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ORIGINAL PAPER

Where Do Sexual Dysfunctions Fit into the Meta-Structure of Psychopathology? A Factor Mixture Analysis

Miriam K. Forbes[1] · Andrew J. Baillie[1] · Carolyn A. Schniering[2]

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Abstract Sexual dysfunctions have not been included in research on the broad structure of psychopathology to date, despite their high prevalence and impact on quality of life. Preliminary research has shown that they may fit well in an internalizing spectrum, alongside depressive and anxiety disorders. This study compared dimensional and categorical models of the relationships between depression, anxiety, and sexual problems with "hybrid" models (i.e., factor mixture analyses), which combine dimensional and categorical components simultaneously. Participants ($n =$ 1000) were selectively recruited to include a range of symptom levels, and completed a series of self-report measures online. A hybrid model that combined dimensional and categorical components fit best for men and women. Taken together, the results are consistent with a nosology that explicitly recognizes the relationships between the diagnostic chapters of depressive and anxiety disorders and sexual dysfunctions, but still maintains discrete diagnoses, which is compatible with the structure of the DSM-5 and upcoming ICD-11.

Keywords Sexual dysfunctions · Internalizing psychopathology · Meta-structure · DSM-5 · ICD-11

✉ Miriam K. Forbes
miri.forbes@mq.edu.au

[1] Centre for Emotional Health and NHMRC Centre of Research Excellence in Mental Health and Substance Use, Department of Psychology, Macquarie University, Sydney, NSW 2109, Australia

[2] Centre for Emotional Health, Department of Psychology, Macquarie University, Sydney, NSW, Australia

Introduction

Sexual dysfunctions are highly prevalent, and associated with marked personal distress and decreased quality of life (e.g., McCabe, 1997). In addition, they have exceptionally high rates of co-occurrence with depressive and anxiety disorders (see Laurent & Simons, 2009 for a review). This comorbidity is related to increased chronicity and severity, resistance to treatment, and worse long-term outcomes for patients (e.g., Hoyer, Uhmann, Rambow, & Jacobi, 2009; Shabsigh et al., 1998; van Lankveld & Grotjohann, 2000). When the disorders are not treated together, patients tend to have negative treatment outcomes, drop out of treatment, and subsequently are likely not to seek help again (Shabsigh et al., 1998; van Lankveld & Grotjohann, 2000). Despite this, the disorders tend to be treated separately, and sexual dysfunctions often go undiagnosed and unrecognized in primary care (Moreira, Glasser, King, Duarte, & Gingell, 2008; Read, King, & Watson, 1997).

This clinical separation is likely influenced by their historical separation in our nosologies. The *Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition* (DSM-5) and the *International Classification of Diseases—Eleventh Edition Beta Draft* (ICD-11) now incorporate dimensional spectra of psychopathology (e.g., the internalizing spectrum and the externalizing spectrum) to account for the body of research that documents the systematic patterns of co-occurrence between larger groups of disorders. The internalizing–externalizing framework has been researched extensively; it interprets comorbidity between disorders as an indicator of stable, underlying core psychological processes (Krueger, 1999), and has been expanded to include many types of psychopathology, including depressive and anxiety disorders, posttraumatic stress disorder, obsessive–compulsive disorder, bipolar disorder, eating disorders, schizophrenia, and personality disorders (Kotov et al., 2011; Krueger, 2005; Krueger,

Caspi, Moffit, & Silva, 1998; Markon, Krueger, & Watson, 2005; Slade & Watson, 2006; Watson, 2005).

Sexual dysfunctions also have strong and multifaceted relationships with depressive and anxiety disorders that are consistent with a shared underlying factor of internalizing psychopathology (see Laurent & Simons, 2009 for a review), and preliminary research has shown that a dimensional model that includes sexual problems in the internalizing spectrum fits better than a categorical model that separates the disorders (Forbes, Baillie, & Schniering, 2014a; Forbes & Schniering, 2013). While the DSM-5 suggests that the new meta-structure will encourage broad investigations within proposed chapters and across adjacent chapters (American Psychiatric Association [APA], 2013, p. 13), the opposite is happening for the Sexual Dysfunctions chapter, which appears to have been overlooked in the formulation of a meta-structure (e.g., Kendler, 2009; Krueger, Watson, & Barlow, 2005; Markon, 2010). However, there is growing evidence to propose a shift in our nosology, and at least three of the indicators that were used to determine the meta-structure are relevant to depression, anxiety, and sexual problems: abnormalities of emotional or cognitive processing (Nobre & Pinto-Gouveia, 2003, 2006, 2009), high comorbidity (Laurent & Simons, 2009), and shared treatment response (e.g., Brotto, Basson, & Luria, 2008; McCabe, 2001). It is important to define the nature of the relationships between these disorders to help understand etiology, course, and treatment response. These sorts of research questions were widespread leading up to the release of the DSM-5, and primarily centered around whether the latent structures of disorders—and of psychopathology more broadly—were dimensional or categorical. A brief overview of this literature is provided below.

Theoretical and Statistical Methods to Determine the Structure of Psychopathology

To briefly summarize, categorical models fulfill the needs of clinicians, researchers and insurance companies, as they classify and diagnose individuals (Andrews, Anderson, Slade, & Sunderland, 2008). Dimensional models provide an alternative framework to understand the shared aspects of disorders, and recognize the relationships between them, but do not provide a means for diagnosis; this perspective is arguably more suited to the nature of psychopathology, and explains the robust patterns of comorbidity between disorders (Krueger & Markon, 2006). Categorical models are often examined using latent profile analysis (LPA; i.e., latent class analysis using continuous variables), which groups individuals according to their observed symptom response patterns; it explains patterns of co-occurrence with respect to a number of mutually exclusive underlying classes (Krueger, Markon, Patrick, & Iacono, 2005). Dimensional relationships between disorders are typically investigated using factor analytic (FA) methods, which allow for the unique and shared aspects of disorders, and explains patterns with respect to underlying continuous dimensions (Widiger & Samuel, 2005). However, neither statistical method alone suits both the nature of psychopathology and the needs of clinicians, and both rely on statistical assumptions that do not hold for psychopathology.[1] As such, while these methods are helpful theoretically, they are flawed in their practical applications.

Factor mixture analyses (FMAs)—or "hybrid models"—were recently developed, and simultaneously incorporate both dimensional *and* categorical components (i.e., factors and classes, respectively) without relying on an a priori assumption about the underlying structure of the relationships as dimensional or categorical (Masyn et al., 2010). FMAs can detect common processes for large groups of people, but also allow for different structural relationships within groups (i.e., classes) that do not share these common processes. This feature is excellent for modeling comorbidity, as it allows us to determine whether one nosological model might fit for everyone, or if some groups of individuals have a different set of relationships. FMAs combine the strengths of LPA and FA to offer a strong theoretical solution that is compatible with our nosology and relaxes the rigid statistical assumptions of each model in isolation (Clark et al., 2013). In short, a model that maintains separate diagnoses—and recognizes the potentially nuanced relationships between them—meets the needs of clinicians and researchers and is an important step toward more effective diagnosis and pre-emptive transdiagnostic treatment. Accordingly, FMAs are strong and informative statistical models for our nosological systems, and are compatible with the structure of the DSM-5 and ICD-11 Beta Draft (APA, 2013; World Health Organization [WHO], 2013).

Application of These Methods to Sexual Dysfunctions, Depression, and Anxiety

In the context of depression, anxiety, and sexual problems, preliminary research has empirically evaluated dimensional and categorical models and found both types of relationships, with particularly strong evidence for dimensional relationships for women: Forbes and Schniering (2013) evaluated an expanded FA model of the internalizing spectrum that included sexual problems alongside depression and anxiety. This model fit well for women, and Forbes et al. (2014a) subsequently found that this model also fit well for 96 % of men in their sample. However, Forbes et al. also found that there were evident categorical relationships for men.

[1] LPA does not allow for varying severity within categories, and relies on a conditional independence assumption (i.e., the assumption that disorders are completely unrelated to each other within each class; Masyn, Henderson, & Greenbaum, 2010); neither of these rigid assumptions is compatible with what is known about the nature of psychopathology. FAs rely on the assumptions that all individuals are from the same homogeneous population (i.e., share the same patterns of relationships), and that individual differences arise purely from differences on an underlying factor, which are both unlikely to be true in the real world.

The results of these studies have limited reliability and generalizability due to the restricted variance in symptom levels for men, and the exclusion of adolescents and participants who were not sexually active in the past 4 weeks. Variation in symptom levels is particularly important for these sorts of analyses because the covariation among disorders forms the basis of the statistical analyses. Furthermore, the models tested were limited by the assumptions of the LPA and FA methods, their utility in the real world was not sufficient, and valuable information was lost in both models by forcing a single type of structure. Logically, both dimensional *and* categorical relationships would be present: there are clear relationships between the diagnostic groups, but there are also differences between the sexual and emotional domains, so it is likely that neither a forced dimensional or categorical structure would be ideal. In this context, FMAs provide a uniquely helpful conceptualization that is suited to investigate the nature of the relationships of interest.

The Present Study

The aim of the present study was to define an empirically supported nosological model of the relationships between depression, anxiety, and sexual problems, with a focus on using innovative statistical techniques. As such, FMAs were used to build on existing research. The primary analyses focused on the responses from participants who engaged in intercourse in the past 4 weeks, as these responses provide complete information on the experience of sexual problems. The model of best fit for these participants was also examined for the participants who had not engaged in intercourse in the past 4 weeks. All analyses were conducted separately for men and women to allow for differences in male and female sexual response. Based on the work of Forbes and Schniering (2013) and Forbes et al. (2014a), it was hypothesized that the models of best fit for women would have strong dimensional characteristics; for men, it was hypothesized that the models of best fit would incorporate both dimensional and categorical components. More broadly, it was hypothesized that both genders would need dimensional components to adequately represent the relationships between disorders.

Method

Participants and Procedure

To address these hypotheses, a wide range of respondents completed online self-report measures on symptoms of affective disorders and sexual dysfunctions. The present study used the first time point from a six time point longitudinal study. Participants were recruited by responding to print and online advertisements, which were disseminated as widely as possible and specifically placed to recruit participants with varying symptom levels for the disorders of interest (e.g., Impotence Australia, beyondblue, The Happiness Institute, community centers, doctors surgeries). Advertisements directed participants to the study website "to help us understand the relationship between mood, stress levels and sexuality over time," where the details of the study were provided. Participants self-selected into the study. The study was approved by the Macquarie University Human Research Ethics Committee, and respondents were required to provide informed consent and declare their age before they were able to access the survey. Those under 16 years of age were not permitted access—as this is the average legal age for sexual consent in Australia—and this was the only exclusion criterion. Eligible participants completed brief demographic information and the measures relevant to their gender, providing data on their symptoms of depression, anxiety, and sexual dysfunction. At the completion of the survey, respondents were automatically entered into the draw for a prepaid $100 credit card.

A total of 1110 adults from the general population started the study. Incomplete responses ($n = 110$, 11 %) were excluded from analyses, resulting in a final sample of 1000 participants. Table 1 provides demographic and symptom-level information about these participants. Of the included sample, 72 % were female ($n = 721$), 28 % were male ($n = 279$), and the average age was 31.9 years ($SD = 11.9$). Participants who had engaged in intercourse in the past 4 weeks (the "intercourse group"; $n = 707$) were the primary sample, as they provided complete information for all of the variables of interest. Models were also analyzed for the "no-intercourse group" ($n = 293$), as a comparison.

Measures

The measures for this study assessed symptoms of major depression, generalized anxiety disorder (GAD), social anxiety, obsessive–compulsive disorder (OCD), panic disorder, and sexual dysfunctions, as described below. These measures were all self-report Likert scales, chosen for their brevity and high criterion validity to DSM disorders. The diagnostic cut-off scores described for each measure were used to delineate the descriptive statistics in Table 1.

Depression

The Patient Health Questionnaire (PHQ-9; Kroenke, Spitzer, & Williams, 2001) is a 9-item measure of depressive symptoms, and has been shown to have good reliability (Lowe, Kroenke, Herzog, & Grafe, 2004). Diagnostic validity of the PHQ-9 has also been established, and diagnostic cut-off scores with good sensitivity and specificity are available to differentiate the severity of symptom levels (Lowe et al., 2004). Internal consistency in the present study was $\alpha = 0.90$.

GAD

The Brief Measure for Assessing Generalized Anxiety Disorder (GAD-7; Spitzer, Kroenke, Williams, & Lowe, 2006) is a 7-item

Table 1 Descriptive statistics for demographics and observed variables for women and men

Variable (possible range)	Women		Men	
	Intercourse in the past 4 weeks ($n = 526$)	No intercourse ($n = 195$)	Intercourse in the past 4 weeks ($n = 181$)	No intercourse ($n = 98$)
Age (in years)	30.32 (10.47)	31.89 (12.28)	34.51 (13.26)	35.47 (13.94)
Relationship—living together	285 (54.2 %)	80 (41.0 %)**	89 (49.2 %)	34 (34.7 %)**
Employment—full time work	215 (40.9 %)	77 (39.5 %)**	122 (67.4 %)	54 (55.1 %)
Education—university degree	347 (66.0 %)	133 (68.2 %)	106 (58.6 %)	45 (45.9 %)**
Family—no children	386 (73.4 %)	138 (70.8 %)	111 (61.3 %)	65 (66.3 %)
Depression (0–27)	7.16 (5.52)	9.14 (6.92)	7.13 (5.80)	8.04 (5.86)
Moderate to severe depression	153 (29.1 %)	76 (39.0 %)	51 (28.2 %)	35 (35.71 %)
GAD (0–21)	6.03 (4.84)	6.92 (5.48)**	6.17 (5.06)	6.09 (5.66)
Significant or severe GAD	120 (22.8 %)	55 (28.2 %)	47 (26.0 %)	25 (25.5 %)
Social anxiety (0–68)	14.45 (12.57)	17.44 (14.20)**	13.74 (13.41)	15.84 (13.18)
Over threshold for SA	156 (29.7 %)	117 (60.0 %)	50 (27.6 %)	34 (34.7 %)
Obsessive compulsivity (0–72)	9.92 (10.04)	12.28 (12.14)**	10.91 (11.87)	10.48 (9.39)
Over threshold for OCD	118 (22.4 %)	49 (25.1 %)	34 (18.8 %)	20 (20.4 %)
Panic disorder (0–4)	2.65 (4.32)	3.23 (5.00)**	2.45 (4.14)	3.11 (4.89)
Mild or severe PD	88 (16.7 %)	39 (20.0 %)	25 (13.8 %)	17 (17.3 %)
Sexually related distress (0–52)	15.17 (13.10)	18.11 (13.92)**	–	–
Over cut-off for likely FSD	290 (55.1 %)	127 (65.1 %)	–	–
Sexual desire (0–26)	13.72 (6.03)	21.40 (4.43)**	–	–
High probability of HSDD	175 (33.3 %)	152 (77.9 %)	–	–
Arousal sensation (0–16)	7.14 (4.20)	7.84 (3.58)	–	–
High probability of FSAD	163 (31.0 %)	18 (31.6 %)	–	–
Lubrication (0–8)	3.25 (2.15)	3.58 (1.92)	–	–
High probability of FSAD	157 (29.8 %)	19 (33.3 %)	–	–
Cognitive arousal (0–8)	3.17 (2.19)	3.93 (2.31)**	–	–
High probability of FSAD	146 (27.8 %)	25 (43.9 %)	–	–
Orgasmic function (0–14)	5.85 (4.13)	6.05 (4.25)	–	–
High probability of FSOD	186 (35.4 %)	28 (37.3 %)	–	–
Sexual pain (0–13)	1.58 (2.33)	–	–	–
High probability of dyspareunia	26 (4.9 %)	–	–	–
Erectile function (0–24)	–	–	3.30 (4.73)	4.05(6.12)
Mild to severe ED	–	–	48 (25.4 %)	17 (17.4 %)
Sexual satisfaction (0–100)	–	–	34.89 (30.16)	76.04 (25.89)**
Ejaculatory control (0–100)	–	–	36.46 (32.06)	–
PE-related distress (0–100)	–	–	25.21 (29.33)	17.05 (25.39)
Desire (0–98)	–	–	32.68 (14.08)	38.74 (20.82)**

Means (Standard deviations) or *N* (% of respondents). Higher scores indicate higher symptom levels

GAD generalized anxiety disorder, *OCD* obsessive–compulsive disorder, *PD* panic disorder, *FSD* female sexual dysfunction, *HSDD* hypoactive sexual desire disorder, *FSAD* female sexual arousal disorder, *FSOD* female sexual orgasmic disorder, *ED* erectile dysfunction, *PE* premature ejaculation

** Independent samples *t* test *p* value <.01, compared within gender

measure of GAD with very good reliability and high construct validity. It also has established cut-off scores to ascertain the severity of GAD. Internal consistency in the present study was $\alpha = 0.91$.

Social Anxiety

The Social Phobia Inventory (SPIN; Connor et al., 2000) consists of 17 items, and is the only self-report measure of social

anxiety that measures a spectrum of fear, avoidance, and physiological symptoms. It has excellent internal consistency, good construct validity, and a threshold to establish the likely presence of social anxiety. Internal consistency in the present study was $\alpha = 0.93$.

OCD

The Obsessive–Compulsive Inventory-Revised (OCI-R; Foa et al., 2002) is an 18-item self-report measure that measures six subscales (washing, checking, ordering, obsessing, hoarding, and neutralizing) and gives a total score. It has been shown to have good internal consistency, convergent validity, and test–retest reliability (Foa et al., 2002), and has a threshold score to determine the likely presence or absence of OCD. Internal consistency in the present study was $\alpha = 0.92$.

Panic Disorder

The Panic Disorder Severity Scale-Self-Report (PDSS-SR; Shear et al., 1997) is a 7-item measure of panic disorder severity. The PDSS-SR has high internal consistency, and convergent and discriminant validity (Houck, Spiegel, Shear, & Stat, 2002). The PDSS-SR also has good clinical and criterion validity, and existing clinical severity cut-off scores. Internal consistency in the present study was $\alpha = 0.85$.

Female Sexual Problems

The Abbreviated Sexual Function Questionnaire (ASFQ; Williams, Abraham, & Symonds, 2010) is a 20-item screening tool for female sexual dysfunction (FSD) that includes six domains of sexual function: sexual desire, arousal sensation, cognitive arousal, lubrication, orgasmic function, and sexual pain. The ASFQ has excellent criterion validity, and good reliability and construct validity. While the three arousal domains do not have criterion validity individually, they were retained as separate variables to allow them to function differentially in the models. Internal consistency for the subscales in the present study ranged from $\alpha = 0.83$ to 0.91.

The Female Sexual Distress Scale-Revised (FSDS-R; Derogatis, Clayton, Lewis-D'Agostino, Wunderlich, & Fu, 2008) is a 13-item measure of for assessing sexually related distress in women, to be used in conjunction with the ASFQ for screening for sexual dysfunctions. Sexually related distress was measured separately from sexual function to provide additional clinical information on whether sexual problems were associated with distress, in accordance with Hayes' (2008) recommendation. It has demonstrated good discriminant validity, high test–retest reliability, and a high degree of internal consistency, and has a cut-off score established to determine the presence of likely FSD. Internal consistency in the present study was $\alpha = 0.95$.

Male Sexual Problems

The International Index of Erectile Function (IIEF; Rosen et al., 1997) was designed for—and tested on—sufferers of erectile dysfunction, and subsequently has outstanding psychometric properties only for the 6-item erectile function subscale. The other subscales (satisfaction, orgasmic function, sexual desire) are inadequate measures for the purposes of this study (see Forbes, Baillie, & Schniering, 2014b, for a review). Consequently, only the erectile function subscale was used in this study. Internal consistency in the present study was $\alpha = 0.91$.

The Index of Premature Ejaculation (IPE; Althof et al., 2006) is a 10-item index of premature ejaculation (PE) that assesses control over ejaculation, distress related to PE, and general sexual satisfaction. The IPE has been shown to possess very good discriminant validity, good convergent validity, and good internal consistency. Internal consistency for the subscales in the present study ranged from $\alpha = 0.90$ to 0.93.

The Sexual Desire Inventory (SDI; Spector, Carey, & Steinberg, 1996) has 13 items, and was used to measure male dyadic and solitary sexual desire. It has been shown to have high internal consistency, and construct validity. Internal consistency in the present study was $\alpha = 0.90$.

Data Analysis

Disorders were conceptualized as continuous by using the total score from each measure. This decision was made to retain valuable information about symptom variation and severity above and below the diagnostic threshold (Krueger et al., 1998). Sexual function items were reverse-scored so that higher scores indicated greater dysfunction, in line with all other measures. The scales of the observed variables varied greatly, and this is known to cause convergence problems in complex models (Muthén & Muthén, 2011), so scores were standardized. Because of the general community sample used, symptom measures were moderately positively skewed (maximum skew statistic was 1.7); consequently, variables were treated as censored from below to account for floor effects and nonnormality. A robust maximum likelihood estimator (MLR) was used, which treated disorders as continuous.

Clark et al. (2013) described five different broad types of FMA models (FMA-1 to FMA-5), each with different parameter restrictions. In practice, the more restrictive models (e.g., FMA-1 and FMA-2) often do not fit real data well (Clark et al., 2013). Accordingly, and for the sake of brevity, FMAs based on the less-restrictive FMA-4[2] from Clark et al. are compared with the FAs

[2] In this type of FMA, the means of the continuous disorder scores are allowed to vary across classes, as a variety of symptom severity levels are expected between groups. Factor loadings are held invariant across classes, which suggests that the disorders are being measured the same way across all classes; but factor variances and covariances and the factor covariance matrix are freely estimated in each class, which allows for a range of severity levels within and between classes. This will allow us to determine if there are categorically

and LPAs of best fit. The recommendations of Clark et al. (2013), Masyn et al. (2010), and Muthén (2002) were used to determine which model provided the best fit to the data, using a combination of statistical and substantive model checking. LPA and exploratory FA (EFA) models need to be run before fitting an FMA. The Vuong–Lo–Mendell–Rubin (VLMR) Likelihood Ratio Test (LRT), Lo–Mendell–Rubin (LMR) LRT (Lo, Mendell, & Rubin, 2001) and Bootstrapped LRT (BLRT)[3] are tests to decide which LPA model provides the best number of symptom profiles to characterize the groups in the data. The LRTs provide *p*-values that indicate whether a $(k-1)$ class model can be rejected in favor of a *k*-class model (e.g., whether a two-class model can be rejected in favor of a three-class model). The first model that has a non-significant *p* value ($p > .05$) is rejected in favor of the previous model (i.e., the model with one less class) because this indicates that the additional class did not contribute significantly to the model. It is also important to assess the value and utility of the profiles (i.e., how informative the model is) and whether the profile sizes and proportions indicate over-extraction (i.e., are very small; Masyn et al., 2010); entropy is a measure of the degree to which classes are distinguishable, and the precision with which individuals are placed in classes, with values close to 1 being ideal (Masyn et al., 2010). For EFAs, an interpretable factor structure with high factor determinacy scores (FDs; scores close to 1 indicate a unique solution for the factor analysis) is evidence for a strong model.

The best LPA is the end point for increasing the number of classes in an FMA, and the best EFA is the end point for increasing the number of factors. These models are then combined using an iterative approach—building up from one factor and one class—until the maximum number of factors and classes is reached. The resulting FMAs are compared using the same methods for choosing an LPA model. The best LPA, EFA, and FMA models are then compared using the Bayesian Information Criterion (BIC)—which has been shown to be the most reliable comparison criterion (Nylund et al., 2007)— and by checking the theoretical implications of the model. It is also important that the classes have utility and value in their interpretation. This study included additional information criteria—the Akaike's Information Criterion (AIC) and sample size-adjusted BIC (ABIC)— which have been shown to outperform the BIC for models with larger class separation (Lubke & Neale, 2006).

Participants in the "no-intercourse" group could not provide responses for some of the sexual problems variables, and so could not be included in the primary analyses. In order to analyze the structure of the relationships in these groups, the model of best fit from the primary analyses was also examined in these samples: structural invariance was held based on the results of the primary analyses, but the means and variances of observed variables were allowed to be free, as we would not necessarily expect the same symptom levels between groups. We can interpret these models as having the same underlying latent variables because they have the same number of factors, and equal factor loadings and intercepts (Clark et al., 2013). Missingness for the "no-intercourse groups" was dealt with using full information maximum likelihood estimation (FIML). An information-theoretic approach was used to identify the best model for each group. This type of approach emphasizes parsimony (i.e., efficient and accurate representations of observed data), which is ideal for nosological models (Krueger et al., 2005). The data were scored and transformed—and descriptive statistics were computed—using SPSS Statistics Version 19.0 for Macintosh. The primary analyses were conducted with MPlus Version 6.1 (Muthén & Muthén, 2011).

Results

Descriptive Statistics

Participants Who Had Engaged in Intercourse in the Past 4 Weeks

Descriptive statistics for the observed variables are presented in Table 1. Observed variables tended to have high symptom rates for a community sample. Twenty-to-forty per cent of the "intercourse groups" reached the cut-offs for moderate or significant dysfunction across most disorders, with the exception of panic disorder, female sexual pain disorders, and erectile dysfunction (8.5 % met the "severe" cut-off). Comparing men and women in the "intercourse groups," there were no significant differences in depression and anxiety symptom levels. The "intercourse groups" thus had a wide and adequate range of symptom levels that were optimal for testing the models of interest in the present study.

Intercourse versus No-Intercourse Groups

Independent samples *t* tests and chi square analyses showed that, compared with women in the "intercourse group," women who had not had intercourse in the past 4 weeks ($n = 195$) tended to have higher levels of depression, GAD, social anxiety, OCD, panic disorder, and sexually related distress; and lower levels of desire and cognitive arousal. There were no differences between groups in arousal sensation, lubrication, orgasmic function, age, number of children, or education levels. This pattern seems to show that affective and cognitive symptoms were more severe for women who had not engaged in intercourse in the past 4 weeks, but there were no clear differences for self-reported physiological symptoms of sexual dysfunction. Men who had not engaged in

Footnote 2 continued
different groups in the sample, or if the same underlying structure is appropriate for all groups.

[3] The BLRT *p*-values did not reach nonsignificance in any of the analyses, and so the *p*-values are not included in the tables (all *p*s < .0001). Models were selected according to the VLMR and LMR *p*-values, as well as the information criteria and substantive model interpretation (Nylund, Asparouhov, & Muthén, 2007).

intercourse in the past 4 weeks ($n = 98$) had significantly lower sexual satisfaction, and lower levels of desire than the intercourse group.

Women

Latent Profile and Exploratory Factor Analyses

Table 2 shows the model fit indices for women. A three-class LPA was chosen as the best categorical model, based on the significant VLMR and LMR p-values for the four-class model, the strong class enumeration, and because each of the three classes had an interpretable structure. A two-factor EFA was chosen as the best dimensional model, as it had the strongest factor structure, high FDs, and an interpretable factor structure of a depression/anxiety factor and sexual problems factor.

Factor Mixture Analysis

The results of the LPAs and EFAs suggested that FMAs with a maximum of three classes and two factors should be fit to the data. The two-factor structure was specified based on the EFA structure, so that depression and anxiety disorders loaded onto factor one, and sexual problems loaded onto factor two (see Table 3). For each set of models, the two-factor structure was clearly better than the one-factor structure, with the BIC 400–500 points lower. None of the two-factor models had nonsignificant LRTs, so they were compared using the BIC. The three-class two-factor model had the lowest LL and BIC, and the best entropy (see Table 2).

Figure 1 shows the symptom profiles for the three classes. The first and largest class, 77 % of the sample, is the lowest line on the profile plot, with all disorders at similarly low symptom levels; individuals in this class were not likely to report any high symptom levels. The second class, 18 % of the sample, had a high estimated mean for symptoms of panic disorder, and the third class, 5 % of the sample, had elevated estimated means for sexual pain and sexually related distress. Table 3 shows the factor structure within each class, which is similar across each of the classes: there are moderate to strong highly significant factor loadings, sexual pain is a poor indicator, and the factors are correlated at $r = .3$ in each class (range from $r = .30$ to $r = .32$, all ps $< .001$). The mean symptom levels vary between each class, but the model suggests each class has the same underlying structure of relationships between symptoms, and a generally dimensional structure with two separate but related factors. This FMA is consistent with a nosological model that maintains separate diagnostic categories (e.g., panic disorder is required to describe the profile pattern for class two), while explicitly recognizing the relationships between them. Comparing the three best models for women, the three-class two-factor FMA provided the best fit to the data (see Table 2).

Women Who Had not Engaged in Intercourse

The three-class two-factor FMA was also tested for the group of women who had not engaged in intercourse in the past 4 weeks ($n = 195$). Pain during intercourse could not be estimated for this group. As such, the FMA was estimated with depression, GAD, social anxiety, OCD, panic disorder, sexually related distress, desire, cognitive arousal, lubrication, arousal sensation, and orgasmic function. The arousal and orgasm variables were estimated based on women who had engaged in sexual activity without penetrative vaginal sex (e.g., masturbation, oral sex). The model had entropy of .86, with VLMR and LMR p values $< .0001$, so the model was not rejected. The three classes can be interpreted as having the same underlying latent variables as the intercourse group because they have the same number of factors, equal factor loadings, and equal means. This model suggests that the "no-intercourse group" of women tended to have higher symptom levels than the women who had engaged in intercourse in the past 4 weeks, but the same factor and class structure were appropriate.

Men

Latent Profile and Exploratory Factor Analyses

Table 4 shows the model fit indices for men. Due to the significant VLMR and LMR p values for the four-class model, the high entropy, and the clear profile structure, the three-class model was chosen as the best LPA. The two-factor EFA showed the same structure as the EFA for women, with a stronger correlation of $r = .54$ ($p < .001$) between factors. However, the three-factor EFA was chosen as best, based on its low BIC, strong factor structure, and good FDs. This model had a clear factor structure that mirrored the models tested in Forbes and Schniering (2013) and Forbes et al. (2014a): a depression and GAD factor (i.e., Distress); a social anxiety, OCD, and panic factor (i.e., Fear); and a sexual problems factor. The Fear and Distress factors were strongly correlated with one another ($r = .71$, $p < .001$), and both were moderately correlated with the sexual problems factor (both rs $= .45$, $p < .001$). Sexual desire was not a good indicator for any of the factors.

Factor Mixture Analysis

Models with one to three classes and one to three factors were fit to the data, based on the results of the EFA and LPA. The factor structures were based on the EFA results for one-, two-, and three-factor models. All of the three-class models had nonsignificant LRTs, which indicated a two-class model. The two-class two-factor FMA had a low BIC, significant LRTs, and excellent entropy (see Table 4). Figure 2 shows the symptom profiles for the two-class two-factor FMA for men. Class one was large—88 % of the sample—and showed similar estimated mean symptom levels across all disorders. The second class—comprised

Table 2 Model fit indices for latent profile analyses (LPAs), exploratory factor analyses (EFAs), and factor mixture analyses (FMAs) for women who had engaged in intercourse in the past 4 weeks ($N = 526$)

LPAs	LL	*k*	BIC	ABIC	AIC	VLMR	LMR	Entropy
1 class	−9045.06	24	18,240.45	18,164.26	18,138.12	–	–	–
2 classes	−8039.89	37	16,851.53	16,734.08	16,693.79	0.000	0.000	0.897
3 classes	−8018.15	50	16,349.46	16,190.75	16,136.29	0.021	0.022	0.904
4 classes	−7870.03	63	16,134.65	15,934.68	15,866.06	0.598	0.600	0.896
5 classes	−7718.47	76	15,912.96	15,671.71	15,588.94	0.118	0.119	0.893

EFAs	LL	*k*	BIC	ABIC	AIC	FD			
						1	2	3	4
1 factor	−8153.65	36	16,532.79	16,418.52	16,379.31	.947			
2 factors	−7601.82	47	15,498.03	15,348.84	15,297.65	.946	0.953		
3 factors	−7566.56	57	15,490.13	15,309.19	15,247.11	.944	0.953	0.867	
4 factors	−7542.61	66	15,498.61	15,289.11	15,217.22	.940	0.894	0.948	0.861

FMAs	LL	*k*	BIC	ABIC	AIC	VLMR	LMR	Entropy
1 class 1 factor	−8153.90	36	16,533.28	16,419.01	16,379.80	–	–	–
1 class 2 factors	−7652.97	37	15,537.68	15,420.23	15,379.93	–	–	–
2 classes 1 factor	−7700.59	50	15,714.34	15,555.63	15,501.17	0.000	0.000	0.909
2 classes 2 factors	−7488.82	53	15,309.60	15,141.37	15,083.64	0.002	0.002	0.940
3 classes 1 factor	−7558.50	64	15,517.87	15,314.71	15,245.01	0.135	0.138	0.864
3 classes 2 factors	−7354.29	71	15,153.28	14,927.91	14,850.58	0.000	0.000	0.956

Models were run using maximum likelihood estimation with robust standard errors (MLR), and variables were treated as censored from below

LL log-likelihood, *k* number of free parameters, *BIC* Bayesian information criterion, *ABIC* sample size-adjusted BIC, *AIC* Akaike's information criterion, *VLMR* Vuong–Lo–Mendell–Rubin likelihood ratio test *p* value, *LMR* Lo–Mendell–Rubin likelihood ratio test *p* value, *FD* factor determinacy score

of the other 12 %—had elevated mood and anxiety symptoms, with spikes at OCD and PE-related distress.

Table 5 shows the internal factor structure of the two classes in the two-class two-factor FMA. In contrast to the FMA for women, the two classes show very different internal factor structures; while the observed variable loadings are similar between the two classes, the relationships between the factors are polar opposites. Class one has a strong correlation between the factors ($r = .56$, $p < .001$), whereas class two has a nonsignificant negative relationship between the factors ($r = -.23$, $p = .331$). For both classes, desire is not a strong indicator. This structure suggests that 88 % of the sample have the same symptom profiles with varying severity, denoting a clear dimensional structure with two related but distinct latent variables. In contrast, the other 12 % of the sample have a clear categorical relationship, where the latent variables are unrelated.

Follow-up analyses were conducted to better understand these group differences using independent samples *t* tests. Compared with class one, class two had significantly higher levels of all symptoms, except desire, which explains why desire was not a good indicator for class membership. There were no demographic differences between the classes. Class two is a small group ($n = 22$) so there is low power to detect group differences effectively, but the bivariate zero-order correlation matrix showed almost no intercorrelations between the factors for this group, in contrast with class one. This suggests that class two has higher symptom levels, but that these men are displaying either sexual *or* affective disorders, not both. Due to the interpretable factors, the low BIC, excellent entropy, and significant LRTs, the two-class two-factor FMA was chosen as the best for men (see Table 4).

Men Who Had not Engaged in Intercourse

This model was also examined for the men who had not engaged in intercourse in the past 4 weeks ($n = 98$). Control over ejaculation could not be estimated, because it was assessed solely from ejaculation during intercourse, but PE-related distress had complete responses for 55 participants, who apparently responded based on sexual activity other than penetrative intercourse. The model had entropy of .83, but had nonsignificant LRT *p*-values (VLMR $p = .086$, LMR $p = .091$), which suggested that a one-class model might be suited better to the data. However, a one-class FMA failed to converge. In the two-class two-factor FMA, 87 % of the sample showed dimensional patterns in class one,

Table 3 Standardized factor loadings for factor mixture analysis (FMA) classes for women who had engaged in intercourse in the past 4 weeks ($n = 526$)

Disorder	FMA					
	Class 1		Class 2		Class 3	
	1	2	1	2	1	2
GAD	**0.74**		**0.82**		**0.90**	
Depression	**0.75**		**0.82**		**0.91**	
OCD	**0.61**		**0.71**		**0.83**	
Panic disorder	**0.37**		**0.46**		**0.60**	
Social anxiety	**0.61**		**0.68**		**0.80**	
Cognitive arousal		**0.90**		**0.91**		**0.92**
Lubrication		**0.77**		**0.79**		**0.80**
Arousal sensation		**0.77**		**0.79**		**0.80**
Sexual desire		**0.70**		**0.73**		**0.75**
Orgasmic function		**0.62**		**0.65**		**0.67**
Sexually related distress		**0.59**		**0.62**		**0.64**
Sexual pain		0.14		**0.**15		**0.**16

Significant factor loadings >0.1 are shown, and factor loadings >0.3 are bolded. Standardized loadings are shown to take into account differences in factor variance across models in order to compare the loadings

GAD generalized anxiety disorder, *OCD* obsessive–compulsive disorder

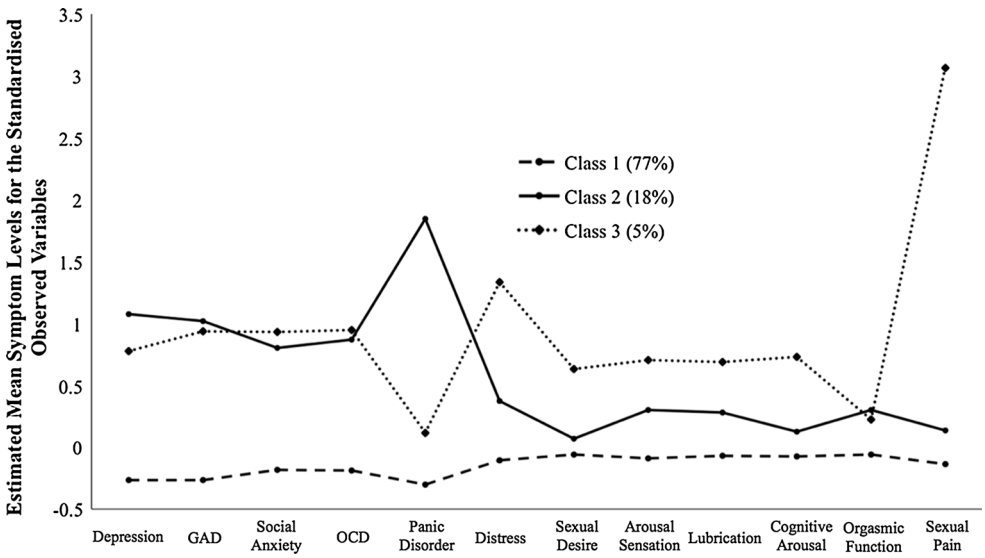

Fig. 1 Estimated mean profiles for the three-class two-factor factor mixture analysis for women who had engaged in intercourse in the past 4 weeks ($n = 526$). *GAD* generalized anxiety disorder, *OCD* obsessive–compulsive disorder

while the 13 % in class two had high estimated mean ED, and low sexual satisfaction.

Discussion

This study sought to define an empirically supported model of the relationships between depression, anxiety, and sexual problems to aid classification and diagnosis. Dimensional, categorical, and hybrid models were compared separately for men and women who had engaged in intercourse in the past 4 weeks, and hybrid models provided the best fit for both groups. For women, a three-class two-factor model was best, which had the same factor structure in all three classes. For men, a two-class two-factor model was best, which described the strong dimensional relationships for the majority of the sample, and accounted for the small group of men who showed no dimensional relationships across diagnostic classes (e.g., the presence of one type of sexual problem was related to other sexual problems, rather than to depression or anxiety). Specific disorders were important to characterize some sub-groups for both genders. These models also provided reasonable fit for participants who had not engaged in intercourse in the past 4

Table 4 Model fit indices for latent profile analyses (LPAs), exploratory factor analyses (EFAs), and factor mixture analyses (FMAs) for men who had engaged in intercourse in the past 4 weeks ($n = 181$)

LPAs	LL	*k*	BIC	ABIC	AIC	VLMR	LMR	Entropy
1 class	−2503.70	20	5111.37	5048.03	5047.40	–	–	–
2 classes	−2206.09	31	4573.33	4475.15	4474.17	0.002	0.003	0.918
3 classes	−2114.80	42	4447.94	4314.92	4313.60	0.040	0.043	0.937
4 classes	−2064.34	53	4404.21	4236.35	4234.69	0.317	0.325	0.911
5 classes	−2008.35	64	4349.40	4146.71	4144.70	0.275	0.280	0.935

EFAs	LL	*k*	BIC	ABIC	AIC	FD			
						1	2	3	4
1 factor	−2144.37	30	4444.70	4349.69	4348.74	0.958	–	–	–
2 factors	−2048.04	39	4298.81	4175.30	4174.07	0.953	0.973	–	–
3 factors	−2023.38	47	4291.08	4142.23	4140.75	0.942	0.939	0.984	–
4 factors	−2013.97	54	4308.66	4137.64	4135.94	0.940	0.894	0.948	0.861

FMAs	LL	*k*	BIC	ABIC	AIC	VLMR	LMR	Entropy
1 class 1 factor	−2144.33	30	4444.61	4349.60	4348.66	–	–	–
1 class 2 factors	−2067.01	31	4295.17	4197.00	4196.02	–	–	–
1 class 3 factors	−2052.25	33	4276.06	4171.54	4170.51	–	–	–
2 classes 1 factor	−2035.82	42	4289.98	4156.96	4155.64	0.031	0.033	0.914
2 classes 2 factors	−1996.19	45	4226.31	4083.79	4082.37	0.024	0.026	0.978
2 classes 3 factors	−1973.64	49	4202.00	4046.82	4202.00	0.057	0.058	0.848
3 classes 1 factor	−1983.67	54	4248.05	4077.03	4075.33	0.331	0.336	0.951
3 classes 2 factors	−1935.78	59	4178.28	3991.42	3989.57	0.085	0.088	0.892
3 classes 3 factors	−1918.47	67	4185.23	3973.04	3970.94	0.239	0.242	0.872

Models were run using maximum likelihood estimation with robust standard errors (MLR), and variables were treated as censored from below

LL log-likelihood, *k* number of free parameters, *BIC* Bayesian information criterion, *ABIC* sample size-adjusted BIC, *AIC* Akaike's information criterion, *VLMR* Vuong–Lo–Mendell–Rubin likelihood ratio test *p* value, *LMR* Lo–Mendell–Rubin likelihood ratio test *p* value, *FD* factor determinacy score

weeks. These results are interpreted below to explain how they inform theoretical models, followed by an explanation of the implications for sexual dysfunctions in the meta-structure of psychopathology.

Results for Women

The model of best fit for women was a three-class two-factor hybrid model. One class had high levels of panic, and another had high sexual pain and distress. However, a very similar factor structure was evident in all three classes, despite the fact that the factor structure was free to vary within each class. More specifically, within each class depressive and anxiety disorders loaded strongly onto one factor, all sexual problems except pain loaded strongly onto the other factor, and the factors were correlated with one another. The fact that pain was a poor indicator in the models could be explained by research that has found sexual pain to function as a relatively independent dimension from other sexual problems (i.e., it may be characterized by predominantly unique variance in these models; Binik et al., 2002). The relatively low levels of sexual pain reported by women in the present sample (i.e., restriction of range) may also have contributed to the poorer fit of pain as an indicator in the model. However, pain was an important variable in the model; specifically, elevated sexual pain was a defining characteristic of the participants in class three, where it had an elevated estimated mean.

The same model (i.e., a three-class two-factor hybrid model) provided an adequate fit for women who had not engaged in intercourse in the past 4 weeks. These women tended to have higher levels of all affective and cognitive symptoms compared with women who had engaged in intercourse, which might suggest a further relationship between low mood, stress, and a lack of sexual interest or activity. Taken together, these findings are compatible with our nosology—they signal a need for the relationships between depression, anxiety, and sexual problems to be explicitly recognized, and for some form of discrete diagnoses to be retained.

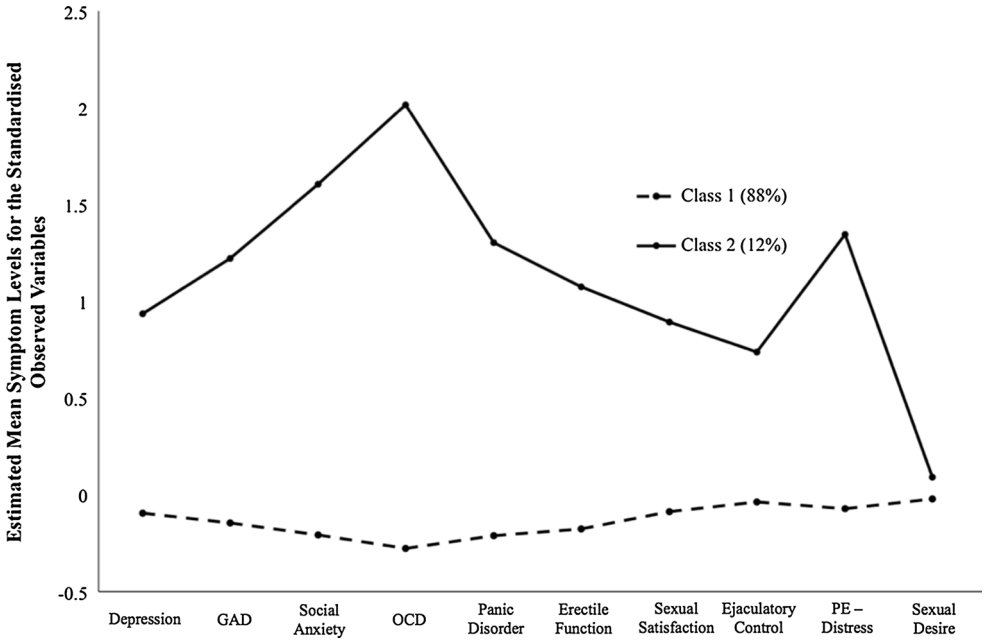

Fig. 2 Estimated mean profiles for the two-class two-factor factor mixture analysis for men who had engaged in intercourse in the past 4 weeks ($n = 181$). *GAD* generalized anxiety disorder, *OCD* obsessive–compulsive disorder, *PE* premature ejaculation

Table 5 Standardized factor loadings for factor mixture analysis (FMA) classes for men who had engaged in intercourse in the past 4 weeks ($n = 181$)

Disorder	FMA			
	Class 1		Class 2	
	1	2	1	2
Depression	**0.81**		**0.89**	
GAD	**0.85**		**0.91**	
Social anxiety	**0.56**		**0.68**	
OCD	**0.71**		**0.81**	
Panic disorder	**0.51**		**0.64**	
Erectile function		**0.45**		**0.42**
Sexual satisfaction		**0.67**		**0.65**
Ejaculatory control		**0.96**		**0.95**
PE-related distress		**0.81**		**0.79**
Sexual desire		0.29		0.27

Factor loadings >0.10 are shown, and factor loadings >.30 are bolded. Standardized loadings are shown to take into account differences in factor variance across models in order to compare the loadings

GAD generalized anxiety disorder, *OCD* obsessive–compulsive disorder, *PE* premature ejaculation

Results for Men

The best model for men was a two-class two-factor FMA. Depression and anxiety disorders loaded strongly onto one factor, and all sexual problems except desire loaded strongly onto the other. This model showed very strong dimensional relationships for a large proportion of the sample (88 %). However, a significant minority of men showed no relationships between the depression and anxiety latent variable and the sexual problems latent variable, which mirrored the small group of men with categorical relationships found in Forbes et al. (2014a). While the large dimensional class had strong intercorrelations between all of the disorders, the relationships in the smaller class tended to be within DSM diagnostic groups. This is an interesting finding because the smaller class had higher levels of all disorder symptoms, which is in contrast to the literature that shows increased severity is related to higher levels of comorbidity between disorders (Kessler, Chiu, Demler, & Walters, 2005). The characteristics that differentiate these men require further investigation in future research, but could be as simple as non-comorbid disorder presentation.

Male sexual desire did not discriminate between the two classes of the FMA, or provide a significant contribution to the model. This is consistent with previous research for men (e.g., Forbes et al., 2014a; Forbes & Schniering, 2013), but in contrast to the results for women where desire was a strong indicator in all of the models tested. This finding suggests that male sexual desire may not share the same underlying factor as other aspects of male sexual function, and depression and anxiety. For women, however, there was a clear overlap between desire, arousal, and orgasmic function; and more broadly between desire, depression, and anxiety.

The two-class two-factor FMA also provided adequate fit for men who had not engaged in intercourse in the past 4 weeks: there was a large dimensional class and a small class of men with high estimated ED and low sexual satisfaction. However, it is important to note that the likelihood ratio tests indicated that it is also possible this second class was artificially imposed on the data. The men who had not engaged in intercourse in the past 4 weeks had no significant symptom-level differences from men who had engaged in intercourse, except for slightly lower desire and sexual satisfaction. This is in contrast to the series of significant differences found for

women, which might suggest that intercourse frequency is less related to affective states for men than for women. The gender differences found here are consistent with research on male and female sexual response cycles: desire, arousal and orgasm appear to be functioning as separate but theoretically related domains for men (cf. Masters & Johnson, 1970); for women, the sexual domains are closely related, and appear to be influenced by emotional, contextual and relationship factors (Basson, 2005). This research can shed some light on the apparently stronger influences of mood and stress on the frequency of intercourse for women, and on the pervasive relationships between depression, anxiety, and sexual problems.

Implications

Taken together, these results suggest that there are dimensional relationships between depression, anxiety, and sexual problems for the majority of men and women, including those who had not engaged in intercourse in the past 4 weeks. Finding strong dimensional relationships for the large majority of participants is particularly significant, given the statistical methods allowed for separate groups with disparate relationships. This study thus provides further evidence that sexual dysfunctions belong in the internalizing spectrum of psychopathology alongside depressive and anxiety disorders.

One might wonder whether the two-factor structure of the models is consistent with a shared underlying liability between the disorders. We would suggest that it is almost inevitable for sexual problems to separate from depression and anxiety in a factor analysis due to the symptom overlap between depressive and anxiety disorders, the overlap in domains that are measured (i.e., cognitive and emotional versus sexual), and the similar stem-and-response measures for depressive and anxiety symptoms (i.e., measurement overlap). The case for interpreting these relationships as an indication of a shared liability between the disorders is in their dimensional relationships, high rates of comorbidity, shared cognitive and affective characteristics, shared treatment response, and the lack of causal relationships between them (Forbes, Baillie, & Schniering, 2015). These findings can be accommodated in a nosology that explicitly recognizes the relationships between the diagnostic chapters of Depressive Disorders, Anxiety Disorders, and Sexual Dysfunctions, but still maintains discrete diagnoses, which is compatible with the structure of the DSM-5 and ICD-11. This could be in the form of moving the Sexual Dysfunctions chapter closer to the Depressive Disorders and Anxiety Disorders chapters in the DSM-5, in continuity with the current representation of the meta-structure of psychopathology; through a recommendation for clinicians and physicians to screen for comorbid symptoms in the presence of related diagnoses; or in the form of multiple coding where disorders can be classified as members of multiple classes so clinicians appreciate the presence of both mechanisms in their understanding of pathology and treatment (as in the ICD-11 Beta Draft; WHO, 2013). Regardless of the method, in recognizing these relationships, our nosology will progress toward an empirically supported structure and may improve patient outcomes.

Strengths and Limitations

The primary limitation of this study is a nonrepresentative convenience sample (i.e., respondents tended to be highly educated, working full time, living with a partner, and/or without children), which may have limited generalizability to the wider population and to clinical samples. The results relied on self-reported symptoms in the absence of clinical diagnostic information such as duration of symptoms beyond the recall period of 4 weeks. The use of different sexual function measures also meant that the results for men and women cannot be directly compared, making it difficult to determine how much of the gender differences were due to population differences, rather than measurement methods. The sample size for men was small in the context of the complexity of some of the models, which may have generated unstable parameter estimates, so these results require replication in other samples. While the groups who had not engaged in intercourse in the past 4 weeks were also small, most parameters were fixed in these analyses, so the sample size is less of a concern. It is also important to note that the decision to rely on a 4-week recall period generated a measurement artifact of "no-intercourse" groups of participants who had not engaged in sexual intercourse during that time. Longer or shorter recall periods should be included in future research. Despite these limitations, this study has strengths in its sophisticated statistical analyses, broad symptom-level sample, and through the inclusion of participants who had not engaged in intercourse and/or were sexually inactive in the study period. The results thus extend our understanding of these relationships to populations that might not include penetrative intercourse in their repertoire of sexual behavior (e.g., people who are HIV positive, lesbian, elderly, or who simply do not include penetrative sex as part of their sexual activity).

Conclusion

In short, this study strengthens our understanding of the relationships between depression, anxiety, and sexual problems, and suggests that an empirically driven nosology should explicitly recognize the relationships between them. Such a move would facilitate research across these diagnostic chapters, which would work toward improving our understanding of their etiology, risk factors, course, and treatment response. Low recognition rates of sexual problems in primary care could be improved if the relationships between these disorders were highlighted in our nosology, and a raised awareness of these relationships would increase the likelihood of treating the disorders together, which could subsequently improve patients' outcomes. Future research should seek to replicate these results in diverse samples, and examine longitudinal hybrid models of these relationships.

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