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ORIGINAL PAPER

# Personality disorders and physical comorbidities in adults from the United States: data from the National Epidemiologic Survey on Alcohol and Related Conditions

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**Abstract**
*Purpose* There is a paucity of research examining the relationship between personality disorders (PDs) and chronic physical comorbidities. Consequently, we investigated associations between individual PDs and PD Clusters, and various common disease groups [cardiovascular disease (CVD), diabetes, arthritis and gastrointestinal disease (GI)] in a nationally representative survey of adults from the United States.
*Methods* This study utilized pooled data ($n = 34{,}653$; $\geq$20 years) from Waves 1 and 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. PDs were assessed using the Alcohol Use Disorder and Associated Disabilities Interview Schedule- Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. Physical conditions were based on self-reports of being diagnosed by a health professional. Unadjusted and adjusted logistic regressions examined the relationship between PDs and physical conditions.
*Results* After adjustment (sociodemographic factors, past-year mood, anxiety and substance use disorders), Clusters A, B and C PDs were each associated with physical conditions (all $p \leq 0.01$). Of the individual PDs, schizoid, schizotypal, narcissistic, borderline and obsessive–compulsive PDs were associated with CVD (all $p \leq 0.01$) among younger adults. Paranoid, antisocial, borderline and avoidant PDs and younger adults with schizoid, schizotypal and obsessive–compulsive PDs were each associated with arthritis (all $p \leq 0.01$). Significant associations were seen between paranoid, schizoid and schizotypal PDs and diabetes (all $p \leq 0.01$). Finally, schizotypal, antisocial, borderline and narcissistic PDs were associated with GI conditions (all $p \leq 0.01$).
*Conclusions* PDs were consistently associated with physical conditions. Investigation of PDs and their relationship with physical health outcomes warrant further research attention as these findings have important clinical implications.

**Keywords** Personality disorders · Comorbidity · Physical conditions · NESARC

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## Introduction

Personality disorder (PD) is characterized by marked and relatively enduring impairments in self-organization and

interpersonal relating that deviate from cultural norms [1]. The DSM-5 has continued the DSM-IV definition of PD as a group of 10 disorders that are organized into three Clusters, based on similar features among these disorders. Cluster A encompasses odd or eccentric features; Cluster B encompasses dramatic, emotional, and impulsive features; and Cluster C encompasses anxious and fearful features [1]. The prevalence of these PDs in the community is estimated to be between 4.4 and 13.4 % [2–5]. PD is increasingly recognized as having significant public health implications in its own right and due to high rates of co-occurrence with and effects upon other psychiatric disorders and high levels of functional impairment and physical disability [6, 7]. Furthermore, PD has been linked with adverse consequences in other public health domains, such as education and employment [8] and crime [9]. However, little is known about the effects of PD on physical health.

Both psychiatric disorders and many common and chronic diseases including cardiovascular diseases (CVD), diabetes, gastrointestinal (GI) diseases and musculoskeletal disorders are national health priorities in many countries, due to their significant health and economic burden. An increasing body of population-based research has demonstrated that there is an important and complex link between psychiatric disorders and physical conditions. For example, mood and psychotic disorders in particular, and to a lesser extent anxiety and substance use disorders have been associated with an increased risk of physical conditions, which are hypothesized to be mediated by a host of biological, psychological and social factors [10–15]. Preliminary research also suggests that PD is associated with physical conditions [16–20]. For example, data from a national household survey of Great Britain found adolescents and adults (16–74 years) who screened positive for PD were more likely to report having ischemic heart disease or stroke [16]. Due to the brief measures used to screen for PD, the findings from that study were discussed in the context of those "at risk" only; it is imperative that studies utilize structured, validated measures of PD, in order to overcome prior methodological limitations. Moreover, longitudinal data (23-year follow-up) from adults in the United States Baltimore Epidemiological Catchment Area study revealed that DSM-III Cluster B PD was associated with incident self-reported CVD [20] and CVD related mortality. It was reported that methodological shortcomings precluded further analyses examining associations between Clusters A and C PD with CVD, which led the authors to call for large-scale epidemiological studies with sufficient statistical power to undertake these analyses [20]. These investigations might be particularly important given that Cluster A PDs and features [21, 22], and Cluster C [21] have been shown to be associated with higher prevalence of cigarette smoking (a robust risk factor for CVD and type 2 diabetes).

Others have shown individual PDs (chiefly from Cluster B) to be associated with increased risk for CVD, hepatic diseases, GI diseases, venereal disease, and overall medical burden [17, 19]. However, there are inconsistencies among study findings as to whether PD presents unique risk for physical comorbidities independent of the effects of other co-occurring mental disorder including depression [19, 20, 23] which has been shown to be associated with the development of CVD [24]. Furthermore, it is unknown whether each DSM-IV PD is associated with increased risk of a variety of commonly occurring physical conditions independent of other mental disorders.

It is also plausible that inconsistencies in the literature might be explained by age; with sample characteristics of prior studies varying considerably in age ranges such as 16–74 years [16], ≥18 years [17, 25], and 55–65 years in another [23]. However, prior studies have not further extrapolated the relationship between PDs and physical comorbidities by investigating these associations in younger and older age strata.

Therefore, the aim of this study was to examine whether each of the DSM-IV PDs and each of the Cluster A, B, and C PD groups is associated with CVD, arthritis, diabetes and GI disease, utilizing data from a nationally representative sample of US adults enrolled in the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). Furthermore, while prior studies have reported promising preliminary data, we sought to extend their findings to determine whether both age and/or gender may be an effect modifier in the relationship between PDs and physical comorbidities. Such analyses might provide a context for identifying whether the risk for physical health conditions is age and/or gender dependent, and whether PD might present a unique risk above the known risks of other psychiatric disorders in the expression of physical health conditions not only in older adult populations but also much earlier in the lifespan. The current study aims to address a current gap in the evidence-base by undertaking a structured and validated examination of all current PDs, along with high prevalence physical comorbidities utilizing a representative, US population-based cohort.

## Materials and methods

### Sample and procedures

We analyzed data from waves 1 (2001–2002) and 2 (2004–2005) of the NESARC, a nationally representative sample of community-dwelling American adults (≥20 years) residing in the US including the Districts of

Columbia, Alaska, and Hawaii. A total of 34,653 participants responded to both waves, which resulted in a response rate of 86.7 % for wave 2 (i.e., 86.7 % of eligible participants from wave 1 responded at wave 2). The cumulative response rate was 70.2 %, which equals the product of the wave 1 (81.0 %) and wave 2 (86.7 %) response rates.

The sample excludes adults who were deceased, deported, institutionalized or on active military duty on follow-up. Trained lay interviewers from the US Census Bureau with at least 5 years of experience conducted face-to-face interviews and written informed consent was obtained from all participants. The US Census Bureau and the US Office of Management and Budget reviewed the research protocol and provided full ethical approval. A more detailed description of methodology and sampling procedures of the NESARC can be found elsewhere [26, 27].

## Psychiatric disorders

DSM-IV axis I and II disorders were assessed using the Alcohol Use Disorders and Associated Disabilities Interview Schedule IV (AUDADIS-IV), a reliable and valid instrument designed for administration to the general population by lay interviewers [28].

The primary variables of interest were lifetime DSM-IV PDs. During wave 1, seven PDs were assessed (avoidant, dependent, obsessive–compulsive, paranoid, schizoid, histrionic and antisocial PDs), and the other three were assessed in wave 2 (borderline, schizotypal, and narcissistic PDs). Past-year diagnoses of any mood disorder (i.e., major depression, dysthymia, and mania or hypomania), any anxiety disorder (i.e., panic disorder with and without agoraphobia, social phobia, specific phobia, generalized anxiety disorder, and posttraumatic stress disorder), and any substance use disorder (i.e., alcohol abuse and dependence, nicotine dependence, and drug abuse and dependence) were also assessed at wave 2. [29]. Derived from US population-based samples, test–retest reliability coefficients for diagnoses of the individual PDs assessed in wave 1 were in the fair to good range ($k = 0.40$–$0.67$); and slightly higher ($k = 0.67$–$0.71$) for those assessed in wave 2 [29]. Similarly, test–retest reliability coefficients for other lifetime and past-year DSM-IV mental disorders were in the fair to good range: substance use ($k = 0.60$–$0.74$), mood ($k = 0.58$–$0.65$), and anxiety disorders ($k = 0.40$–$0.52$) [28]. In addition, there is some support for the classification of PDs into Clusters A, B, and C using the AUDADIS-IV [30].

## Physical conditions

Past-year prevalence of physical conditions was assessed at wave 2 and included CVDs (chest pain or angina pectoris, rapid heartbeat or tachycardia, a heart attack or myocardial infarction (MI), stroke, hypertension, arteriosclerosis, or any other form of heart disease), diabetes, arthritis and GI diseases (stomach ulcer or gastritis). The survey assessed physical conditions by first having respondents indicate if they had one of the physical conditions in the past year. If they endorsed having the physical condition, they were subsequently asked if a physician or other health professional made the diagnosis. In this study, the latter (more stringent criterion) was used. These measures of physical conditions have been used in several previous studies [17, 19, 31], and self-reported data have been shown to have acceptable concordance with medical records of diagnosed physical conditions [32]. Details of data collection regarding the independent and dependent variables of interest are published in greater detail elsewhere [19].

## Socio-demographics

In the present study, we examined the following wave 2 socio-demographic variables as covariates: age, sex, race/ethnicity, education, household income, and marital status. In part, aging populations have influenced epidemiological patterns of increasing non-communicable diseases worldwide [33]. Age has also been shown to have moderating effects upon the relationship between psychiatric and physical comorbidities [34]. Therefore, we also examined age as an interaction term in our analyses. For the covariates, we assessed age as a continuous variable and categorized sex, race/ethnicity (White, Black, American Indian/Alaska Native, Asian/Native Hawaiian/Other Pacific Islander, and Hispanic, other), educational attainment (less than high school, high school, some college or higher), household income in $US (0–$19,999, $20,000–$34,999, $35,000–$59,999, and $60,000+), and marital status (married or living with someone as if married, widowed/separated/divorced, never married). To examine interactions between age, PDs and comorbidities, we applied the dichotomized categories of $<55$ and $\geq 55$ years of age, to maintain consistency with prior research examining other mental disorders and outcomes related to physical health and service utilization [25, 35–37]. Furthermore, some studies have suggested that epidemiological transitions such as earlier-and later-age to retirement, reduce the relevancy of a traditional cut-point of 65 years [36–38].

## Statistics

We calculated cross tabulations, which provided weighted prevalence rates for the primary variables of interest across each of the assessed physical conditions. PDs were also categorized into Cluster A (paranoid, schizoid, and

schizotypal), Cluster B (antisocial, borderline, histrionic, and narcissistic), Cluster C (avoidant, dependent, and obsessive–compulsive), and any PD.

Bivariate logistic regressions first examined the relationship between any PD, PD Clusters, and each specific PD with past-year physical conditions. Multivariate logistic regression further examined the relationship between lifetime PDs and physical conditions in a model adjusting for the socio-demographic variables and any past-year mood, anxiety, and substance use disorder. We performed interactions with the dichotomous age variable (<55, ≥55 years old) in the unadjusted model. For those interactions that were significant, data were stratified and the results are displayed accordingly in both unadjusted and adjusted models (Tables 2, 3, 4, 5).

To control for type I error and multiple comparisons, a more conservative $p$ value is reported ($p \leq 0.001$ or $p \leq 0.01$) with associated 99 % confidence intervals (99 % CI). These data were analyzed using SUDAAN 10.0.1 [39], which employs the Taylor series linearization method [40] for variance estimation to account for the complex sampling design of the NESARC. Appropriate weighting to these data were applied to ensure representativeness of the US population, which adjusted for socio-demographic variables and response/nonresponse based on the 2,000 US Census [41].

## Results

Table 1 presents the characteristics of the study population, stratified by the physical conditions (CVD, arthritis, diabetes and GI disease) and age (<55 and ≥55 years).

### Cardiovascular disease

Of those with a PD, 29.1 % had comorbid CVD. When stratified by Clusters, 32.1 % with a Cluster A PD had CVD, 29.0 % of those with a Cluster B PD and 30.6 % with a Cluster C PD.

In the bivariate analyses (Table 2), we observed significant and positive associations between younger adults (<55 years) with PDs from Clusters A, B and C, and CVDs. There were also significant and positive associations for the individual PDs: schizoid, schizotypal and CVD, and a significant negative association for antisocial and CVD. Among older adults (<55 years), significant and positive associations were observed for borderline, dependent, and obsessive–compulsive PDs, and CVD.

In the adjusted model (Table 2), among younger adults, Cluster A PDs showed the strongest positive association with CVD (AOR 1.36, 99 % CI 1.14–1.63), followed by Cluster B PDs (AOR 1.27, 99 % CI 1.07–1.50), and then C (AOR 1.23, 99 % CI 1.03–1.46). Of the individual PDs, significantly greater odds for CVD were observed for comorbid schizoid (AOR 1.50, 99 % CI 1.20–1.89), schizotypal (AOR 1.64, 99 % CI 1.34–2.02), and narcissistic PDs (AOR 1.20, 99 % CI 1.01–1.42). Significant and positive associations with CVD were also observed in the younger age group for borderline (AOR 1.47, 99 % CI 1.17–1.85) and obsessive–compulsive PDs (AOR 1.25, 99 % CI 1.04–1.50). The association between antisocial PD and CVDs was not sustained after adjustment (Table 3).

### Arthritis

Of those individuals with any PD, a Cluster A, B or C PD, 22.8, 24.7, 22.1 and 25 % had comorbid arthritis, respectively. Significant and positive associations were observed between Cluster A and C PDs and arthritis among younger adults, and both Cluster A and C PDs among older adults (Table 3). Of the individual PDs, borderline, and avoidant were each significantly and positively associated with arthritis. Significant and positive associations were also seen with arthritis among younger adults for obsessive–compulsive and schizoid, and for both age groups for schizotypal.

In the adjusted model (Table 3), younger adults with Cluster A PDs showed the strongest positive association with comorbid arthritis (AOR 1.38, 99 % CI 1.11–1.75), followed by those of any age with PDs in Cluster B (AOR 1.38, 99 % CI 1.18–1.60), and C among younger adults (AOR 1.35, 99 % CI 1.08–1.69). Of the individual PDs, there was an increased odds of arthritis for those meeting criteria for paranoid (AOR 1.28, 99 % CI 1.02–1.61), antisocial (AOR 1.61, 99 % CI 1.24–2.07), borderline (AOR 1.59, 99 % CI 1.27–1.98) and avoidant PDs (AOR 1.47, 99 % CI 1.11–1.96). There were also significantly increased odds for arthritis among younger adults with schizoid (AOR 1.62, 99 % CI 1.16–2.26), schizotypal (AOR 1.58, 99 % CI 1.18–2.13) and obsessive–compulsive PDs (AOR 1.41, 99 % CI 1.12–1.79).

### Diabetes

Of those individuals with any PD, 8.5 % had comorbid diabetes. 10.2 % with Cluster A had diabetes, 8.1 % of those with Cluster B and 8.5 % with Cluster C PDs.

In bivariate analyses (Table 2), only Cluster A PDs and schizotypal were significantly associated with diabetes.

In multivariate analyses, the only PD Cluster to show a significant association with diabetes was Cluster A (AOR 1.50, 99 % CI 1.21–1.88) (Table 4). We also observed significant associations with diabetes in those of all ages from paranoid (AOR 1.46, 99 % CI 1.08–1.98, schizoid

**Table 1** Socio-demographic characteristics of the study population ($n = 34,653$), lifetime prevalence of DSM-IV axis I and physical conditions, presented as frequencies and percentages

| | Total *n* (%) ($n = 34,653$) | Cardiovascular disease *n* (%) ($n = 10,687$) | Arthritis *n* (%) ($n = 7,826$) | Diabetes *n* (%) ($n = 3,201$) | Gastrointestinal disease *n* (%) ($n = 2,408$) |
|---|---|---|---|---|---|
| Gender | | | | | |
| Women | 20,089 (52.1) | 6,485 (30.8) | 5,332 (26.0) | 1,880 (8.4) | 1,630 (7.7) |
| Men | 14,564 (47.9) | 4,202 (27.3) | 2,494 (17.1) | 1,321 (8.0) | 778 (5.1) |
| Age | | | | | |
| <55 years | 22,341 (66.1) | 3,805 (16.2) | 2,391 (10.8) | 989 (3.9) | 1,153 (5.0) |
| ≥55 years | 12,312 (34.0) | 6,882 (54.4) | 5,435 (43.1) | 2,212 (16.4) | 1,255 (9.3) |
| Race/ethnicity | | | | | |
| White, non-hispanic | 20,161 (70.9) | 6,296 (30.4) | 5,016 (23.9) | 1,577 (7.6) | 1,324 (6.4) |
| Black, non-hispanic | 6,587 (11.1) | 2,617 (34.3) | 1,661 (21.2) | 880 (11.5) | 467 (6.1) |
| American Indian/Alaska Native, non-hispanic | 578 (2.2) | 179 (32.8) | 149 (26.6) | 76 (12.3) | 52 (9.9) |
| Asian/Native/Hawaiian/Pacific Islander, non-hispanic | 968 (4.3) | 185 (21.2) | 114 (11.4) | 51 (5.9) | 40 (4.3) |
| Hispanic/other | 6,359 (11.6) | 1,410 (18.9) | 886 (11.8) | 617 (8.5) | 525 (7.3) |
| Education | | | | | |
| Less than high school | 5,514 (14.0) | 2,273 (38.3) | 1,838 (31.8) | 848 (13.6) | 593 (9.8) |
| High school or equivalent | 9,452 (27.5) | 3,265 (33.1) | 2,467 (25.8) | 1,000 (9.9) | 706 (7.2) |
| Some college or more | 19,687 (58.5) | 5,149 (25.1) | 3,521 (17.4) | 1,353 (6.1) | 1,109 (5.3) |
| Marital status | | | | | |
| Married/living together as if married | 18,866 (63.8) | 5,343 (28.9) | 3,757 (21.0) | 1,570 (7.9) | 1,218 (6.2) |
| Widowed/separated/divorced | 9,149 (18.9) | 4,139 (43.6) | 3,300 (35.5) | 1,265 (12.7) | 873 (9.3) |
| Never married | 6,638 (17.4) | 1,205 (14.6) | 769 (9.5) | 366 (4.4) | 317 (4.0) |
| Annual household income ($US) | | | | | |
| ≤$19,999 | 8,031 (18.6) | 3,498 (40.2) | 2,836 (32.6) | 1,174 (13.2) | 891 (9.9) |
| $20,000–$34,999 | 6,882 (18.5) | 2,259 (32.6) | 1,705 (26.2) | 700 (9.4) | 518 (7.6) |
| $35,000–$59,999 | 8,444 (25.2) | 2,361 (28.4) | 1,594 (19.6) | 714 (8.2) | 468 (5.5) |
| ≥$60,000 | 11,296 (37.8) | 2,569 (22.6) | 1,691 (15.6) | 613 (5.1) | 531 (4.8) |
| Psychiatric disorders | | | | | |
| Past-year mood disorder | 3,795 (10.4) | 1,317 (32.8) | 1,050 (27.1) | 383 (8.7) | 489 (12.1) |
| Past-year anxiety disorder | 5,524 (15.1) | 2,008 (34.3) | 1,607 (27.9) | 596 (9.4) | 677 (11.3) |
| Past-year substance disorder | 6,905 (21.2) | 1,803 (24.2) | 1,378 (19.1) | 479 (5.7) | 562 (7.8) |

*n* = presented are raw. Percentages are weighted and indicate the proportion of those with the particular variable or variable level (e.g., gender) that have the physical condition (column) stratified by age: <55 and ≥55 years. Past-year mood disorder = major depression, dysthymia, mania, hypomania; past-year anxiety disorder = panic disorder with and without agoraphobia, social phobia, specific phobia, generalised anxiety disorder, posttraumatic stress disorder; past-year substance disorder = alcohol abuse and dependence, nicotine dependence, drug abuse and dependence

(AOR 1.44, 99 % CI 1.02–2.03) and schizotypal PDs (AOR 1.51, 99 % CI 1.12–2.04) (Table 4).

### Gastrointestinal disease

Of individuals with any PD, the overall proportion with comorbid GI diseases was 8.8 %. We observed 10.5 % of individuals with Cluster A, 9.7 % of those with Cluster B and 8.9 % from Cluster C to have GI diseases.

In the bivariate analyses (Table 5), there were significant and positive associations between GI diseases and Cluster A, B and C PDs. With the exception of histrionic PD, there were also significant and positive associations between all PDs and GI diseases.

After adjustment, there was an increased risk of GI disease for those with a Cluster A (AOR 1.41, 99 % CI 1.16–1.72) and Cluster B PD (AOR 1.48, 99 % CI 1.20–1.81) (Table 5). Of the individual PDs, paranoid

**Table 2** Prevalence, odds ratios (OR) and 99 % confidence intervals (99 % CI) of personality disorders predicting co-occurring cardiovascular disease (CVD)

| Personality disorder | Total *n* (%) | PD yes *n* = (%) | PD no *n* = (%) | Cardiovascular disease | |
|---|---|---|---|---|---|
| | | CVD yes | CVD yes | Bivariate OR (99 % CI) | Model 1: AOR (99 % CI) |
| Any personality disorder | | | | | |
| All | 7,783 (21.5) | 24,012 (9.1) | 8,286 (29.2) | – | – |
| <55 years | – | – | – | 1.55 (1.37–1.75)** | 1.25 (1.09–1.43)** |
| ≥55 years | – | – | – | 1.10 (0.93–1.30) | 1.03 (0.86–1.23) |
| Any Cluster A personality disorder | | | | | |
| All | 3,449 (9.0) | 1,154 (32.0) | 9,553 (28.9) | – | – |
| <55 years | – | – | – | 1.80 (1.53–2.11)** | 1.36 (1.14–1.63)** |
| ≥55 years | – | – | – | 1.33 (1.03–1.72)* | 1.14 (0.87–1.49) |
| Paranoid | | | | | |
| All | 1,689 (4.3) | 513 (28.2) | 10,174 (29.1) | 0.96 (0.78–1.17) | 1.17 (0.93–1.47) |
| Schizoid | | | | | |
| All | 1,144 (3.1) | 399 (35.4) | 10,288 (28.9) | 1.35 (1.10–1.66)** | 1.50 (1.20–1.89)** |
| Schizotypal | | | | | |
| All | 1,534 (3.9) | 575 (37.5) | 10,112 (28.8) | 1.48 (1.26–1.75)** | 1.64 (1.34–2.02)** |
| Any Cluster B personality disorder | | | | | |
| All | 4,843 (13.3) | 1,494 (29.0) | 9,189 (29.1) | – | – |
| <55 years | – | – | – | 1.62 (1.40–1.88)** | 1.27 (1.07–1.50)** |
| ≥55 years | – | – | – | 1.12 (0.91–1.38) | 1.03 (0.83–1.28) |
| Antisocial | | | | | |
| All | 1,226 (3.8) | 303 (24.6) | 10,384 (29.3) | 0.79 (0.63–0.98)* | 1.25 (0.97–1.62) |
| Borderline | | | | | |
| All | 2,231 (5.9) | 744 (34.0) | 9,913 (28.8) | – | – |
| <55 years | – | – | – | 2.16 (1.81–2.58)** | 1.47 (1.17–1.85)** |
| ≥55 years | – | – | – | 1.29 (0.94–1.76) | 1.05 (0.75–1.47) |
| Histrionic | | | | | |
| All | 651 (1.8) | 181 (25.9) | 10,506 (29.2) | 0.85 (0.63–1.14) | 1.31 (0.96–1.79) |
| Narcissistic | | | | | |
| All | 2,449 (6.2) | 781 (29.5) | 9,906 (29.1) | 1.02 (0.86–1.20) | 1.20 (1.01–1.42)* |
| Any Cluster C personality disorder | | | | | |
| All | 3,244 (9.4) | 1,040 (30.6) | 9,647 (30.0) | – | – |
| <55 years | – | – | – | 1.49 (1.26–1.75)** | 1.23 (1.03–1.46)* |
| ≥55 years | – | – | – | 1.06 (0.84–1.33) | 1.02 (0.80–1.29) |
| Avoidant | | | | | |
| All | 821 (2.3) | 262 (29.1) | 10,425 (29.1) | 1.00 (0.78–1.28) | 1.19 (0.89–1.59) |
| Dependent | | | | | |
| All | 147 (0.4) | 50 (30.3) | 10,637 (29.1) | – | 1.35 (0.63–2.89) |
| <55 years | – | – | – | 2.34 (1.0–5.22)** | – |
| ≥55 years | – | – | – | 0.60 (0.21–1.76) | – |
| Obsessive–compulsive | | | | | |
| All | 2,753 (8.1) | 889 (31.2) | 9,798 (29.0) | – | – |
| <55 years | – | – | – | 1.76 (1.41–2.20)** | 1.25 (1.04–1.50)* |
| ≥55 years | – | – | – | 1.14 (0.89–1.46) | 1.06 (0.84–1.36) |

Total *n* = presented are raw, prevalence (%) for personality disorders and for CVD "yes" among those with and without the specific personality disorder (column) are weighted. Significant age interactions are stratified: <55 and ≥55 years. * $p \leq 0.01$, ** $p \leq 0.001$. Model 1 AOR: adjusted for sex, race/ethnicity, marital status, education, income, age (continuous), past-year mood, anxiety and substance use disorders

**Table 3** Prevalence, odds ratios (OR) and 99 % confidence intervals (99 % CI) of personality disorders predicting co-occurring arthritis

| Personality disorder | Total *n* (%) | PD yes *n* = (%) | PD no *n* = (%) | Arthritis | |
|---|---|---|---|---|---|
| | | Arthritis yes | Arthritis yes | Bivariate OR (99 % CI) | Model 1: AOR (99 % CI) |
| Any personality disorder | | | | | |
| All | 7,783 (21.5) | 616 (27.2) | 7,210 (21.4) | – | – |
| <55 years | – | – | – | 1.75 (1.50–2.05)** | 1.36 (1.13–1.64)** |
| ≥55 years | – | – | – | 1.27 (1.08–1.49)** | 1.22 (1.03–1.43)* |
| Any Cluster A personality disorder | | | | | |
| All | 3,449 (9.0) | 875 (24.7) | 6,951 (21.4) | – | – |
| <55 years | – | – | – | 1.98 (1.62–2.42)** | 1.39 (1.11–1.75)** |
| ≥55 years | – | – | – | 1.36 (1.05–1.76)* | 1.15 (0.89–1.48) |
| Paranoid | | | | | |
| All | 1,689 (4.3) | 22.9 % | 21.7 % | 1.08 (0.89–1.30) | 1.28 (1.02–1.61)* |
| Schizoid | | | | | |
| All | 1,144 (3.1) | 297 (27.5) | 7,529 (21.6) | – | – |
| <55 years | – | – | – | 2.22 (1.60–3.06)** | 1.62 (1.16–2.26)** |
| ≥55 years | – | – | – | 1.29 (0.91–1.82) | 1.18 (0.83–1.68) |
| Schizotypal | | | | | |
| All | 1,534 (3.9) | 446 (28.0) | 7,380 (21.5) | – | – |
| <55 years | – | – | – | 2.42 (1.87–3.13)** | 1.58 (1.18–2.13)** |
| ≥55 years | – | – | – | 1.47 (0.99–2.16)* | 1.16 (0.78–1.72) |
| Any Cluster B personality disorder | | | | | |
| All | 4,843 (13.3) | 1,112 (22.1) | 6,714 (21.7) | 1.03 (0.91–1.15) | 1.38 (1.18–1.60)** |
| Antisocial | | | | | |
| All | 1,226 (3.8) | 235 (20.3) | 7,591 (21.8 %) | 0.92 (0.73–1.15) | 1.61 (1.24–2.07)** |
| Borderline | | | | | |
| All | 2,231 (5.9) | 616 (27.7) | 7,210 (21.4) | 1.41 (1.21–1.65)** | 1.59 (1.27–1.98)** |
| Histrionic | | | | | |
| All | 651 (1.8) | 134 (18.5) | 7,692 (21.8) | 1.82 (0.58–1.14) | 1.17 (0.81–1.70) |
| Narcissistic | | | | | |
| All | 2,449 (6.2) | 559 (21.0) | 7,267 (21.8) | 0.96 (0.81–1.12) | 1.19 (0.98–1.44) |
| Any Cluster C personality disorder | | | | | |
| All | 3,244 (9.4) | 824 (22.8) | 7,002 (21.4) | 1.75 (1.43–2.16)** | 1.35 (1.08–1.69)** |
| <55 years | – | – | – | 1.26 (1.00–1.60)* | 1.20 (0.93–1.54) |
| ≥55 years | – | – | – | 1.08 (0.89–1.30) | 1.28 (1.02–1.61)* |
| Avoidant | | | | | |
| All | 821 (2.3) | 231 (26.5) | 7,595 (21.6) | 1.31 (1.01–1.70)* | 1.47 (1.11–1.96)** |
| Dependent | | | | | |
| All | 147 (0.4) | 44 (30.0) | 7,782 (21.8) | 1.48 (0.78–2.79) | 1.39 (0.68–2.85) |
| Obsessive–compulsive | | | | | |
| All | 2,753 (8.1) | 685 (24.8) | 7,141 (21.5) | – | – |
| <55 years | – | – | – | 1.76 (1.41–2.20)** | 1.41 (1.12–1.79)** |
| ≥55 years | – | – | – | 1.14 (0.89–1.46) | 1.11 (0.85–1.45) |

Total *n* = presented are raw, prevalence (%) for personality disorders and for arthritis "yes" among those with and without the specific personality disorder (column) are weighted. Significant age interactions are stratified: <55 and ≥55 years. * $p \leq 0.01$, ** $p \leq 0.001$. Model 1 AOR: adjusted for sex, race/ethnicity, marital status, education, income, age (continuous), past-year mood, anxiety and substance use disorders

(AOR 1.31, 99 % CI 1.00–1.73), schizoid (AOR 1.37, 99 % CI 0.99–1.91), schizotypal (AOR 1.64, 99 % CI 1.24–2.15), antisocial (AOR 1.63, 99 % CI 1.14–2.33), borderline (AOR 1.38, 99 % CI 1.06–1.81) and narcissistic PDs (AOR 1.34, 99 % CI 1.04–1.72) each were associated with an increased odds of GI disease. No further significant

**Table 4** Prevalence, odds ratios (OR) and 99 % confidence intervals (99 % CI) of personality disorders predicting co-occurring diabetes

| Personality disorder | Total $n = (\%)$ | PD yes $n = (\%)$ Diabetes yes | PD no $n = (\%)$ Diabetes yes | Diabetes | |
|---|---|---|---|---|---|
| | | | | Bivariate OR (99 % CI) | Model 1: AOR (99 % CI) |
| Any personality disorder | | | | | |
| All | 7,783 (21.5) | 735 (8.5) | 2,466 (8.1) | 1.06 (0.92–1.21) | 1.28 (1.08–1.51)** |
| Any Cluster A personality disorder | | | | | |
| All | 3,449 (9.0) | 391 (10.2) | 2,810 (8.0) | 1.32 (1.09–1.59)** | 1.50 (1.21–1.88)** |
| Paranoid | | | | | |
| All | 1,689 (4.3) | 184 (9.9) | 3,017 (8.1) | 1.24 (0.94–1.64) | 1.46 (1.08–1.98)* |
| Schizoid | | | | | |
| All | 1,144 (3.1) | 123 (10.6) | 3,078 (8.1) | 1.35 (0.98–1.84) | 1.44 (1.02–2.03)* |
| Schizotypal | | | | | |
| All | 1,534 (3.9) | 191 (11.2) | 3,010 (8.1) | 1.44 (1.11–1.85)** | 1.51 (1.12–2.04)** |
| Any Cluster B personality disorder | | | | | |
| All | 4,843 (13.3) | 442 (8.1) | 2,759 (8.2) | 0.99 (0.81–1.19) | 1.21 (0.97–1.52) |
| Antisocial | | | | | |
| All | 1,226 (3.8) | 93 (7.0) | 3,108 (8.2) | 0.84 (0.60–1.16) | 1.21 (0.86–1.70) |
| Borderline | | | | | |
| All | 2,231 (5.9) | 244 (9.3) | 2,977 (8.1) | 1.17 (0.91–1.50) | 1.35 (1.00–1.83)* |
| Histrionic | | | | | |
| All | 651 (1.8) | 51 (6.1) | 3,150 (8.1) | 0.72 (0.46–1.13) | 1.04 (0.66–1.65) |
| Narcissistic | | | | | |
| All | 2,449 (6.2) | 246 (9.3) | 2,955 (8.1) | 1.17 (0.88–1.55) | 1.29 (0.96–1.74) |
| Any Cluster C personality disorder | | | | | |
| All | 3,244 (9.4) | 314 (8.5) | 2,887 (8.2) | 1.04 (0.86–1.26) | 1.17 (0.95–1.45) |
| Avoidant | | | | | |
| All | 821 (2.3) | 82 (8.3) | 3,119 (8.2) | 1.01 (0.69–1.48) | 1.20 (0.79–1.82) |
| Dependent | | | | | |
| All | 147 (0.4) | 13 (8.4) | 3,118 (8.2) | 1.03 (0.36–2.99) | 1.13 (0.38–3.36) |
| Obsessive–compulsive | | | | | |
| All | 2,753 (8.1) | 264 (8.6) | 2,937 (8.1) | 1.06 (0.86–1.30) | 1.17 (0.93–1.48) |

Total $n =$ presented are raw, prevalence (%) for personality disorders and for diabetes "yes" among those with and without the specific personality disorder (column) are weighted. Significant age interactions are stratified: <55 and ≥55 years. * $p \leq 0.01$, ** $p \leq 0.001$. Model 1 AOR: adjusted for sex, race/ethnicity, marital status, education, income, age (continuous), past-year mood, anxiety and substance use disorders

associations were seen for avoidant, dependent and obsessive–compulsive PDs.

## Discussion

This study investigated the associations between the full range of DSM-IV PDs and PD Clusters and common, chronic physical comorbidities among a large representative sample of US adults. The associations reported were independent of other frequently co-occurring DSM-IV axis I disorders and socio-demographic factors, indicating a potential role for PDs as a risk factor of poorer physical health. The major findings to emerge from the study include significant associations between individual PDs from Cluster A and diabetes and GI diseases, respectively. In addition, we observed a relationship between several individual PDs (schizoid, schizotypal, borderline, obsessive–compulsive) and CVD and/or arthritis in the younger. To the best of our knowledge, these data are the first to report these associations. In addition, we also observed associations between a range of individual PDs and CVD and arthritis, contributing to the relatively sparse evidence-base in this area of enquiry.

### Cardiovascular disease

Our data are consistent with other population-based studies reporting significant associations between any PD, PD Clusters and individual PDs with CVD in adults [16, 17, 19, 20]. Individuals who screened positive for any DSM-IV PD in the National Psychiatric Morbidity Survey of Great Britain were more likely to have self-reported stroke or ischemic heart disease after adjusting for age, sex, occupation, smoking and alcohol use, hypertension or diabetes [16]. Furthermore, individuals with antisocial PD were

**Table 5** Prevalence, odds ratios (OR) and 99 % confidence intervals (99 % CI) of personality disorders predicting co-occurring gastrointestinal (GI) diseases

| Personality disorder | Total *n* (%) | PD yes *n* = (%) | PD no *n* = (%) | Gastrointestinal disease | |
|---|---|---|---|---|---|
| | | GI disease yes | GI disease yes | Bivariate OR (99 % CI) | Model 1: AOR (99 % CI) |
| Any personality disorder | | | | | |
| All | 7,783 (21.5) | 749 (8.9) | 1,659 (5.8) | 1.57 (1.36–1.81)** | 1.36 (1.15–1.62)** |
| Any Cluster A personality disorder | | | | | |
| All | 3,449 (9.0) | 403 (10.5) | 2,005 (6.0) | 1.83 (1.53–2.19)** | 1.41 (1.16–1.72)** |
| Paranoid | | | | | |
| All | 1,689 (4.3) | 195 (10.3) | 2,213 (6.3) | 1.73 (1.33–2.24)** | 1.31 (1.00–1.73)* |
| Schizoid | | | | | |
| All | 1,144 (3.1) | 124 (10.7) | 2,284 (6.3) | 1.78 (1.29–2.45)** | 1.37 (0.99–1.91)* |
| Schizotypal | | | | | |
| All | 1,534 (3.9) | 218 (13.3) | 2,190 (6.2) | 2.34 (1.83–2.99)** | 1.64 (1.24–2.15)** |
| Any Cluster B personality disorder | | | | | |
| All | 4,843 (13.3) | 507 (9.7) | 1,901 (5.9) | 1.71 (1.44–2.03)** | 1.48 (1.20–1.81)** |
| Antisocial | | | | | |
| All | 1,226 (3.8) | 125 (9.7) | 2,283 (6.3) | 1.59 (1.15–2.18)** | 1.63 (1.14–2.33)** |
| Borderline | | | | | |
| All | 2,231 (5.9) | 296 (12.1) | 2,112 (6.0) | 2.13 (1.71–2.66)** | 1.38 (1.06–1.81)* |
| Histrionic | | | | | |
| All | 651 (1.8) | 64 (9.0) | 2,344 (6.4) | 1.45 (0.91–2.29) | 1.25 (0.78–2.02) |
| Narcissistic | | | | | |
| All | 2,449 (6.2) | 246 (9.4) | 2,162 (6.2) | 1.57 (1.25–1.97)** | 1.34 (1.04–1.72)* |
| Any Cluster C personality disorder | | | | | |
| All | 3,244 (9.4) | 319 (8.9) | 2,098 (6.2) | 1.49 (1.20–1.83)** | 1.25 (1.00–1.56)* |
| Avoidant | | | | | |
| All | 821 (2.3) | 106 (10.3) | 2,302 (6.3) | 1.96 (1.33–2.88)** | 1.40 (0.94–2.09) |
| Dependent | | | | | |
| All | 147 (0.4) | 25 (17.3) | 2,383 (6.4) | 3.06 (1.27–7.41)** | 1.79 (0.75–4.28) |
| Obsessive–compulsive | | | | | |
| All | 2,753 (8.1) | 255 (8.6) | 2,153 (6.3) | 1.41 (1.12–1.78)** | 1.22 (0.96–1.55) |

Total *n* = presented are raw, prevalence (%) for personality disorders and for gastrointestinal disease "yes" among those with and without the specific personality disorder (column) are weighted. Significant age interactions are stratified: <55 and ≥55 years. * $p \leq 0.01$, ** $p \leq 0.001$. Model 1 AOR: adjusted for sex, race/ethnicity, marital status, education, income, age (continuous), past-year mood, anxiety and substance use disorders

reported to have increased odds of coronary heart disease (CHD) in Wave 1 of the NESARC [17], as was seen in the present study when grouped with other CVDs. In NESARC (wave 2), borderline PD was associated with self-reported diagnosis of CVD (chest pain or angina pectoris, rapid heartbeat or tachycardia, MI, or any other form of heart disease), but not stroke [19]. Moreover, US adults in the St Louis Personality and Aging Network study ($n = 1{,}051$, 55–64 years), with interviewer-rated borderline PD features had a three to fourfold increase odds of self-reported heart disease [23].

Finally, the National Institute of Mental Health Epidemiological Catchment Area study reported that DSM-III Cluster B PDs were associated with approximately fourfold increased risk of incident self-reported CVD (rheumatic fever, rheumatic heart disease, angina pectoris, congestive heart failure, MI) in adults (18–64 years). Moreover, those with Cluster B PDs had approximately a sixfold increased risk of CHD mortality over the 23 years of follow-up [20].

We extend prior studies by providing new evidence for associations between younger adults (<55 years) with borderline PD and CVD, indicating that borderline PD might present a unique risk for CVD for younger adults.

### Arthritis

To our knowledge this is the first study to report associations between PDs from Cluster A with increased odds of

arthritis. In other studies using NESARC data from wave 1, antisocial PD features were associated with past-year arthritis [17], as was borderline PD in wave 2 [19]. In contrast, others have suggested that chronic pain could potentially play a role in exacerbating personality pathology in those with arthritis [18, 43]. In NESARC (wave 1), past-year arthritis, assessed as the exposure variable of interest, was associated with increased odds of several individual PDs (paranoid, schizoid, antisocial, histrionic, and obsessive–compulsive PDs). Given that the brief data to date relating to the association between PDs and arthritis is cross-sectional [17–19], longitudinal studies are required to ascertain causal associations. However, the current study extends prior studies by demonstrating among younger individuals an effect modification of age in the relationship between several PDs and arthritis. By definition, features of personality disorder are known to emerge in adolescence and early adulthood [1]. Our preliminary analyses suggest that it might be more likely that PDs might be associated with the development of arthritis, given that the common sequelae of many arthritic diseases are older age.

### Diabetes

To the best of our knowledge, these data are the first to indicate significant and positive associations between PDs from Cluster A and diabetes in a representative population-based study. Similarly, data from the World Health Survey reported that increasing numbers of psychotic symptoms were associated with increased likelihood of diabetes [44]. Potentially, individuals with PDs from Cluster A might have a greater propensity for metabolic abnormalities, in turn, increasing the risk for developing type 2 diabetes. For example, individuals with schizophrenia have an increased frequency of type 2 diabetes. This appears to be modulated by impaired fasting glucose tolerance and increased insulin resistance, independent of antipsychotic medication use [45]. It is also plausible that unhealthy lifestyle behaviors and obesity, which are also known health risk factors for diabetes [46], might have a role in mediating the associations between PDs from Cluster A with diabetes. For example, body mass index (BMI) ($\geq$30) has been reported to mediate the relationship between other PD features (borderline) and self-reported chronic physical conditions [23]. However, given the evidence base is limited further studies are required to replicate these cross-sectional observations and extend these findings using longitudinal study designs.

### Gastrointestinal disease

Cluster A PDs and specifically schizotypal PD showed the strongest association with GI diseases across the lifespan. Additionally, individuals with PDs from Cluster B (antisocial, borderline and narcissistic PDs) and Cluster C (obsessive–compulsive PD) were also more likely to report being diagnosed with GI disease than individuals without those PDs. Previous analyses from wave 2 NESARC examining borderline PD only, reported increased odds of GI disease for those with this PD [19], an association postulated to be mediated via dysregulation of brain-gut neuroenteric systems. Furthermore the current study extended these observations to examine the relationship with all PDs and whether age moderated these associations. Moreover, PDs from all Clusters were associated with GI disease, indicating PDs as a group of psychiatric disorders might have a general rather than specific relationship with GI disease. Given the cross-sectional nature of the current evidence base, the reverse association, of GI disease exacerbating PD symptomatology cannot be ruled out.

### Mechanisms

It is well-known that increasing age is associated with declines in physical functioning and increased overall medical burden. However, in our current study, age was an effect modifier in the relationship between several individual PDs with CVD and/or arthritis, whereby younger individuals were shown to have increased risk. This age-related finding is important, given that both CVD and arthritis are commonly diagnosed among older age groups. Due to the paucity of extant data, few comparisons can be made with prior studies. However, we can speculate that the emergence of PD features in adolescence and early adulthood might increase the risk for joint trauma via risk-taking behaviors and injuries. Trauma to the joints increases the risk for developing lesions of the bone marrow [47]. Moreover, it is biologically plausible that even after taking into account adult lifestyle risk factors and exposure to significant traumatic events during sensitive periods in personality development might lead to chronic physical conditions and increase overall mortality [48]. For example, adverse childhood events have been shown to be associated with a marker of constricting blood vessel health (elevated plasma endothelin-1 levels) in young adulthood [49].

Other shared risk factors for both CVD and (to a lesser extent) arthritis, include cigarette smoking. While we adjusted for past-year nicotine dependence, it was not possible to account for earlier smoking behaviors. It has been shown that adolescents with borderline PD have an earlier age of onset of smoking [42], thus increasing the risk for these conditions much earlier in life. Smoking is also a known robust risk factor for diabetes; however, such risk factors in the presence of PD earlier in the lifespan might a have distinct role in precipitating the pathophysiological expression of CVD and arthritis compared to

diabetes and GI. Alternatively, is it possible that the reverse relationship might exist, where rarer physical conditions in young adulthood, might be associated with maladaptive coping styles and have effects upon the development of personality pathology. As such there is a need for longitudinal studies that examine PDs and cardio-metabolic conditions across the full age range, including adolescents.

Despite our data suggesting that there might be unique pathological mechanisms in the relationship between PDs and some physical conditions in younger adults, there might be other shared risk factors and pathways demonstrating that PDs and physical health conditions from the studied disease groups share common antecedents. For example several of the physical conditions examined in this study have etiological origins in inflammatory processes. There is evidence to suggest that patients with mood disorders and psychiatric comorbidities have been shown have elevated levels of pro-inflammatory cytokines which promote systemic inflammation [50, 51]. To date little is known regarding the association between inflammation and PDs. Although it is possible that PDs directly affect physiological dysregulation such as inflammatory processes, it is possible that there is a secondary mediator. Specifically, it is possible that known lifestyle and behavior correlates of individuals with PDs such as harmful levels of alcohol consumption, cigarette smoking and medication use might modulate biological processes promoting systemic inflammation [50, 52] and thus mediate the relationship between PDs and physical comorbidities. These unhealthy lifestyle factors are also simultaneously linked to a dysregulation in both peripheral immune function and the stress-response system [52], increasing the risk for physical disease.

Weight gain is also a common correlate of typical and atypical antipsychotics, mood stabilizers and tricyclic antidepressants commonly used to treat psychotic disorders, bipolar disorder, and psychiatric comorbidities including PDs [53]. Metabolic disturbances such as obesity thus increase the risk for physical disease inclusive of CVD and diabetes. Interestingly, PDs from Cluster A share "odd/eccentric" features which more closely resemble psychotic symptoms than PDs from Clusters B or C, showed the strongest association with diabetes than the other physical conditions examined in the current study. Unfortunately, this study did not have access to respondents' medication histories, and thus we are unable to examine the possibility that medication use might have had an unmeasured mediation effect on the observed associations between PDs and CVD and diabetes.

The interaction between PDs and medical comorbidity might also be mediated by other health behaviors. It is known that people with PDs have poorer levels of adherence and engagement in treatment, which might be a potential pathway [54]. Further, it is also well known that individuals with PDs suffer significant social disadvantage such as disruption to education and employment. Specifically PDs as a group are associated with lower educational attainment [8], household income [35] and are prevalent among the homeless [55]. Socially disadvantaged individuals are also more likely to have poorer health literacy which is consistently associated with poorer physical health and treatment adherence outcomes [56]. While little is known of the relationship between PDs and health literacy, it is possible that social disadvantage plays a role in the risk for physical disease for those with PDs, via poorer access to care and barriers to effective treatment and management of both mental and physical disorders. It is also possible that disturbances in cognition and affect which are reflective of PDs could impact upon competencies to appraise health information and engage in appropriate help-seeking behaviors. Finally, current classification systems postulate that PD symptoms and behaviors typically manifest in adolescents or early adulthood, thus we predicted that PDs increase the risk for physical comorbidities. However, our analyses of these associations were cross-sectional, and we cannot rule out the potential that chronic diseases of the young, such as diabetes, might be associated with the development of PD via their effects upon personality development.

## Strengths/limitations

This study has notable strengths. The study used a large and representative sample of adults from the US, along with validated tools for the assessment of PDs and psychiatric comorbidities among this population. Furthermore, when considering the robust link between depression (a common mental disorder which is also highly comorbid with PD) and CVD, our findings (adjusted for a variety of mood, anxiety and substance use disorders) suggest that the effects of PD on the risk for physical conditions are not simply driven by the effects of other mental disorders. Notwithstanding the methodological strengths of the NESARC, we acknowledge there are some limitations to consider upon interpreting our data. We utilized pooled data from waves 1 and 2 of the NESARC and as such, the full range of PDs was not assessed at a unified point in time (2001–2002 and 2004–2007 respectively). It might be that there is a longitudinal relationship between some PDs that were assessed in wave 1 and physical comorbidities. However, it was not possible to ascertain this because of the cross-sectional nature of the present study, which examines lifetime PDs and past-year physical conditions. Additionally, despite the wide use of the AUDADIS-IV in

NESARC, it has been suggested that the threshold for diagnosing PDs is too low, potentially inflating prevalence rates (21.5 % for any PD) compared with prior studies [57].

In the absence of clinical data to inform assessment of physical comorbidities, this study used self-reported information of being diagnosed by a health professional. As previously published [19], self-reported data has acceptable concordance with medical records of diagnosed physical conditions [32]. However, we cannot rule out the potential for recall bias, or the risk of differential reporting of physical conditions by PD status. Moreover, while we adjusted for the potential effects of substance use disorders (i.e. a proxy for harmful alcohol and tobacco use), and mood and anxiety disorders (i.e. proxy for medication use, such as antidepressants), we did not adjust for other important lifestyle correlates that are likely to be risk factors for chronic physical comorbidities. These include levels of physical activity, BMI and other prescription or non-prescription medication use. As such, additional studies examining the mediating or moderating effects of lifestyle correlates in the relationship between PDs and physical comorbidities are needed.

## Conclusions

Physical comorbidities in individuals with PDs are severely under-recognized. Our study provides preliminary evidence of associations between individual PDs and PD Clusters with a range of physical comorbidities from diverse chronic disease groups. Furthermore, these findings strengthen the sparse evidence base in this growing field of enquiry. However, there is a clear need for further investigations regarding the relationship between PDs and physical comorbidities. This might determine whether screening for physical conditions is warranted in individuals with PDs in general health care systems. This will in turn, generate appropriate referrals to optimize overall patient health. Furthermore, a more comprehensive understanding of the relationship between physical comorbidities in those with PDs across the lifespan might further improve prevention and treatment options and outcomes for these individuals.

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**Conflict of interest** The authors have no conflict of interest to declare.

**Ethical standard** The US Census Bureau and the US Office of Management and Budget reviewed the research protocol and provided full ethical approval and therefore performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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