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ORIGINAL PAPER

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Axis I disorders and personality disorders as risk factors for suicide

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Abstract There is a lack of psychological autopsy studies assessing the influence of axis I disorders on axis II disorders as risk factors for suicide. Therefore, we investigated the association between personality disorders, axis I disorders, and suicide. Psychiatric disorders were evaluated by a semi-structured interview including the Structured Clinical Interview for DSM-IV Axis I (SCID-I) and Personality Disorders (SCID-II) in 163 completed suicides (mean age 49.6 ± 19.3 years; 64.4 % men) and by personal interview in 396 population-based control persons (mean age 51.6 ± 17.0 years; 55.8 % men). In both genders, suicides significantly more often had personality disorders of all clusters than controls, also after adjustment for axis I disorders ($p < 0.001$, each). In addition, alcohol-related disorders, major depression, and co-occurrence of personality disorders of more than one cluster (men: OR = 16.13; women: OR = 20.43) remained independent predictors for suicide in both genders, "pure" cluster B personality disorders only in women and "pure" cluster C personality disorders only in men. In both genders, co-occurrence of personality disorders of more than one cluster contributed to risk of completed suicide after control for axis I psychiatric disorders and has to be considered as an independent risk factor for suicide.

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Introduction

Although in Germany in 2000, suicide rate was only 20.3/100,000 for men and 7.0/100,000 for women, suicide accounted for 11,065 deaths, which is the third highest absolute number of suicides in Europe (Statistisches Bundesamt 2002).

Follow-up studies have shown that virtually all psychiatric axis I and personality disorders have an increased risk of suicide; however, results about suicide risk in dementia and in female substance-related disorders were ambiguous (Harris and Barraclough 1997; De Hert and Peuskens 1998; Baxter and Appleby 1999; Hiroeh et al. 2001; De Hert et al. 2001; Angst et al. 2002). Major community-based psychological autopsy studies have found that between 70 % (Houston et al. 2001) and 100 % (Dorpat und Ripley 1960) of all suicide victims suffered from a psychiatric axis I disorder and up to 62 % from personality disorder (Cheng et al. 1997).

Axis I disorders

In general, affective disorders and substance use disorders are the most common diagnoses in suicides (see Schneider 2003). Retrospective analyses have found between 25 % (Vijayakumar and Rajkumar 1999) and 64 % (Barraclough et al. 1974) of suicides suffering from mood disorders with the percentage of bipolar disorders mostly under 5 % (Schneider 2003). Bipolar disorder was reported as a risk factor for suicide only in older subjects (Waern et al. 2002). Up to 87 % of suicides (Cheng 1995) suffered from a depressive disorder. Case-control studies using the psychological autopsy approach identified major depression as a risk factor for suicide in both genders over all age groups (Cheng 1995;

Foster et al. 1999; Vijayakumar and Rajkumar 1999), in ages over 65 (Waern et al. 2002, 2003), and in young men (Lesage et al. 1994). In psychological autopsy studies comprising both genders, suicides suffered significantly more often from substance-related disorders than controls (Cheng 1995; Vijayakumar and Rajkumar 1999; Foster et al. 1999), also if assessing only young adults (Lesage et al. 1994; Appleby et al. 1999) or people over 65 years (Waern et al. 2002; Waern 2003). Especially alcohol-related disorders were repeatedly identified as risk factors for suicide despite differences in diagnostic methods and criteria, age groups, and percentage of females (Lesage et al. 1994; Cheng 1995; Foster et al. 1999; Vijayakumar and Rajkumar 1999; Waern 2003; Appleby et al. 1999).

Population-based controlled psychological autopsy studies did not identify dementia or other organic mental disorders as risk factors for suicide (Waern et al. 2002; Chiu et al. 2004). Controlled studies with psychological autopsy design have shown that schizophrenia was more often observed in suicides than in controls (Cheng 1995; Foster et al. 1999; Vijayakumar and Rajkumar 1999), especially in people under 35 years (Lesage et al. 1994; Appleby et al. 1999). Anxiety and adjustment disorders were not conclusively identified as risk factors for suicide in controlled psychological autopsy studies (Lesage et al. 1994; Cheng 1995; Vijayakumar and Rajkumar 1999; Appleby et al. 1999; Foster et al. 1999; Waern et al. 2002). In postmortems, only between 2 % (in Taiwan, Cheng 1995) and 14 % (in Swedish women, Asgard 1990) of all suicides were diagnosed with adjustment disorders and up to 11 % of all suicides with anxiety disorders with higher proportions in women (up to 20 %; Henriksson et al. 1993; Foster et al. 1999).

Personality disorders

Personality disorders, including their life-long difficulties in creating and maintaining supportive social networks with relevant others, are an important determinant for suicide. Controlled retrospective studies identified personality disorders as risk factors for suicide (Lesage et al. 1994; Cheng et al. 1997; Foster et al. 1999; Vijayakumar and Rajkumar 1999), in youth independently of axis I disorders (Brent et al. 1994). Foster et al. (1999) and Brent et al. (1994) assessed clusters of personality disorders (DSM-III-R) as risk factors for suicide in a mixed age and gender sample and in 13 to 19 year olds: both authors found the "dramatic" cluster B and "anxious" cluster C personality disorders as risk factors for suicide. Foster et al. (1999) identified all clusters of personality disorders as risk factors for suicide in the univariate analysis, but after adjustment for axis I disorders only cluster A ("odd" cluster) and cluster C personality disorders remained significant risk factors. Emotionally unstable and borderline personality disorder were shown as the most frequent personality disorders in suicides (Rich und Runeson 1992; Henriksson et al. 1993) and were found as risk factors for suicide in controlled studies (Lesage et al. 1994; Cheng et al. 1997 [ICD-10], Foster et al. 1999). Antisocial personality disorder is also frequent, especially in adolescent suicides (up to 43 %; Marttunen et al. 1994), and often comorbid with borderline personality disorder (e. g. Rich and Runeson 1992; Lesage et al. 1994).

Prevalences of personality disorders vary in psychological autopsy studies. In studies without use of structured diagnostic instruments, low proportions of axis II disorders or merely axis I disorders were diagnosed, especially if personality disorders were not in the fore of the psychiatric problems. Studies employing structured or semi-structured instruments for assessment of personality disorders have found higher rates of personality disorders (e. g. Lesage et al. 1994; Cheng et al. 1997). Inclusion of "abnormal personalities" also raises the percentage of personality disorders (up to 70 %; Isometsä et al. 1996). Suicide victims with personality disorder as primary diagnoses represent only a small proportion of all suicides (9 %; Dorpat and Ripley 1960; Henriksson et al. 1993). Comorbidity of axis I and axis II disorders is reported in 14 % (Vijayakumar and Rajkumar 1999) to 58 % of all suicide victims (Cheng et al. 1997).

Although axis I and personality disorders are well-known risk factors for suicide, regional and gender differences in risk constellations must be assumed. Despite known gender differences of suicide victims (Rich et al. 1988; Möller-Leimkühler 2003) and the much higher suicide risk for men, it is not clear to what extent psychiatric diagnoses, especially personality disorders, account for gender differences in suicide risk. To our knowledge, none of the controlled psychological autopsy studies focused on women. Therefore, we decided to assess our hypotheses separately for men and for women.

The hypotheses of our psychological autopsy study were that (1) personality disorders are risk factors for suicide, independent of possible effects of DSM-IV axis I disorders, but modified by gender and (2) co-occurrence of personality disorders of several clusters will elevate suicide risk. Thus this study estimates the association between (1) personality disorders and suicide risk, and (2) axis I disorders and suicide risk, and (3) examines the extent to which the association between suicide risk and "pure" and comorbid clusters of personality disorders may be explained by axis I disorders.

Methods

Study population

All 263 suicides (mean age 50.9 ± 19.6 years [mean ± S. D.]; 66.2 % males) who died in the Frankfurt/Main area (population: about one million inhabitants) in 1999 and 2000 were included in the study. All suicides were classified as certain suicides (ICD-10 X 60 – X 84) by the Center of Forensic Medicine, which examines all deaths by unnatural or uncertain causes in this region. Twenty suicides did not have any

1st or 2nd degree relatives or other close persons; the relatives of 22 suicide victims could not be interviewed in German language and/or were living outside of Germany. In 58 cases, informants of the deceased declined the participation in the study. The relatives of the resulting 163 suicides (mean age 49.8 ± 19.3 years; 64.4 % males; = sample 1) were interviewed employing the psychological autopsy method with a semi-structured interview (see below) 8.5 ± 6.8 months after the suicide. There were no significant differences between the included and excluded suicides with respect to gender (p = n. s., $\chi^2 = 1.44$; df = 1; χ^2-test) and mean age (non-responders: men: 53.3 ± 19.5 years; p = n. s., t = 1.82, df = 149.9; women: 57.2 ± 15.2 years; p = n. s., t = 1.33, df = 68.9; t-test). Key informants of the deceased were spouses (35 %), adult children (20.9 %), parents (17.8 %), sisters and brothers (12.9 %), and other relatives and friends (13.5 %).

In addition, out of the 685 population-based controls contacted, 396 persons (mean age 51.6 ± 17.0 years; 55.8 % males; = sample 2), who were comparable to the suicides regarding residential area, age, and gender, were personally interviewed. The controls were chosen by "random digit dialling". The suicides' relatives and the control persons were contacted by mail introducing them to the research project. All potential informants were told that the participation was voluntary. Control persons were also asked to give their permission for repetition of the interview, for interviews by two interviewers and for asking a close relative or friend to give an interview about the control person himself or herself.

Instruments and diagnostic procedure

A semi-structured interview, a modified and translated version of the interview applied in the National Suicide Prevention Project in Finland (Henriksson et al. 1993) and the Structured Clinical Interview for DSM-IV Axis I and II (SCID-I, SCID-II, German version; Wittchen et al. 1997; Fydrich et al. 1997) were carried out with control persons and with informants about the suicide cases. The whole interview takes about three hours to complete. As recommended, SCID-II was employed after SCID-I. Dementia and other cognitive disorders were diagnosed using the DSM-IV algorithm. All psychiatric diagnoses were lifetime diagnoses.

In order to prove validity of our method, we assessed concordance of DSM-IV axis I and II diagnoses by personal and informant's interview (Schneider et al. 2004): Agreement by personal and relative's interview generated kappa coefficients above 0.79 for most Axis I and above 0.65 for most personality disorder diagnoses; Kendall's tau for dimensional individual personality disorder scores ranged from 0.22 to 0.72. In 69 (31.2 %) male and 56 (32 %) female control persons and in 39 (37.5 %) male and 20 (33.9 %) female suicide victims SCID-II results were excluded from statistical analyses because of incomplete data. SCID-II was deemed as "incomplete" when at least two items were "not known" for at least one personality disorder.

The study protocol was approved by the ethics' committee of the Medical Faculty of the University of Frankfurt/Main and performed in accordance with the ethical standards laid down in the Declaration of Helsinki.

Statistical analyses

The statistical analyses were performed with SPSS version 12.0 for Windows (Chicago, USA) and BIAS for Windows, version 8.02 (Ackermann 2004). T-tests were employed for continuous variables. Chi² analysis was used to compare subjects with missing and without missing personality disorder diagnoses assessed by SCID-II. The association between suicide and diagnoses was estimated with odds ratios (OR) and 95 % confidence intervals (95 % CI) for both genders separately. Adjustment of ORs for the potential confounding effects of other risk factors may be achieved by incorporating such variables in unconditional logistic regression analysis (Backward, WALD). Furthermore, in order to estimate the independent contribution of significant predictors for suicide, we performed a binary logistic regression to compute odds ratios and 95 % confidence intervals. Axis I disorders with prevalences of at least six persons in suicides were included in logistic regression models. Variables that were entered into the logistic regression models (after adjustment for age) included alcohol-related disorder, schizophrenia and other psychotic disorders, single-episode and recurrent major depressive disorder, adjustment disorders and posttraumatic stress disorders, and clusters of personality disorders. In addition, delirium, dementia, amnestic and other cognitive disorders, cannabis- and polysubstance-related disorders, and bipolar disorder were included for men and sedative-related disorders for women. Interaction of factors was included, if prevalence of co-occurrence of these factors was observed in at least six persons. The level of statistical significance was set at $\alpha = 0.05$.

Results

Mean age did not significantly differ between male suicides (48.2 ± 19.4 years) and controls (51.2 ± 15.8 years) and female suicides (52.1 ± 19.2 years) and controls (52.2 ± 18.5 years; t-test). In both genders, in suicides and in controls, subjects who have missing data of personality disorder diagnoses (men: suicides: 51.8 ± 18.5 years, controls: 53.8 ± 15.8 years; women: suicides: 56.0 ± 16.8 years, controls: 53.4 ± 18.8 years) were older than subjects without missing data of personality disorder diagnoses (men: suicides: 46.7 ± 19.8 years, controls: 50.1 ± 15.6 years; women: suicides: 50.3 ± 20.0 years, controls: 51.6 ± 18.4 years;), but without statistical significance (t-test). Male suicide victims with missing data had significantly less often cannabinoid-related disorders than male suicides without missing data (0 % vs. 15.9 %, $\chi^2 = 6.24$, $p < 0.05$). In both genders, prevalences of other axis I diagnoses did not significantly differ between subjects with and without missing SCID-II data, neither in suicides nor in control persons.

Axis I disorders

Ninety four (90.4 %) of all male suicide victims fulfilled criteria for at least one lifetime DSM-IV axis I diagnosis compared with 66 (29.9 %) of the control persons. At least one lifetime DSM-IV axis I disorder was diagnosed in 52 female (88.1 %) suicides compared with 62 female controls (35.4 %; Table 1). 40.4 % of all male suicides and 33.9 % of all female suicides fulfilled criteria of more than one axis I disorder compared to 8.1 % and 10.3 % in controls. In both genders, suicide risk was significantly elevated in schizophrenia and other psychotic disorders, in substance-related disorders, and in affective disorders (Table 1). In substance-related disorders, alcohol-related disorders and polysubstance-related disorders were significantly associated with increased suicide risk in men as well as in women. In men, cognitive disorders and neurotic, stress-related and somatoform disorders revealed also significantly elevated odds ratios. Table 1 shows that recurrent major depressive disorder was a strong risk factor for suicide, especially for males; in men, significantly higher suicide risk was also observed in single-episode major depressive disorder as well as in bipolar disorder (Table 1).

Table 1 Associations between axis I disorders (DSM-IV) and suicide

	Males			Females		
	C (n = 221)	S (n = 104)	OR (95% CI)	C (n = 175)	S (n = 59)	OR (95% CI)
At least one axis I disorder	29.9%	90.4%	**22.08 (12.16–40.09)*** **	35.4%	88.1%	**16.10 (7.57–34.26)*** **
Delirium, dementia, amnestic, and other cognitive disorders	0.9%	5.8%	**6.70 (1.63–27.59)*** **	2.9%	6.8%	2.47 (0.67–9.19)
Substance-related disorders	20.8%	45.2%	**3.14 (1.91–5.14)*** **	12.0%	33.9%	**3.76 (1.91–7.42)*** **
Alcohol-related disorders	9.0%	25.0%	**3.35 (1.81–6.21)*** **	4.0%	16.9%	**4.90 (1.91–12.56)*** **
Cannabinoid-related disorders	7.7%	10.6%	1.42 (0.64–3.14)	4.0%	1.7%	0.41 (0.053–3.24)
Sedative-related disorders	3.6%	2.9%	0.79 (0.21–3.04)	6.3%	11.9%	2.01 (0.75–5.37)
Polysubstance-related disorders	1.4%	8.7%	**6.88 (2.15–22.05)** **	0.0%	3.4%	**15.26 (1.71–136.14)***
Schizophrenia and other psychotic disorders	0.5%	11.5%	**28.70 (7.18–114.64)*** **	0.0%	16.9%	**74.45 (16.27–340.73)*** **
Affective disorders	5.0%	33.7%	**9.68 (5.08–18.44)*** **	15.4%	44.1%	**4.32 (2.30–8.13)*** **
Bipolar disorders[a]	0.0%	5.8%	**27.91 (4.37–178.45)*** **	2.3%	5.1%	2.29 (0.52–10.17)
Major depressive disorder, single episode[a]	2.7%	12.5%	**5.12 (2.05–12.77)*** **	6.9%	11.9%	1.83 (0.69–4.84)
Major depressive disorder, recurrent[a]	0.0%	11.5%	**59.86 (12.57–285.19)*** **	2.9%	23.7%	**10.58 (4.25–26.35)*** **
Dysthymic disorder	2.3%	4.8%	2.18 (0.63–7.51)	4.6%	5.1%	1.12 (0.29–4.37)
Anxiety, adjustment, and somatoform disorders	7.7%	21.2%	**3.22 (1.67–6.22)*** **	12.6%	18.6%	1.59 (0.72–3.51)
Phobic and panic disorders, GAS	4.1%	4.8%	1.19 (0.39–3.64)	6.9%	6.8%	0.99 (0.31–3.20)
Obsessive-compulsive disorder	0.0%	0.0%	–	0.6%	0.0%	–
Somatoform disorders	0.0%	1.9%	**10.80 (1.12–103.46)***	0.6%	1.7%	3.00 (0.21–42.96)
Posttraumatic stress disorder, adjustment disorders	4.1%	15.4%	**4.29 (1.92–9.53)*** **	5.7%	10.2%	1.87 (0.66–5.32)
Other axis I-disorders (including eating disorders)	0.0%	0.0%	–	0.0%	6.8%	–

C Control persons; *S* Suicides; *OR* odds ratio; *CI* confidence interval; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; – no calculation because of inclusion of various diagnoses or calculation of odds ratios not possible; [a] all major depressive episodes without full remission in suicides

Axis II disorders

In both genders, a significantly increased risk of suicide was associated with the presence of at least one axis II disorder and all clusters of personality disorders including paranoid, histrionic, borderline, narcissistic, avoidant, and dependent personality disorder (Tables 2 and 3). Additionally, in men the other personality disorders of cluster C (dependent, obsessive-compulsive, depressive, and passive-aggressive) and schizotypal personality disorder showed significant odds ratios (Table 2).

Cluster A, cluster B, and cluster C personality disorders revealed significantly elevated odds ratios in both genders (Table 3). Male suicides had significantly higher frequency of only "pure" cluster C disorders, also after adjustment for axis I disorders with prevalences over five persons in suicides (Table 3). Women who had committed suicide significantly more often showed cluster B personality disorders without personality disorders out of other clusters, also after adjustment for axis I disorders with 13-fold increased suicide risk (Table 3). Cluster A, cluster B, and cluster C personality disorders co-occurring with personality disorders of other clusters revealed significantly increased odds ratios in both genders, even after adjustment for comorbidity with axis I disorders (Table 3).

Axis I and Axis II comorbidity – men

Regarding comorbidity of any axis I and any axis II diagnosis (suicides: 68.9%, controls: 15.3%), threefold higher odds ratios compared with diagnosis of any axis I disorder without a personality disorder (suicides: 24.6%, controls: 17.3%; OR = 3.17; 95% CI 1.42–7.08; $p < 0.01$) and tenfold higher odds ratios compared with diagnosis of any personality disorders without an axis I disorder (suicides: 4.9%, controls: 11.3%; OR = 10.35; 95% CI 3.16–33.85; $p < 0.001$) were shown.

Cognitive disorders, alcohol-related disorders, cannabis-related and polysubstance-related disorders, schizophrenia and other psychotic disorders, single-episode major depressive disorder, and adjustment disorders remained significant in a logistic regression model including only axis I disorders (see above); bipolar and recurrent major depressive disorder lost significance in the final model (Table 4). The addition of cluster A, cluster B, cluster C personality disorders, and co-occurrence of personality disorders of more than one cluster to the model produced no changes in the significant axis I disorders, and "pure" cluster C personality disorders and combination of personality disorders of two or more clusters showed highly significant odds ratios (Table 4). Also "missing data" of personality disorders revealed significantly increased odds ratios (Table 4).

Table 2 Associations of axis II disorders (DSM-IV) and suicide

	Males			Females		
	C (n = 221)	S (n = 104)	OR (95% CI)	C (n = 175)	S (n = 59)	OR (95% CI)
At least one Axis II disorder	27.0%	72.3%	**7.07 (3.82–13.10)*** **	24.4%	66.7%	**6.21 (2.94–13.09)*** **
Axis II disorders of more than one cluster	8.0%	42.6%	**8.54 (4.20–17.38)*** **	8.5%	30.8%	**4.76 (1.96–11.56)*** **
Cluster A personality disorders						
Paranoid	3.3%	20.0%	**7.25 (2.77–18.94)*** **	2.6%	17.9%	**8.31 (2.44–28.32)*** **
Schizoid	5.3%	10.8%	2.16 (0.76–6.11)	5.1%	12.8%	2.72 (0.81–9.13)
Schizotypal	0.7%	6.5%	**10.34 (1.69–63.26)***	4.3%	5.1%	1.20 (0.22–6.47)
Cluster B personality disorders						
Histrionic	1.3%	10.8%	**8.99 (2.32–34.83)****	0.9%	17.9%	**25.38 (5.57–115.68)*** **
Narcissistic	6.0%	27.7%	**6.04 (2.72–13.42)*** **	2.6%	20.5%	**9.81 (3–32.04)*** **
Borderline	2.6%	28.1%	**14.38 (5.68–36.42)*** **	6.8%	25.6%	**4.70 (1.81–12.22)****
Antisocial	2.6%	7.9%	3.11 (0.88–11.58)	0.8%	2.6%	3.11 (0.22–44.66)
Cluster C personality disorders						
Avoidant	4.0%	23.1%	**7.25 (2.96–17.75)*** **	4.3%	15.4%	**4.07 (1.26–13.21)***
Dependent	1.3%	6.2%	**4.89 (1.01–23.55)***	0.0%	5.1%	**15.67 (1.75–140.62)***
Obsessive-compulsive	8.6%	23.1%	**3.19 (1.45–6.97)****	8.5%	17.9%	2.34 (0.84–6.52)
Depressive	0.7%	4.6%	**7.26 (1.01–52.05)***	3.4%	5.1%	1.53 (0.27–8.63)
Passive-aggressive	4.6%	26.2%	**7.29 (3.13–16.96)*** **	5.1%	12.8%	2.72 (0.81–9.13)

C Control persons; *S* Suicides; *OR* odds ratio; *CI* confidence interval; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 3 Clusters of axis II disorders (DSM-IV) and comorbidity with axis II disorders of other clusters

Men	C N = 221	S N = 104	OR	CI 95%	OR[a]	CI 95%[a]
At least one Axis II disorder	27.0%	72.3%	**7.07*** **	**3.82–13.10**	**7.16*** **	**2.66–19.23**
Cluster A	7.3%	29.0%	**5.17*** **	**2.39–11.18**	**4.12****	**1.48–11.48**
Cluster A without any other clusters	4.7%	6.5%	1.81	0.51–6.46	1.65	0.37–7.32
Cluster A with any other clusters	2.7%	22.6%	**11.06*** **	**3.46–35.33**	**9.23****	**2.25–37.91**
Cluster B	10.6%	45.3%	**6.99*** **	**3.59–13.63**	**4.19****	**1.72–10.18**
Cluster B without any other clusters	4.0%	6.3%	2.50	0.67–9.34	0.96	0.15–6.06
Cluster B with any other clusters	6.6%	37.5%	**9.00*** **	**3.95–20.52**	**5.74*** **	**2.10–15.68**
Cluster C	17.9%	53.8%	**5.36*** **	**2.90–9.91**	**7.60*** **	**3.17–19.20**
Cluster C without any other clusters	9.9%	16.9%	**3.03***	**1.26–7.27**	**5.07***	**1.32–19.50**
Cluster C with any other clusters	7.9%	36.9%	**8.27*** **	**3.72–18.39**	**9.50*** **	**3.27–27.59**
Women	**N = 175**	**N = 59**				
At least one Axis II disorder	24.4%	66.7%	**6.21*** **	**2.94–13.09**	**8.91*** **	**3.31–23.97**
Cluster A	9.4%	25.6%	**3.32***	**1.33–8.32**	**5.01****	**1.75–14.38**
Cluster A without any other clusters	3.4%	2.6%	0.91	0.10–8.49	1.11	0.10–12.73
Cluster A with any other clusters	6.0%	23.1%	**4.70****	**1.61–13.70**	**7.47****	**2.31–24.10**
Cluster B	9.4%	46.2%	**8.26*** **	**3.67–18.61**	**13.24*** **	**4.61–38.01**
Cluster B without any other clusters	4.3%	23.1%	**9.08*** **	**2.77–29.84**	**12.85*** **	**3.22–51.23**
Cluster B with any other clusters	5.1%	23.1%	**7.57*** **	**2.44–23.53**	**13.57*** **	**3.76–48.97**
Cluster C	16.2%	33.3%	**2.58***	**1.14–5.82**	2.07	0.77–5.56
Cluster C without any other clusters	8.5%	10.3%	1.51	0.44–5.20	0.66	0.12–3.46
Cluster C with any other clusters	7.7%	23.1%	**3.77***	**1.36–10.45**	**4.82****	**1.57–14.80**

C control persons; *S* suicides; *OR* Odds ratio (adjusted for age); * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; [a] Men: adjusted for age, cognitive disorders, alcohol-related disorders, cannabis-related disorders, polysubstance-related disorders, schizophrenia and other psychotic disorders, bipolar disorders, major depression (single episode, recurrent), adjustment disorders; women: adjusted for alcohol-related disorders, sedative-related disorders, schizophrenia and other psychotic disorders, major depression, single episode and recurrent, adjustment disorders and posttraumatic stress disorders

Table 4 Logistic regression analysis: Axis I without and with axis II disorders – men

	OR[a]	CI 95%[a]	OR[b]	CI 95%[b]
Delirium, dementia, amnestic and other cognitive disorders	**24.14*** **	**4.60–126.85**	**13.55****	**2.48–73.94**
Alcohol-related disorders	**5.14*** **	**2.43–10.89**	**3.66****	**1.67–8.02**
Cannabis-related disorders	**3.03***	**1.20–7.65**	**3.95***	**1.34–11.68**
Polysubstance-related disorders	**11.72****	**2.59–52.98**	**16.91****	**3.17–90.03**
Schizophrenia and other psychotic disorders	**62.08*** **	**7.50–514.09**	**70.06*** **	**6.97–704.41**
Major depressive disorder, single episode	**11.24*** **	**3.83–33.03**	**11.29*** **	**3.48–36.61**
Posttraumatic stress disorder and adjustment disorders	**10.54*** **	**4.12–26.97**	**59.70*** **	**11.15–319.78**
Personality disorders	–	–	**1.00**	
Only Cluster A	–	–	**5.15***	**1.01–26.22**
Only Cluster B	–	–	2.15	0.30–15.21
Only Cluster C	–	–	**9.38****	**2.18–40.34**
Co-occurrence of more than one cluster	–	–	**16.13*** **	**4.86–53.50**
Missing data	–	–	**6.27*** **	**2.34–16.81**

[a] Variables included in logistic regression analysis: Delirium, dementia, amnestic and other cognitive disorders, alcohol-related disorders, cannabis-related disorders, polysubstance-related disorders, schizophrenia and other psychotic disorders, bipolar disorders, major depression, single episode and recurrent, adjustment disorder, interaction between alcohol-related disorders and adjustment disorders.

[b] Variables included in logistic regression analysis: Delirium, dementia, amnestic and other cognitive disorders, alcohol-related disorders, cannabis-related disorders, polysubstance-related disorders, schizophrenia and other psychotic disorders, bipolar disorders, major depression, single episode and recurrent, adjustment disorders and posttraumatic stress disorders, personality disorders (cluster A, B, C and comorbidity of clusters), interaction of alcohol-related disorders and adjustment disorders, interaction of alcohol- and cannabis-related disorders and of major depression, single episode with cluster B personality disorders, interaction of alcohol- and cannabis-related disorders, of major depression, single episode and of adjustment disorders with cluster C personality disorders.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Axis I and Axis II comorbidity – women

Estimated suicide risk associated with comorbidity of axis I and axis II disorders (suicides: 56.4 %, controls: 12.8 %) was 3.5 times higher than suicide risk associated with any axis I disorder without a personality disorder (suicides: 33.3 %, controls: 26.5 %, OR = 3.50, 95 % CI 1.40–8.71; $p < 0.01$) and five times higher than suicide risk associated with personality disorder without an axis I diagnosis (suicides: 10.3 %, controls: 12 %, OR = 5.13, 95 % CI 1.48–17.86 $p < 0.05$).

A significantly increased suicide risk was associated with alcohol-related disorders and major depressive disorder, single episode and recurrent, in the multivariate analysis. Schizophrenia and other psychotic disorders did not remain significant in the final model (Table 5). When cluster A, cluster B, cluster C personality disorders, and combination of more than one cluster were additionally entered in the logistic model, single episode of major depression lost significance as an independent risk factor; "pure" cluster B personality disorders and co-occurrence of personality disorders of at least two clusters showed significantly increased odds ratios (Table 5).

Discussion and conclusion

Our findings confirm the important role of psychiatric illness as a risk factor for suicide as shown by other psychological autopsy studies with case-control design (see Cavanagh et al. 2003; see Schneider 2003). In the present study, the estimated risk of suicide for presence of at least one axis I disorder was 22 times greater for men and 16 times greater for women than in the absence of an axis I disorder; the estimated suicide risk for the presence of at least one axis II disorder was seven times greater for men and six times greater for women than in the absence of a personality disorder. In both genders, estimated suicide risk for personality disorders was only marginally influenced by adjustment for axis I disorders. Co-occurrence of personality disorders of more than one cluster was associated with highly elevated suicide risk, about 16-fold in men and 20-fold in women, even after a more inclusive approach, while in women only "pure" cluster B and in men "pure" cluster C personality disorders contributed independently to suicide risk with high significance in our model.

Table 5 Logistic regression analysis: Axis I without and with axis II disorders – women

	OR[a]	CI 95 %[a]	OR[b]	CI 95 %[b]
Alcohol-related disorders	**6.64****	**2.22–19.89**	**4.49***	**1.27–15.93**
Sedative-related disorders	[c]		**4.95***	**1.25–19.55**
Major depressive disorder, single episode	**2.93***	**1.00–8.56**	[c]	
Major Depressive disorder, recurrent	**17.04*****	**5.56–52.26**	**32.53*****	**9.20–115.11**
Personality disorders	–	–	1.00	
Only Cluster A	–	–	3.71	0.31–44.10
Only Cluster B	–	–	**21.47*****	**4.72–97.55**
Only Cluster C	–	–	1.29	0.22–7.46
Co-occurrence of more than one cluster	–	–	**20.43*****	**5.77–72.32**

[a] Variables included in logistic regression analysis: Alcohol-related disorders, sedative-related disorders, schizophrenia and other psychotic disorders, major depression, single episode and recurrent, adjustment disorders and posttraumatic stress disorders.
[b] Variables included in logistic regression analysis: Alcohol-related disorders, sedative-related disorders, schizophrenia and other psychotic disorders, major depression, single episode and recurrent, adjustment disorders and posttraumatic stress disorders, personality disorders (cluster A, B, C and comorbidity of clusters), interaction of alcohol-related disorders with cluster B personality disorders, interaction of major depression, single episode,with cluster C personality disorders.
[c] variables that did not remain in the final model.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Methodological issues

To our knowledge, this is the first population-based psychological autopsy study focusing on the assessment of interactions between personality disorders and axis I disorders as risk factors for suicide in both genders separately. Causes of deaths were precisely classified as suicides by the Center of Forensic Medicine, which examines all uncertain deaths in the Frankfurt area. Another strength of our study – as in psychological autopsy studies in general – is that psychiatric disorders were identified regardless of health care registers. However, some methodological limitations have to be considered: (1) Our study shares the methodological limitations of all psychological autopsy studies, which include the possibility of incomplete and biased information (Brent et al. 1988; Beskow et al. 1990). Yet, our own results (Schneider et al. 2004) and recent research (Kelly and Mann 1996; Conner et al. 2001) show validity of the psychiatric diagnoses including axis II diagnoses by proxy approach. It is difficult and also ethically questionable to assess living controls by best-estimate method (Leckman et al. 1982) as described by Hawton et al. (1998). (2) As shown in a Canadian (Lesage et al. 1994) and several British studies (Appleby et al. 1999; Cavanagh et al. 1999; Hawton et al. 2002) and a very recent Chinese study (Chiu et al. 2004), we did not achieve high response rates, neither in suicides nor in controls. Unfortunately, due to data protection regulations, we did not obtain detailed information about suicides and controls if informants declined an interview, but age and gender of included and excluded suicides did not differ significantly. Especially control persons with mental disorders might refuse participation in the study, which may result in underreporting of psychiatric diagnoses in controls. Furthermore, some informants might conceal psychiatric disorders. However, we have no hints for bias, as prevalences of axis I disorders of the control group correspond to those of the general population (Wittchen et al. 1999; Meyer et al. 2000; Strobl et al. 2002). Contrary to our findings, Wittchen et al. (1999) and Meyer et al. (2000) had observed higher prevalences of somatoform disorders in the general population in Germany; this may be due to differences in study design and instruments. Prevalence of any personality disorder in the control group was higher than in another German study (Maier et al. 1992). Other studies using different instruments and DSM-III or DSM-III-R as diagnostic system have found up to 22.5 % personality disorders in community samples (Torgersen et al. 2001). (3) The diagnostic subgroups in our study were small, which is reflected in the wide confidence intervals. This may result in a high risk of false negative findings attributable to low statistical power. (4) Moreover, in men somatoform disorders and in women polysubstance-related disorders, both significant risk factors in univariate analysis, were not included in the logistic model due to their low prevalences. Finally, (5) interpretation of other variables that would have confounded the effect of personality disorders on suicide risk like social factors or life events (Heikkinen et al. 1997a, 1997b) have been omitted in our study, but should be included in future research.

Findings

The results of this study support our hypotheses that (1) axis I disorders and (2) personality disorders are risk factors for suicide, and (3) personality disorders are risk factors for suicide independent of axis I disorders. In male suicides, the percentage of at least one axis I disorder corresponds with other European studies; in women, the percentage of suicides suffering from at least one axis I disorder is slightly lower in our study

than in other European studies (Beskow 1979; Asgard 1990; Henriksson et al. 1993; Foster et al. 1997). In line with other authors (Cheng 1995; Foster et al. 1999; Vijayakumar and Rajkumar 1999) we identified psychiatric axis I disorder and comorbidity of several axis I disorders as well as comorbidity of axis I and axis II disorders as risk factors for suicide. Comorbidity of several axis I disorders, mostly major depression with substance-related disorders, was associated with a higher suicide risk in Cheng's (1995) mixed gender sample than in ours. This could be explained by the higher percentage of suicide victims with comorbidity in Taiwan than in Frankfurt; our result is similar to those of retrospective studies in Finland and Northern Ireland (Henriksson et al. 1993; Foster et al. 1997).

Axis I disorders

In men cognitive disorders, alcohol-related disorders, polysubstance-related disorders, schizophrenia and other psychotic disorders, single-episode major depressive disorder, and adjustment disorders and in women alcohol-related disorders and recurrent major depressive disorder remained significantly associated with suicide risk, independently of the statistical model used. These results underline the importance of especially alcohol-related disorders and major depressive disorder as predictors for suicide in both genders.

The estimated risk for suicide in the presence of alcohol-related disorders was about four times greater in men and five times greater in women than in its absence; these results are in line with the elevated suicide risk for alcohol dependence in samples including predominantly men (Cheng 1995; Foster et al. 1999). In a Swedish study (Waern 2003) including elderly suicides, alcohol-related disorders were independent risk factors for suicide in both genders. A recent British psychiatric register study failed to show an association between alcohol dependence and suicide in women of mixed ages (Baxter and Appleby 1999). However, former British studies (Barraclough et al. 1974) found low alcohol consumption in female suicides; moreover, register studies will miss individuals who do not seek psychiatric care. We observed alcohol-related disorders in 25 % of male and 17 % of female suicides, a figure that is similar to older US results (Robins et al. 1959). However, prevalences of alcohol-related disorders have been found to vary in mixed age suicides in both genders (Arato et al. 1988; Henriksson et al. 1993; Foster et al. 1997).

In men, we noted multiple substance-related disorder as a risk factor for suicide, with the highest odds ratio after inclusion of other axis I and personality disorders in the model. We showed in a recent analysis of our sample (Schneider et al. in press) that polysubstance-related disorders were associated with suicide risk in younger men; this is concordant with the finding that drug consumption occurs most frequently in young male suicides (Conwell et al. 1996), mostly as consumption of multiple drugs (Fowler et al. 1986). The multivariate analysis also indicated that cannabis-related disorders might be associated with suicide in men and sedative-related disorders with suicide in women. Prevalences of other substance use disorders than alcohol use disorders in male suicides were higher than in other European studies (Beskow 1979; Henriksson et al. 1993; Foster et al. 1997) and consistent with US results (Rich et al. 1988). With respect to female suicides, they were higher than in Swedish and Finnish (Asgard 1990; Henriksson et al. 1993), but similar to US and Northern Irish reports (Rich et al. 1988; Foster et al. 1997). These findings may reflect real international differences, but could also indicate a recent increase of other substance-related than alcohol-related disorders.

We have demonstrated that major depression is a risk factor for suicide in both genders, which is in line with results of mixed age and gender samples (Cheng 1995; Foster et al. 1999). In this study, however, only single-episode major depressive disorder in men and merely recurrent major depressive disorder in women were associated with suicide in a more inclusive approach. Identifying recurrent major depressive disorder as a risk factor for female suicide only was somewhat unexpected because of an earlier report describing recurrent major depression as the axis I disorder with the highest odds ratio in an elderly mixed gender sample (Waern et al. 2002). However, contrary to our results, these authors had medical records at their disposal, where these former episodes were documented. Furthermore, since men preferentially present "atypical" depressive symptoms (Rutz 1999), male depression often remains unrecognized, probably particularly in outpatient samples (Möller-Leimkühler et al. 2004). Our prevalences of major depressive disorder are close to results of European psychological autopsy studies, in men (Arato et al. 1988; Foster et al. 1997; Henriksson et al. 1993) as well as in women (Asgard 1990), although prevalences have wide ranges (see Schneider 2003).

According to the majority of previous reports (see Schneider 2003), prevalences of bipolar disorder and of dysthymia were low. As in the Indian mixed age and gender study (Vijayakumar and Rajkumar 1999), dysthymia and bipolar disorder were not associated with suicide in both genders in the more inclusive approach. Cheng (1995) reported that dysthymia is linked with significantly elevated odds ratios, but he diagnosed dysthymic disorder in 26 % of all suicides, a much higher proportion than in all other previous reports.

The prevalences of schizophrenia and other psychotic disorders were very similar to those of previous studies (Robins et al. 1959; Henriksson et al. 1993; Rich et al. 1988). We noted a highly elevated suicide risk for "schizophrenia and other psychotic disorders" for both genders in the univariate analysis. In men, even in the multivariate model, the estimated risk for suicide in the presence of schizophrenia and other psychotic disorders was about 70 times greater than in its absence. Schizophrenia and other psychotic disorders was not identified as an independent risk factor for women after in-

clusion of other psychiatric disorders. Follow-up studies (Harris and Barraclough 1998; Baxter and Appleby 1999; Hiroeh et al. 2001) did not demonstrate gender differences for suicide risk in schizophrenia, but De Hert et al. (2001) reported a significantly higher suicide rate for men than for women.

Cognitive disorders (DSM-IV) were identified as independent risk factors for suicide in our male sample. Confirming results of studies comprising mostly elderly (see Schneider et al. 2001; Harwood et al. 2001; Waern et al. 2002), we observed only one male suicide who suffered from dementia; the other five male suicides and the two control persons diagnosed with cognitive disorders fulfilled criteria for personality change, mood disorder, or mental disorder not otherwise specified due to a general medical condition.

In suicides, prevalences of adjustment and posttraumatic stress disorders are within the ranges given by other authors, in both genders (Rich et al. 1988; Asgard 1990; Henriksson et al. 1993; Foster et al. 1997). Our findings have established adjustment and posttraumatic stress disorders as an independent risk factor for male suicide only, with a high odds ratio after inclusion of clusters of personality disorders. In a recent report of our study (Schneider et al. in press) we demonstrated that adjustment disorders are particularly associated with male elderly suicide, which indicates the important role of life events relating to subsequent development of psychiatric symptoms and their contribution to male suicide risk. In agreement with controlled mixed age psychological autopsy studies comprising mostly men (Foster et al. 1999; Vijayakumar and Rajkumar 1999), anxiety disorders were not identified as a risk factor for suicide. Concordant to the literature (see Schneider 2003), we seldom observed somatoform disorders, eating disorders, and obsessive-compulsive disorders in suicides in our study.

Personality disorders

The results of the present study support our prediction of a higher prevalence of DSM-IV axis II disorders in the suicide group than in the control group. The odds ratio of at least one personality disorder was in the range of the odds ratios calculated by other authors (Cheng et al. 1997; Vijayakumar and Rajkumar 1999; Foster et al. 1999) using SAP, a semi-structured interview for DSM-III-R and ICD-10 (Mann et al. 1981; Pilgrim et al. 1993).

The overall prevalence of personality disorders in our study was high, but in keeping with recent results: Cheng et al. (1997) reported personality disorders to range between 46.7 % and 76.7 % in completed suicides among three ethnic groups in Taiwan. Earlier (Barraclough et al. 1974; Henriksson et al. 1993) as well as more recent reports of mixed age and gender samples (Foster et al. 1999; Vijayakumar and Rajkumar 1999) showed much lower rates. However, different diagnostic systems and interviews were applied in these studies; therefore, comparability of their results is limited. The surveys finding high prevalences of personality disorders used more specific structured interviews than we did. In fact, proportions of suicides with personality disorders would rise after inclusion of subjects with personality trait accentuation (Harwood et al. 2001; Houston et al. 2001) or of cases in which diagnosis of personality disorder could not be excluded (e. g. Henriksson et al. 1993). Furthermore, personality disorders seem to be less frequent in older than in younger age groups (Henriksson et al. 1995; Isometsä et al. 1996); but our results are possibly distorted because younger control persons and informants of younger suicides agreed to or were able to complete SCID-II more frequently. This might be caused by younger interviewees' better endurance and higher interest in the study.

As in the Northern Irish study using DSM-III-R (Foster et al. 1999) we found cluster A, cluster B, and cluster C personality disorders associated with suicide risk. Borderline and emotionally unstable personality disorders were the most common personality disorders in mixed age suicides (Henriksson et al. 1993; Cheng et al. 1997; Foster et al. 1999) and were associated with increased suicide risk (Cheng et al. 1997; Foster et al. 1999). Foster et al. (1997, 1999) found paranoid personality disorder and avoidant personality disorder as the two other most frequent personality disorders in suicides. These results resemble our findings, which may imply common characteristics in suicide completers.

After taking into account the presence of axis I disorders, co-occurrence of personality disorders of more than one cluster was associated with 16-fold suicide risk in men and 20-fold suicide risk in women. This result supports our prediction of more "cluster combinations" of personality disorders in the suicide than in the control group. For men cluster C and for women cluster B personality disorders without presence of personality disorders out of other clusters increased suicide risk even independently of axis I disorders. In women, a dramatic and erratic and in men, an anxious, inhibited temperament may predispose to suicidal behavior. "Missing data" of personality disorders were associated with increased suicide risk in men. Relatives might not be able or willing to give sufficient information of a suicide's personality characteristics, if they missed an intimate or a good relation to the deceased. The social relationships of these deceased men might have been damaged by dysfunctional behavior due to "not normal" personality traits.

Implications for suicide prevention

In both genders, prevention, precise recognition, and adequate treatment of psychopathological symptoms and psychiatric disorders (Müller-Oerlinghausen 2001; Meltzer et al. 2003; Müller-Oerlinghausen 2003; Barak et al. 2004; Bradvik and Berglund 2005; Baca-Garcia et al. 2005) play key roles in suicide prevention. Heritability of axis I disorders like alcohol use disorders and major de-

pression (Bierut et al. 1999; Kendler et al. 2001; Tyndale 2003) and of personality disorders (Torgersen et al. 2000) is well known. The interaction of genetic with environmental factors (Reif and Lesch 2003) and hormones (Baca-Garcia et al. 2003) should also be included in considerations about suicide prevention. By gaining a better understanding of these complex interactions, new pharmacological and behavioral treatment approaches could be provided and help to reduce suicide risk.

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