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Potentially traumatic interpersonal events, psychological distress and recurrent headache in a population-based cohort of adolescents: the HUNT study

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ABSTRACT

Objectives: Recurrent headache co-occurs commonly with psychological distress, such as anxiety or depression. Potentially traumatic interpersonal events (PTIEs) could represent important precursors of psychological distress and recurrent headache in adolescents. Our objective was to assess the hypothesised association between exposure to PTIEs and recurrent migraine and tension-type headache (TTH) in adolescents, and to further examine the potential impact of psychological distress on this relationship.

Design: Population-based, cross-sectional cohort study. The study includes self-reported data from youth on exposure to potentially traumatic events, psychological distress and a validated interview on headache.

Setting: The adolescent part of the Nord-Trøndelag Health Study 2006–2008 (HUNT), conducted in Norway.

Participants: A cohort of 10 464 adolescents were invited to the study. Age ranged from 12 to 20 years. The response rate was 73% (7620), of whom 50% (3832) were girls.

Main outcome measures: Data from the headache interview served as the outcome. Recurrent headache was defined as headache recurring at least monthly during the past year, and was subclassified into monthly, weekly and daily complaints. Subtypes were classified as TTH, migraine, migraine with TTH and/or non-classifiable headache, in accordance with the International Classification of Headache Disorders criteria, second edition.

Results: Multiple logistic regression analysis, adjusted for sociodemographics, showed consistently significant associations between exposure to PTIEs and recurrent headache, regardless of the frequency or subtype of headache. Increasing exposure to PTIEs was associated with higher prevalence of recurrent headache, indicating a dose–response relationship. The strength of associations between exposure to PTIEs and all recurrent headache disorders was significantly attenuated when psychological distress was entered into the regression equation.

ARTICLE SUMMARY

Article focus

- The main focus was to examine, in a population-based cohort of adolescents, the associations between exposure to potentially traumatic interpersonal events (PTIEs) and migraine and tension-type headaches (TTHs), meeting the International Classification of Headache Disorders, second edition (ICHD-II) criteria.
- Further, we aimed to assess the impact of psychological distress on the relationship between PTIEs and recurrent headache.

Key messages

- Our study suggests a strong and consistent relationship between exposure to PTIEs and prevalence of ICHD-II defined migraine and TTH in a population-based cohort study of adolescents.
- Exposure to increasing numbers of types of PTIEs was consistently associated with higher prevalence of all assessed subtypes and frequencies of headache, indicating a dose–response relationship.
- Adolescents exposed to PTIEs reported higher levels of psychological distress than their non-victimised peers. Further, adjustment for experienced psychological distress consistently and significantly attenuated strength of associations between PTIEs and recurrent headache.

Strengths and limitations of this study

- The strengths of this study were the large sample size, the overall high-participation rate and the use of a validated headache interview, based on the ICHD (II) criteria and the opportunity to assess the impact of multiple PTIEs and confounding factors within a population-based cohort of adolescents.
- The retrospective, cross-sectional study design did not allow for causal inference, or differentiation between mediational and confounding effects. Findings should be interpreted within the given constraints of the study.

Conclusions: The empirical evidence of a strong and cumulative relationship between exposure to PTIEs, psychological distress and recurrent headache indicates a need for the integration of somatic and psychological healthcare services for adolescents in the prevention, assessment and treatment of recurrent headache. Prospective studies are needed.

Recurrent headache is the most common pain condition during adolescence, and is associated with limitations in everyday life, affecting school functioning and relationships with family and peers.[1 2] Prepubertal onset of headache, high pain intensity, migraine and co-occurring psychological distress is related to chronification and disability in childhood and adolescence.[1 3 4] Further, headache-related disability at diagnosis seems to be predictive of headache-related functional impairment decades later.[5]

From early childhood to adolescence, there is a marked increase in the prevalence of headache, which is accompanied by an emerging discrepancy between genders. Prevalence tend to stabilise in boys, and increase gradually throughout adolescence in girls.[6]

Primary tension-type and migraine headaches are by far the most frequent subtypes of recurrent headache in adolescence.[6] Secondary headaches are consequents upon other conditions, such as medication overuse,[7] infection or trauma. Primary and secondary headaches often partly overlap.[8] The aetiological factors, and pathways leading to the onset and chronification of headache disorders, are largely unknown,[9] yet recognised as multifactorial, including heredity, age and sex, somatic, psychological and behavioural disorders,[10 11] head injuries,[12] unfavourable lifestyle (such as smoking, inactivity[13] and inadequacy of sleep[1]) and lack of social and economic resources within families, in schools and societies.[14–16] Despite distinguishing features related to migraine headaches, the primary headaches may in part share pathophysiological mechanisms, related to the chronification of disorders,[9 17] reflected in an observed continuum of clinical severity, ranging from tension-type complaints, through migraine,[18] to combined migraine with tension-type headache (TTH).[19]

Recently, researchers have explored the potential role of negative life events on the development of psychosomatic outcomes, including headache, in adolescence. Positive associations have been found between a range of childhood adversities and headache, including economic hardship,[16] parental separation,[20] poor family environment or neglect,[21] and potentially traumatic events such as disaster,[22] exposure to abuse[23 24] and bullying.[25] A recent population-based study of adolescents has suggested a dose–response relationship between frequency of childhood physical abuse and severe headaches, including migraine,[23] supported by findings from a large convenience sample study of adults,[26] and a multicentre study of adult migraineurs, alike.[27] Despite these suggestive findings, the evidence for an association between exposure to childhood trauma and recurrent headache is currently debated.[28]

The association between adverse experiences and mood and anxiety disorders in adolescents, however, is thoroughly documented.[29] Exposure to severe family adversity, or potentially traumatic interpersonal events (PTIEs), especially early exposure to abuse or neglect[30] witnessing domestic violence,[31] exposure to bullying[32] or sexually related victimisation,[33] is recognised as particularly detrimental and associated with prolonged trajectories and comorbidity.[25 34] A steady aggravation of psychological distress is further documented in relation to exposure to multiple types of PTIEs.[35] Findings from high-exposure populations suggest that exposure to PTIEs will, regardless of psychological vulnerability, lead to psychological distress of clinical significance in anyone, although the thresholds vary individually.[34 36] These main trends seem to be similar for both sexes.[37]

During childhood, PTIE-exposure is generally evenly distributed, followed by emerging sex-related discrepancies in patterns of distribution of PTIEs during adolescence. Adolescent girls continuously experience more sexually related and close-network PTIEs, while boys gradually get more exposed to all other types of single events. Post-traumatic stress reactions are generally reported 2–3 times more often by adolescent girls, in comparison to boys.[37]

Current epidemiological evidence of a gradual increase in risk of exposure to PTIEs throughout childhood and adolescence,[33] strongly associated with the onset of psychological distress,[30] which again often co-occurs with emerging recurrent headaches,[4] implies possible shared causal pathways.[38] We therefore need to study associations between the exposure to PTIEs, psychological distress and recurrent headache in adolescents.[28] The present study was designed to acquire knowledge of associations between exposure to PTIEs and International Classification of Headache Disorders criteria, second edition (ICHD-II) defined migraine and TTH, in a population-based cohort of adolescents. The impact of psychological distress upon the relationship between exposure to PTIEs and recurrent headache was tested specifically.

METHODS

The Young-HUNT 3 Study (http://www.ntnu.edu/hunt/inenglish) is a population-based, cross-sectional cohort study of Norwegian youth in Nord-Trøndelag county, conducted between 2006 and 2008, in which 10 464 adolescents were invited to participate.[39] The study, which comprises a general health questionnaire, a clinical assessment and a headache interview, was approved by the Norwegian Regional Committee for Medical and Health Research Ethics. Inclusion was based on written consent from participants aged 16 years and older and from parents for those under 16, in accordance with Norwegian law.

Participants

In 2006, there were 128 694 inhabitants in Nord-Trøndelag. Over 95% were ethnic Norwegians, the workforce was generally well educated and unemployment was less than 3%. All adolescents in the county, within an age-range qualifying for attendance in junior or senior high school, were invited to the study. Of the 10 464 invited adolescents, 5614 were students in junior high, 4357 in senior high and 493 adolescents were not in school. Most adolescents were from 13 through 18 years of age, although age ranged from 12 to 20 years. Non-participation was mainly due to the lack of enrolment, absenteeism or participation in class activities outside school. In total, 8200 (78%) adolescents completed the general health questionnaire: more specifically 85% (4749) of the junior high students, 77% (3336) of the senior high students and 23% (115) of the adolescents not in school. Further, a total of 73% (7620) also completed the interview on headache.

During a school lesson, students completed a self-administered questionnaire containing over 100 health-related and lifestyle-related questions, including items on potentially traumatic events, psychological distress and post-traumatic stress reactions, in addition to background information on family structure and family economy (http://www.ntnu.edu/hunt/data/que). Within 1 month of completion of the questionnaire, a validated semistructured clinical headache interview was conducted.[40]

Recurrent headache

All adolescents were asked if they had experienced recurring headache not caused by a cold (infection) or illness within the past 12 months. 'Yes' responders were read two descriptive texts of prototypic symptoms for TTH and migraine. They were asked if they recognised either, both or neither descriptions as resembling their own complaints. Thus, the interview differentiated between three types of headache: tension-type and/or migraine and/or non-classifiable headache. The frequency of recurrent headache was labelled as monthly (1–3 days/month), weekly (1–4 days/week) and daily (>4 days/week). Adolescents reporting 'no recurrent headache' and 'headache less than monthly' were defined as having 'no recurrent headache', whereas all other headache frequencies were referred to as 'recurrent headache'. This recognition-based headache assessment has previously been validated against extensive semistructured interviews by neurologists,[40] in accordance with ICHD-II.[8]

Sociodemography

Information on sex was drawn from the Norwegian National Population Registry, whereas age was calculated by subtracting the date of birth from the date of completion of the questionnaire. The sociodemographic variable 'family structure' was computed from 12 self-reported items on cohabitants, and was dichotomised into 'living with both parents' versus 'other' family structures, such as; living with a single parent, step-parents, foster parents or without guardians.[20 33] The variable 'family economy', based on a self-reported estimation of family affordance in comparison with most others, categorised as 'above average', 'average' and 'below average', represented the socioeconomic situation, as inequalities in family affluence have previously been shown to be strongly related to inequalities in adolescent health.[16]

Potentially traumatic interpersonal events

In this study, PTIEs were defined as social interactions where an individual is subjected to intentional threats, use of physical force or power, which may cause immediate or long-term adverse health outcomes. Exposure encompasses direct and indirect (witnessing) subjection to PTIEs. A number of potentially traumatic events were screened for, among which we identified five items as being PTIEs. The items were introduced using the following question: Have you ever experienced any of these events? Select one of the following response options: 'No', 'Yes, during the past year' or 'Yes, during lifetime'. The PTIE-related questions in our study were formulated as follows: (1) been subjected to violence (beaten or injured), (2) seen others being subjected to violence, (3) been subjected to unpleasant/disagreeable sexual acts by someone approximately your own age, (4) been subjected to unpleasant/disagreeable sexual acts by an adult and (5) been threatened or physically harassed by fellow students at school over a period of time. These items were dichotomised into 'No, not experienced' and 'Yes, during lifetime' (combining the two original 'yes' categories).

Psychological distress

General psychological distress was measured by a five-item, short-version instrument, named SCL-5, modified from the 25-item Hopkins's Symptom Checklist (HSCL) subscale on anxiety and depression, measured on a four-point Likert scale.[41] The derived items were introduced as follows: Below is a list of some problems and complaints. Have you been bothered by any of this during the last 14 days? (select one alternative: 1='not bothered', 2='a little bothered', 3='quite bothered' and 4='very bothered') 'Been constantly afraid or anxious', 'Felt tense, distressed or restless', 'Felt hopeless when you think about the future', 'Felt dejected or sad' and 'Worried too much about different things?' A mean score ranging from 1 to 4 was computed. SCL-5 has previously been validated as a screening instrument for mental illness or psychological distress.[42]

Adolescents reporting one or more PTIEs were asked three yes/no questions on post-traumatic stress reactions, derived from the child version of the UCLA PTSD index for DSM-IV,[43] where two items measured current intrusion or re-experience, and one measured current avoidance.

STATISTICS

Descriptive data were presented according to the frequency of recurrent headaches (table 1). Adjusted ORs and 95% CIs were obtained from logistic regression models that estimated the likelihood of experiencing recurrent headaches according to each of the four categories of exposure to PTIEs within a complete case sample of 6787/10464 (65%) adolescents (regression model 1, tables 2–4).[44] The number of types of PTIEs was summed for each respondent (range 0–5), and PTIE scores of 3, 4 or 5 were combined in one category (≥3). All models included age, sex, family structure and

Table 1 Headache type, sociodemographics, exposure to PTIEs, and psychological distress, by frequency of recurrent headache, in 7620 adolescents*†

Variables	N	No Recurrent Headache N (%)/mean (SD)	Recurrent headache Monthly N (%)/mean (SD)	Weekly N (%)/mean (SD)	Daily N (%)/mean (SD)	p Value
Female						
Headache	3832	2707 (71)	653 (17)	385 (10)	87 (2)	
TTH		–	461 (71)	249 (65)	39 (45)	
Migraine, without TTH		–	137 (21)	78 (20)	19 (22)	
Migraine, with TTH		–	24 (4)	43 (11)	22 (25)	
Non-classifiable		–	31 (5)	15 (4)	7 (8)	<0.001‡
Age (years)	3832	15.8 (1.7)	15.9 (1.7)	16.1 (1.8)	16.0 (1.7)	0.016§
Family structure	3798					
Living w/both parents		1819 (68)	396 (61)	216 (57)	42 (48)	
Other		865 (32)	250 (39)	165 (43)	45 (52)	<0.001‡
Family economy	3630					
Above average		413 (16)	77 (13)	57 (16)	8 (10)	
Average		1946 (76)	456 (75)	252 (69)	62 (73)	
Below average		215 (8)	74 (12)	55 (15)	15 (18)	<0.001‡
Sum of PTIE¶	3662					
0		2031 (78)	423 (68)	226 (61)	47 (56)	
1		382 (15)	119 (19)	69 (19)	22 (26)	
2		108 (4)	50 (8)	39 (11)	5 (6)	
≥3		68 (3)	28 (5)	35 (9)	10 (12)	<0.001‡
Psychological distress**	3740	1.6 (0.5)	1.8 (0.6)	2.0 (0.7)	2.0 (0.7)	<0.001§
Male						
Headache	3788	3204 (85)	418 (11)	145 (4)	21 (1)	
TTH		–	324 (78)	98 (68)	13 (62)	
Migraine, without TTH		–	70 (17)	25 (17)	2 (10)	
Migraine, with TTH		–	9 (2)	12 (8)	4 (19)	
Non-classifiable		–	15 (4)	10 (7)	2 (9)	<0.001‡
Age (years)	3788	15.8 (1.7)	15.7 (1.7)	15.7 (1.6)	15.8 (2.1)	0.596§
Family structure	3748					
Living w/both parents		2206 (70)	273 (66)	85 (60)	12 (60)	
Other		968 (30)	139 (34)	57 (40)	8 (40)	0.047‡
Family economy	3465					
Above average		614 (21)	82 (22)	26 (20)	0 (0)	
Average		2107 (72)	262 (69)	89 (67)	12 (63)	
Below average		211 (7)	38 (10)	17 (13)	7 (37)	<0.001‡
Sum of PTIEs¶	3527					
0		2023 (68)	244 (64)	70 (53)	9 (50)	
1		622 (21)	67 (17)	31 (24)	4 (22)	
2		255 (9)	49 (13)	18 (14)	3 (17)	
≥3		95 (3)	23 (6)	12 (9)	2 (11)	<0.001‡
Psychological distress**	3617	1.3 (0.4)	1.5 (0.5)	1.5 (0.6)	1.9 (0.7)	<0.001§

*Recurrent headache is defined as headache ≥ monthly.
†Owing to rounding, percentages may not total 100.
‡Pearson χ^2 test.
§ANOVA, analysis of variance.
¶Exposure to PTIEs is measured as the sum of five binary variables.
**Range of possible score is 1–4.
PTIE, potentially traumatic interpersonal event; TTH, tension-type headache.

Table 2 Recurrent headache in relation to exposure to PTIEs and psychological distress, by sex*†‡

		Recurrent headache (n=1514)			
		Female (n=1021)		Male (n=496)	
Variables	n	Model 1 OR_1 (CI)	Model 2 OR_2 (CI)	Model 1 OR_1 (CI)	Model 2 OR_2 (CI)
Sum of PTIEs					
0	4789	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
1	1250	1.46 (1.20 to 1.78)	1.25 (1.02 to 1.53)	1.04 (0.81 to 1.34)	0.93 (0.72 to 1.20)
2	496	2.28 (1.69 to 3.08)	1.73 (1.27 to 2.36)	1.71 (1.25 to 2.33)	1.41 (1.03 to 1.94)
≥3	252	2.61 (1.82 to 3.75)	1.69 (1.15 to 2.47)	2.29 (1.49 to 3.52)	1.57 (1.00 to 2.47)
Overall p value		<0.001	<0.001	<0.001	0.029
Psychological distress	6787		1.94 (1.70 to 2.22)		2.10 (1.72 to 2.58)

*Study definitions and measures are explained in footnotes to table 1.
†Analyses are restricted to adolescents no missing values for all included variables (3494 females and 3293 males).
‡Both regression models are adjusted for age, family structure and family economy. Model 2 is additionally adjusted for psychological distress.
OR_1 and OR_2, OR for regression models 1 and 2, respectively; PTIE, potentially traumatic interpersonal event.

family economy as covariates, based on a priori reasoning. The main analysis of general recurrent headache was stratified according to sex (table 2).

Furthermore, we tested whether adjustment for psychological distress significantly altered the estimated strength of associations between PTIEs and recurrent headache. The magnitude and significance of the alteration in ORs was assessed by bootstrapping, a general procedure for computing CI without making distributional assumptions.[44 45] Specifically, we used bootstrap methods with 10 000 replicated samples to calculate bootstrap percentile 95% CIs for the ratio between ORs in the two models (OR from model 2 (OR_2)/OR from model 1 (OR_1). Bootstrap estimated CIs not including 1 indicated a significant difference between the two models. Estimated CIs above 1 would indicate a significant strengthening of the association, while CIs below 1 indicated attenuation in the strength of the relationship between PTIEs and recurrent headache, after adjustment for psychological distress. Lack of power, due to low numbers or measurement uncertainties, however, would make the ORs less reliable and the CIs wider, but would not make the ORs systematically closer to, or further from, the value 1.

In supplementary logistic regression analyses, we assessed potential differences in strength of associations between exposure to PTIEs and monthly, weekly and daily headache, respectively, followed by analysis of differences in strength of associations between PTIE exposure and headache by subtypes TTH, migraine without TTH and migraine with TTH (see online supplementary tables A1 and A2 in appendix).

Last, we performed a subgroup, multiple regression analysis, assessing the relationship between PTIEs and recurrent headache, with and without adjustment for post-traumatic stress reactions, within the1740/6787 (26%) adolescents exposed to any PTIEs. Furthermore, we repeated analysis, with inclusion of the measure for psychological distress (SCL-5). Analyses were undertaken using SPSS V.20, in combination with the program R (The R Foundation for Statistical Computing, Vienna, Austria) package boot for bootstrap calculations.

RESULTS

The demographic data are displayed in table 1.

Generally, twice as many girls as boys reported recurrent headache. Among girls, 20% reported TTH and 8% reported migraine (with or without TTH), while 11% of boys reported TTH and 3% reported migraine. Prevalence increased with age in girls, but not in boys. About two-thirds of adolescents with only TTH or migraine reported monthly recurrence, while those with combined migraine and TTH headache mostly reported weekly or daily complaints. Despite sex differences in headache prevalence, the sociodemographic distribution of recurrent headache followed similar patterns for both sexes, linking living in 'other' family structures and having a family economy 'below average' with recurrent headache.

In the present study, 26% of girls and 33% of boys reported exposure to one or more types of PTIEs, while 4% of both sexes reported exposure to three or more types of PTIEs. Adolescents without recurrent headache reported the lowest exposure to PTIEs, with 73% reporting no exposure, 18% reporting exposure to one, and 9% reporting exposure to two or more PTIEs. Whereas the highest degree of PTIE exposure was observed among adolescents with daily headache, of whom only 55% reported no exposure, 25% reported exposure to one and 20% reported exposure to two or more PTIEs. Mean score for psychological distress was 1.49 (±0.55; SCL-5), and increasing distress was significantly associated with recurrent headache, as assessed in univariate analysis.

A multiple logistic regression analysis, adjusted for sociodemographic factors, revealed a steady trend of increasing odds for recurrent headache with increasing exposure to PTIEs (table 2, model 1). The strength of associations between exposure to PTIEs and recurrent

Table 3 Recurrent headache by frequency, in relation to exposure to PTIEs, sex and psychological distress*†‡

		Recurrent headache (n=1514)					
		Monthly (n=942)		Weekly (n=472)		Daily (n=100)	
Variables	n	Model 1 OR_1 (CI)	Model 2 OR_2 (CI)	Model 1 OR_1 (CI)	Model 2 OR_2 (CI)	Model 1 OR_1 (CI)	Model 2 OR_2 (CI)
Sum of PTIEs							
0	4789	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
1	1250	1.17 (0.97 to 1.41)	1.05 (0.87 to 1.27)	1.40 (1.08 to 1.81)	1.18 (0.91 to 1.53)	2.03 (1.23 to 3.36)	1.58 (0.95 to 2.64)
2	496	1.77 (1.37 to 2.28)	1.46 (1.12 to 1.90)	2.46 (1.77 to 3.41)	1.78 (1.26 to 2.50)	1.93 (0.89 to 4.20)	1.17 (0.52 to 2.63)
≥3	252	1.74 (1.22 to 2.48)	1.30 (0.90 to 1.87)	3.80 (2.61 to 5.54)	2.18 (1.45 to 3.27)	4.53 (2.26 to 9.07)	2.03 (0.95 to 4.34)
Overall p value		<0.001	0.028	<0.001	<0.001	<0.001	0.164
Sex§	6787	1.89 (1.64 to 2.19)	1.60 (1.38 to 1.87)	3.51 (2.82 to 4.37)	2.62 (2.09 to 3.30)	5.14 (3.06 to 8.64)	3.56 (2.09 to 6.07)
Psychological Distress	6787		1.71 (1.50 to 1.95)		2.24 (1.90 to 2.63)		2.78 (2.03 to 3.80)

*Study definitions and measures are defined in footnotes to table 1.
†Analyses are restricted to adolescents without missing values (n=6787).
‡Both models are adjusted for sex, age, family structure and family economy. Model 2 is additionally adjusted for psychological distress.
§Male is reference category.
OR_1 and OR_2, OR for regression models 1 and 2, respectively; PTIE, potentially traumatic interpersonal event.

Table 4 Recurrent headache by type, in relation to exposure to PTIEs, sex and psychological distress* †‡

		Recurrent headache (n=1445)					
		TTH (n=1048)		Migraine without TTH (n=293)		Migraine with TTH (n=104)	
Variables	n	Model 1 OR (CI)	Model 2 OR (CI)	Model 1 OR (CI)	Model 2 OR (CI)	Model 1 OR (CI)	Model 2 OR (CI)
Sum of PTIEs							
0	4789	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
1	1250	1.16 (0.97 to 1.39)	1.01 (0.84 to 1.22)	1.59 (1.17 to 2.17)	1.40 (1.02 to 1.92)	1.64 (0.98 to 2.76)	1.38 (0.82 to 2.33)
2	496	1.71 (1.34 to 2.20)	1.35 (1.04 to 1.75)	2.26 (1.17 to 2.17)	1.76 (1.14 to 2.72)	3.72 (2.04 to 6.76)	2.46 (1.32 to 4.60)
≥3	252	2.12 (1.54 to 2.92)	1.42 (1.02 to 1.99)	3.39 (2.10 to 5.48)	2.19 (1.31 to 3.66)	6.08 (3.16 to 11.70)	3.36 (1.66 to 6.77)
Overall p value		<0.001	0.034	<0.001	0.003	<0.001	0.002
Sex§	6787	2.10 (1.83 to 2.42)	1.71 (1.47 to 1.97)	3.08 (2.36 to 4.02)	2.49 (1.88 to 3.28)	4.73 (2.91 to 7.68)	3.38 (2.05 to 5.57)
Psychological distress	6787		1.95 (1.72 to 2.21)		1.83 (1.49 to 2.25)		2.41 (1.77 to 3.27)

*Study definitions and measures are defined in footnotes to table 1.
†Analyses were restricted to adolescents without missing values (n=6787). Data for analysis of non-classifiable recurrent headache (n=69) are not presented.
‡Model 1 is adjusted for sex, age, family structure and family economy. Model 2 is adjusted for psychological distress, sex, age, family structure and family economy.
§Male is reference category.
PTIE, potentially traumatic interpersonal event; TTH, tension-type headache.

headache consistently and significantly decreased after psychological distress was entered into the regression equation (table 2, model 2), as assessed in the analysis of ratio of OR with bootstrap 95% CIs. Moreover, the magnitude of attenuation in ORs seemed to increase with increasing exposure to PTIEs.

Similarly, the associations between exposure to PTIEs and headache by 'monthly', 'weekly' and 'daily' recurrence, respectively, were all significant and cumulative (model 1, table 3). For all frequencies of recurrent headache as outcomes, we observed a significant attenuation in ORs, with inclusion of psychological distress in the logistic regression analyses (model 2). We found a stronger relationship between exposure to PTIEs and weekly, or more frequent, headache, compared with monthly headache. This difference in strength of associations levelled out when adjusting for psychological distress (see online supplementary table A1).

The association between exposure to PTIEs and subtypes of recurrent headache followed a similar consistently significant and cumulative pattern for all assessed subtypes of recurrent headache; including TTH, migraine without TTH, migraine with TTH and non-classifiable headache (model 1, table 4). Adding psychological distress in regression model 2 for all four subtypes of recurrent headache yielded a significant reduction in ORs for all analyses. The association between PTIEs and recurrent headache was significantly stronger among adolescents reporting any migraine (with or without TTH), in comparison to adolescents reporting TTH only (see online supplementary table A2). This observed difference between subtypes seemed to be mainly driven by a stronger association between exposure to PTIEs and migraine with TTH, as opposed to TTH only. We found no significant difference in associations between victimization and the two groups of migraine; migraine with TTH and migraine without TTH.

Furthermore, in subgroup analysis investigating the impact of post-traumatic stress reactions on the relationship between exposure to PTIEs and recurrent headache, post-traumatic stress reactions independently and significantly attenuated ORs, the contribution of post-traumatic stress reactions became insignificant when we additionally adjusted for general psychological distress.

DISCUSSION

To our knowledge, this is the first population-based study to comprehensively assess associations between exposure to multiple PTIEs and recurrent headache meeting the ICHD-II criteria. The study documents a strong and consistent relationship between exposure to PTIEs and recurrent headache experienced by adolescents. The association was observed for monthly, weekly and daily headache, although it was significantly stronger for weekly or more frequent. A similar, robust pattern was found between exposure to PTIEs and ICHD-II defined TTH, migraine without TTH, migraine with TTH and non-classifiable headache. Increasing exposure to PTIEs was associated with higher prevalence of all assessed frequencies and subtypes of recurrent headache, indicating a dose–response relationship. Furthermore, adjustment for psychological distress led to a consistent and significant decrease in strength of associations between exposure to PTIEs and all frequencies and subtypes of recurrent headache. Post-traumatic stress reactions seem to play a similar role, although adjustment for general distress levelled out its specific effect. This may indicate that general psychological distress, as measured within this study, encompasses post-traumatic stress reactions, as found in a recent study of comorbidity in adolescents.[46]

The strengths of this study were the large sample size, the overall high participation rate, the use of a validated headache interview based on the ICHD-II criteria,[40] and the opportunity to assess the impact of several types of PTIEs and confounding factors, within a population-based cohort of adolescents.

Importantly, the retrospective, cross-sectional study design did not allow for causal inference, or differentiation between confounding and mediational effects. Findings should thus be interpreted within the given constraints of the study. The lower participation and response rate among adolescents not enrolled in school, as well as among those in senior high school compared with junior high school, represents a possible selection bias. Additionally, young adolescents, boys and adolescents not living with both parents were less likely to respond to the PTIE items. This missing pattern may represent another source of selection bias. The most prominent observed selection bias within this study is the high non-response among adolescents not enrolled in school, which may have led to an underestimation of the associations.[47] Our measures of PTIEs lack event-specific information on relationship to the perpetrator, severity, frequency, duration and recency of exposure[48] and commonly occurring PTIEs, such as emotional abuse, peer-relational victimisation and cyber bullying, were not addressed.[49 50] The aforementioned uncertainties, related to the measurement of PTIEs, may have affected the observed strengths of associations. Furthermore, analysis on an additional outcome measure of headache-related functional impairment would most probably have strengthened associations.[24] Despite these accounted for potential selection biases and measurement uncertainties, it is quite likely that the main findings can be generalised to other adolescent populations.

Prevalence rates of recurrent headache, including frequencies and subtypes of complaints, were in large unchanged in comparison with national headache prevalence from 1995 to 1997[51] and within the lower range of aggregated international estimates.[6] Further, the observed patterns of distribution of recurrent headache in this study, in relation to sex, age,[6] sociodemography[2 16 20] and psychological distress,[2 4 10 19] complied with previous epidemiological documentation. Likewise, the observed

prevalence of exposure to PTIEs in our study was within the lower range, and distribution followed patterns similar to those observed in comparable studies, although comparison across measures and populations is difficult.[28 33] Regarding the levels of psychological distress, the screening estimates were in correspondence with prior national and international findings.[42 46]

Our main findings substantiate recent but scarce evidence provided by cross-sectional population-based studies of adolescents of a significant association between exposure to PTIEs and headache. Two of these studies used the ICHD-II criteria.[14 21 23 25] Further, results are in coherence with one population-based,[52] two clinical[27 53] and another two convenience sample[26 54] retrospective, cross-sectional studies of adults, of which one used the ICHD-II criteria.[27] Apart from one adolescent study which examined girls only,[14] and the adult convenience sample study,[26] the sample sizes in these studies were smaller than in the present study. Generally, the adolescent studies assessed exposure to one type of PTIEs only, while the adult studies looked specifically at child abuse and family dysfunction.

Concerning temporality of associations, a large cohort study using follow-up data over 12 years of adolescent and adult Canadians recently found childhood adversity and depression to be significant predictors of adult migraine.[38] Additionally, observational, prospective, convenience sample studies of adolescents exposed to bullying lend evidence to the more general relationship between victimisation and psychosomatic complaints, although the headache measurements in these studies were too imprecise to draw more specific conclusions of associations.[49 55 56] Taken together, some evidence suggests that PTIEs may be important factors on the causal pathway leading to the onset and chronification of headache disorder.

Among the relationships observed between exposure to PTIEs and the main subtypes of headache, migraine was most strongly linked to exposure. The observed stronger association between PTIEs and migraine, as opposed to TTH, seemed to be explained in large by the stronger association between exposure to PTIEs and combined headache (migraine with TTH). This may indicate that exposure to PTIEs predisposes to more severe and complex head pains,[57] reflecting a pattern similar to that observed in the relationship between PTIE-exposure and comorbidity of psychiatric disorders.[29] Such an interpretation complies with previous findings that migraines in general and combined migraines specifically tend to be clinically more severe and disabling, compared to TTH only.[18 19] On the other hand, the observed discrepancies in strength of associations may be an artefact of underlying chronification of complaints, as migraine with TTH was more often experienced weekly or daily, as opposed to migraine or TTH only, which mostly recurred monthly.

Our findings suggest that psychological distress may play an important role as a confounder or as a mediator. A mediating role would comply with current pathophysiological understanding, where violence as an environmental stressor may acutely or over time overwhelm, exhaust and further dysregulate the stress response system.[58] Pathological effects such as recurrent headache, though initially induced by external trauma, may largely be related to persistence of physiological distress, functioning as an internal stressor that triggers cerebral sensitisation and hypersensitivity through alterations of shared neuroendoimmunological pathways of emotion and pain, which in turn may lead to hyperalgesia and chronification of headache disorders.[3 9 17 59] Future interdisciplinary studies need to explore these suggested mechanisms to delineate aetiological pathways and further enable tailored interventions.

Sex differences in the strength of associations between PTIEs and recurrent headache may be related to the gender-biased qualitative differences of reported PTIEs, such as girls being more prone to sexual abuse and exposure within their social networks.[37] Such exposure is associated with worse health outcomes, which are possibly related to the developmental stage at the time of abuse, proximity to the perpetrator and the persistence and severity of the abuse.[31 60] Other possible mechanisms may be related to developmental biological differences, or sociocultural gender role expectations affecting reaction patterns,[61] predisposing girls to internalising as opposed to externalising behaviour, which in turn increases their susceptibility to experiencing persistent chronic pain.[62]

Conclusion and implications

Our main findings comply with essential features of current theoretical models of developmental psychopathology,[63] recurrent pain[62] and chronic paediatric headache[3 17 64] that underscore the need for a biopsychosocial approach to understand adverse-health outcomes in childhood. Knowing that recurrent headaches are among the most common causes of disability in adults and adolescents alike,[1 18] substantiated empirical evidence of a strong, consistent and cumulative relationship between exposure to PTIEs, psychological distress and recurrent headache, regardless of subtype, demands further investigation.[23] We are currently at a stage where we recognise that childhood victimisation and adversities do little good for psychological and somatic health and development, and yet we lack valid, distinct and precise knowledge to guide public health interventions and clinical practice. Thus, primarily there is a need for more comprehensive, interdisciplinary research, preferably prospective, using valid measurements of risk factors and clinically applicable outcome measures, aiming to identify underlying gene–environment interplay or biopsychosocial causal pathways as targets of tailored prevention and intervention. Second, from a more general public health perspective, the observed dependency between exposure to PTIEs and highly prevalent psychological and somatic conditions challenges the traditional

dichotomisation of health services, requiring the establishment and maintenance of low threshold, local-health services directed towards adolescents that integrate and accommodate psychological and somatic needs.[64–67]

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Contributors SØS carried out the data processing, analysed the data, and drafted and revised the paper. She is the guarantor. GD and J-AZ contributed to the integration of the headache interview, measures of victimisation and post-traumatic distress in the Young-HUNT3 Study. GD and ST wrote the original study protocol, applied for and received the grant for the study and further participated in the epidemiological modelling, analysis and writing of the manuscript. TW-L contributed to the statistical analysis. J-AZ participated in the design of the study and helped to write the manuscript. All authors have read and approved the final version of the manuscript.

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Competing interests None.

Ethics approval Inclusion was based on written consent from participants aged 16 years and older and from parents for those under 16, in accordance with Norwegian law. This study was approved by the Norwegian Regional Committee for Medical and Health Research Ethics.

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Data sharing statement Data are available from the HUNT study http://www.huntbiosciences.com/Cohorts/Diabetes/The-HUNT-Bio-And-Databank. The general health questionnaire and headache interview used in the study are accessible from the HUNT Bio-And-Databank (http://www.ntnu.edu/hunt/data/que).

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Potentially traumatic interpersonal events, psychological distress and recurrent headache in a population-based cohort of adolescents: the HUNT study

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Notes