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The underlying structure of comorbid mental health and substance use disorders in prison populations

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Short title for use as running head: Comorbidity in prison populations

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Abstract

Background: High rates of mental disorders have been reported for prison populations. Understanding patterns of comorbidity may be essential for the development of adequate treatment interventions. The present study aimed to assess the underlying structure of comorbidity between mental health and substance use disorders in prison populations.

Methods: Current mental disorders were assessed using the Mini-International Neuropsychiatric Interview in a cross-sectional observational study of 427 people consecutively committed to prison facilities in Santiago de Chile. Five alternative structural models were tested using confirmatory factor analysis (CFA). Latent class analysis (LCA) of comorbid mental health and substance use disorders was carried out.

Results: CFA indicated the best fit for a bifactor model with a general psychopathology P factor and specific internalizing and externalizing factors. Borderline personality disorder loaded highest on the P factor (0.85). The latent comorbidity structure showed a four-class solution representing one class without relevant comorbidities (48% prevalence) and three classes representing the following comorbidities: 1. externalizing disorders including substance use and antisocial personality disorder (31%) 2. internalizing disorders including anxiety disorders (10%) and 3. all types of disorders co-occurring (11%). Major depression and borderline personality disorder were present across all three latent classes of comorbidity.

Conclusions: Prison mental health services need to serve a highly comorbid population. Specific approaches may be useful for an externalizing and an internalizing spectrum of disorders. An important group of people with all types of mental disorders co-occurring is particularly worrying and may need new approaches in treatment development.

Introduction

Comorbidities of mental disorders are common among prison populations. Recent studies indicate that comorbid mental disorders are present in about 90% of the imprisoned people with bipolar disorder, schizophrenia, or antisocial personality disorder [1]. Many imprisoned people have substance use disorders in addition to other mental health problems [2]. People with comorbid substance use disorders and other mental disorders are more likely to reoffend [3], engage in violent behaviors, and have higher incidence of suicide attempts compared to offender populations without substance use problems [4]. Co-occurring mental disorders can be reliable, covariant indicators of stable, underlying "core psychopathological phenomena" [5]. Comorbid conditions may explain the overlap of prison populations and people receiving hospitalization in psychiatric facilities [6, 7]. Acknowledging the latent comorbidity structure of mental health problems in prison populations may be essential to the development of adequate interventions and services [8].

Studies assessing the underlying structure of mental disorders in the general population indicate the presence of externalizing and internalizing dimensions [9, 10]. The externalizing dimension implies to experience problems outwards and to attribute causes to the surroundings. It includes substance use disorders and behavioral disorders (e.g., conduct disorder, oppositional defiant disorder, and antisocial personality disorder). The internalizing dimension may include the two factors distress and fear [11-13]. Distress is associated with disorders such as major depression, dysthymia and generalized anxiety disorder. Fear is associated with panic disorder, social phobia and simple phobias [14]. Growing evidence points towards bifactor models, in which a general psychopathology ("P") factor coexists with the more specific externalizing and internalizing factors [15-18]. In the bifactor model all items load on a general psychopathology ("P") factor, in addition to subsets of items loading on two or more specific factors that are

uncorrelated with the general factor [19]. Most studies assessing externalizing and internalizing factors in prison populations were conducted using symptom-based outcomes from psychological symptom scales [8, 20-28] to validate the instrument. These studies supported the externalizing and internalizing dimensions as useful frameworks for describing and explaining co-occurring mental disorders in prison. Only one psychological study [8] examined the comorbidity structure using different CFA models with the primary goal to investigate the latent externalizing psychopathologic structure in prisoners. In this study, a bifactor model with a general externalizing factor and two residual factors, (callous-aggressive behavior and substance misuse) had the best data fit. In the few studies that used both psychological scales and clinical diagnoses assessing comorbidities [23, 29], there was evidence of sufficient criterial validity of the externalizing and internalizing framework. However, in these clinical studies, competitive models of the comorbidity structure in prison inmates were not investigated.

The present study aimed to assess the underlying structure of comorbid mental health and substance use disorders in prison populations using a segmentation approach with different competitive models. We hypothesized that the structure was like in the general population.

Material und Methods

Setting and design

Mental disorders were assessed in a cross-sectional observational study of consecutively committed prison populations. [30]. The study was approved by the Ethics Review Board of the University of Chile (Acta de Aprobación 01 from 25.01.2012) and by the Ministry of Justice of the Republic of Chile (reference: Subsecretaria de Justicia 15.03.2012). All interviewees provided written informed consent. Participants were randomly selected at intake to the three remand prison facilities serving the metropolitan region of Santiago de Chile between February and September 2013. Details on the sampling were reported elsewhere [30]. The fully structured

Mini-International Neuropsychiatric Interview (MINI) was conducted to assess mental health and substance use disorders for DSM-IV [31]. Additionally, the interview schedule was supplemented by the module for borderline personality disorder of the Structured Clinical Interview for DSM-IV (SCID-II) [32]. The interviews were usually conducted within the first week of imprisonment (median 5 days; mean 7.7 days after imprisonment). Interviewers were four clinical psychologists and a nurse trained and supervised by a senior consultant psychiatrist in using the instruments. In order to improve inter-rater concordance, pairs of interviewers conducted the first 20 interviews together. The interviewers alternated the lead of the interview and discussed points of possible discordance. The interviews lasted for 45–60 min and were held in a separate room of the prison to ensure confidentiality. Details on the procedures were described elsewhere [30]

Data analysis

Comorbidity was assessed by descriptive statistics and by calculating tetrachoric correlations of current mental disorders. To reduce the dimensionality of the correlation matrix, we examined only current mental disorders with prevalences of ≥ 5%. Alcohol abuse and dependence was collapsed into one category as alcohol use disorders. Illicit drug abuse and dependence were collapsed into illicit drug use disorder. Otherwise, the categories may violate the assumption of conditional independence. In order to improve the comparability of the results with other studies using the framework of externalizing and internalizing dimensions, the psychotic disorders were excluded from the analyses [33].

Based on the analytic methods of the hierarchical structure of psychopathology used in previous studies [15, 16], we tested five viable alternative nested structural models of confirmatory factor analysis (CFA) for the comorbidity of 10 current mental disorders: (1) a unidimensional model; (2A) a 2-factor oblique model specifying internalizing and externalizing factors; (2B) a general

bifactor model [19] with a general psychopathology P factor, in addition to specific externalizing and internalizing factors, (3A) a 3-factor oblique model specifying fear, distress, and externalizing factors; and (3B) a general bifactor model in addition to the externalizing, distress, and fear factors. Consistent with the bifactor model, covariances among general and domain-specific factors were fixed to zero. As established by B.B. Lahey [15], factor analysis was performed twice, using both maximum-likelihood estimation with robust standard errors (MLR) and weighted least-squares (WLSMV).

We evaluated the fit of competitive models using tests of significance and descriptive goodness-of-fit measures. The $\chi 2$ test should be non-significant for a good fit. If the $\chi 2$ difference between two competitive models is significant, the null hypothesis of equal fit for both models should be rejected using scaled Satorra–Bentler [34]. The a-level of significance was set at 0.05. The Comparative Fit Index (CFI) should be above 0.95, and the Root Mean Square Error of Approximation (RMSEA) Index should ideally be around 0.05, and not higher than 0.10 for a good model-data fit. The Tucker-Lewis-Index (TLI) should have values as low as 0.90. For the Standardized Root Mean-square Residual (SRMR), a cut-off as low as 0.08 has been suggested. Models with lower Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and adjusted Bayesian Information Criterion (aBIC) indicate better fit [34].

We assessed comorbidity using latent class analysis (LCA) of the 10 current mental disorders that were included in the CFA. Both CFA and LCA are based on the segmentation approach and can be used to assess the latent comorbidity structure. In CFA, factor loadings are regression coefficients. In comparison, item-response probabilities in LCA are conditional probabilities. Therefore, LCA does not require the assumption of multivariate normality nor of continuity of measurement. Whereas CFA was carried out for testing the hypothesis that the items were associated with specific factors, LCA was used as a validation method for testing

whether a theoretically defined factor structure adequately represented the data [35]. To determine the optimal number of latent classes, we used six models of LCA based on the expectation maximization algorithm. The models were assessed based on Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), adjusted Bayesian Information Criterion (aBIC), and Akaike Information Criterion with a penalty factor of three (AIC3). The lowest values indicate the best fit. Additionally, the Lo-Mendell-Rubin likelihood ratio test (LMR-LRT) was implemented [36]. LMR-LRT provides a k-1 likelihood ratio-based method for determining the ideal number of trajectories; a low p value ($p < .05$) indicates that the k trajectory model is a better fit to the data compared to the k-1 trajectory model. Greater importance was given to the LMR-LRT, aBIC and AIC3 because they are typically more reliable than AIC or BIC [37, 38].

Descriptive analysis was conducted using statistical packages SPSS 21. The correlation analysis, CFA, and LCA were carried out with Mplus software package, Version 7 and random LCA and poLCA running in R version 3.4.1 (R Core Team, 2017).

Results

The sample included 229 imprisoned men and 198 imprisoned women. The mean age was 30.0 (±11.7) years for the men and 33.5 (±11.0) years for the women. Sociodemographic characteristics and the prevalences of mental disorders were reported elsewhere [30, 39]. At least one current mental health or substance use disorder was present in 336 (78.7%) participants. The mean number of mental disorders was 2.60 ± 2.18. Among those with current mental disorders, n=71 (16.6%) had one disorder, n=64 (15.0%) had two disorders, and n=201 (47.1%) had three or more disorders. Tetrachoric correlations between mental disorders (Table 1) were positive (100.0%) and mostly significant (92.0%). The highest correlations were found between borderline personality disorders and antisocial personality disorders. High correlations

were also found between anxiety disorders (panic disorder, agoraphobia and obsessive-compulsive disorder) and between personality disorders and illicit drug use disorders (borderline personality disorder and illicit drug use disorder, antisocial personality disorder and illicit drug use disorder).

The bifactor model 2B specifying the P factor, internalizing and externalizing factors showed the best fit compared with the other models using both MLR (Table 2) and WSLMV (not shown). The bifactor model 3B with the P factor and three-group factors did not converge. Factor loadings for the best-fitting model 2B are shown in Figure 1. Borderline personality disorder (0.85), antisocial personality disorder (0.52) and major depression (0.47) had the highest loadings on the P factor. All mental disorders loaded significantly on the P factor. All internalizing mental disorders loaded significantly on the specific internalizing factor, except major depression. Alcohol use disorder and antisocial personality disorder loaded significantly on the specific externalizing factor, whereas borderline personality disorder and illicit drug use disorder had robust loadings on the P factor but non-significant loadings on the externalizing factor.

Table 3 shows goodness-of-fit indices for different models of LCA. Using LCA, the AIC showed the best fit for the five-class solution. BIC indicated the best fit for the three-class solution. However, the AIC3 and aBIC showed the best fit for the four-class solution. Using the LMR-LRT, the two-class model outperformed the one-class model ($P<0.001$), the three-class model outperformed the two-class model ($P<0.001$), the four-class model ranked over the three-class model ($P<0.05$) and the comparison between four-class model and five-class model was not significant ($P=0.255$). In summary, both penalized-likelihood information criteria and the LMR-LRT indicated the best fit for the four-class model.

Figure 2 shows the class-conditional outcome probabilities of the four classes and the probabilities of mental disorders to be present in each class. In the text, the predicted class memberships are reported. Close to half of the sample (48%) belonged to Class 1 without relevant comorbidity and a mean of 0.8±0.9 current mental disorders. The externalizing and internalizing dimensions identified by CFA were represented in Class 2 and Class 3. Class 2 with a mean of 3.7±1.0 comorbid disorders represented 31% of the sample including people with antisocial and substance use disorders. The prevalence of Class 3 was 10% of the sample including people with anxiety disorders and a mean of 3.3±1.0 comorbid disorders. Class 4 represented 11% of the sample and indicated high numbers of all types of mental disorders (6.6±1.2). Major depression and borderline personality disorder loaded high on Class 2, Class 3, and Class 4.

Discussion

Main findings

A bifactor model specifying the general psychopathology P factor as well as internalizing and externalizing factors showed the best fit compared with other models that have been found in the general population. Borderline personality disorder, antisocial personality disorder and major depression had the highest loadings on the P factor. The latent comorbidity structure of mental disorders showed four classes. One class corresponding to close to half of the sample (48%) did not show relevant numbers of comorbidity. More than half of the sample were represented by three classes of comorbidities: 1. externalizing disorders including substance use disorders (31%), 2. internalizing disorders (10%) and 3. a group of multiple comorbidities including all types of disorders (11%).

Strengths and limitations

This is the first study testing the underlying structure of comorbid mental health and substance disorders in prison populations with respect to a general psychopathology, externalizing and internalizing factors. The assessment included CFA and LCA. The advantage of the bifactor comorbidity model is that the strength of the P factor and specific factors can be quantified and predicted by other variables, which is not possible when using the unidimensional or hierarchical oblique models. However, this study has also several limitations. CFA and LCA were carried out on the same dataset, because the sample was relatively small. This examination of comorbidities was conducted at one single point in time and there are not any comparable data available from the general population in Chile. Mental disorders with low prevalences were excluded from the analyses. The standardized diagnostic interview did not include important externalizing and internalizing disorders such as attention deficit hyperactivity disorder. Furthermore, the present sample included mainly urban Chilean population shortly after intake to a correctional facility, which may limit the generalizability to prison populations in other countries and settings.

Comparison with the literature

Mental disorders of prison populations have so far mainly been reported and reviewed as the prevalence of single disorders [40-43]. Very few papers have addressed the prevalence of comorbidity of mental health and substance use disorders in prison populations [44]. Acknowledging the underlying structure of comorbidity and the prevalence of classes of comorbidity may be more useful to inform service development.

The underlying structure of comorbidity reported in this study showed similarities and differences with the general population. High loadings of personality disorders on the P factor and high loadings of alcohol use disorders on the externalizing factor were consistent with

results from other studies in general and prison populations [17, 23]. Recent studies indicated that borderline personality disorders were comorbid with several other forms of psychopathology and associated with more than one underlying dimension (i.e. the distress subfactor of the internalizing dimension and the externalizing dimension) [45, 46]. Analyses within the externalizing spectrum using psychometric scales have found the best fit for the bifactor model comprising a general externalizing factor as well as aggression and substance misuse as factors [47]. Whereas items on scales representing problematic impulsivity and irresponsibility had the highest loadings on the general externalizing factor, items on scales related to substance use loaded on the factor representing substance misuse. Individuals with a range of interpersonal difficulties, including violent behaviours, as well as histories of juvenile and adult offending scored high on the general externalizing factor [8].

In contrast to general populations, major depression in prison populations may represent not only the internalizing dimension, but also the P factor and the externalizing dimension. There are external factors in prison populations that can contribute to major depression including stress of court proceedings, violence, isolation, overcrowding, lack of meaningful activity, separation from families and friends, and the insecurity about future prospects [48-50]. The rates of comorbid major depression and several externalizing disorders such as drug use disorders and alcohol use disorders may be higher in prison populations than in community samples [51].

Implications for service development

People with comorbid internalizing disorders may require special attention to be protected from victimization especially in Latin American prison contexts [52]. Depression symptoms and major depression predicted non-adherence to correctional substance use programs [53] and poorer addiction treatment outcomes [54]. In recent years, dual diagnosis services for the complex needs of people with severe mental disorders and alcohol or illicit drug use problems

have been established in community settings [55, 56]. This type of services may be a step forward for prison populations. A subgroup of prisoners with highly comorbid disorders of all types may require the development of completely novel interventions, since evidence of effectiveness for treatments in such highly comorbid conditions is still lacking.

Conclusions

This study identifies three groups of comorbidity comprising more than half of the prison population. The study supports a bifactor model with a general P factor, internalizing and externalizing factors. Major depression and borderline personality disorder were highly prevalent in three latent classes contradicting findings from general populations. The underlying structure of comorbidities may inform the development of correctional treatment programs in targeting subgroups of people with comorbid internalizing, externalizing and highly comorbid mental disorders of all types. Dual disorder services could be a starting point to address highly comorbid mental health conditions in prisons and in the community. Future research could assess the model fit in different countries and legal justice contexts.

Acknowledgements

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Figures

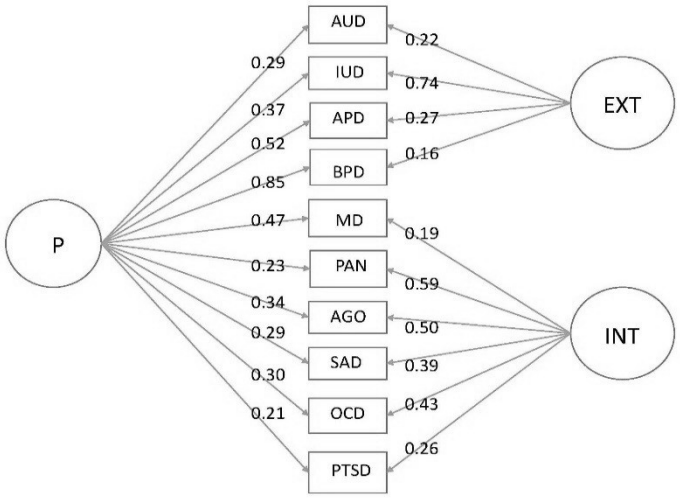

Figure 1: Factor loadings for the best-fitting bifactor Model 2B (Table 3) of comorbidity in prison inmates. P=General psychopathology factor; EXT=Externalizing factor; INT=Internalizing factor. MD=Major depression, PAN=Panic disorder, AGO=Agoraphobia, SAD=Social anxiety disorder, OCD=Obsessive-compulsive disorder, PTSD=Posttraumatic stress disorder, APD=Antisocial personality disorder, BPD=Borderline personality disorder, AUD=Alcohol use disorder, IUD=Illicit drug use disorder.

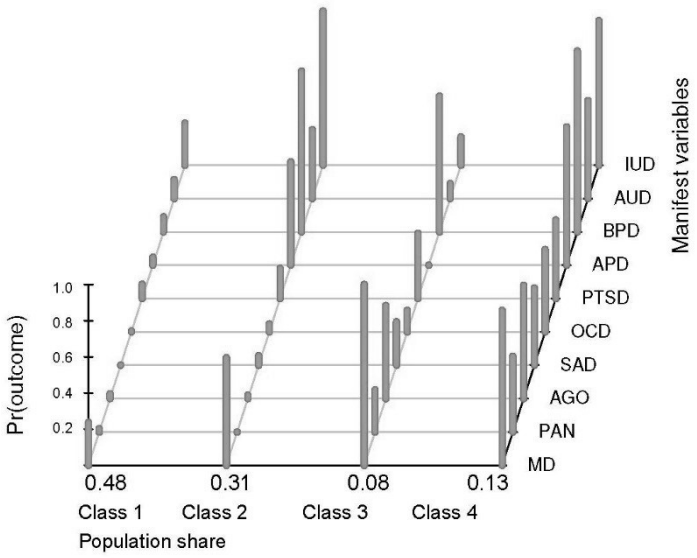

Figure 2: A model of four latent classes representing comorbid metal disorders of prison populations in Chile. Population shares indicate the probabilities of the four latent classes. Grey bars represent the conditional probabilities of mental disorders (manifest variables) to be present in each latent class. Taller bars correspond to conditional probabilities closer to 1. MD=Major depression, PAN=Panic disorder, AGO=Agoraphobia, SAD=Social anxiety disorder, OCD=Obsessive-compulsive disorder, PTSD=Posttraumatic stress disorder, APD=Antisocial personality disorder, BPD=Borderline personality disorder, AUD=Alcohol use disorder, IUD=Illicit drug use disorder.

Tables

Table 1: Tetrachoric correlations between current mental disorders

Mental Disorders	MD	PAN	AGO	SAD	OCD	PTSD	APD	BPD	AUD	IUD
MD	1.00***									
PAN	0.47***	1.00***								
AGO	0.50***	0.69***	1.00***							
SAD	0.51***	0.53***	0.58***	1.00***						
OCD	0.48***	0.64***	0.52***	0.60***	1.00***					
PTSD	0.39***	0.42***	0.41***	0.29*	0.36**	1.00***				
APD	0.37***	0.27*	0.28**	0.28**	0.40***	0.20*	1.00***			
BPD	0.59***	0.46***	0.59***	0.59***	0.61***	0.32***	0.75***	1.00***		
AUD	0.18*	0.20†	0.19†	0.26*	0.38***	0.23*	0.35***	0.47***	1.00***	
IUD	0.29***	0.19†	0.11†	0.28*	0.24*	0.26**	0.62***	0.63***	0.46***	1.00***

MD=First episode major depression, PAN=Panic disorder, AGO=Agoraphobia, SAD=Social anxiety disorder, OCD=Obsessive-compulsive disorder, PTSD=Posttraumatic stress disorder, APD=Antisocial personality disorder, BPD=Borderline personality disorder, AUD=Alcohol use disorder, IUD=Illicit drug use disorder.

*** $p<0.001$; ** $p<0.01$; * $p<0.05$;† not significant.

Table 2: Comparisons of alternative models of psychiatric comorbidity in prison inmates using confirmatory factor analysis.

	Model	χ2	df	P	Comparative SB test of model fit	P	AIC	BIC	aBIC	RMSEA (90 % CI)	SRMR	CFI	TLI
1	Unidimensional model	130.26	35	0.000			3501.3	3622.9	3527.75	0.09 (0.08-0.11)	0.07	0.80	0.74
2A	2-factor model oblique (externalizing, internalizing)	57.89	34	0.006	2A vs. 1: $\chi^2(1)=31.15$	P<0.001	3402.3	3528.0	3429.67	0.05 (0.02-0.05)	0.04	0.95	0.94
2B	General bifactor model (externalizing, internalizing, plus general psychopathology)	22.92	25	0.582	2B vs. 2A: $\chi^2(9)=33.48$	P<0.001	3374.4	3536.6	3409.68	0.00 (0.00-0.03)	0.03	1.00	1.01
3A	3-factor oblique model (externalizing, distress, fears)	50.47	33	0.034	3A vs. 2A: $\chi^2(1)=0.10$	0.752	3392.3	3526.1	3421.39	0.04 (0.01-0.06)	0.04	0.97	0.96
3B	General bifactor model (externalizing, distress, fears, plus general psychopathology)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note: SB = Satorra-Bentler adjustment; df = degrees of freedom; AIC=Akiake Information Criterion; BIC = Bayesian Information Criterion; aBIC adjusted Bayesian Information Criterion; NA=not available.

Table 3: Goodness-of-Fit for latent class analysis (LCA).

LCA	Parameter	Number of classes					
		1 Class	**2 Classes**	**3 Classes**	**4 Classes**	**5 Classes**	**6 Classes**
	AIC	4284.86	3838.10	3767.15	3736.83	**3731.63**	3738.57
	AIC3	4294.86	3859.10	3799.15	**3779.83**	3785.63	3803.57
	BIC	4325.43	3923.29	**3896.97**	3911.27	3950.69	4002.26
	aBIC	4293.69	3856.65	3795.42	**3774.79**	3779.31	3800.80
	Log likelihood	-2132.43	-1898.05	-1851.58	-1825.41	-1811.81	-1804.28
	Penalised log likelihood	-2132.52	-1898.17	-1851.72	-1825.51	-1811.99	-1804.49

AIC: Akaike Information Criterion; AIC 3: Akaike Information Criterion with a penalty factor of three; BIC: Bayesian Information Criterion; aBIC adjusted Bayesian Information Criterion.