Coloring of the past via respondent's current psychological state, mediation, and the association between childhood disadvantage and morbidity in adulthood

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Abstract

Objective: Many researchers view retrospective reports with skepticism. Indeed, the observed association between retrospectively-reported childhood disadvantage (CD) and morbidity in adulthood has been criticized as an artefactual correlation driven by the psychological state of the respondent at the time of reporting (current psychological state). The aim of this study was to assess the role of current psychological state in the association between childhood disadvantage and morbidity in adulthood. **Methods:** The present analysis used cross-sectional data collected in 2007-2008 within the framework of the Tromsø Study (N=10,765), a representative study of adult men and women in Norway. The association between CD and the physical health outcomes heart attack, angina pectoris, chronic bronchitis/emphysema/COPD, diabetes mellitus, hypothyroid/low metabolism, migraine, hypertension, and comorbidity (i.e., the sum of these physical health outcomes) was assessed with Poisson regression models. Relative risks (RR) and 95% confidence intervals (CI) were estimated. A wide range of indicators of respondents' current psychological state were included in the models to assess the % attenuation in estimates. **Results:** CD was associated with an increased risk of heart attack, angina pectoris, chronic bronchitis/emphysema/COPD, diabetes mellitus, hypothyroid/low metabolism, migraine, hypertension, and comorbidity ($p<0.05$), *independent* of respondents' current psychological state. A sizeable proportion (23-42%) of the association between CD and physical health outcomes was driven by recall bias or mediation via respondents' current psychological state. Controlling for indicators of current psychological state reduced the strength of associations between CD and physical health outcomes; however, the *independent* associations remained in the same direction. **Conclusion:** The association between retrospectively-reported CD and physical health outcomes in adulthood is not driven entirely by respondent's current psychological state.

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Keywords: childhood disadvantage; social epidemiology; social causation; life course; anchoring; recall bias; measurement error; differential error; non-differential error; reliability; validity

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Introduction

The association between retrospectively-reported childhood disadvantage (CD) and morbidity in adulthood is far from conclusive (Gerlsma et al., 1997; Kendall-Tackett and Becker-Blease, 2004; Pinto et al., 2014; Pinto and Maia, 2013; Raphael, 2005; Raphael et al., 2004; Reuben et al., 2016; Susser and Widom, 2012; Tietjen, 2010; White et al., 2007; Widom et al., 2004; Yarrow et al., 1970). However, since it is relatively easy and cost-effective to include indicators of CD in surveys, most studies have utilized retrospective reports of CD. Accordingly, a growing area of research has focused on quantifying measurement error (differential or non-differential) in survey research, and on the influence of such errors on the associations of interest (Fergusson et al., 2011; Fergusson et al., 2000; Gerlsma et al., 1997; Sheikh, 2018a; Smith, 2009; Vuolo et al., 2014).

The psychological state of respondents at the time of reporting (current psychological state) may confound the association between CD and morbidity in multiple ways, and the nature of these psychological processes (Aneshensel et al., 1987; Gilbert, 2006; Reuben et al., 2016; Smith, 2009) may determine the accuracy of the association between CD and morbidity (White et al., 2007; Widom et al., 2004). A key criticism of the observed association between CD and morbidity has been that it is an artefactual correlation driven by the current psychological state of the respondent via the "coloring" of responses (Havari and Mazzonna, 2015; Smith, 2009; Susser and Widom, 2012), influence of contemporary adaptation (Reuben et al., 2016), inaccuracy of memory (Parks and Balon, 1995), and biases in perception and retrieval (Gerlsma et al., 1997; Raphael et al., 2004; Widom et al., 2007; Widom et al., 2004).

Memory impairments (Bremner, 1999) and personality factors (Reuben et al., 2016) may affect recall in both directions (Femina et al., 1990; Parks and Balon, 1995; Widom et al., 2004). Previous evidence has suggested that recall bias is more of a concern among the

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mentally *healthy* than the *unhealthy*, as mentally healthy individuals tend to recall their childhood as better than it was (Brewin, 1988; Reuben et al., 2016; Taylor and Brown, 1988). Recall of CD may also be subject to mood-congruency bias, which may operate in unpredictable directions (Raphael and Cloitre, 1994; Singer and Salovey, 1988; Steele et al., 1980). Indeed, autobiographical memory is also reconstructive (Aneshensel et al., 1987; Bradburn et al., 1987; Gilbert, 2006; Matt et al., 1992; McFarland and Buehler, 1998; Offer et al., 2000; Ross, 1989).

Recent changes in psychopathology and symptomatology may provide a new anchor (Haas, 2007; von Fintel and Posel, 2016) for remembering and evaluating CD. For instance, people who have more problems in adulthood might report more problems when reflecting on their childhood (Susser and Widom, 2012, p. 674). Some evidence has suggested that individuals with very poor mental health in adulthood may better remember CD. If such coloring were sufficiently important, the relationship between childhood and adult health would flow through the mechanism of memory retrieval and attribution from the adult to childhood years (Smith, 2009, p. 398). Therefore, it is necessary to know whether the association between CD and morbidity is free from biases related to current psychological state (i.e, *independent* of respondents' mental health) (Gerlsma et al., 1997; Robins et al., 1985; Sheikh, 2018a; Widom et al., 2004).

Retrospectively-reported CD is an inherently subjective evaluation, and an individual's subjective threshold may change over time, with CD-related psychopathology and symptomatology waxing and waning over the life course (Deary et al., 2009; Sheikh, 2018a). Therefore, recall bias in the association between CD and morbidity may also differ by age group (Beckett et al., 2001; Beckett et al., 2000; Halverson, 1988; Havari and Mazzonna, 2015; Herzog and Rodgers, 1989; Lindsay et al., 2004). With time, respondents may remember their childhood as better than it was, or forget negative events (Bradburn et

al., 1987; Field, 1981; Lindsay et al., 2004; Williams, 1994); declines in memory (Bremner, 1999; Deary et al., 2009; Herzog and Rodgers, 1989; Lindsay et al., 2004) can result in unreliable reports of CD and lead to an under-estimation of associations among older respondents (Dube et al., 2004; Sheikh, 2018a; Williams, 1994). If the association between CD and morbidity declines with age, it could be interpreted as an increase in age-related non-differential recall errors [see also (Campbell et al., 2016)]. For instance, if non-differential measurement error increases with age, the observed association between CD and morbidity among older respondents would be biased towards the null (i.e., underestimated). An alternative explanation of the same pattern could be that more at risk/disadvantaged respondents died, leading to a selection bias in estimates (biased downwards).

Nonetheless, Hardt et al. argued that "The human memory system does not work like a tape recorder where aspects of the experiences simply fade over time" (Hardt et al., 2010, p. 425). Therefore, it could be that the process of re-weaving and re-constructing a memory of CD is colored by one's current psychological state (Aneshensel et al., 1987; Bradburn et al., 1987; Gilbert, 2006; Matt et al., 1992; McFarland and Buehler, 1998; Offer et al., 2000; Ross, 1989), rather than a decline in memory. However, the degree of decline in memory might be associated with current psychological state, which could lead to bias in unpredictable directions (Bower, 1981; Bremner, 1999; Hardt and Rutter, 2004; Lewinsohn and Rosenbaum, 1987; Matt et al., 1992; McFarland and Buehler, 1998; White et al., 2007). If younger, unhealthy respondents recall their childhood as worse than it was, and older, unhealthy respondents recall their childhood as better than it was (and vice-versa), the association between CD and morbidity among younger respondents would be stronger than that among older respondents (Sheikh, 2018a). Another explanation of the same pattern might be that CDs have more negative effects on health in young adulthood, and this influence diminishes with time (Campbell et al., 2016; Sheikh, 2018a). Social representation of certain

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CDs, such as childhood abuse, has also changed during the past decades, which in turn could affect the frequency with which they are reported. So far, there is no consensus between these explanations, and studies have shown mixed results (Beckett et al., 2000; Brown, 2013; Campbell et al., 2016; Haas, 2007; Hardt et al., 2010; Sheikh, 2018a; Strömgren, 1977).

Naturally, these concerns have led some researchers to say that recall is not dependable (Bradburn et al., 1987, p. 241), and their reports provide the rationale for suggesting that CD may not affect health at all; rather, it may be the respondent's current psychological state that drives the association. Several studies have shown that recall of CD is fairly reliable (Dube et al., 2004; Goodman et al., 2016; Havari and Mazzonna, 2015; Krieger et al., 1998; Robins et al., 1985; Ward, 2011). However, the factors that foster or impede recall of CD (Gerlsma et al., 1997; Hardt and Rutter, 2004) and affect the association between CD and morbidity have rarely been explored (Gerlsma et al., 1997; Sheikh, 2018a). If recall bias differs across age groups (Field, 1981; Halverson, 1988), one possibility is to control (Sheikh, 2018a) for a wide range of mental health indicators in the association between CD and morbidity in an attempt to block any systematic differences in evaluating and remembering childhood circumstances by age group or cohort. If the magnitude of the *independent* association between CD and morbidity in adulthood remains strong after controlling for indicators of current psychological state, it indicates that the association between CD and morbidity is not driven entirely by recall bias or mediation via mental health. However, if after controlling for these indicators the magnitude of the *independent* association is close to the null, it indicates that the association is driven primarily by recall bias or mediation via respondent's mental health.

Sheikh (2018a) assessed the *independent* association between childhood abuse and several physical health outcomes and found that up to 19% of the association is driven by the mental health of the respondent. However, only a single binary variable [prevalence of

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psychiatric problems (Sheikh, 2018e)] was used as an indicator of respondent's mental health (Sheikh, 2018a). An alternative explanation for the evidence on recall bias in cross-sectional studies is mediation, shared etiology, and affective/psychological states, i.e., psychogenic relations and psychological factors affecting physical health (Tietjen, 2010). CD may affect psychopathology (Sheikh, 2018b, c, e), which in turn may affect physical health outcomes (Mock and Arai, 2011; Scott et al., 2011; Scott et al., 2008). Indeed, indicators of mental health could very well be situated on the causal pathway between CD to adult physical health. One of the reasons that people exposed to CD might have poor physical health is that CD causes poor mental health that then leads to poor physical health. Some respondents may minimize or deny having experienced severe CD (Femina et al., 1990; Kuh and Ben-Shlomo, 2004; Sullivan, 1973). This conscious denial, subconscious repression, or dissociation (Memon and Young, 1997) may lead to unhealthy coping (Kendall-Tackett and Becker-Blease, 2004) and health-related lifestyle choices, which may increase the risk for several physical health outcomes (Lewis, 1995; Sheikh, 2018a). Several studies have explored this mediating mechanism (Mock and Arai, 2011; Scott et al., 2011; Scott et al., 2008), but the results of these studies should be interpreted with caution, given the stringent set of assumptions for assessing mediation. This does not mean that the underlying theory (i.e., the mediating role of psychopathology) may not be true; rather that the validity of these estimates and their causal interpretations are questionable. Nonetheless, the possibility of mediation prevents quantification of recall bias alone. In summary, the association between CD and morbidity in adulthood in cross-sectional population-based samples remains unclear (Sheikh, 2018a), particularly with reference to respondent's current psychological state and age.

In this study, we assessed 1) the association between CD and physical health outcomes, and; 2) the attenuation in these associations due to respondent's current psychological state.

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Methods

Study population

The Tromsø Study is a longitudinal prospective cohort study and its participants are considered representative of the adult population residing in the municipality of Tromsø (Jacobsen et al., 2012). The present analysis includes cross-sectional data collected for Tromsø VI in 2007-2008; 19,762 subjects were invited and 12,981 (65.7%) returned the questionnaire. To preserve temporality between CD and morbidity, respondents that reported a diagnosis of physical health outcomes before the age 18 years were excluded (n=2216). The remaining study sample (n=10,765) comprised participants aged 30-87 (mean: 57.5 years).

Ethical approval

This investigation was carried out in accordance with the latest version of the Declaration of Helsinki. The Tromsø Study has been approved by the Regional Committee for Medical and Health Research Ethics, the Data Inspectorate, and the Norwegian Directorate of Health. Written informed consent was obtained from all participants included in the study.

Study variables

Exposure (childhood disadvantage)

CD is defined as a conglomerate of factors that have been used in a similar manner in previous studies (Sheikh, 2018d). The present analysis used six indicators of retrospectively-reported CD (Sheikh, 2018b). Parental education was used as an indicator of social background in childhood (Sheikh, 2018b). Mother's and father's education were obtained on a 5-level scale: 1) college or university (4 years or more); 2) college or university (less than 4 years); 3) high school diploma; 4) vocational school or technical school; and 5) primary and

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secondary school or similar (i.e., 7-10 years of schooling), which was considered a CD. Childhood financial conditions was used as an indicator of economic background, and was obtained through the question: "How was your family's financial situation when you were a child?" Participants replied using a 4-point scale ranging from *very difficult* (1) to *very good* (4) (Sheikh, 2018a, b; Sheikh et al., 2018). Those who answered *difficult* or *very difficult* were considered to have this CD. The test-retest reliability of childhood financial conditions was good ($Kappa_{weighted}$: 0.61, 95% confidence interval [CI] 0.59; 0.63) in the Tromsø Study (Sheikh, 2018d). Information on adverse childhood experiences were obtained through the question: "Have you over a long period experienced any of the following as a child?: (i) being tormented or threatened with violence; (ii) being beaten, kicked, or the victim of other types of violence; and (iii) someone in your close family using alcohol or drugs in such a way that caused you worry. Each of these adverse childhood experiences was considered a CD (Sheikh, 2018d). The internal reliability of these adverse childhood experiences was good in the Tromsø Study (Sheikh, 2018a). A composite variable was then constructed as the sum of all six CDs, thus scores ranged from 0 to 6 (mean: 1.92, standard deviation [SD]: 1.22).

Outcome (morbidity)

Self-reported diagnoses of physical health outcomes in the Tromsø Study are valid (Engstad et al., 2000; Falkegård et al., 2015). For instance, previous evidence showed that 79.2% of self-reported stroke corresponds with clinical examination [positive predictive value (PPV) = 0.79; specificity = 99%] (Engstad et al., 2000). However, self-reported hypertension had a PPV of 0.80 (Falkegård et al., 2015).

The questions on self-reported diagnosis of 12 physical health outcomes: heart attack, angina pectoris, stroke/brain hemorrhage, atrial fibrillation, osteoporosis, asthma, chronic bronchitis/emphysema/COPD, diabetes mellitus, hypothyroid/low metabolism, kidney

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disease (excluding urinary tract infection), migraine, and hypertension, were included in the questionnaire. Participants completed a separate question for each physical health outcome, as follows: “Do you have, or have you had [physical health outcome]?” A comorbidity variable was then constructed as the sum of the twelve physical health outcomes (mean: 0.77, SD: 0.99).

Indicators of current psychological state

Current psychological state was assessed by several questions on anxiety; depression; insomnia; psychological distress; use of sleeping pills, antidepressants, and tranquilizers; memory problems; and prevalence of psychiatric problems. Anxiety and depression was measured by a question with three response alternatives (1=I am not anxious or depressed, 2=I am somewhat anxious or depressed, 3=I am very anxious or depressed). Depression was also measured by the question: “Have you been feeling unhappy and depressed during the past two weeks?”, with four possible responses (1=not at all, 2=no more than usual, 3= rather more than usual, 4=much more than usual). Psychological distress was measured using the Hopkins Symptom Checklist (HSCL-10) (Sheikh, 2018b; Sheikh et al., 2018). The HSCL-10 consists of 10 items on a four-point scale, ranging from *not at all* (1) to *extremely* (4). The HSCL-10 had an acceptable degree of internal consistency in this sample (Cronbach’s alpha: 0.89, mean inter-item correlation: 0.42, McDonald’s omega coefficient for composite reliability: 0.90). An HSCL-10 score between 10 and 40 was calculated by summing the 10 indicators, where 40 represented the highest and 10 represented the lowest score for psychological distress (mean: 12.78, SD: 3.60). Sleeping difficulty was measured by the question: “Have you had difficulty sleeping during the past couple of weeks?” (1=not at all, 2=no more than usual, 3=rather more than usual, 4=much more than usual). Insomnia was measured by the question: “How often do you suffer from sleeplessness?” (1=never, or just a

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few times a year, 2=1-3 times a month, 3=approximately once a week, 4=more than once a month). Consultation with a psychiatrist was measured by the question: "Have you during the past year visited a psychiatrist?" (0=no, 1=yes). Use of sleeping pills, antidepressants and tranquilizers was measured by three separate questions: "How often have you used sleeping pills/antidepressants/tranquilizers during the last 4 weeks?" (1=not used, 2=less frequently than every week, 3=every week, but not daily, 4=daily). Forgetfulness was measured by the question: "Do you often forget where you have placed your things?" (0=no, 1=yes), and decline in memory was measured by the question: "Has your memory declined?" (0=no, 1=yes). Memory examination was measured by the question: "Have you been examined for memory problems?" (0=no, 1=yes). Prevalence of psychiatric problems was measured by the question: "Do you have, or have you had psychiatric problems?" (0=no, 1=yes) (Sheikh, 2018e).

Confounding variables

The potential confounding variables age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach/duodenal ulcer, asthma, diabetes, and dementia were chosen based on *a priori* knowledge of the association between the exposures and outcomes under study (Sheikh, 2018a, b, c, d, e; Sheikh et al., 2014, 2016; Sheikh et al., 2018). Valid information on age and sex was obtained from Statistics Norway by using the unique personal identification number of each participant.

Statistical Analysis

All statistical analyses were conducted using Stata version 15. Missing values were generated with multiple imputation (with chained equations) to avoid any bias in the association of

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interest introduced by excluding individuals with missing data. A comparison between the complete-case (excluding missing) and the imputed dataset is presented with proportions (%), and mean (standard error, SE). We estimated Pearson product-moment correlations between indicators of CD (see eTable 1), and between physical health outcomes (see eTable 2). Statistically significant ($p<0.05$) multiplicative interactions were observed between CD and age, regressed on hypertension and comorbidity. Therefore, estimates for the association between CD and hypertension and that between CD and comorbidities were stratified into tertiles of age. No statistically significant multiplicative interactions between CD and sex were observed; therefore, estimates are provided for men and women combined. The association between tertile age groups and CD, comorbidity, and indicators of mental health were assessed by Poisson regression models and ordinary least square regression models (Sheikh, 2018a; Sheikh et al., 2018). Incidence rate ratios, relative risks (RRs), ordinary least square estimates (β) and corresponding 95% CIs are presented. The associations between CD and heart attack, angina pectoris, chronic bronchitis/emphysema/COPD, diabetes mellitus, and migraine were assessed with Poisson regression models (Sheikh, 2018a; Sheikh et al., 2018). Both the unadjusted (crude) and adjusted estimates are presented. The associations between CD, and hypertension and comorbidity, stratified by tertile age groups, were assessed with Poisson regression models (Sheikh, 2018a; Sheikh et al., 2018). No statistically significant ($p<0.05$) associations between CD and stroke/brain hemorrhage, atrial fibrillation, osteoporosis, asthma, or kidney disease were observed; therefore, these associations are not presented.

Assessing recall bias and mediation via respondent's current psychological state

Recall bias and mediation via respondent's current psychological state was assessed with the difference-in-coefficients method (Sheikh, 2018b, e). No statistically significant

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multiplicative interactions between CD and indicators of respondent's current psychological state were observed in this sample. Indicators of current psychological state were included in the models to assess the attenuation in estimates, and % attenuation between estimates. If indicators of current psychological state confound or mediate the association between CD and physical health outcomes, the effects of CD should decline when they are added to the models (Sheikh, 2018b, e). SEs were derived with bias-corrected bootstrapping for hypothesis testing, and 95% CIs are presented (Sheikh, 2018b, e).

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Results

The percentage of missing information for each variable was as follows: mother's education (9.5%), father's education (10.6%), childhood financial conditions (7.3%), childhood disadvantage (11.4%), heart attack (0.9%), angina pectoris (1.2%), stroke/brain hemorrhage (1.2%), atrial fibrillation (2.0%), osteoporosis (1.3%), asthma (1.1%), chronic bronchitis/emphysema/COPD (1.2%), diabetes mellitus (0.9%), hypothyroid/low metabolism (1.8%), kidney disease (excluding urinary tract infection) (1.2%), migraine (1.2%), hypertension (1.1%), and comorbidity (6.5%).

The majority of our 10,765 respondents were over 50 years old (66.8%), and 51.1% were women (Table 1). Among parental outcomes, angina pectoris (22.0%) and cerebral stroke/brain hemorrhage (22.0%) were most prevalent; psychiatric problems (7.9%) and osteoporosis (9.0%) were the least prevalent (Table 1). Over 2.3% of the respondents reported having a consultation with a psychiatrist during the past year, and 9.1% reported psychiatric problems over the course of life (Table 1). The average number of CDs among respondents was almost 2, and the average number of physical health outcomes was 0.8 (Table 1). The prevalence of physical health outcomes were: 5.2% for heart attack, 4.7% for angina pectoris, 2.5% for stroke/brain hemorrhage, 5.4% for atrial fibrillation, 3.5% for osteoporosis, 5.4% for asthma, 2.5% for chronic bronchitis/emphysema/COPD, 4.5% for diabetes mellitus, 7.5% for hypothyroid/low metabolism, 2.3% for kidney disease, 7.0% for migraine, and 26.3% for hypertension (Table 1). Indicators of CD were significantly associated with each other (see eTable 1).

Compared to respondent's aged 30-50 years, older respondents reported more CDs and more comorbidities ($p<0.05$) (Table 2). Similarly, older age was associated ($p<0.05$) with increased levels of self-reported depression, psychological distress, sleeping difficulty, insomnia, forgetfulness, and decline in memory (Table 2). Moreover, older respondents were

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more likely to report the use of sleeping pills, antidepressants, and tranquilizers ($p<0.05$) (Table 2).

Adjusted for age, sex, and parental history of health outcomes, CD was not significantly associated with stroke (p=0.592), atrial fibrillation (p=0.745), osteoporosis (p=0.276), asthma (p=0.272), and kidney disease (p=0.466) in this study sample. CD was associated with a 12% increased risk of heart attack (RR=1.12, 95% CI: 1.11-1.15), a 13% increased risk of angina pectoris (RR=1.13, 95% CI: 1.06-1.23), a 25% increased risk of chronic bronchitis/emphysema/COPD (RR=1.25, 95% CI: 1.11-1.42), a 12% increased risk of diabetes mellitus (RR=1.12, 95% CI: 1.05-1.24), and an 11% ($p<0.05$) increased risk of hypothyroid/low metabolism and migraine (Table 3). Controlling for indicators of current psychological state significantly reduced the strength of the associations between CD and physical health outcomes; however, the *independent* associations remained in the same direction (Table 3). The % attenuation in the estimate of CD after controlling for current psychological state was 27.41% for heart attack (95% CI: 14.68-43.80), 42.44% for angina pectoris (95% CI: 24.32-89.01), 35.44% for chronic bronchitis/emphysema/COPD (95% CI: 25.23-53.90), 23.27% for diabetes mellitus (95% CI: 10.91-51.89), 27.48% for hypothyroid/low metabolism (95% CI: 13.68-62.82), and 32.80% for migraine (95% CI: 18.31-62.47) (Table 3).

Stratifying the association between CD and hypertension, and between CD and comorbidity by tertile age groups showed three patterns. First, the associations for comorbidity were strongest among the youngest respondents, and weakest among the oldest respondents (Table 4). This pattern persisted even after controlling for indicators of current psychological state (Table 4). Second, stratifying the % attenuation estimates by tertile age groups for hypertension did not show a clear pattern (Table 4). The % attenuation in the association between CD and hypertension after controlling for indicators of current

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psychological state was 22.62% for respondents aged 30-50 years (95% CI: 9.34-56.13), 31.24% for respondents aged 51-63 years of age (95% CI: 12.34-87.67), and 21.24% for respondents aged 64-87 years of age (95% CI: 4.73-67.84) (Table 4). Third, stratifying the association between CD and comorbidity by tertile age groups showed that the magnitude of % attenuations increased with age. Accordingly, the % attenuation estimates were weakest in the youngest age group, while they were strongest for oldest age group (Table 4). The % attenuation in the association between CD and comorbidity after controlling for indicators of current psychological state were 31.35% for respondents aged 30-50 years (95% CI: 18.78-49.17), 39.78% for respondents aged 51-63 years of age (95% CI: 25.02-59.27), and 50.40% for respondents aged 64-87 years of age (95% CI: 25.93-71.83) (Table 4).

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Discussion

The objective of this study was to examine whether participants' "current psychological state" significantly affects the association between recalled CD and adult morbidity in a cross-sectional sample of the general Norwegian population. The results showed that the inclusion of indicators of current psychological state attenuated the relationship between CD and morbidity, which suggests a potential upward bias in estimates if these indicators had not been included in the models. However, the results of this study do not support the claim that the association between retrospectively-reported CD and physical health outcomes is an artefactual association driven by a respondents' current psychological state. The % attenuations represent recall bias and mediation; although, the design of the study does not allow us to separate these mechanisms.

Although ours is not the first study to examine the indirect validity, recall bias, or mediation via mental health (Gerlsma et al., 1997; Hardt et al., 2010; Robins et al., 1985; Sheikh, 2018a; von Fintel and Posel, 2016) in the association between CD and morbidity, the present study offered two advantages. First, we assessed the *independent* associations in a large representative sample of adult men and women, which facilitated the stratification of results by tertile age groups (Lindsay et al., 2004). Second, we assessed the *independent* association between CD and a wide range of physical health outcomes in adulthood.

Age was associated with CD, comorbidity in adulthood, and increased levels of psychological symptoms in adulthood. However, it is interesting to note that the magnitude of the % attenuation increased with age for comorbidity, but not for hypertension. Widom et al. (2004) speculated that reliability of certain retrospectively-reported CDs is high at older ages because at that time the memory of one's life story is well-established. If that were true, the % attenuation estimates (recall bias due to respondents' psychological state) would be close to null at older ages, which was not the case in this study [see also (Campbell et al., 2016;

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Sheikh, 2018a)]. A plausible explanation for this pattern may be that older respondents with poor mental health may over-report certain disease diagnoses and remember their childhood to be worse than it was (or vice-versa). Therefore, recall bias may artificially inflate, as comorbidity in this study was constructed as the sum of physical health outcomes. However, this inflation or accumulation of bias may only apply to certain respondents (Raphael, 2005; Reuben et al., 2016) or outcomes. Since older respondents are more likely to have multiple physical health conditions, an accumulation of these biases (by summing the number of physical health outcomes) may result in a higher % attenuation in this subgroup. However, this accumulation does not occur for individual physical health outcomes (e.g., hypertension); consequently, the % attenuations do not increase with age.

No statistically significant associations between CD and stroke, atrial fibrillation, osteoporosis, asthma, or kidney disease were observed in this sample; therefore, it is plausible that the association between CD and comorbidity may be biased. We performed sensitivity analyses by constructing a comorbidity variable that did not include stroke, atrial fibrillation, osteoporosis, asthma, or kidney disease, and assessed its association with CD (see eTable 3). No statistically significant multiplicative interaction between CD and age was observed for this 'selective' comorbidity variable; therefore, the estimates were not stratified by age groups. However, the associations and % attenuation in these estimates remained in similar direction (see eTable 3). Independent associations between each CD and physical health outcomes have been shown in earlier studies based on data from the Tromsø Study (Sheikh, 2018a, c).

The findings of this study suggest that some of the effect of CD on morbidity is driven by recall bias and mediation by respondent's psychopathology. However, some alternative explanations should be considered for the interpretation of these findings. The first is that there is considerable measurement error in the CD reports (Dube et al., 2004; Hardt et al.,

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2010), and by controlling for current psychological state, the correlation between the measurement error in the CD variable and the true value of this variable is controlled. The individual components of CD score were summed after they were each dichotomized, leading to a loss of information for each component. The CD measure included variables that vary considerably with respect to whether they invite interpretation that might foster recall bias. For instance, the questions used to measure substance abuse distress included "…caused you to worry", which builds the possibility for subjectivity into the question. A person who worries a lot might also worry about their relative's substance use and respond "yes." However, someone who is not a worrier might say "no", even with the same level of exposure to drugs and alcohol in a relative.

The second alternative explanation is somatogenic relations, i.e., physical health/morbidity affecting psychological state. Suffering from chronic physical conditions may pose considerable indirect risks to one's psychological state via economic hardship and other psychosocial factors (Pan et al., 2010). Among chronically ill respondents with an everyday experience of distressing symptoms, it is plausible that this physical distress can contribute spurious covariation to the CD-morbidity association. For example, Jorgensen et al. (1996) found that blood pressure levels is negatively associated with affectivity symptoms among subjects without an awareness of the disease, but positively associated among those who are aware of the disease. These findings suggest that awareness of diagnostic status may impact on the reporting of negative affectivity, which may extend beyond hypertension (Jorgensen et al., 1996).

The % attenuation in the estimates suggests that a sizeable proportion, though not major, of the associations between CD and morbidity are driven by current psychological state. Controlling for current psychological state in the models attenuated these estimates, but it did not eliminate the effect of CD on morbidity. Therefore, it is particularly important to

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note that if the magnitude of association between CD and morbidity is small, then the results (and consequently the inferences) should be interpreted cautiously. Since the present study had a cross-sectional design, there was a potential for upward bias in estimates due to shared-method variance that cannot be ignored. Indeed, the design of this study is correlational. In must be noted that most of the indicators of current psychological state in this study represented symptomatology over the past few weeks; therefore, the temporality between psychological state and physical health outcomes cannot be assumed with certainty.

In summary, the results of this study showed that the association between CD and physical health outcomes in adulthood is not driven entirely by recall bias or mediation via respondent's psychological state in a large cross-sectional sample of adults in Norway. These findings imply that retrospective data do not produce artefactual correlations with respect to the *direction* of associations between CD and morbidity in adulthood.

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Table 1. General characteristics of the study sample (N=10,765).

		Complete-case data	Imputed data
		n (%)	%
Age (mean: 57.5, standard deviation: 12.6)	30-50 years	3569 (33.2)	-[b]
	51-63 years	3554 (33.0)	-[b]
	64-87 years	3642 (33.8)	-[b]
Sex	Male	5268 (48.9)	-[b]
	Female	5497 (51.1)	-[b]
Parental history of psychopathology	Yes	846 (7.9)	-[b]
Parental history of heart attack	Yes	1528 (14.2)	-[b]
Parental history of angina pectoris	Yes	2370 (22.0)	-[b]
Parental history of cerebral stroke/brain hemorrhage	Yes	2225 (20.7)	-[b]
Parental history of osteoporosis	Yes	969 (9.0)	-[b]
Parental history of stomach or duodenal ulcer	Yes	1588 (14.8)	-[b]
Parental history of asthma	Yes	1164 (10.8)	-[b]
Parental history of diabetes mellitus	Yes	1617 (15.0)	-[b]
Parental history of dementia	Yes	1167 (10.8)	-[b]
Anxiety and depression [a]	Mean (SE)	1.2 (0.01)	1.2 (0.01)
Depression [a]	Mean (SE)	1.5 (0.01)	1.5 (0.01)
Psychological distress (HSCL-10) [a]	Mean (SE)	12.6 (0.04)	12.8 (0.04)
Sleeping difficulty [a]	Mean (SE)	1.6 (0.01)	1.6 (0.01)
Insomnia [a]	Mean (SE)	1.6 (0.01)	1.6 (0.01)
Consultation with psychiatrist [a]	Yes	238 (2.3)	2.3
Use of sleeping pills [a]	Mean (SE)	1.2 (0.01)	1.2 (0.01)
Use of antidepressants [a]	Mean (SE)	1.1 (0.01)	1.1 (0.01)
Use of tranquilizers [a]	Mean (SE)	1.1 (0.01)	1.1 (0.01)
Forgetfulness [a]	Yes	2540 (25.9)	26.3
Decline in memory [a]	Yes	4869 (49.2)	49.5
Memory examination [a]	Yes	112 (1.1)	1.2
Prevalence of psychiatric problems [a]	Yes	961 (9.1)	9.1
Childhood disadvantage [a, c]	Mean (SE)	1.9 (0.01)	1.9 (0.01)
Heart attack	Yes	542 (5.1)	5.2
Angina pectoris	Yes	484 (4.6)	4.7
Stroke/brain hemorrhage	Yes	259 (2.4)	2.5
Atrial fibrillation	Yes	549 (5.2)	5.4
Osteoporosis	Yes	362 (3.4)	3.5
Asthma	Yes	571 (5.4)	5.4
Chronic bronchitis/emphysema/COPD	Yes	254 (2.4)	2.5
Diabetes mellitus	Yes	476 (4.5)	4.5
Hypothyroid/low metabolism	Yes	784 (7.4)	7.5
Kidney disease (excluding urinary tract infection)	Yes	240 (2.3)	2.3
Migraine	Yes	745 (7.0)	7.0
Hypertension	Yes	2788 (26.2)	26.3
Comorbidity [a, d]	Mean (SE)	0.7 (0.01)	0.8 (0.01)

[a] The numbers for some variables do not add up to 10,765 due to missing values.
[b] There were no missing values, so no imputations were made for these variables.
[c] The six childhood disadvantages considered were: low mother's and father's education (parental primary and secondary school or similar), difficult or very difficult subjective childhood financial conditions, psychological abuse, physical abuse, and substance abuse distress in childhood.
[d] The twelve physical health outcomes considered were: heart attack, angina pectoris, stroke/brain hemorrhage, atrial fibrillation, osteoporosis, asthma, chronic bronchitis/emphysema/COPD, diabetes mellitus, hypothyroid/low metabolism, kidney disease (excluding urinary tract infection), migraine, and hypertension.
SE: standard error; HSCL-10: Hopkins Symptom Check List-10.

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Table 2. Association between age and covariates.

	Age: 30-50 years	Age: 51-63 years		Age: 64-87 years	
		Unadjusted	Adjusted [c]	Unadjusted	Adjusted [c]
	ref	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**
Childhood disadvantage [a]	ref	1.62 (1.53, 1.71)	1.62 (1.54, 1.72)	1.81 (1.72, 1.91)	1.87 (1.77, 1.97)
		IRR (95% CI)	**IRR (95% CI)**	**IRR (95% CI)**	**IRR (95% CI)**
Comorbidity [b]	ref	1.41 (1.36, 1.47)	1.41 (1.36, 1.47)	2.45 (2.34, 2.57)	2.49 (2.38, 2.61)
		β (95% CI)	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
Anxiety and depression	ref	0.01 (-0.01, 0.03)	0.01 (-0.01, 0.03)	0.01 (-0.01, 0.03)	0.02 (0.01, 0.04)
Depression	ref	-0.02 (-0.05, 0.01)	-0.02 (-0.05, 0.01)	-0.06 (-0.09, -0.02)	-0.04 (-0.07, -0.01)
Psychological distress (HSCL-10)	ref	0.04 (-0.14, 0.21)	0.06 (-0.12, 0.24)	-0.17 (-0.34, 0.00)	-0.03 (-0.20, -0.14)
Sleeping difficulty	ref	0.05 (0.02, 0.09)	0.05 (0.02, 0.09)	0.08 (0.05, 0.12)	0.10 (0.06, 0.13)
Insomnia	ref	0.18 (0.14, 0.23)	0.19 (0.14, 0.23)	0.23 (0.18, 0.28)	0.25 (0.21, 0.30)
		RR (95% CI)	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**
Consultation with psychiatrist	ref	0.98 (0.98, 0.99)	0.99 (0.98, 0.99)	0.98 (0.97, 0.98)	0.98 (0.97, 0.99)
		β (95% CI)	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
Use of sleeping pills	ref	0.10 (0.08, 0.13)	0.10 (0.07, 0.12)	0.22 (0.19, 0.24)	0.21 (0.18, 0.23)
Use of antidepressants	ref	0.02 (0.01, 0.04)	0.03 (0.01, 0.05)	0.04 (0.02, 0.06)	0.05 (0.03, 0.07)
Use of tranquilizers	ref	0.03 (0.02, 0.05)	0.04 (0.02, 0.06)	0.07 (0.05, 0.09)	0.08 (0.06, 0.10)
		RR (95% CI)	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**
Forgetfulness	ref	1.07 (1.05, 1.09)	1.07 (1.05, 1.09)	1.20 (1.17, 1.22)	1.20 (1.18, 1.23)
Decline in memory	ref	1.21 (1.18, 1.23)	1.20 (1.17, 1.23)	1.39 (1.36, 1.42)	1.40 (1.37, 1.43)
Memory examination	ref	1.01 (1.01, 1.01)	1.01 (1.01, 1.01)	1.01 (1.01, 1.02)	1.01 (1.01, 1.02)

[a] The six childhood disadvantages considered were: low mother's and father's education (parental primary and secondary school or similar), difficult or very difficult subjective childhood financial conditions, psychological abuse, physical abuse, and substance abuse distress in childhood.

[b] The twelve physical health outcomes considered were: heart attack, angina pectoris, stroke/brain hemorrhage, atrial fibrillation, osteoporosis, asthma, chronic bronchitis/emphysema/COPD, diabetes mellitus, hypothyroid/low metabolism, kidney disease (excluding urinary tract infection), migraine, and hypertension.

[c] Adjusted for age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach or duodenal cancer, asthma, and diabetes mellitus.

RR: relative risk; IRR: incidence risk ratio; CI: confidence interval; HSCL-10: Hopkins Symptom Check List-10.

Table 3. Influence of respondents' current psychological state on the association between childhood disadvantage and physical health outcomes.

	Heart attack			
	Adjusted for confounding variables	Model 1+indicators of mental health	Difference between Model 1 and Model 2	% attenuation between Model 1 and Model 2
	Model 1 [b]	Model 2 [c]	$e^{\beta_{Model\ 1}-\beta_{Model\ 2}}$	$e^{(\beta_{Model\ 1}-\beta_{Model\ 2})/100}$
	RR (95% CI)	RR (95% CI)	RR (95% CI)	% (95% CI)
Childhood disadvantage [a]	1.12 (1.11, 1.15)	1.08 (1.07, 1.10)	1.03 (1.02, 1.04)	27.41 (14.68, 43.80)
	Angina pectoris			
	1.13 (1.06, 1.23)	1.07 (1.01, 1.16)	1.05 (1.03, 1.08)	42.44 (24.32, 89.01)
	Chronic bronchitis/emphysema/COPD			
	1.25 (1.11, 1.42)	1.15 (1.05, 1.29)	1.08 (1.06, 1.12)	35.44 (25.23, 53.90)
	Diabetes mellitus			
	1.12 (1.05, 1.24)	1.09 (1.02, 1.19)	1.03 (1.01, 1.04)	23.27 (10.91, 51.89)
	Hypothyroid/low metabolism			
	1.11 (1.04, 1.18)	1.08 (1.02, 1.15)	1.03 (1.02, 1.04)	27.48 (13.68, 62.82)
	Migraine			
	1.11 (1.06, 1.18)	1.08 (1.02, 1.14)	1.04 (1.02, 1.05)	32.80 (18.31, 62.47)

[a] The six childhood disadvantages considered were: low mother's and father's education (parental primary and secondary school or similar), difficult or very difficult subjective childhood financial conditions, psychological abuse, physical abuse, and substance abuse distress in childhood.

[b] Adjusted for age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach or duodenal cancer, asthma, and diabetes mellitus.

[c] Adjusted for age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach or duodenal cancer, asthma, and diabetes mellitus + anxiety and depression, depression, psychological distress (HSCL-10), sleeping difficulty, insomnia, consultation with psychiatrist, use of sleeping pills, use of antidepressants, use of tranquilizers, forgetfulness, decline in memory, and memory examination.

RR: relative risk; CI: confidence interval.

Table 4. Influence of respondents' current psychological state on the association between childhood disadvantage, and hypertension and comorbidity.

			Hypertension			
			Adjusted for confounding variables	Model 1+ indicators of mental health	Difference between Model 1 and Model 2	% attenuation between Model 1 and Model 2
			Model 1 [c]	Model 2 [d]	$e^{\beta_{Model\ 1}-\beta_{Model\ 2}}$	$e^{(\beta_{Model\ 1}-\beta_{Model\ 2})/100}$
			RR (95% CI)	RR (95% CI)	RR (95% CI)	% (95% CI)
Childhood disadvantage [a]	Age 30-50 years	N=3569	1.13 (1.05, 1.20)	1.10 (1.02, 1.18)	1.03 (1.01, 1.05)	22.62 (9.34, 56.13)
	Age 51-63 years	N=3554	1.07 (1.02, 1.12)	1.05 (1.00, 1.10)	1.02 (1.01, 1.03)	31.14 (12.34, 87.67)
	Age 64-87 years	N=3642	1.05 (1.01, 1.09)	1.04 (1.01, 1.07)	1.01 (1.01, 1.02)	21.24 (4.73, 67.84)
			Comorbidity [b]			
			IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	% (95% CI)
	Age 30-50 years	N=3569	1.13 (1.07, 1.18)	1.08 (1.03, 1.13)	1.04 (1.02, 1.05)	31.35 (18.78, 49.17)
Childhood disadvantage [a]	Age 51-63 years	N=3554	1.11 (1.06, 1.15)	1.07 (1.02, 1.10)	1.04 (1.03, 1.06)	39.78 (25.02, 59.27)
	Age 64-87 years	N=3642	1.04 (1.01, 1.08)	1.02 (0.99, 1.05)	1.02 (1.01, 1.03)	50.40 (25.93, 71.83)

[a] The six childhood disadvantages considered were: low mother's and father's education (parental primary and secondary school or similar), difficult or very difficult subjective childhood financial conditions, psychological abuse, physical abuse, and substance abuse distress in childhood.
[b] The twelve physical health outcomes considered were: heart attack, angina pectoris, stroke/brain hemorrhage, atrial fibrillation, osteoporosis, asthma, chronic bronchitis/emphysema/COPD, diabetes mellitus, hypothyroid/low metabolism, kidney disease (excluding urinary tract infection), migraine, and hypertension.
[c] Adjusted for age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach or duodenal cancer, asthma, and diabetes mellitus.
[d] adjusted for age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach or duodenal cancer, asthma, and diabetes mellitus + Anxiety and depression, depression, psychological distress (HSCL-10), sleeping difficulty, insomnia, consultation with psychiatrist, use of sleeping pills, use of antidepressants, use of tranquilizers, forgetfulness, decline in memory, and memory examination.
RR: relative risk; IRR: incidence risk ratio; CI: confidence interval.

eTable 1. Bivariate Pearson product-moment correlations between indicators of childhood disadvantage (n=10,765)

	1	2	3	4	5	6
	r	r	r	r	r	r
1. Mother's education	1.00					
2. Father's education	0.61 [c]	1.00				
3. Childhood financial conditions	-0.19 [c]	-0.24 [c]	1.00			
4. Psychological abuse	-0.06 [c]	-0.05 [c]	-0.11 [c]	1.00		
5. Physical abuse	-0.04 [b]	-0.04 [c]	-0.09 [c]	0.51 [c]	1.00	
6. Substance abuse distress	-0.02 [a]	-0.04 [b]	-0.09 [c]	0.16 [c]	0.14 [c]	1.00

[a]p<0.05
[b]p<0.01
[c]p<0.001

eTable 2. Bivariate Pearson product-moment correlations between physical health outcomes (n=10,765)

	1	2	3	4	5	6	7	8	9	10	11	12
	r	r	r	r	r	r	r	r	r	r	r	r
1. Heart attack	1.00											
2. Angina pectoris	0.34 [d]	1.00										
3. Stroke/brain hemorrhage	0.08 [d]	0.11 [d]	1.00									
4. Atrial fibrillation	0.13 [d]	0.18 [d]	0.11 [d]	1.00								
5. Osteoporosis	0.04 [c]	0.02 [a]	0.05 [d]	0.05 [d]	1.00							
6. Asthma	0.01	0.02	0.02	0.03 [b]	0.07 [d]	1.00						
7. Chronic bronchitis/emphysema/COPD	0.08 [d]	0.09 [d]	0.07 [d]	0.08 [d]	0.09 [d]	0.24 [d]	1.00					
8. Diabetes mellitus	0.09 [d]	0.10 [d]	0.08 [d]	0.06 [d]	0.01	0.02	0.03 [c]	1.00				
9. Hypothyroid/low metabolism	0.02 [b]	0.05 [d]	0.01	0.05 [d]	0.06 [d]	0.03 [c]	0.03 [c]	0.03 [b]	1.00			
10. Kidney disease	0.07 [d]	0.05 [d]	0.03 [c]	0.03 [b]	0.01	0.03 [c]	0.04 [c]	0.03 [c]	0.01	1.00		
11. Migraine	-0.03 [b]	-0.01	-0.01	-0.01	0.04 [d]	0.05 [d]	0.02 [a]	-0.03 [c]	0.03 [c]	0.06 [d]	1.00	
12. Hypertension	0.12 [d]	0.12 [d]	0.13 [d]	0.12 [d]	0.07 [d]	0.05 [d]	0.04 [d]	0.18 [d]	0.06 [d]	0.05 [d]	0.03 [c]	1.00

[a]p<0.1
[b]p<0.05
[c]p<0.01
[d]p<0.001

eTable 3. Influence of respondents' current psychological state on the association between childhood disadvantage and comorbidity.

	Comorbidity [b]			
	Adjusted for confounding variables	Model 1+ indicators of mental health	Difference between Model 1 and Model 2	% attenuation between Model 1 and Model 2
	Model 1 [c]	Model 2 [d]	$e^{\beta Model\ 1-\beta Model\ 2}$	$e^{(\beta Model\ 1-\beta Model\ 2)/100}$
	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	% (95% CI)
Childhood disadvantage [a]	1.10 (1.08, 1.13)	1.07 (1.05, 1.10)	1.03 (1.02, 1.03)	28.10 (20.96, 36.62)

[a] The six childhood disadvantages considered were: low mother's and father's education (parental primary and secondary school or similar), difficult or very difficult subjective childhood financial conditions, psychological abuse, physical abuse, and substance abuse distress in childhood.
[b] The seven physical health outcomes considered were: heart attack, angina pectoris, chronic bronchitis/emphysema/COPD, diabetes mellitus, hypothyroid/low metabolism, hypertension, and migraine.
[c] Adjusted for age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach or duodenal cancer, asthma, and diabetes mellitus.
[d] adjusted for age, sex, parental history of psychopathology, heart attack, angina pectoris, cerebral stroke/brain hemorrhage, osteoporosis, stomach or duodenal cancer, asthma, and diabetes mellitus + Anxiety and depression, depression, psychological distress (HSCL-10), sleeping difficulty, insomnia, consultation with psychiatrist, use of sleeping pills, use of antidepressants, use of tranquilizers, forgetfulness, decline in memory, and memory examination.
IRR: incidence risk ratio; CI: confidence interval.