

Research Article

PERSONALITY AND DEPRESSIVE SYMPTOMS: INDIVIDUAL PARTICIPANT META-ANALYSIS OF 10 COHORT STUDIES

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Background: *Personality is suggested to be a major risk factor for depression but large-scale individual participant meta-analyses on this topic are lacking.* **Method:** *Data from 10 prospective community cohort studies with 117,899 participants (mean age 49.0 years; 54.7% women) were pooled for individual participant meta-analysis to determine the association between personality traits of the five-factor model and risk of depressive symptoms.* **Results:** *In cross-sectional analysis, low extraversion (pooled standardized regression coefficient (B) = −.08; 95% confidence interval = −0.11, −0.04), high neuroticism (B = .39; 0.32, 0.45), and low conscientiousness (B = −.09; −0.10, −0.06) were associated with depressive symptoms. Similar associations were observed in longitudinal analyses adjusted for baseline depressive symptoms (n = 56,735; mean follow-up of 5.0 years): low extraversion (B = −.03; −0.05, −0.01), high neuroticism (B = .12; 0.10, 0.13), and low conscientiousness (B = −.04; −0.06, −0.02) were associated with an increased risk of depressive symptoms at follow-up. In turn, depressive symptoms were associated with personality change in extraversion (B = −.07; 95% CI = −0.12, −0.02), neuroticism (B = .23; 0.09, 0.36), agreeableness (B = −.09; −0.15, −0.04), conscientiousness (B = −.14; −0.21, −0.07), and openness to experience (B = −.04; −0.08, 0.00).* **Conclusions:** *Personality traits are prospectively associated with the development of depressive symptoms. Depressive symptoms, in turn, are associated with changes in personality that may be temporary or persistent.* *Depression and Anxiety 32:461–470, 2015.* © 2015 Wiley Periodicals, Inc.

Key words: *depressive disorders; psychiatric epidemiology; depression risk; personality; publication bias; neuroticism; prospective studies*

INTRODUCTION

Depression is a highly prevalent and often long-term mental disorder reducing quality of life and causing increased health care costs, loss of productive working days, and disability.^[1] Although the etiology of depression is multifactorial, personality is among the important characteristics that have been hypothesized to predict depression. In addition, personality dysfunction has been associated with poor outcome of depression,

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increased risk of suicide, and extensive use of treatment.^[2,3] Different personality traits have been associated with depressive disorders, for example, major depressive disorder (MDD), and depressive symptoms,^[4-6] and at least six theoretical models (i.e., common cause, spectrum, vulnerability, precursor, pathoplasty, and scar) have been proposed to explain these associations.^[7-11] However, it has been argued that research in this field may be biased in favor of publishing positive results.^[12,13] Thus, published evidence may have overestimated the strength of the personality–depression association. In addition, only few studies have taken into account reverse causation, that is, that depressive symptoms might also predict change in personality.

The largest meta-analytic review of published data to date included up to 14,563 patients and 60,576 controls and reported that individuals suffering from depressive disorders, that is, MDD, unipolar depression, and dysthymic disorder, had higher levels of neuroticism and lower levels of both extraversion and conscientiousness when compared to healthy controls.^[5] A longitudinal association between high neuroticism and depressive symptoms or depression was observed in another recent meta-analysis that examined the relationship between neuroticism and depressive symptoms in prospective studies.^[6] However, other personality dimensions were not included in meta-analyses of prospective studies. In addition, the degree and direction of potential publication bias in the literature-based meta-analyses has not been examined.^[12,14,15] It has also been shown that depressive symptoms might predict change in personality.^[16] Recently, in a sample of 1,739 Finnish men and women, reciprocal relationship between negative emotionality, that is, neuroticism, and depressive symptoms was found over 15 years of follow-up.^[17] However, it is not known whether these results can be generalized to other populations.

To address these limitations, we pooled unpublished data from 10 prospective cohort studies with 117,899 participants for an individual participants meta-analysis to investigate the possible two-way relationship between personality traits of the five-factor model of personality with depressive symptoms. The five-factor model of personality includes five personality traits (extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience) and is currently the most widely used theory of personality.^[18] Based on previous findings,^[5,6] we hypothesized that low extraversion, high neuroticism, and low conscientiousness may be associated with increased depressive symptoms. We also expected that the association between high neuroticism and depressive symptoms would be stronger than the associations between low extraversion and low conscientiousness with depressive symptoms. As age, gender, education, ethnicity, and marital status have also been linked to depressive symptoms,^[19,20] we tested whether these factors might moderate the association between personality and depressive symptoms.

MATERIALS AND METHODS

Data for the current study were selected by searching the data collections of the Inter-University Consortium for Political and Social Research (ICPSR; <http://www.icpsr.umich.edu/icpsrweb/ICPSR/>) and the Economic and Social Data Service (<http://ukdataservice.ac.uk/>) to identify eligible large-scale cohort studies that have repeated measurements of personality and depressive symptoms. Studies that included information on participant's personality assessed with at least the brief 15-item questionnaire or with more comprehensive questionnaires based on the five-factor model and depressive symptoms were eligible for the analysis.

Following cohorts studies were included in the present meta-analysis: the National Longitudinal Study of Adolescent Health (AddHealth), British Household Panel Survey (BHPS), German Socio-Economic Panel Study (GSOEP), Household, Income and Labour Dynamics in Australia (HILDA) Survey, Health and Retirement Study (HRS), Midlife in the United States (MIDUS), National Child Development Study (NCDS), Understanding Society (US), Wisconsin Longitudinal Study graduate (WLSG) sample, and Wisconsin Longitudinal Study sibling (WLSS) sample. All these studies are well-characterized longitudinal cohort studies with large sample sizes. AddHealth and US did not have follow-up data on depressive symptoms after the assessment of personality, and thus these cohorts were included only in the cross-sectional analyses. The relevant local ethics committees approved all the included cohort studies. Full details of the cohorts and used measures can be found in the Supporting Information Appendix.

MEASUREMENT OF PERSONALITY

The five-factor model personality traits were assessed with standardized questionnaire instruments as follows: 20-item International Personality Item Pool measure was used in AddHealth^[21]; 15-item version of the Big Five Inventory (BFI) was used in BHPS, GSOEP, and US^[22,23]; 36-item inventory based on Saucier's and Goldberg's Big Five Markers Scale was used in HILDA^[24]; 25-item questionnaire was used in HRS and MIDUS^[25]; 50-item International Personality Item Pool questionnaire in NCDS^[26]; and 29-item version of the BFI was used in WLSG and WLSS.^[22,23] These instruments measure the following five higher order personality traits that sum up individual variation in personality dispositions: extraversion (e.g., sociability and sensitivity to positive emotions), neuroticism (e.g., low emotional stability and proneness to anxiety), agreeableness (e.g., cooperativeness and trust toward other people), conscientiousness (e.g., self-control and allegiance to social norms), and openness to experience (e.g., curiosity and open-mindedness).

MEASUREMENT OF DEPRESSIVE SYMPTOMS

Depressive symptoms were measured with the Center for Epidemiologic Studies Depression Scale (CES-D)^[27] in AddHealth, HRS, WLSG, and WLSS; General Health Questionnaire (GHQ)^[28] in BHPS and US; Mental Component Summary Scale (MCS)^[29] in GSOEP; Mental Health Inventory (MHI), a subscale from the SF-36 general health survey, in HILDA; the World Mental Health Organization's Composite International Diagnostic Interview Short Form (CIDI-SF)^[30] in MIDUS; and Malaise Inventory in NCDS.^[31]

STATISTICAL ANALYSIS

Cross-sectional associations between the personality traits and depressive symptoms in the total sample and within different subgroups were examined using linear regression analysis and partial correlation adjusting for sex, age at baseline, and ethnicity/nationality (0 = majority, i.e., in most cohort non-Hispanic Caucasians; 1 = other).

Personality scores and depressive symptoms were standardized (standard deviation (SD) = 1). Longitudinal associations between the personality traits and depressive symptoms were analyzed in two separate ways. First, the association between the personality traits at baseline and depressive symptoms at follow-up was examined adjusting for depressive symptoms at baseline plus sex, age at baseline, ethnicity/nationality, and the length of follow-up period in months. Second, to examine reverse causality, that is, the hypothesis that depressive symptoms predict change in personality, the association between baseline depressive symptoms and personality at follow-up was examined adjusting the models for baseline personality trait, sex, age at baseline, ethnicity/nationality, and the length of follow-up in months. To facilitate interpretation of effect sizes in the personality change analysis, personality traits were first transformed into T -scores (mean = 50, SD = 10) before analysis using means and SD s at Time 1 as the metric against which to standardize scores at both Time 1 and Time 2.

In the main analyses, two-step individual participant meta-analysis was used.^[32] All models were first fitted separately within each cohort, and the results from the individual cohorts were then pooled by using random-effects meta-analysis. Standard errors in cohorts based on household sampling were calculated by using a robust estimator method to take into account the nonindependence of individuals from the same households. Heterogeneity in the effect sizes was examined using the I^2 estimates. To examine potential sources of heterogeneity,^[33] additional sensitivity analyses were carried out using one-step individual participant meta-analysis where data were first pooled and models then fitted taking into account the clustering of observations within each study. Meta-analysis was performed with the metan package of Stata, version 13.1, software (StataCorp LP, College Station, TX).

RESULTS

The sample characteristics are shown in Table 1. In total, 117,899 participants (mean age 49.0 years; 54.7% women; age range 15–104 years) were included in the current study.

Cross-sectional associations between personality traits and depressive symptoms are presented in Fig. 1. Low extraversion (pooled B = $-.08$; 95% CI = -0.11 , -0.04) and high neuroticism (pooled B = $.39$; 95% CI = 0.32 , 0.45) were associated with depressive symptoms. In addition, low conscientiousness was associated with depressive symptoms (pooled B = $-.08$; 95% CI = -0.10 , -0.06). However, there was heterogeneity across studies (extraversion and depressive symptoms: I^2 = 91%, P < .001; neuroticism and depressive symptoms: I^2 = 97%, P < .001; conscientiousness and depressive symptoms: I^2 = 68%, P < .01). Subgroup analyses according to sex, age, education, marital status, and ethnicity/nationality are reported in Supporting Information Table S1. Low openness to experience was associated with depressive symptoms among individuals from ethnic or national minorities (pooled B = $-.03$; 95% CI = -0.06 , 0.00), but not among individual from ethnic or national majorities (pooled B = $.01$; 95% CI = -0.02 , 0.03). There were no other significant differences in associations between any of the subgroups (P > .05). Additional sensitivity analyses with multilevel regression showed that the covariates (i.e., age, sex, race/ethnicity, marital status, and education) reduced the observed heterogeneity only

marginally, that is, by 5.0% in extraversion and 3.4% in neuroticism (Supporting Information Table S2).

Mean follow-up period across cohort studies with two depression measurement points was 5.0 years (n = 56,735). The test–retest partial correlation (adjusted for age, sex, and race) of depressive symptoms was 0.41, and the equivalent test–retest correlation of personality traits was as follows: extraversion: r = 0.69; neuroticism: r = 0.61; agreeableness: r = 0.57; conscientiousness: r = 0.59; and openness to experience: r = 0.66.

Longitudinal associations between personality at baseline and depressive symptoms at follow-up, adjusted for depressive symptoms at baseline, are shown in Fig. 2. Again, low extraversion was associated with increased depressive symptoms (pooled B = $-.03$; 95% CI = -0.05 , -0.01) and high neuroticism was positively associated with depressive symptoms (pooled B = $.12$; 95% CI = 0.10 , 0.13). In addition, low conscientiousness was associated with increased depressive symptoms (pooled B = $-.04$; 95% CI = -0.06 , -0.02). There was no significant heterogeneity in study-specific estimates in the longitudinal analysis.

Test of reverse causality, that is, baseline depressive symptoms predicting change in personality traits, is shown in Fig. 3. Depressive symptoms were associated with lower subsequent extraversion (pooled B = $-.07$; 95% CI = -0.12 , -0.02), higher neuroticism (pooled B = $.23$; 95% CI = 0.09 , 0.36), and lower scores of agreeableness (pooled B = $-.09$; 95% CI = -0.15 , -0.04), conscientiousness (pooled B = $-.14$; 95% CI = -0.21 , -0.07), and openness to experience (pooled B = $-.04$; 95% CI = -0.08 , 0.00). However, there was considerable heterogeneity in these associations across studies (extraversion: I^2 = 94%, P < .001; neuroticism: I^2 = 99%, P < .001; agreeableness: I^2 = 94%, P < .001; conscientiousness: I^2 = 96%, P < .001; openness to experience: I^2 = 87%, P < .001).

DISCUSSION

This study examined the association between personality traits and depressive symptoms using individual participant meta-analysis of unpublished open-access data. Over 115,000 participants were included in the cross-sectional analysis and over 55,000 participants in the longitudinal analysis. Low extraversion, high neuroticism, and low conscientiousness were associated with depressive symptoms in both cross-sectional and longitudinal analysis. There was no evidence of heterogeneity in study-specific estimates of the longitudinal associations. However, we found some evidence that the association between personality and depressive symptoms might be bidirectional. The analysis of reverse causation showed that depressive symptoms predicted higher neuroticism and lower extraversion, agreeableness, and conscientiousness at baseline, although there was significant heterogeneity in study-specific estimates of these associations.

TABLE 1. Descriptive characteristics of the participants by cohort study

	AddHealth	BHPS	GSOEP	HILDA	HRS	MIDUS	NCDS	US	WLSG	WLSS
Number of participants										
Cross-sectional analysis	5,025	13,626	18,303	11,046	13,614	6,259	8,608	30,877	6,612	3,929
Longitudinal analysis	–	10,585	12,679	8,462	12,195	4,634	–	–	5,214	2,966
Age	29.0 (1.8)	45.4 (18.3)	47.3 (17.3)	43.8 (17.9)	67.2 (10.4)	46.8 (12.9)	47.2 (17.9)	50.3 (0.5)	54.1 (0.5)	53.1 (7.3)
Sex										
Men	45.9 (2,309)	45.4 (6,282)	47.9 (9,790)	46.7 (5,182)	40.8 (5,669)	47.5 (2,971)	48.1 (4,141)	43.8 (13,532)	46.2 (3,083)	46.5 (1,847)
Women	54.1 (2,717)	54.6 (7,541)	52.1 (10,644)	53.3 (5,909)	59.2 (8,231)	52.5 (3,288)	51.9 (4,467)	56.2 (17,386)	53.8 (3,591)	53.5 (2,122)
Education										
Primary	33.6 (1,687)	27.8 (3,788)	16.1 (2,787)	34.6 (3,825)	18.2 (2,481)	8.7 (545)	18.1 (1,557)	42.6 (13,009)	72.1 (4,769)	5.2 (204)
Secondary	53.5 (2,686)	57.7 (7,861)	61.3 (10,636)	44.3 (4,894)	55.3 (7,524)	59.3 (3,704)	61.7 (5,308)	20.2 (6,177)	27.9 (1,843)	64.2 (2,521)
Tertiary	13.0 (652)	14.5 (1,972)	22.6 (3,927)	21.1 (2,327)	26.4 (3,594)	32.0 (1,997)	20.3 (1,743)	37.2 (11,357)	–	30.6 (1,204)
Nationality/ethnicity										
Majority	71.8 (3,609)	85.5 (11,644)	93.1 (17,045)	79.2 (8,751)	78.1 (10,631)	88.9 (5,567)	98.0 (8,437)	83.1 (25,674)	100.0 (6,612)	100.0 (3,929)
Minority	28.2 (1,416)	14.5 (1,982)	6.9 (1,258)	20.8 (2,295)	21.9 (2,983)	11.1 (692)	2.0 (171)	16.9 (5,203)	–	–
Marital status										
Married/cohabiting	41.6 (2,092)	52.0 (7,081)	60.1 (11,009)	59.3 (6,551)	63.7 (8,675)	67.7 (4,234)	70.0 (6,028)	63.3 (19,531)	83.3 (5,504)	80.9 (3,151)
Single	58.4 (2,933)	48.0 (6,540)	39.9 (7,294)	40.7 (4,495)	36.3 (4,936)	32.3 (2,022)	30.0 (2,580)	36.7 (11,345)	16.7 (1,107)	19.1 (744)
Follow-up time (months)	–	36.1 (1.3)	48.1 (1.6)	48.0 (1.3)	35.6 (15.9)	107.5 (6.3)	–	–	134.0 (4.2)	135.9 (6.7)
Baseline depressive symptoms	2.6 (2.5)	11.3 (5.5)	11.4 (3.6)	25.8 (16.8)	1.4 (1.9)	0.7 (1.9)	3.4 (4.5)	11.1 (5.5)	17.3 (6.0)	17.4 (6.3)
Follow-up depressive symptoms	–	11.5 (5.6)	11.5 (3.5)	24.8 (16.7)	1.4 (1.9)	0.6 (1.7)	–	–	16.5 (5.6)	16.8 (5.9)

Note: Values are means (and SDs). Because of missing data in covariates, numbers of covariate frequencies may not add up to the total number of participants with personality and baseline depressive symptoms data.

AddHealth, National Longitudinal Study of Adolescent Health; BHPS, British Household Panel Survey; GSOEP, German Socio-Economic Panel Study; HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study; MIDUS, Midlife in the United States; NCDS, National Child Development Study; US, Understanding Society; WLSG, Wisconsin Longitudinal Study Graduate Sample; WLSS, Wisconsin Longitudinal Study Sibling Sample.

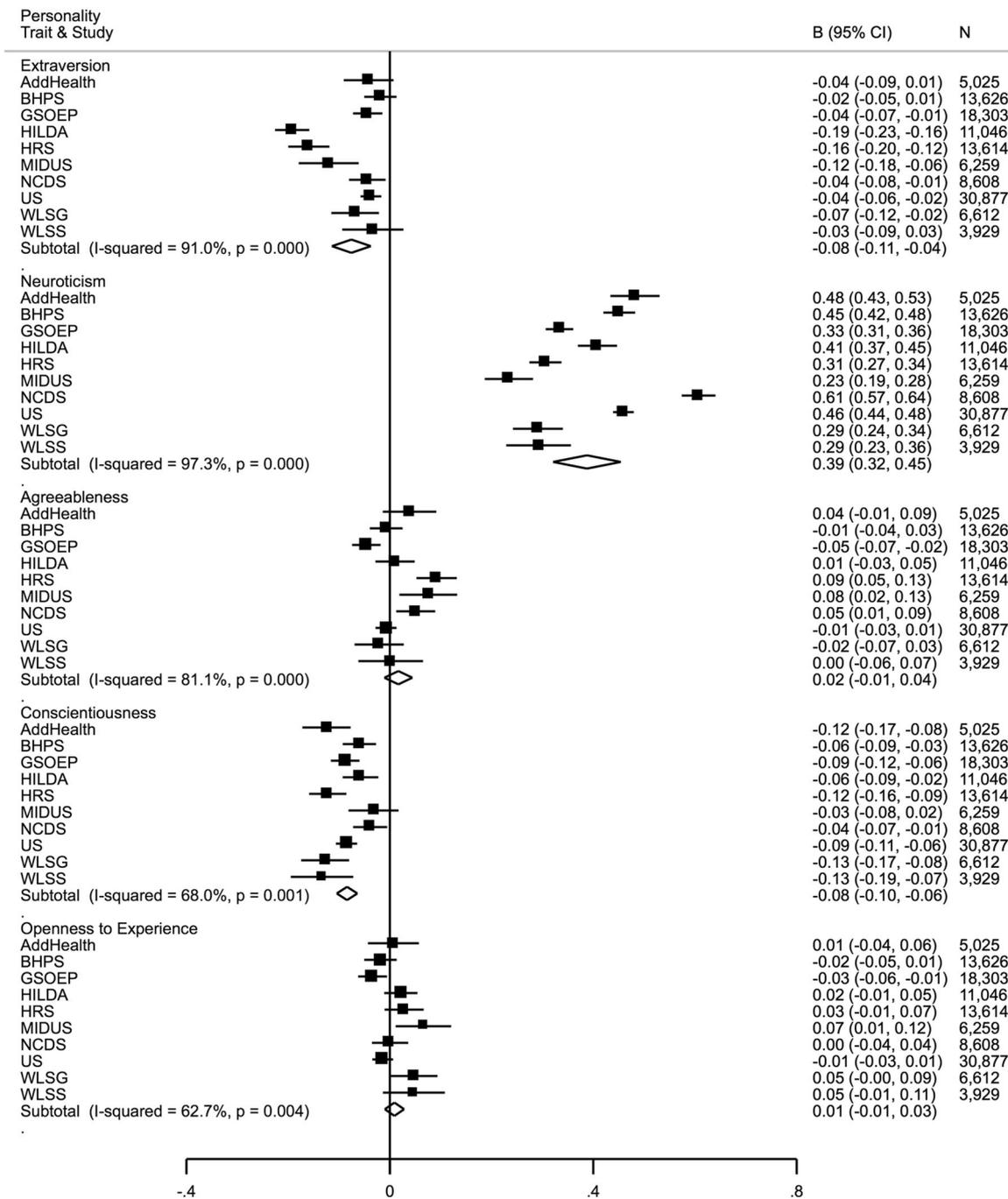


Figure 1. Cross-sectional associations between five-factor model personality traits and depressive symptoms. Values are regression coefficients (and 95% confidence intervals) per 1 SD increment in personality trait. Personality traits are adjusted for each other in addition to sex, age, and race/ethnicity. AddHealth, National Longitudinal Study of Adolescent Health; BHPS, British Household Panel Survey; GSOEP, German Socio-Economic Panel Study; HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study; MIDUS, Midlife in the United States; NCDS, National Child Development Study; US, Understanding Society; WLSG, Wisconsin Longitudinal Study Graduate Sample; WLSS, Wisconsin Longitudinal Study Sibling Sample.

This is the largest meta-analysis of multiple personality traits and depressive symptoms to date,^[5] and the first based on a prospective study design. These results are in line with previous findings, which have shown that low extraversion, high neuroticism, and low

conscientiousness are associated with depression.^[4,5] However, the effect sizes in the current study were considerable lower in both cross-sectional and longitudinal analyses than in the earlier literature-based meta-analyses. In the literature-based meta-analysis of

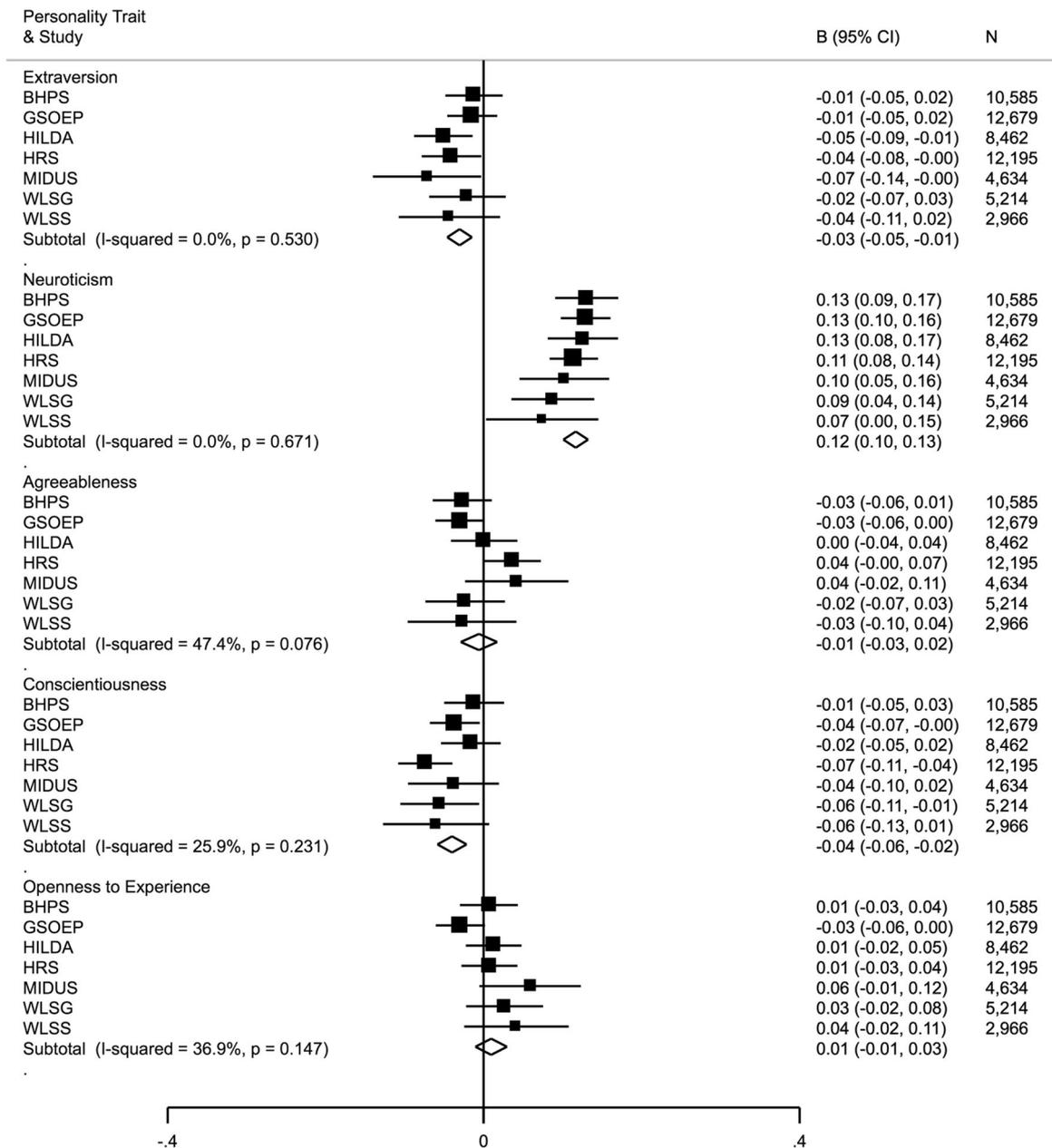


Figure 2. Longitudinal associations between five-factor model personality traits and depressive symptoms adjusted for baseline depressive symptoms. Values are regression coefficients (and 95% confidence intervals) per 1 SD increment in personality trait. Personality traits are also adjusted for each other in addition to sex, age, and race/ethnicity. BHPS, British Household Panel Survey; GSOEP, German Socio-Economic Panel Study; HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study; MIDUS, Midlife in the United States; WLSG, Wisconsin Longitudinal Study Graduate Sample; WLSS, Wisconsin Longitudinal Study Sibling Sample.

Kotov and co-workers,^[3] the correlations with MDD were 0.47 for neuroticism, -0.25 for extraversion, and -0.36 for conscientiousness. In the current study, the corresponding partial correlations (adjusted for age, sex, race, and other personality traits) were 0.37, -0.07, and -0.09. Thus, the present associations of neuroticism, extraversion, and conscientiousness were 21, 72, and 75% smaller compared to the literature meta-analysis. A cor-

responding discrepancy was found in the longitudinal analysis where the effect size between neuroticism and depressive symptoms was two thirds lower when compared to cross-sectional analysis, whereas the previous literature-based meta-analysis reported that the effect size was about half lower in the longitudinal versus cross-sectional analyses.^[6] The reasons for these differences are not known, however, it is possible that publication

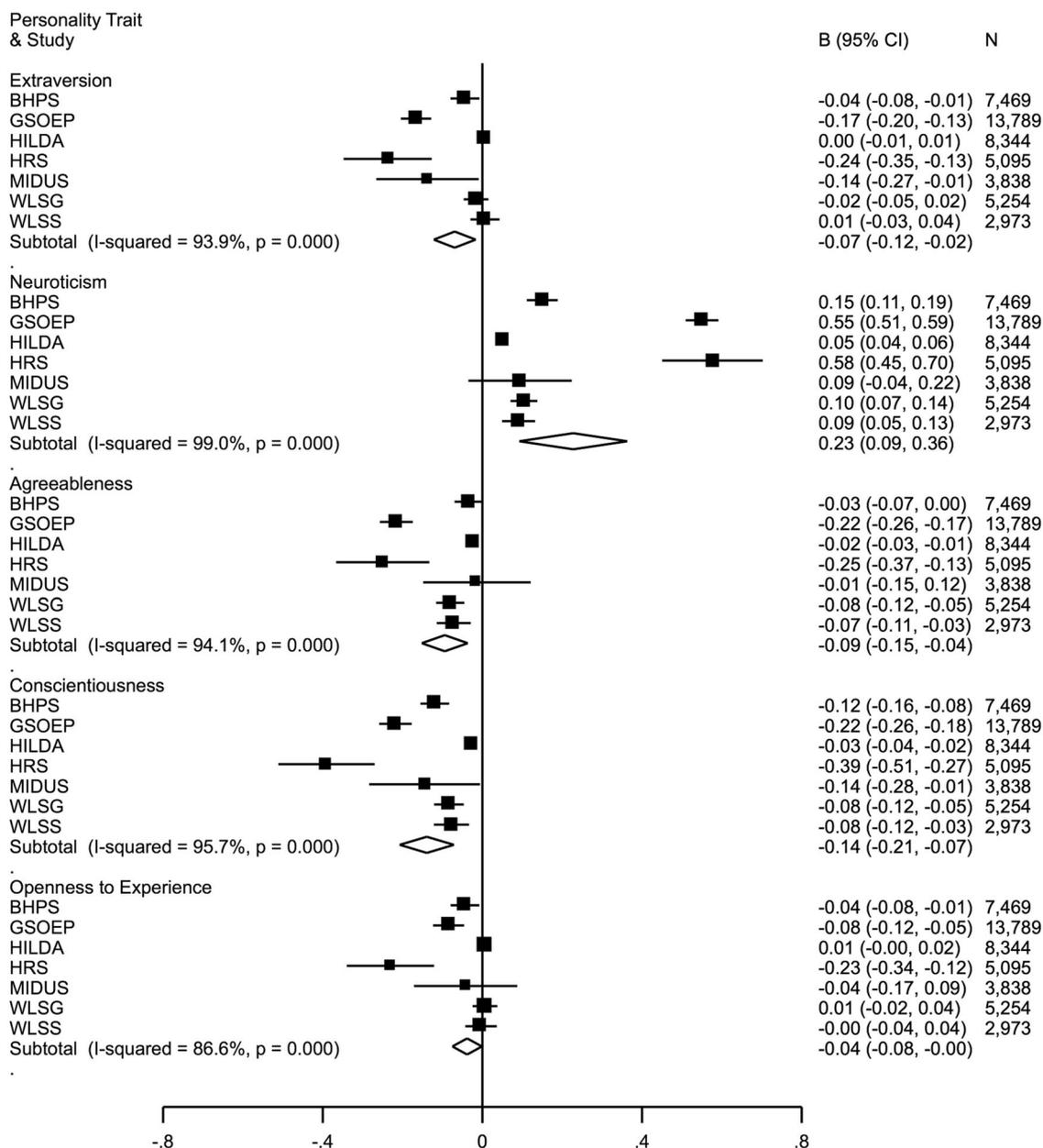


Figure 3. Associations between depressive symptoms and personality change between baseline and follow-up. Analyses are adjusted for sex, age, race, and follow-up time. Values are regression coefficients (and 95% confidence intervals) indicating linear change in personality traits T-score. BHPS, British Household Panel Survey; GSOEP, German Socio-Economic Panel Study; HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study; MIDUS, Midlife in the United States; WLSG, Wisconsin Longitudinal Study Graduate Sample; WLSS, Wisconsin Longitudinal Study Sibling Sample.

bias may have contributed to the higher effect estimates in previous meta-analyses based on published data. In addition, methodological differences may be a contributing factor for the relatively high attenuation in the associations of extraversion and conscientiousness with depressive symptoms because the current study analyses were adjusted for neuroticism, whereas this adjustment was missing in previous meta-analyses.

We found evidence of reverse causation because depressive symptoms predicted change in all personality

traits. The largest effect was found in increase of neuroticism, which was equal to the effect size of a previous study showing effects sizes of single chronic diseases associated with changes in neuroticism,^[34] and moderate or small effects in decrease of extraversion, agreeableness, and conscientiousness. There are relatively few prior studies that have examined the association between depressive symptoms and personality change using large prospective samples. Although there are some findings showing that depression is associated

with personality change,^[16,17,35] supporting the hypothesis that depression causes “a scar” in personality, other studies have failed to support this.^[36,37] However, it has been argued that the possible scarring effect of depression should be examined using continuous depressive symptoms scores rather than depression diagnosis to capture the interplay between depression and personality, especially neuroticism.^[38] Although, based on our results, it might be an overestimation to say that depressive symptoms cause persistent scars in personality, our findings clearly indicate that there is a bidirectional relationship between depressive symptoms and neuroticism. However, considerably heterogeneity across studies indicates that there are some other factors that play a role also in this reciprocal relationship.

There are at least six alternative and partially overlapping theoretical models (i.e., common cause, spectrum, vulnerability, precursor, pathoplasty, and scar/complication) that have been proposed to explain the personality–depression association, and all these models have been supported to some degree.^[7–11] The common cause model posits that common determinants, for example, genetic factors, explain the association between personality and depression; the finding that neuroticism and depressive symptoms share a large genetic background is consistent with this possibility.^[39] The spectrum model postulates that high neuroticism and depressive symptoms are different manifestations of the same underlying processes. This model implies that depression is defined by symptoms as well as personality style and is discussed in particular in relation to atypical depression.^[40] According to the vulnerability model, personality represents a risk or contributing factor for the depression onset (e.g., high neuroticism either causes depression or enhances the impact of other depression risk factors such as stressful life events^[41,42]). In the pathoplasty model, personality does not directly cause depression, but once depression has developed, personality influences the severity of pattern of symptoms.^[43,44] Finally, whereas the scar model suggests that depression causes persistent personality change, the complication model suggests that this change is likely to be only temporary.^[45]

Although the aim of the current study was not to compare these models, the results suggest that certain explanations may be more plausible than others. The findings that neuroticism was cross-sectionally and prospectively associated with depressive symptoms and that neuroticism was slightly more stable than depressive symptoms are consistent with both the common cause and vulnerability models. In addition, the association between depressive symptoms and future personality change supports both the scar and complication models. These findings are partially in agreement with previous studies suggesting that common cause, spectrum, and vulnerability models best explain the association between neuroticism and depression.^[6] Future studies should examine in more detail these issues and in particular whether the changes

observed in personality dispositions are temporary or persistent.

Some evidence suggests that personality predicts recurrent depressive episodes.^[46,47] Although we were able to demonstrate an association between depression and a change in personality dispositions, we did not have data to determine those related to the first depressive episode or recurrent depression and whether the association with personality would differ between the two. Thus, the possibility that the role of personality is bigger in recurrent depression than in single depressive episodes should be further examined in future studies with more than two waves of personality and depressive symptoms measures.

Considerable heterogeneity was observed in the associations between personality and depressive symptoms, and this heterogeneity was not explained by the covariates available. Future studies should examine biological and sociocultural factors, which were unmeasured or measured imprecisely in the present study, to identify the source of heterogeneity across the studies. The etiology of depression is multifactorial, including genetic, epigenetic, biological, behavioral, and environmental factors, so personality should be considered only as one of the factors contributing to depression risk. Also, personality may be differently related to different subtypes of depression, such as atypical or melancholic depression, which could not be examined in the present study.

It has been consistently found that prevalence of depressive symptoms is higher among women than men,^[48,49] and there is some evidence that neuroticism might be stronger predictor of depression in women than men.^[50] However, our results did not find any differences between women and men in the association of neuroticism and depressive symptoms.

Although neuroticism has been hypothesized to be an important predictor of physical diseases,^[51] recent studies with larger sample sizes have shown that low conscientiousness may be the only personality trait that is consistently associated with chronic diseases and risk factors such as obesity,^[52] diabetes,^[53] and coronary heart disease and stroke,^[54] and all-cause mortality.^[55] Whether depression is a mediating factor between neuroticism and physical disease should be investigated in future studies.

The clinical utility of the five-factor model has been challenged by some studies,^[56] but other studies suggest that the five-factor model has prognostic value and is useful in defining normal and abnormal personality functioning.^[57] For example, interventions for alcohol and drug misuse may be more effective when targeted at individuals with certain personality dispositions, at least in adolescents.^[58] Thus, information on personality may contribute to optimal allocation of prevention and treatment resources. In future studies, it would be worth considering also targeting individuals who are in high-risk depression group due to their personality. This could be especially important because it has been estimated that the costs of neuroticism are larger than the costs of common mental disorders.^[59] It would also be important to

start planning interventions that focus more on the roots of neuroticism rather than the outcomes of it.

STUDY LIMITATIONS

This study has some limitations. First, due to nature of the included studies, that is, large epidemiological community studies, personality was measured with relatively short questionnaires, which reduces the reliability of the used personality measures. However, it has been demonstrated that short questionnaires work adequately well,^[60] and thus their use can be justified. In addition, depressive symptoms were measured with a number of different instruments from which some are specific measures of depressive symptoms such as CES-D, whereas others such as GHQ are general measures of mental health. This can naturally create measurement error and thus bias in the study results. However, the study results were rather consistent, which inclines that measurement error was not a significant source of bias. Study participants were mostly adults with mean age of 49 years, which indicates that current results might not be generalizable to younger participants. For example, the levels of both depressive symptoms and neuroticism have been shown to vary across life-span,^[61,62] which creates the possibility that the relationship between personality and depressive symptoms might differ across life course. This is something that further studies should investigate in detail.

CONCLUSION

In conclusion, results from the current individual participant study with 117,899 participants demonstrate that personality traits extraversion, neuroticism, and conscientiousness are associated with depressive symptoms. In turn, depressive symptoms are associated with future personality change that could be a temporary or persistent. Further research is needed to determine whether personality should be taken into account when designing future preventions and interventions targeting to reduce the burden of depression.

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