stronger for women than for men for LC3 ("adolescent emotional abuse") (PRs 1.23 for women vs. 1.09 for men) and LC4 ("child and adolescent physical and emotional abuse") (PRs 1.16 for women vs. 1.08 for men). Associations of maltreatment LCs with eating disorder behaviors appeared stronger for men than for women for LC3 ("adolescent emotional abuse") (PRs 2.86 for men vs. 1.66 for women) and LC4 ("child and adolescent physical and emotional abuse") (PRs 4.21 for men vs. 2.10 for women).

When we limited our sample to include only individuals who had at least 80 % probability of a class membership, effect estimates were highly similar in magnitude and direction for all health outcomes among both women and men (Supplemental Table 2).

4. Discussion

The present study adds to the growing literature that supports using a person-centered approach to examine the consequences due to complex patterns of maltreatment (Rivera et al., 2018; Roesch et al., 2010). Previous research has identified great heterogeneity in individuals' maltreatment experiences based on the types, developmental timing, and duration of abuse, and each of these factors may affect risk for health outcomes (Manly et al., 2001; Warmingham et al., 2019). While some studies have used LCA to capture the co-occurrence of abuse types, and two of these studies (to our knowledge) have included a variable in their analyses to indicate the number of developmental periods abuse was experienced (Havlicek, 2014; Warmingham et al., 2019), our study is the first to include specific indicators for child and adolescent physical, sexual, and emotional abuse using LCA. We identified five maltreatment subgroups characterized primarily by: 1) no/low abuse (58.5 %); 2) child physical abuse (15.6 %); 3) adolescent emotional abuse (8.8 %); 4) child and adolescent physical and emotional abuse (16.0 %), and; 5) child and adolescent sexual abuse (1.1 %). The importance of considering the developmental timing of maltreatment in classifications is highlighted by the fact that two classes were characterized by a high probability of abuse in only one developmental period, whereas two classes were marked by high probability of abuse sustained throughout childhood and adolescence.

As hypothesized, maltreatment LCs were uniquely associated with a range of adverse health indicators among both women and men, suggesting that the identified classes are indeed valid and may capture varying levels of risk associated with different patterns of abuse. The strongest effect estimates were generally seen for classes characterized by abuse sustained across both childhood and adolescence. Strong effect estimates were also observed for LC3 ("adolescent emotional abuse") among both women and men. The consequences due to emotional abuse have been studied less than those due to sexual or physical abuse. Our results suggest that emotional abuse is likely to co-occur with other forms of abuse, and that even if it is the predominant form of abuse, it is associated with a range of adverse health outcomes. Furthermore, our findings suggest that different patterns of maltreatment may be uniquely associated with some health outcomes for women and men. We found that associations of maltreatment LCs with eating disorder behaviors were particularly strong for men in LC4 "child and adolescent physical and emotional abuse."

Our study has several implications. First, over 40 % of individuals in this large community-based sample were assigned to a maltreatment LC characterized by abuse, which were associated with numerous adverse health outcomes in adulthood. This highlights the fact that maltreatment is widespread and that, if maltreatment indeed causes these health outcomes, preventing maltreatment has the potential to substantially decrease the prevalence of such outcomes at the population-level. Second, the majority of

Table 5Prevalence ratios (PR) and 95 % confidence intervals (CI) from log-binomial models^a using generalized estimating equations predicting adverse adult health outcomes among women and men.

	Overweight/obesity, PR (95 % CI)	High depressive symptoms, PR (95 % CI)	Drug use, PR (95 % CI)	Binge drinking, PR (95 % CI)	Eating disorder behaviors, PR (95 % CI)
Women					
Maltreatment latent class					
LC1: "No/Low probability of abuse"	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
LC2: "Child physical abuse"	1.14 (1.00, 1.28)	1.33 (1.03, 1.71)	1.21 (1.06, 1.37)	1.02 (0.89, 1.17)	1.28 (0.99, 1.65)
LC3: "Adolescent emotional abuse"	1.27 (1.12, 1.44)	2.15 (1.72, 2.68)	1.64 (1.47, 1.84)	1.25 (1.10, 1.43)	1.66 (1.30, 2.12)
LC4: "Child and adolescent physical and emotional abuse"	1.36 (1.22, 1.50)	2.87 (2.41, 3.41)	1.66 (1.50, 1.83)	1.16 (1.03, 1.30)	2.10 (1.73, 2.54)
LC5: "Child and adolescent sexual abuse"	1.39 (1.05, 1.84)	2.13 (1.27, 3.58)	2.37 (1.97, 2.86)	1.20 (0.86, 1.69)	2.37 (1.46, 3.85)
Men					
Maltreatment latent class					
LC1: "No/Low probability of abuse"	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
LC2: "Child physical abuse"	1.06 (0.97, 1.17)	1.16 (0.84, 1.60)	1.03 (0.90, 1.18)	1.09 (0.97, 1.22)	1.22 (0.61, 2.44)
LC3: "Adolescent emotional abuse"	1.20 (1.04, 1.39)	2.23 (1.52, 3.28)	1.75 (1.51, 2.03)	1.09 (0.90, 1.32)	2.86 (1.30, 6.31)
LC4: "Child and adolescent physical and emotional abuse"	1.16 (1.05, 1.28)	2.84 (2.19, 3.67)	1.49 (1.32, 1.68)	1.08 (0.95, 1.22)	4.21 (2.50, 7.09)
LC5: "Child and adolescent sexual abuse"	—	—	—	—	—

^a Models adjusted for age, race, household income, and maternal age at the participant's birth, and accounted for non-independence due to sibling sets.

individuals who reported abuse reported multiple forms. Our findings suggest that if any abuse type is identified in children or adolescents, it is likely that they have also either previously experienced, currently experience, or are at risk of experiencing additional forms of abuse. Children and adolescents who report abuse should thus be screened for additional abuse types in order to effectively treat all abuse types and prevent future maltreatment. Third, maltreatment LCs that were characterized by abuse sustained across childhood and adolescence were common (17 % of the overall sample), and these maltreatment LCs tended to have the strongest associations with health indicators. Early detection of maltreatment in childhood may help to prevent maltreatment in adolescence, which may disrupt an individual's patterning of maltreatment and thus their risk of negative health sequelae.

There are some limitations to this study. First, maltreatment was self-reported. However, self-reported maltreatment measures have been found to be reliable even among people reporting far into adulthood (over age 65 years) (Dube, Williamson, Thompson, Felitti, & Anda, 2004). Moreover, obtaining information on maltreatment from other sources (namely court records or parents) is likely to result in under-ascertainment because the majority of maltreatment cases are never officially reported (Sedlak & Broadhurst, 1996), children do not always tell their parents about maltreatment, and parents are more likely than strangers to be perpetrator and thus may not report maltreatment (U.S. Department of Health & Human Services, 2020). Second, our sample was 95 % White and all participants were children of nurses. Our results therefore may not be generalizable to non-White individuals or more economically diverse populations. However, our sample represents individuals across all regions in the U.S. and was large and community-based. Studies that use only reported maltreatment cases may represent the most severe cases of abuse, and such studies also depend on varying definitions of abuse across states. Community-based studies are thus more likely to be representative of the true distribution of maltreatment in the population and help ensure definitions of maltreatment are uniform across locations. A third limitation is that the Growing Up Today Study did not collect information on neglect, which is estimated to affect about 15 % of children in the U.S. (Finkelhor et al., 2013). Neglect may co-occur with other forms of abuse, but also may be the predominant form of maltreatment for a subgroup of individuals (Hazzard, Bauer, Mukherjee, Miller, & Sonnevile, 2019; Rivera et al., 2018; Warmingham et al., 2019). Our exposure classification may have been even more nuanced if we had been able to include neglect, and the observed associations may in part be due to co-occurring neglect. Moreover, our observed associations of maltreatment LCs with adverse health outcomes may have been biased toward the null if individuals in our reference group ("no/low abuse") truly belong to a LC characterized by neglect, which we were unable to capture.

Overall, our study highlights the utility of LCA to classify maltreatment according to the types, developmental timing, and duration of abuse. This approach identified distinct maltreatment subgroups that had unique associations with a range of health outcomes in adulthood, suggesting that the maltreatment subgroups were valid and may capture varying levels of risk associated with different patterns of abuse across childhood and adolescence. Future replications of this approach in more racially, ethnically, and economically diverse samples are needed. Moreover, future research should extend these findings by also including variables for neglect, and should examine predictors and longitudinal outcomes associated with maltreatment subgroups. Lastly, future research should examine whether more nuanced information on the developmental timing of maltreatment (i.e., early childhood and adolescence vs. late childhood and adolescence) helps to further distinguish meaningful maltreatment subgroups.

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Contributorship statement

HZ conceptualized the study, analyzed the data, and prepared the initial and revised manuscript. HZ, AF, SB, SBA, AS, NH, and MS contributed significantly to the interpretation of findings and critically revised the manuscript. All authors approved of the final version of this manuscript.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.chiabu.2020.104574>.

References

- Affifi, T. O., Sareen, J., Fortier, J., Taillieu, T., Turner, S., Cheung, K., & Henriksen, C. A. (2017). Child maltreatment and eating disorders among men and women in adulthood: Results from a nationally representative United States sample. *The International Journal of Eating Disorders*, 50(11), 1281–1296.
- Barros, A. J., & Hirakata, V. N. (2003). Alternatives for logistic regression in cross-sectional studies: An empirical comparison of models that directly estimate the prevalence ratio. *BMC Medical Research Methodology*, 3(1), 21.
- Bernstein, D. P., Fink, L., Handelsman, L., Foote, J., Lovejoy, M., ... Ruggiero, J. (1994). Initial reliability and validity of a new retrospective measure of child abuse and neglect. *The American Journal of Psychiatry*, 151(8), 1132.
- Celeux, G., & Soromenho, G. (1996). An entropy criterion for assessing the number of clusters in a mixture model. *Journal of Classification*, 13(2), 195–212.
- Dube, S. R., Williamson, D. F., Thompson, T., Felitti, V. J., & Anda, R. F. (2004). Assessing the reliability of retrospective reports of adverse childhood experiences among adult HMO members attending a primary care clinic. *Child Abuse & Neglect*, 28, 729–737.
- Duncan, A. E., Bucholz, K. K., Neuman, R. J., Agrawal, A., Madden, P. A., & Heath, A. C. (2007). Clustering of eating disorder symptoms in a general population female twin sample: A latent class analysis. *Psychological Medicine*, 37(8), 1097–1107.
- Duncan, A. E., Sartor, C. E., Jonson-Reid, M., Munn-Chernoff, M. A., Eschenbacher, M. A., Diemer, E. W., ... Heath, A. C. (2015). Associations between body mass index, post-traumatic stress disorder, and child maltreatment in young women. *Child Abuse & Neglect*, 45, 154–162.
- Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., ... Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine*, 14(4), 245–258.
- Field, A. E., Sonneville, K. R., Micali, N., Crosby, R. D., Swanson, S. A., Laird, N. M., ... Horton, N. J. (2012). Prospective association of common eating disorders and adverse outcomes. *Pediatrics*, 130(2), e289–e295.
- Field, A. E., Manson, J. E., Taylor, C. B., Willett, W. C., & Colditz, G. A. (2004). Association of weight change, weight control practices, and weight cycling among women in the Nurses' Health Study II. *International Journal of Obesity*, 28(9), 1134.
- Field, A. E., Taylor, C. B., Celio, A., & Colditz, G. A. (2004). Comparison of self-report to interview assessment of bulimic behaviors among preadolescent and adolescent girls and boys. *The International Journal of Eating Disorders*, 35(1), 86–92.
- Finkelhor, D., Ormrod, R. K., & Turner, H. A. (2007). Poly-victimization: A neglected component in child victimization. *Child Abuse & Neglect*, 31(1), 7–26.
- Finkelhor, D., Turner, H. A., Shattuck, A., & Hamby, S. L. (2013). Violence, crime, and abuse exposure in a national sample of children and youth: An update. *JAMA Pediatrics*, 167(7), 614–621.
- Gilbert, R., Widom, C. S., Browne, K., Fergusson, D., Webb, E., & Janson, S. (2009). Burden and consequences of child maltreatment in high-income countries. *Lancet*, 373(9657), 68–81.
- Goodman, E., Hinden, B. R., & Khandelwal, S. (2000). Accuracy of teen and parental reports of obesity and body mass index. *Pediatrics*, 106(1), 52–58.
- Halfon, N., & Hochstein, M. (2002). Life course health development: An integrated framework for developing health, policy, and research. *The Milbank Quarterly*, 80(3), 433–479.
- Havlicek, J. (2014). Maltreatment histories of foster youth exiting out-of-home care through emancipation: A latent class analysis. *Child Maltreatment*, 19(2–4), 199–208.
- Hazzard, V. M., Bauer, K. W., Mukherjee, B., Miller, A. L., & Sonneville, K. R. (2019). Associations between childhood maltreatment latent classes and eating disorder symptoms in a nationally representative sample of young adults in the United States. *Child Abuse & Neglect*, 98(104171).
- Hyman, S. M., Garcia, M., & Sinha, R. (2006). Gender specific associations between types of childhood maltreatment and the onset, escalation and severity of substance use in cocaine dependent adults. *The American Journal of Drug and Alcohol Abuse*, 32(4), 655–664.
- Jaffee, S. R., & Maikovich-Fong, A. K. (2011). Effects of chronic maltreatment and maltreatment timing on children's behavior and cognitive abilities. *J Child Psychology Psychiatry*, 52(2), 184–194.
- Kaplow, J. B., & Widom, C. S. (2007). Age of onset of child maltreatment predicts long-term mental health outcomes. *Journal of Abnormal Psychology*, 116(1), 176.
- Koss, M. P., & Gidycz, C. A. (1985). Sexual experiences survey: Reliability and validity. *Journal of Consulting and Clinical Psychology*, 53(3), 422.
- Lau, A. S., Leeb, R. T., English, D., Graham, J. C., Briggs, E. C., Brody, K. E., & Marshall, J. M. (2005). What's in a name? A comparison of methods for classifying predominant type of maltreatment. *Child Abuse & Neglect*, 29(5), 533–551.
- Manly, J. T., Kim, J. E., Rogosch, F. A., & Cicchetti, D. (2001). Dimensions of child maltreatment and children's adjustment: Contributions of developmental timing and subtype. *Development and Psychopathology*, 13(4), 759–782.
- Mason, S. M., MacLehose, R. F., Katz-Wise, S. L., Austin, S. B., Neumark-Sztainer, D., Harlow, B. L., & Rich-Edwards, J. W. (2015). Childhood abuse victimization, stress-related eating, and weight status in young women. *Annals of Epidemiology*, 25(10), 760–766.
- Muthén, L. K., & Muthén, B. O. (2007). *Statistical analysis with latent variables using Mplus*. Los Angeles, CA: Muthén & Muthén.
- Nooner, K. B., Litrownik, A. J., Thompson, R., Margolis, B., English, D. J., Knight, E. D., ... Roesch, S. (2010). Youth self-report of physical and sexual abuse: A latent class analysis. *Child Abuse & Neglect*, 34(3), 146–154.
- Oberski, D. (2016). *Mixture models: Latent profile and latent class analysis. Modern statistical methods for HCI*. Springer 275–287.
- Radloff, L. S. (1991). The use of the center for epidemiologic studies depression Scale in adolescents and young adults. *Journal of Youth and Adolescence*, 20(2), 149–166.
- Rivera, P. M., Fincham, F. D., & Bray, B. C. (2018). Latent classes of maltreatment: A systematic review and critique. *Child Maltreatment*, 23(1), 3–24.
- Roesch, S. C., Villodas, M., & Villodas, F. (2010). Latent class/profile analysis in maltreatment research: A commentary on Nooner et al., Pears et al., and looking beyond. *Child Abuse & Neglect*, 34(3), 155.
- Rothman, K. J. (1990). No adjustments are needed for multiple comparisons. *Epidemiology*, 1(1), 43–46.
- Sacks, R. M., Takemoto, E., Andrea, S., Dieckmann, N. F., Bauer, K. W., & Boone-Heinonen, J. (2017). Childhood maltreatment and BMI trajectory: The mediating role of depression. *American Journal of Preventive Medicine*, 53(5), 625–633.
- Savitz, D. A., & Olshan, A. F. (1995). Multiple comparisons and related issues in the interpretation of epidemiologic data. *American Journal of Epidemiology*, 142(9), 904.
- Sedlak, A. J., & Broadhurst, D. D. (1996). *Third National Incidence Study of Child Abuse and Neglect*. Washington, D.C.: U.S. Department of Health and Human Services.
- Shevlin, M., & Elklit, A. (2008). A latent class analysis of adolescent adverse life events based on a Danish national youth probability sample. *Nordic Journal of Psychiatry*, 62(3), 218–224.
- Stommel, M., & Schoenborn, C. A. (2009). Accuracy and usefulness of BMI measures based on self-reported weight and height: Findings from the NHANES & NHIS 2001–2006. *BMC Public Health*, 9(1), 421.
- Straus, M. A., Hamby, S. L., Boney-McCoy, S., & Sugarman, D. B. (1996). The revised conflict tactics scales (CTS2) development and preliminary psychometric data. *Journal of Family Issues*, 17(3), 283–316.
- Swanson, S. A., Horton, N. J., Crosby, R. D., Micali, N., Sonneville, K. R., Eddy, K., & Field, A. E. (2014). A latent class analysis to empirically describe eating disorders through developmental stages. *The International Journal of Eating Disorders*, 47(7), 762–772.
- Thornberry, T. P., Ireland, T. O., & Smith, C. A. (2001). The importance of timing: The varying impact of childhood and adolescent maltreatment on multiple problem outcomes. *Development and Psychopathology*, 13(4), 957–979.
- U.S. Department of Health & Human Services (2020). *Child maltreatment 2018*. Retrieved from <https://www.acf.hhs.gov/cb/research-data-technology/statistics-research/child-maltreatment>.
- Vatcheva, K. P., Lee, M., McCormick, J. B., & Rahbar, M. H. (2016). Multicollinearity in regression analyses conducted in epidemiologic studies. *Epidemiology (Sunnyvale, Calif)*, 6(2), 227.
- Warmingham, J. M., Handley, E. D., Rogosch, F. A., Manly, J. T., & Cicchetti, D. (2019). Identifying maltreatment subgroups with patterns of maltreatment subtype and chronicity: A latent class analysis approach. *Child Abuse & Neglect*, 87, 28–39.
- Williamson, D. F., Thompson, T. J., Anda, R. F., Dietz, W. H., & Felitti, V. (2002). Body weight and obesity in adults and self-reported abuse in childhood. *International Journal of Obesity*, 26(8), 1075.