Hospitalization for physical illness and risk of subsequent suicide: a population study

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Abstract. Qin P, Webb R, Kapur N, Sørensen HT (National Centre for Register-Based Research, University of Aarhus, Denmark; Centre for Mental Health and Risk, University of Manchester, UK; and Department of Clinical Epidemiology, Aarhus University Hospital, Denmark). Hospitalization for physical illness and risk of subsequent suicide: a population study. *J Intern Med* 2013; **273**: 48–58.

Objective. To examine suicide risk in relation to physical illness across a broad range of illnesses, including hospitalization history, specific organ or system illness and comorbidity.

Design. A nested case–control study.

Setting. Data were retrieved from five Danish national registers.

Subjects. On the basis of the entire population of Denmark, this study included 27 262 suicide cases, and 468 007 live controls matched for sex and date of birth.

Main outcome measures. Risk of suicide was assessed using conditional logistic regression.

Results. In the study population, 63.5% of suicide cases and 44.5% of comparison controls had a history of hospitalization for physical illness. A physical illness significantly increased the risk of subsequent suicide (incidence rate ratios 2.13, 95% CI 2.07–2.18) with a substantially greater effect in women than in men ($P < 0.01$). The elevated risk increased progressively with frequency and recency of hospitalization and was significant for diseases occurring in all organs or systems of the body. Comorbidity involving several organs or systems increased the risk substantially. The associated estimates were to some extent reduced but remained highly significant after adjustment for psychiatric history and socio-economic status. Taking into account both prevalence and adjusted effect size, physical illness accounted for 24.4%, 21.0% and 32.3% of population attributable risk for suicide in total, male and female populations, respectively.

Conclusions. Physical illness constitutes a significant risk factor for suicide independent of psychiatric and socio-economic factors. Clinicians treating physically ill patients should be aware of the risk, especially amongst those with multiple or recent hospitalizations, or multiple comorbidities.

Keywords: epidemiology, nested case–control design, physical illness, population study, suicide risk.

Introduction

It is well known that people with physical illness are at increased risk of suicide, but the strength of the effect and the differences across a broad range of diagnoses are poorly understood. In general, studies have been conducted to examine whether suicide is associated with a single specific physical illness or generally ill condition. For instance, previous epidemiological studies have indicated an increased suicide risk associated with cancer [1], diabetes [2], epilepsy [3], multiple sclerosis [4, 5], stroke [6], myocardial infarction [7] and allergy [8]. Rarely has any large population been systematically examined for suicide risk across a range of physical conditions simultaneously, to explore the effect of level of comorbidity and to assess the association whilst taking into account personal socio-economic status and psychiatric history. A major reason for this could be the difficulty of obtaining the necessary data. In this large population study, using data from Danish national registers, we have investigated the risk of suicide in relation to physical illness, examining the effects of frequency and recency of hospitalization,

diagnosis according to the categories of the International Classification of Diseases (ICD) and number of comorbid conditions.

Material and methods

Setting

We conducted this study in Denmark (population 5.4 million), where hospital treatment is provided free of charge to all residents. Individual-level data for the entire population were retrieved from several national longitudinal registries and merged using the unique personal identifier (CPR number) given to all Danes by the Civil Registration System at birth and to new residents upon immigration [9].

The Cause-of-Death Register [10] contains information on cause and date of all deaths that have occurred in Denmark since 1969. The Danish National Hospital Register [11] contains individual-level data on diagnoses and dates of contact with all nonpsychiatric hospitals in Denmark since 1978. The Danish Psychiatric Central Register [12], covering all psychiatric facilities in Denmark, maintains a cumulative record of all hospital admissions and discharges since 1969. Data on outpatient contact (visits to emergency departments, hospital outpatient clinics and ambulance calls) have been included in both general and psychiatric hospital registers from 1995. Diagnoses of illness and causes of death were coded according to the ICD, 8th revision (ICD-8), until the end of 1993 and the 10th revision (ICD-10) thereafter. The ICD 9th revision has never been used in Denmark.

The IDA Database (Danish acronym for 'the Integrated Database for Labour Market Research') [13] records annual information on labour market conditions (employment status, type of occupation, job function, employer) and sociodemographic status for all Danish residents. Individual socio-economic data for a given calendar year are complete only for individuals living in Denmark on 31 December of that year.

Study design and participants

We utilized a nested case–control design to select study participants from the national population of Denmark. The Cause-of-Death Register [10] allowed us to identify all suicides (n = 27 380; ICD-8 codes E950–959 and ICD-10 X60–84) that occurred during the period 1981–2006. In line with previous studies of suicide in Denmark [8, 14], we included as study cases only individuals for whom the cause of death

was a definite suicide. We excluded individuals (n = 118) who were not residing in Denmark on 31 December in the preceding year because of the incompleteness of their socio-economic data in the IDA database. Using incidence density sampling [15], we randomly selected up to 20 live controls per suicide case, matched by sex and date of birth, from a 25% representative sample of the national population in the Civil Registration System [9]. The rationale for sampling 20 controls per case was to enable the examination of uncommon exposures with reasonable statistical precision. In total, 27 262 suicide cases, representing 99.6% of all national suicides during the study period, and 468 007 live population controls were included in the study.

Study variables and covariates

We assessed personal history of physical illness through patient records in the Danish National Hospital Register [11]. For each study subject, we retrieved the records of inpatient treatment for physical illness prior to the date of suicide or the matching date for controls and classified the diagnosis of illness by areas of organ or system of the body according to categories of the ICD-10 (chapter headings). We excluded the following conditions from our definition of a physical illness: mental and behavioural disorders (Chapter V), pregnancy and childbirth (Chapter XV), certain conditions of the prenatal period (Chapter XVI) and external causes (chapters XIX and XX, covering all accidental or intentional poisonings and injuries). Details regarding diagnostic codes in ICD-10 and conversion from ICD-8 to ICD-10 codes are provided in the Appendix. We also constructed a few variables of interest including the total number of hospitalizations, time elapsed from the most recent hospitalization and number of comorbid physical illnesses.

At the same time, we obtained personal data on psychiatric history, including both inpatient and outpatient care, from the Danish Psychiatric Central Register [12]. We also extracted individual data on socio-economic status, that is, marital status, annual gross income, place of residence and citizenship, from the IDA database [13]. These data were included for adjustment purposes in the analyses [14].

Statistical analysis

We constructed contingency tables for the main study variables and computed the associated risk of suicide using conditional logistic regression with

the PhReg procedure available in SAS version 9 [16] with each case forming a separate stratum. Because the controls were sampled from individuals at risk of suicide (i.e. incidence density sampling), the estimated odds ratios (ORs) from the analyses were unbiased estimates of incidence rate ratios (IRRs) [17]. We estimated IRRs from crude analyses and from adjusted models controlling for effects of psychiatric history and socio-economic factors. For estimates associated with a specific organ or system illness, we used a generic reference group, that is, individuals without hospitalization for any of the physical illnesses included in the study, and adjusted the estimates for the effect of any illness other than the specified one.

The Wald test was used to determine the significance of estimates relative to the reference group and to examine the overall effect difference across the range of organ or system illnesses. Interactions between sex and overall physical illness and between sex and specific organ or system illness were additionally examined through the likelihood ratio test. Test for trend associated with the number of comorbid illnesses was performed by treating number of physical illnesses as a continuous variable (0–6 corresponding to seven categories; see Table 2). Population attributable risk (PAR) associated with physical illness was calculated based on the adjusted IRRs estimated from the conditional logistic regression analyses and the prevalence in suicide cases of the physical illnesses considered in the study [18]. All *P* values were two sided.

Ethical approval

We obtained approval to conduct the study from the Danish Data Protection Agency.

Results

The study included a total of 27 262 suicide cases and 468 007 live population controls, comprising 18 099 male and 9163 female suicide cases and 307 729 male and 160 278 female control subjects. In the study population, 63.5% of suicide cases and 44.5% of comparison controls had a history of hospitalization because of physical illness (Table 1). For both suicide cases and controls, physical illness was generally more common in women (70.8% of cases; 50.0% of controls) than men (59.7% of cases; 41.6% of controls). A psychiatric history was more common in individuals with physical illness compared with those without: 47.2% of physically ill suicide cases,

40.8% of physically healthy suicide cases, 7.7% of physically ill controls and 3.6% of healthy controls.

Frequency and recency of hospitalization for serious physical illness

Multiple hospitalizations for physical illness as well as a recent hospitalization were more common amongst suicide cases, relative to the control group (Table 1). Of suicide cases with physical illness, 50.2% had been hospitalized three or more times, and 39.8% had been hospitalized within the year prior to suicide; the corresponding values for the comparison controls were 35.3% and 19.4%, respectively.

Using conditional logistic regression to analyse the data, we found that a history of physical illness significantly increased the risk of suicide (crude IRR 2.13, 95% CI 2.07–2.18) and that the effect was greater amongst women than men (crude IRR 1.97, 95% CI 1.91–2.03 for men; crude IRR 2.50, 95% CI 2.38–2.62 for women; test of sex differences: $\chi^2 = 64.64$, $P < 0.001$). We also noted a progressively increased suicide risk associated with both the frequency of previous hospitalizations and the recency of the last hospitalization – the greater the number of hospitalizations or the more recent the last hospitalization, the higher the risk of suicide (Table 1). The observed pattern persisted in the analyses stratified by sex although the associated IRRs were generally higher in women than that in men (data not shown). When the data were adjusted for history of psychiatric illness, the associated IRRs were reduced to some extent, especially in the presence of multiple hospitalizations for physical illness. Still, the increase in associated risks remained highly elevated. Further adjustment for socio-economic status had minimal effect on the risk estimates (adjusted IRR 1.62, 95% CI 1.58–1.67 for total cases; adjusted IRR 1.54, 95% CI 1.49–1.60 for men; adjusted IRR 1.84, 95% CI 1.74–1.94 for women; test of sex differences: $\chi^2 = 51.04$, $P < 0.001$).

Diagnosis by ICD main categories and number of physical illnesses

When diagnoses of physical illness were grouped according to ICD-10 categories (Chapter headings; Table 2), a significantly higher prevalence of physical illness was observed in suicide cases than in controls across all organs or systems of the body. Digestive, circulatory and genitourinary system diseases were amongst the most common illnesses in both suicide cases and comparison controls. It is interesting that a substantial proportion of suicide cases (19.1%) had

Table 1 *Distribution and incidence rate ratio (IRR) of suicide associated with frequency and recency of hospitalization for physical illness*

Physical Illness	Suicide cases n	%	Matched controls n	%	Suicide risk, crude[a] IRR	95% CI	Suicide risk, adjusted I[b] IRR	95% CI	Suicide risk, adjusted II[c] IRR	95% CI
History of hospitalization										
No	9962	36.54	259 804	55.51	1		1	1	1	
Yes	17 300	63.46	208 203	44.49	2.13	2.07–2.18	1.65	1.60–1.69	1.62	1.58–1.67
Frequency of hospitalization										
0	9962	36.54	259 804	55.51	1		1		1	
1–2	8619	31.62	134 640	28.77	1.71	1.66–1.77	1.44	1.40–1.49	1.44	1.39–1.48
3–5	4718	17.31	48 970	10.46	2.57	2.47–2.67	1.82	1.75–1.90	1.79	1.72–1.87
6–10	2581	9.47	17 580	3.76	3.87	3.68–4.06	2.36	2.23–2.49	2.27	2.15–2.40
11–20	1075	3.94	5735	1.23	5.05	4.70–5.43	2.62	2.42–2.84	2.47	2.28–2.68
>20	307	1.13	1278	0.27	6.56	5.76–7.46	2.74	2.37–3.18	2.53	2.18–2.94
Time since last hospitalization										
No history of hospitalization	9962	36.54	259 804	55.51	1		1		1	
Inpatient or the day of discharge	1036	3.80	1920	0.41	13.41	12.37–14.53	10.57	9.63–11.60	10.14	9.24–11.13
1–7 days	511	1.87	1142	0.24	10.65	9.54–11.88	9.01	7.95–10.20	8.68	7.66–9.83
8–30 days	895	3.28	3429	0.73	6.27	5.80–6.78	4.70	4.30–5.14	4.59	4.20–5.02
1–3 months	1354	4.97	7720	1.65	4.31	4.05–4.59	3.07	2.86–3.30	3.02	2.81–3.24
3–6 months	1323	4.85	9811	2.10	3.34	3.14–3.56	2.33	2.18–2.50	2.29	2.14–2.46
6–12 months	1773	6.50	16 329	3.49	2.71	2.57–2.86	1.92	1.81–2.04	1.87	1.77–1.99
1–3 years	3911	14.35	47 817	10.22	2.07	1.99–2.15	1.53	1.47–1.60	1.50	1.44–1.57
3–5 years	2036	7.47	33 574	7.17	1.55	1.48–1.63	1.21	1.15–1.28	1.19	1.13–1.26
>5 years	4461	16.36	86 461	18.47	1.37	1.32–1.42	1.14	1.09–1.19	1.13	1.09–1.18

[a]Crude model IRRs were adjusted for sex and age (through matching).
[b]Model I IRRs were further adjusted for psychiatric history.
[c]Model II IRRs were additionally adjusted for marital status, income, citizenship and place of residence.

been hospitalized at least once because of symptoms, signs and abnormal clinical and laboratory findings not included in other categories.

With the group of individuals with no hospitalization for any physical illness included in the study as a reference, there was a significantly increased risk of suicide associated with specific diseases in all organs or systems of the body. The IRRs associated with the different specific organ or system illnesses varied significantly in magnitude (*P* < 0.001 in both crude and adjusted analyses), from 2.07 to 3.83 in the crude analysis and from 1.56 to 2.04 in the analysis adjusted for psychiatric history and socio-economic status (Table 2). The highest IRRs were

associated with nervous system diseases and the group of unspecified symptoms, signs and abnormal clinical and laboratory findings; the remaining groups of diseases had a comparable effect on suicide risk.

Although analyses stratified by sex showed somewhat similar patterns (Fig. 1), the effects of some organ or system illnesses differed significantly between men and women. Combining the results from adjusted IRRs and the test for sex interaction showed that infectious and parasitic diseases (Chapter I), nervous system diseases (Chapter VI), respiratory system diseases (Chapter X), digestive system diseases (Chapter XI), skin diseases

Table 2 *Distribution and incident rate ratio (IRR) of suicide associated with diagnostic groups according to ICD-10 category*

ICD-10 chapter	Diagnostic category: chapter heading	Suicide cases n	%	Matched controls n	%	Suicide risk[a,b], crude[c] IRR	95% CI	Suicide risk[a,b], adjusted[d] IRR	95% CI
I	Infectious and parasitic diseases	1276	4.68	12 060	2.58	2.81	2.64–2.99	1.76	1.64–1.88
II	Neoplasms	2778	10.19	30 062	6.42	2.36	2.25–2.47	1.92	1.83–2.02
III	Blood and immune mechanism disorders	319	1.17	2653	0.57	2.82	2.50–3.19	1.92	1.68–2.20
IV	Endocrine, nutritional and metabolic diseases	1109	4.07	11 693	2.50	2.43	2.28–2.60	1.61	1.50–1.73
VI	Nervous system diseases	1632	5.99	11 287	2.41	3.83	3.62–4.05	2.02	1.89–2.15
VII, VIII	Sensory organ diseases	1136	4.17	12 035	2.57	2.15	2.01–2.30	1.59	1.48–1.71
IX	Circulatory system diseases	4545	16.67	45 323	9.68	2.36	2.27–2.46	1.72	1.65–1.80
X	Respiratory system diseases	3073	11.27	28 590	6.11	2.76	2.64–2.88	1.90	1.81–1.99
XI	Digestive system diseases	5735	21.04	56 059	11.98	2.57	2.48–2.66	1.73	1.66–1.80
XII	Skin diseases	1180	4.33	11 041	2.36	2.88	2.70–3.07	1.74	1.62–1.86
XIII	Musculoskeletal system diseases	3416	12.53	35 621	7.61	2.48	2.38–2.59	1.82	1.73–1.90
XIV	Genitourinary system diseases	4400	16.14	49 301	10.53	2.28	2.20–2.38	1.71	1.64–1.79
XVII	Congenital malformations	411	1.51	5606	1.20	2.07	1.87–2.29	1.56	1.39–1.74
XVIII	Unspecified symptoms, signs, and abnormal clinical and laboratory findings	5197	19.06	38 603	8.25	3.51	3.39–3.65	2.04	1.96–2.13

[a]The group of individuals with no record of hospitalization for any physical illness was used as the generic reference group for the estimate associated with each specific type of illness.
[b]Test of differences in overall effect size across diagnostic groups: $\chi^2 = 640.21$, df = 13, $P < 0.001$ for the crude estimates; $\chi^2 = 130.09$, df = 13, $P < 0.001$ for the adjusted estimates.
[c]Crude IRRs were adjusted for sex and age (through matching) and the presence of a physical illness other than the specified one.
[d]IRRs were further adjusted for psychiatric history, marital status, income, citizenship and place of residence.

(Chapter XII), musculoskeletal system diseases (Chapter XIII), congenital malformations (Chapter XVII) and unspecified symptoms, signs and abnormal clinical and laboratory findings (Chapter XVII) increased suicide risk significantly more in women than in men, whereas neoplasms (Chapter II) had a significantly greater effect on suicide in men. The increased suicide risk for the other diagnostic categories was comparable for both sexes.

Comorbid illnesses involving multiple organs or systems were more common in suicide cases than in controls (Table 3). Overall, 35.5% of suicide cases, but only 18.4% of controls, had been hospitalized for diseases occurring in more than one organ or system. The associated suicide risk increased progressively with the number of comorbid organ or system

diseases, and the test of trend was highly significant (analogous IRR 1.44, 95% CI 1.42–1.45; $P < 0.0001$). The highly elevated risks associated with multiple comorbidities were largely reduced when the data were adjusted for psychiatric and socio-economic status. Still, the progressive increase in suicide risk associated with multiple comorbidities remained prominent for both sexes together (analogous IRR for trend test 1.23, 95% CI 1.21–1.24; $P < 0.0001$) (Table 3) as well as for men and women separately (data not shown).

Population attributable risk

To assess the proportion of suicides in the population that is attributable to exposure to the physical illnesses considered in this study, we computed the
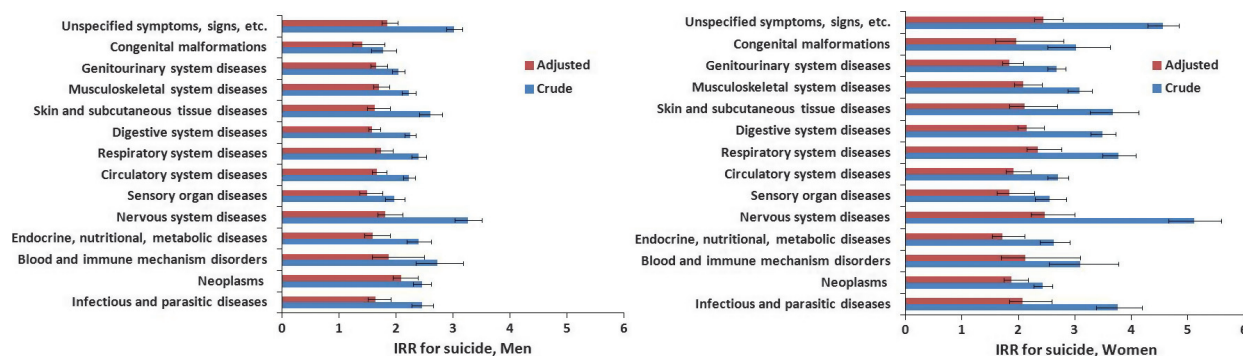
Fig. 1 *Incidence rate ratio (IRR) of suicide associated with diagnostic groups by ICD-10 chapter headings: stratified analyses for men and women separately. The group of individuals with no record of hospitalization for any physical illness was used as the reference group for the estimate associated with each specific type of illness. Crude IRRs were adjusted for sex and age (through matching) and the presence of a physical illness other than the specified one; adjusted IRRs were further adjusted for psychiatric history, marital status, income, citizenship and place of residence. Test of sex differences: P < 0.01 for infectious and parasitic diseases (Chapter I), neoplasms (Chapter II), nervous system diseases (Chapter VI), respiratory system diseases (Chapter X), digestive system diseases (Chapter XI), skin and subcutaneous diseases (Chapter XII), musculoskeletal system diseases (Chapter XIII), congenital malformations (Chapter XVII) and unspecified symptoms, signs and abnormal clinical and laboratory findings (Chapter XVII).*

Table 3 *Distribution and incident rate ratio (IRR) associated with comorbidity of physical illnesses according to number of ICD-10 categories*

Number of physical illnesses	Suicide cases		Matched controls		Suicide risk, crude[a]		Suicide risk, adjusted[b]	
	n	%	n	%	IRR	95% CI	IRR	95% CI
0	9962	36.54	259 804	55.51	1		1	
1	7618	27.94	121 990	26.07	1.67	1.62–1.73	1.42	1.37–1.47
2	4703	17.25	52 203	11.15	2.43	2.34–2.52	1.76	1.69–1.83
3	2579	9.46	20 740	4.43	3.35	3.20–3.52	2.07	1.97–2.19
4	1300	4.77	8231	1.76	4.24	3.98–4.53	2.21	2.06–2.38
5	638	2.34	3258	0.70	5.30	4.84–5.80	2.35	2.12–2.61
>5	462	1.70	1781	0.38	7.07	6.34–7.89	2.71	2.40–3.07
Test of trend[c]					1.44	1.42–1.45	1.23	1.21–1.24

[a]Crude IRRs were adjusted for sex and age (through matching); [b]IRRs were further adjusted for psychiatric history, marital status, income, citizenship and place of residence.
[c]Test for trend was performed by including number of physical illnesses as a continuous variable, that is, from 0 to 6 corresponding to the seven categories.

PAR – a measurement that takes into account both the prevalence of physical illness in the population and the magnitude of its effect on suicide risk (Table 4). We estimated a PAR of 24.4% for the total population, 21.0% for men and 32.3% for women, including a contribution because of a recent hospitalization for physical illness within 30 days of 7.7%, 7.2% and 8.6%, respectively. Illness categories with a high PAR included the group of

unspecified symptoms, signs and abnormal clinical and laboratory findings, as well as digestive, circulatory and genitourinary system diseases.

Discussion

The findings of this large study in the entire population of Denmark show that hospitalization for a physical illness significantly increases the risk of

Table 4 *Population attributable risk (PAR) of suicide associated with physical illness*

ICD-10 chapter	Diagnostic category: chapter headings	Total	Male cases	Female cases
I	Infectious and parasitic diseases	2.0	1.8	2.6
II	Neoplasms	4.9	3.9	7.2
III	Blood and immune mechanism disorders	0.6	0.5	0.7
IV	Endocrine, nutritional and metabolic diseases	1.5	1.3	2.3
VI	Nervous system diseases	3.0	2.4	4.4
VII, VIII	Sensory organ diseases	1.6	1.3	2.2
IX	Circulatory system diseases	7.0	6.8	7.6
X	Respiratory system diseases	5.3	4.8	6.4
XI	Digestive system diseases	8.9	7.9	11.0
XII	Skin diseases	1.8	1.7	2.1
XIII	Musculoskeletal system diseases	5.6	4.7	7.7
XIV	Genitourinary system diseases	6.7	4.4	11.9
XVII	Congenital malformations	0.5	0.5	0.7
XVIII	Unspecified symptoms, signs and abnormal clinical and laboratory findings	9.7	7.5	14.5
Any physical illness included in the study		24.4	21.0	32.3

PAR was calculated based on the adjusted IRR using model II (see legend to Table 1) and the distribution of exposure in the cases. PARs associated with specific diagnostic groups were estimated independently of each other and are not additive. All values are given as percentages.

subsequent suicide, with a substantially greater effect in women than men. The elevated risk increased progressively with the frequency and recency of hospitalization and was significant for all diagnostic groups of disease in any organ or system defined by ICD-10 categories. Comorbidity involving several organs or systems greatly increased suicide risk. At the same time, the observed effect of physical illness was somewhat reduced after adjustment for history of psychiatric illness, which was especially apparent for the estimated risks associated with multiple hospitalizations and multiple comorbidities. Nevertheless, the elevated risks remained highly significant after adjusting for psychiatric history and socio-economic status. Moreover, hospitalization for physical illness accounted for 24.4% of the PAR for suicide in the general population, with a higher attributable fraction for female (32.3%) than for male (21.0%) suicide.

These robust findings support a strong link between physical illness and risk of subsequent suicide in the general population. There have been a number of reports of an increased suicide risk associated with several severe diseases, including amongst others cancer and diabetes [1–8]. The findings of this study extend the existing evidence by demonstrating that a disease of any organ or physical system significantly increases the risk of subsequent suicide, regardless of sex and after controlling for individual psychiatric history and socio-economic status.

A serious physical illness is often accompanied by pain, disability, limited social activity and worry about prognosis and financial loss and can lead to many problems with respect to physical, psychological and social well-being. Although we were not able to assess the severity of specific diagnoses, the observed progressive increase in suicide risk associated with frequency of hospitalization and multiple comorbidities indicates that the severity of physical illness plays an important role in the risk of subsequent suicide. The observed effects of these factors were apparently reduced after adjustment for psychiatric history [19]. Still, being physically severely ill, as evidenced by either multiple hospitalizations or the involvement of several organs or systems, confers a strong risk of subsequent suicide. Patients may choose to end their life to obtain release from a long-term debilitating condition or to avoid experiencing the progression of an illness.

Our finding that variation in effect size across illnesses in various organs or systems is relatively small differs somewhat from the findings of previous studies of suicide in relation to single-disease entities

[1–8, 20, 21]. One methodological explanation could be that diagnoses in this study were broadly grouped on the basis of ICD-10 categories, covering a diversity of illnesses that occur in both severe and less severe forms or have a strong or weak relation to suicide. For instance, the group of nervous system diseases includes both diagnostic entities such as multiple sclerosis with a high risk of suicide [4, 5] and other diagnoses such as Parkinson's disease with a low suicide risk [22]. Another possible explanation is that the variation in risk reported from the previous studies of single-disease groups may be subject to differential selection and information biases. A key strength of this register-based population study was the ability to estimate relative risk across a broad range of different physical illness types within the same study cohort compared with a generic reference category (i.e. individuals without any of the physical illnesses included in the study). This excluded the possibility of differential types and levels of bias, making comparison of risk between diagnostic groups more straightforward.

We observed that a psychiatric history was significantly more common in suicide cases with physical illness compared with those without (47.2% vs. 40.8%) and also that the elevated suicide risk associated with physical illness weakened to some extent after adjustment for history of contact with psychiatric services. These findings are consistent with previous reports of high comorbidity of psychiatric illness, especially depression, in people with physical diseases [19, 23], and suggest that psychiatric illness is an important confounding or mediating factor in the link between physical illness and suicide risk.

To our knowledge, this study is the first to demonstrate a strong impact of the ICD-10 category of unspecified symptoms, signs and abnormal clinical and laboratory findings, in terms of both increased IRR and contributed PAR of suicide. This is noteworthy and consistent with reports indicating that the presence of unexplained somatic symptoms is associated with psychiatric disorders such as major depression and anxiety [24, 25] and that complaints of illness or feeling unwell may provide clues to patients' desire for emotional support [26]. Although our estimates were controlled for the effects of psychiatric history and socio-economic status as well as of specified diagnoses from other ICD chapters, it is still possible that complaints of unspecified symptoms and signs may be linked to undiagnosed psychological symptoms, stress or somatization.

Our observation of a generally stronger effect of physical illness on suicide risk in women than in men suggests that women probably react more strongly to poor health than their male counterparts. This notion is also supported by previous evidence that psychiatric history has a significantly stronger impact on suicide in women than in men [14]. At the same time, some physical illnesses and their influences on suicide may be more sex specific. For instance, we found that illnesses in most organs or systems have a stronger effect on increasing suicide risk in women than in men, but neoplasms increased the risk significantly more in men. Further investigation of detailed diagnoses stratified by sex is needed for better understanding of this issue.

Relative to the intensive research and preventive efforts focusing on suicide in patients with psychiatric illness, subsequent suicide related to physical illness has received little attention. This study is the first to report that around a quarter of all suicides in the general population is attributable to exposure to physical illnesses that require hospital admission for treatment, including a 7.6% contribution because of a recent hospitalization for physical illness within 30 days. These PAR estimates could be subject to revision if more factors that may underlay the link between physical illness and subsequent suicide are taken into consideration. It does, however, indicate that suicide in patients with physical illness is clearly an important public health problem and warrants more investment of social resources and prevention efforts.

Limitations and strengths

A limitation of this study is that we considered only serious physical illnesses resulting in hospitalization. This may provide a slightly skewed picture as the influence of milder physical illnesses was not ascertained and because some severe medical conditions are treated in outpatient care. Similarly, we used psychiatric service contact as a proxy for psychiatric status. This underestimates the full extent of psychiatric disorders and reflects more serious disorders. Moreover, we were only able to obtain individual data on serious physical illness starting in 1978 when the Danish National Hospital Register was established. Thus, our data cover a relatively long period, but do not represent the lifetime of older subjects. Additionally, we detected a strong modification effect of psychiatric history on the link between physical illness and suicide risk, but did not address specifically the temporal relationship between physical illness and comorbid psychiatric disorders in this study.

Furthermore, we grouped the diagnosis of illness based on areas of organ or system using the ICD-10 categories (chapter headings), which captures a mixed effect of illnesses occurring in one organ or body system but is not able to separate individual effects of specific clinical diagnoses on risk of suicide.

A major strength of this study is the coverage of the entire population of Denmark and the availability of precise data collected systematically without any research purpose. This ensures the full representation of a national population and minimizes possible biases that are often induced by recall of information and selected access to healthcare. The results should also be highly applicable to the general public, especially in countries or regions with comparable social settings.

To our knowledge, this study is the first to document suicide risk in relation to physical illness, encompassing hospitalization history, diagnosis and comorbidity and to assess the effect in the context of personal psychiatric and socio-economic status. It is also the first to evaluate the proportion of suicides in the population that is attributable to exposure to the physical illnesses included in the study. These findings will be informative for making strategies to reduce suicide in the general population.

Clinical implications

The results from this population study indicate the need to integrate suicide prevention within hospital treatment as well as within general medical practice [27]. Patients hospitalized for physical illness not only form a well-defined population group at high risk of suicide, but also maintain frequent contact with their general practitioner after hospital discharge. This provides opportunities for both risk assessment and prevention. According to our estimates, almost a quarter of all suicides in the general population could be avoided if prevention efforts were sufficiently implemented in services and settings dealing with people who are hospitalized because of physical illness. Although it is impossible to prevent all suicides in physically ill people, a considerable number of lives could be saved. Clinicians treating people with physical illness should be aware of the risk of suicide, especially amongst patients with multiple or recent hospitalizations or with comorbid physical illnesses.

At the same time, our findings underscore the necessity of further investigation. Whilst physical illness is common, only a small proportion of physically ill patients commit suicide. Therefore, we need to explore more thoroughly the link between various specific diagnoses of physical illness and subsequent suicide and to better understand the characteristics, medical conditions and outlook amongst individuals who are physically ill but do not commit suicide.

Conflict of interest statement

No conflicts of interest to declare.

Authors' contributions

PQ designed the study, compiled the data, conducted the analysis and wrote the report. RW, NK and HTS participated in all discussions about the study design and interpretation of data and made critical revisions to the manuscript for important intellectual content. All authors have seen and approved the final version of the manuscript.

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Appendix

ICD-10 and ICD-8 codes

ICD-10 chapter	Diagnostic category: chapter headings	ICD-10 codes	ICD-8 codes
I	Infectious and parasitic diseases	A00–B99	001–136
II	Neoplasms	C00–D48	140–239
III	Blood and immune mechanism disorders	D50–D89	280–289
IV	Endocrine, nutritional and metabolic diseases	E00–E90	240–279
V[a]	Mental disorders	F00–F99	290–315
VI	Nervous system diseases	G00–G99	320–359
VII, VIII	Sensory organ diseases	H00–H95	360–389
IX	Circulatory system diseases	I00–I99	390–458
X	Respiratory system diseases	J00–J99	460–519
XI	Digestive system diseases	K00–K93	520–577
XII	Skin and subcutaneous tissue diseases	L00–L99	680–709
XIII	Musculoskeletal system diseases	M00–M99	710–738
XIV	Genitourinary system diseases	N00–N99	580–629

Appendix (*Continued*)

ICD-10 chapter	Diagnostic category: chapter headings	ICD-10 codes	ICD-8 codes
XV, XVI[a]	Pregnancy, childbirth and prenatal conditions	O00–P99	630–678, 760–779
XVII	Congenital malformations	Q00–Q96	740–759
XVIII	Unspecified symptoms, signs and abnormal clinical and laboratory findings	R00–R99	780–796
XIX, XX[a]	External causes	S00–T98, V01–Y98	800–999
Suicide		X60–X84	E950–E959

[a]Diagnostic groups are not normally viewed as physical diseases and therefore were excluded from our definition of a physical illness.