

RESEARCH ARTICLE

# Frequency of health care utilization in the year prior to completed suicide: A Danish nationwide matched comparative study

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**Data Availability Statement:** Due to restrictions related to Danish law and protecting patient privacy, the combined set of data as used in this study can only be made available through a trusted third party, Statistics Denmark. This state organisation holds the data used for this study. University-based Danish scientific organisations can be authorized to work with data within Statistics Denmark and such organisation can provide access to individual scientists inside and outside of Denmark. Requests for data may be sent to Statistics Denmark: <http://www.dst.dk/en/>

## Abstract

### Background

Suicide accounts for more than 800,000 annual deaths worldwide. Some of these deaths may be preventable by timely identification of individuals at risk and effective intervention. General practitioners (GPs) may have the potential to play an important role in this process.

### Aim

The present study aimed to assess the frequency of primary health care utilization in the year preceding suicide.

### Methods

Using Danish national registers, we identified all persons who died by suicide in Denmark from 1997 through 2013 and assessed the frequency of their primary care utilization and compared it with that of an age- and sex-matched reference group sampled from the background population.

### Results

We identified 11,191 persons who died by suicide (males: 8,095, females: 3,096). Compared with the reference group (N = 55,955), a greater proportion attended general practice in the year before index date (83% vs. 76%). In the last month before index date, these figures were 32.0% and 19.4%, respectively, corresponding to a difference of 12.0 95% CI: (11.1; 12.9) percentage points after adjustment for demographic characteristics and physical comorbidity. Suicide cases had a higher GP attendance in every week in the year before suicide, but the difference increased specifically in the last four months.

OmDS/organisation/TelefonbogOrg.aspx?kontor=13&tffbogsort=sektion or the Danish Data Protection Agency: <https://www.datatilsynet.dk/kontakt/>.

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## Conclusion

More than 30% attended the GP in the month before the suicide. This indicates that general practice could be a possible place to identify suicide cases and offer intervention. However, although this proportion represents a markedly higher GP attendance than seen in the reference group, almost 70% of those who died by suicide did not attend primary care in the month before the suicide. Our study suggests that it is important that the GPs have easy access to effective suicide prevention programs for patients at risk of suicide, and that persons with suicidal thoughts are encouraged to contact their GP.

## Introduction

More than 800,000 persons die by suicide every year [1]. Mounting evidence suggests that some suicides could be prevented if persons at risk are identified and offered specialized treatment [2–4].

About 98% of the population in Denmark is listed with a specific general practice and receives publicly funded health care services free of charge [5]. General practitioners (GPs) provide first-contact care to unselected health problems and act as gatekeepers to secondary care. Several studies have found that a large proportion of the persons who die by suicide have contacted the GP in the year leading up to the suicide [6–13]. However, previous studies have been limited by small sample sizes [8–12,14], lack of reference group [6,7,9–12], potentially incomplete data [7], and restrictions to selected groups [8,10]. All these limitations challenge the generalizability of findings, including assessment of the extent to which the GP utilization among persons who die by suicide differ from that of persons with similar characteristics who do not die by suicide.

In a large nationwide matched comparative study based on all recorded suicides in Denmark from 1997 through 2013, we aimed to add volume to the body of work on the proportion of individuals attending primary care on a weekly basis in the year prior to suicide and further to compare this proportion with that of a matched reference group in regression analyses adjusted for age, sex, calendar time, socioeconomic characteristics, and physical comorbidity to see if they could be identified in general practice.

## Methods

We conducted a matched comparative study based on information from multiple Danish national registers. Using the unique personal identification number assigned to all Danish citizens at birth or immigration [15], we linked information at the individual level across the registers. We assessed the frequency of daytime face-to-face consultations provided by the GP in the year preceding suicide in persons who died by suicide from 1 January 1997 through 31 December 2013 and compared their frequency of utilization to that of the background population adjusted for important confounding variables [16]. To obtain a more detailed picture of the frequency of health care utilization, we explored different types of services provided by the GP, medicine redemptions, and contacts with the psychiatric treatment system in secondary care.

## Participants

Using the Danish Register of Causes of Death [17], we identified all individuals recorded with suicide from 1 January 1997 through 31 December 2013. Deaths by suicide were identified

using codes X60-X84 and Y87 of the International Classification of Diseases, 10<sup>th</sup> revision (ICD-10). For each suicide case, we randomly sampled five reference persons from the background population matched on sex and age (+/- one month) who were still alive and listed as living in Denmark at the date of the suicide (index date). Information on sex and age was obtained from the Danish civil registration system (CRS) [18], and information on migration was provided by Statistics Denmark. Only persons who had been living in Denmark for at least 12 months prior to the index date were eligible to participate in the study. Sampling was done without replacement for each suicide case and with replacement between suicide cases, i.e. each person could serve as a reference for more than one suicide case, but only once for the same suicide case. Reference persons could later be included as a suicide case if they died by suicide.

## Measurements

We measured the utilization of daytime face-to-face consultations identified in the National Health Insurance Service Register (NHISR) [5]. The NHISR contains data on type of all contacts to the GP, and all data are based on the GPs' invoices for provided services. We did not have access to the actual treatment date, but we were able to identify the week of the remuneration of the GP and the corresponding number of contacts in this week. To obtain a more general picture on the frequency of health care utilization, we investigated the usage of nine different types of services in general practice in the year prior to index date: out-of-hours (OOH) face-to-face consultations, talk therapy sessions, electrocardiograms, blood sample tests, hemoglobin measuring tests, rapid strep tests, urine sample tests, spirometer tests, and C-reactive protein tests (Table B in [S1 Appendix](#)). Furthermore, data on redeemed prescriptions were obtained from the Danish Register of Medicinal Product Statistics [19]. We investigated prescription redemptions categorized according to the Anatomical Therapeutic Chemical (ATC) classification system for antipsychotics (ATC: N05A) and antidepressants (ATC: N06A). As the duration of a prescription could span many months, and a treatment regime could comprise multiple prescription redemptions, we assumed that each prescription lasted for four months, and a person redeeming a new prescription was considered to be under treatment for another four months. In addition, information on contacts with the psychiatric treatment system in secondary care was obtained from the Danish Psychiatric Central Research Register (PCR) [20].

## Covariates

Thirty-one different somatic diseases were identified and included in the analyses as dichotomous variables (Table F in [S1 Appendix](#)). The diseases were defined according to an algorithm developed by Prior et al. [21] encompassing 39 different somatic and mental diseases treated in primary or secondary care. These were identified through the Danish National Patient Registry [22], the PCR, the Danish Cancer Registry [23], the Danish Register of Medicinal Product Statistics, the NHISR, and the National Diabetes Register [24].

Sex and age at index date was found in the CRS.

Level of highest attained education and cohabitation status were obtained from annually updated information from Statistics Denmark, which also provided us with the partner's personal identification number. If a participant's partner had died within the last year, this participant was categorized as recently bereaved. Date of death was identified in the CRS. Cohabitation status was divided into four groups (single, recently bereaved, cohabiting, married). Educational level was divided into three groups according to years of schooling ( $\leq 10$  years, 11–15 years,  $\geq 16$  years) [25]. Persons with no information on highest attained educational level were assigned to the lowest category.

All variables, except sex, age at index date, and calendar time at index date, were considered to be time-dependent and updated continuously.

## Statistical analysis

We dichotomized all contacts and types of services into “usage” and “non-usage” for the time unit of interest. These Bernoulli-distributed variables were analyzed using a generalized linear model with identity link and with varying extent of adjustment. This approach yielded proportion differences (PDs) as the measure of association. Cluster robust variance estimation was applied on the person level to account for the fact that persons could be included in the dataset more than once [26]. Confidence intervals (CI) were calculated on the 95% level.

Regression models were analyzed using three different a priori chosen adjustment models. Model 1 contained the matching variables with an interaction between age and sex. To allow non-linear associations we modelled the continuous variables in a flexible manner using restricted cubic splines with a pre-specified number of knots [27]. We placed knots at equally spaced percentiles to ensure a good fit. We modelled calendar-time and sex-specific splines using four knots. In the two other models, we aimed to see whether socioeconomic status (model 2) and presence of somatic comorbid diseases (model 3) explained some of the observed difference. Besides the variables from model 1, model 2 included educational level, cohabitation status, and the interaction between these variables and age. Model 3 included model 2 and dummy variables for all 31 somatic diseases.

Daytime face-to-face attendance were analyzed in both the entire year before index date and in the last month before index date. For the year prior to the index date, we included number of weeks before index date as both a continuous variable modelled by five-knotted restricted cubic splines and as a categorical variable for illustrative purposes. For all other types of contacts, we investigated frequency of utilization in the year before index date with number of months before index date included as a categorical variable.

In one sensitivity analysis, we excluded participants listed with a GP who requested remuneration for less than 35 weeks in a calendar year since this could be a sign that the GP did not request remuneration systematically every week, which could challenge the precision of the calculation of the treatment week. The algorithm used to identify GP affiliation was defined and developed by Kjærsgaard et al. [28]. In another sensitivity analysis, we excluded participants who had been hospitalized at some time point in the year before index date and, therefore, were unable to attend the GP. We identified all hospitalizations in the Danish National Patient Registry and in the PCR.

All analyses were performed using Stata 13, StatCorp LP, College Station, Texas, USA.

## Ethics statement

The study was approved by the Danish Data Protection Agency, the Danish Health Data Authority, and Statistics Denmark. This type of study did not need approval from the regional ethics committee as all patient information was based on register data, which were anonymized and de-identified prior to analysis by Statistics Denmark.

## Results

We identified 11,191 persons (males: 8,095; females: 3,096) who died by suicide and 55,955 references matched on age and sex. The annual number of suicides decreased slightly over the study period. The number of suicides increased with increasing age until age 60 and decreased after age 60. Compared to the reference group, persons dying by suicide were more likely to

have co-existing somatic diseases, have a short education, be single, and to have recently lost a partner (Table 1).

A higher percentage of the persons who died by suicide attended the GP when compared to the reference group, both in the year before index date (83% vs. 76%) and in the month before index date (32.0% vs. 19.4%) (Fig 1 and Table 2). This corresponds to a difference of 12.6 percentage points (PD: 12.6, 95% CI: (11.7; 13.5)) in model 1. The estimated difference was virtually unchanged when we adjusted for matching variables, cohabitation status, and educational level (PD: 12.5, 95% CI: (11.6; 13.4)). The estimated difference was slightly lower when we further adjusted for somatic diseases (PD: 12.0, 95% CI: (11.1; 12.9)).

The subgroups with the largest unadjusted proportion of daytime face-to-face contacts in the month prior to suicide were suicide cases with two or more comorbid somatic diseases (42.2%), suicide cases who were recently bereaved (41.2%), and suicide cases older than 61 years of age (39.2%). All the variables in Table 3, except calendar time, tended to modify the difference; this was especially seen for cohabitation status and number of somatic comorbid diseases. For example, the PD was 9.8 percentage points for singles and 15.9 percentage points for recently bereaved individuals. Furthermore, the PD tended to decrease with increasing number of somatic comorbid diseases (Table 3).

When we excluded individuals who had been hospitalized within the last year before the index date, the estimated difference attenuated. We found that 10.6 percentage points more of those who died by suicide consulted the GP in the month before index date compared with the reference group (PD: 10.6, 95% CI: (9.4; 11.8)). The estimated difference did not change substantially when we excluded individuals listed with a GP who requested remuneration less than 35 times in the calendar year under study (PD: 12.2, 95% CI: (11.2; 13.2)).

We found that, throughout the year before the index date, a higher proportion of the suicide group than the reference group attended the GP on a weekly basis, even after we adjusted for all the variables in model 3. Furthermore, the PD tended to increase from approximately 4 months before the index date (Fig 2).

Throughout the entire year before index date, a higher proportion in the suicide group had OOH contacts, talk therapy sessions, blood sample tests, psychiatric contacts, antidepressants treatment, and antipsychotics treatment compared to the reference group. Furthermore, the PDs for these outcomes increased during the last months before index date (Figs 3 and 4).

## Discussion

### Key results

In this nationwide matched comparative study ranging from 1997 through 2013, we identified more than 11,000 individuals who died by suicide. A total of 83% of these individuals attended a GP during the year prior to the suicide, the similar figure for the reference group was 76%. We found that, even a year before index date, a higher proportion had contacts related to mental health in the group who died by suicide compared to the reference group; this was seen both in primary care and in the psychiatric treatment system in secondary care. Likewise, a higher proportion of those dying by suicide were treated with antipsychotics and with antidepressants. In both daytime and OOH care, a greater proportion of the suicide cases had face-to-face contacts during the year before the suicide compared to the reference group, and an increased difference was seen in the last four months before the suicide.

### Strengths and limitations

To our knowledge, this is the largest study to date to investigate the frequency of health care utilization prior to completed suicide. A strength of this study is that we used data based on

Table 1. Characteristics of the cohort one month before index date.

	Reference group	Suicide group	Total
	N (column %)	N (column %)	N (column %)
<b>Total</b>	55,955 (100%)	11,191 (100%)	67,146 (100%)
<b>Sex</b>			
Male	40,475 (72.3%)	8,095 (72.3%)	48,570 (72.3%)
Female	15,480 (27.7%)	3,096 (27.7%)	18,576 (27.7%)
<b>Age (years)</b>			
-20	1,345 (2.4%)	269 (2.4%)	1,614 (2.4%)
21–30	4,480 (8%)	896 (8%)	5,376 (8%)
31–40	7,305 (13.1%)	1,461 (13.1%)	8,766 (13.1%)
41–50	10,925 (19.5%)	2,185 (19.5%)	13,110 (19.5%)
51–60	11,210 (20%)	2,242 (20%)	13,452 (20%)
61–70	8,365 (14.9%)	1,673 (14.9%)	10,038 (14.9%)
71–80	6,790 (12.1%)	1,358 (12.1%)	8,148 (12.1%)
81–90	4,645 (8.3%)	929 (8.3%)	5,574 (8.3%)
91–	890 (1.6%)	178 (1.6%)	1,068 (1.6%)
<b>Year of index date</b>			
1997	4,045 (7.2%)	809 (7.2%)	4,854 (7.2%)
1998	3,720 (6.6%)	744 (6.6%)	4,464 (6.6%)
1999	3,765 (6.7%)	753 (6.7%)	4,518 (6.7%)
2000	3,605 (6.4%)	721 (6.4%)	4,326 (6.4%)
2001	3,615 (6.5%)	723 (6.5%)	4,338 (6.5%)
2002	3,410 (6.1%)	682 (6.1%)	4,092 (6.1%)
2003	3,120 (5.6%)	624 (5.6%)	3,744 (5.6%)
2004	3,240 (5.8%)	648 (5.8%)	3,888 (5.8%)
2005	3,125 (5.6%)	625 (5.6%)	3,750 (5.6%)
2006	3,235 (5.8%)	647 (5.8%)	3,882 (5.8%)
2007	2,930 (5.2%)	586 (5.2%)	3,516 (5.2%)
2008	3,020 (5.4%)	604 (5.4%)	3,624 (5.4%)
2009	3,090 (5.5%)	618 (5.5%)	3,708 (5.5%)
2010	2,815 (5%)	563 (5%)	3,378 (5%)
2011	2,950 (5.3%)	590 (5.3%)	3,540 (5.3%)
2012	3,260 (5.8%)	652 (5.8%)	3,912 (5.8%)
2013	3,010 (5.4%)	602 (5.4%)	3,612 (5.4%)
<b>Number of comorbid somatic diseases</b>			
0	33,270 (59.5%)	5,795 (51.8%)	39,065 (58.2%)
1	10,752 (19.2%)	2,398 (21.4%)	13,150 (19.6%)
≥2	11,933 (21.3%)	2,998 (26.8%)	14,931 (22.2%)
<b>Educational level</b>			
≤10	22,517 (40.2%)	5,434 (48.6%)	27,951 (41.6%)
11–15	24,387 (43.6%)	4,416 (39.5%)	28,803 (42.9%)
≥16	9,051 (16.2%)	1,341 (12%)	10,392 (15.5%)
<b>Cohabitation status</b>			
Single	18,447 (33%)	6,056 (54.1%)	24,503 (36.5%)
Recently bereaved	361 (0.6%)	211 (1.9%)	572 (0.9%)
Cohabiting	6,209 (11.1%)	977 (8.7%)	7,186 (10.7%)
Married	30,938 (55.3%)	3,947 (35.3%)	34,885 (52%)

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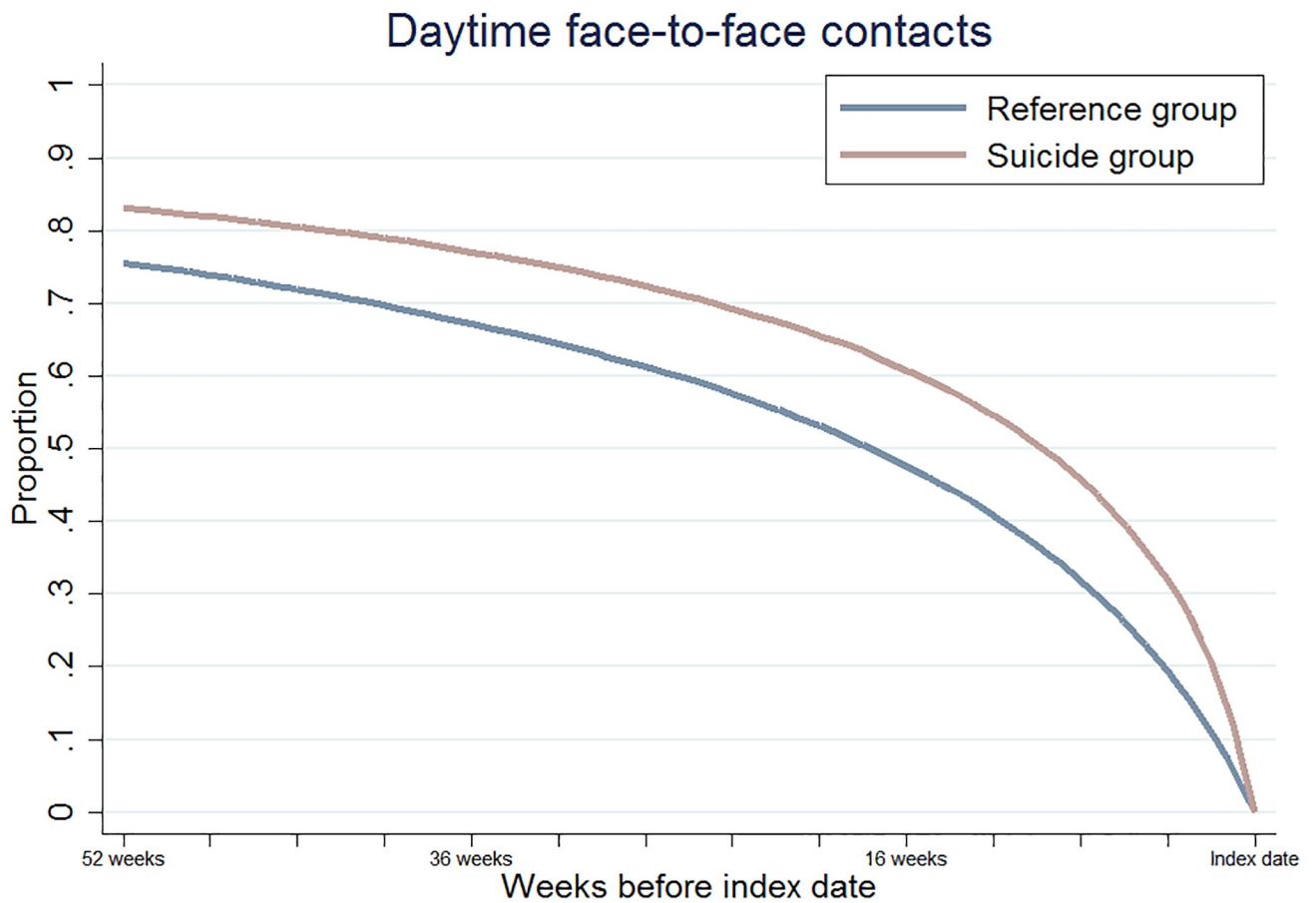


Fig 1. Backwards cumulative proportion of time of last daytime face-to-face contact before index date.

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complete registrations of all suicides in Denmark during a 17-year period with practically no loss to follow-up. Additionally, we also had a matched comparison group. All data used were registered prospectively for administrative purposes, and we thus have no reason to suspect information bias or selection bias.

A limitation of using the NHISR is that we had no information about the reason for encounter with the GP. We only had information on the type of contact, e.g. talk therapy consultations or daytime face-to-face consultations. Another limitation of using the NHISR is that

Table 2. Proportion and proportion difference (PD) for daytime face-to-face contacts in the month before index date.

	Proportion (%) (95% CI)	PD (95% CI)		
		Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>
Reference group	19.4 (19.1; 19.7)	Ref	Ref	Ref
Suicide group	32.0 (31.1; 32.9)	12.6 (11.7; 13.5)	12.5 (11.6; 13.4)	12.0 (11.1; 12.9)

<sup>a</sup>Adjusted for age, sex, and calendar period.

<sup>b</sup>Adjusted for model 1 + socioeconomic status.

<sup>c</sup>Adjusted for model 2 + comorbid somatic diseases.

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**Table 3. Proportion and proportion difference (PD) for daytime face-to-face contacts in the month before index date in subgroups.**

	Reference group	Suicide group	
	Proportion (%) (95% CI)	Proportion (%) (95% CI)	PD (95% CI) <sup>a</sup>
<b>Sex</b>			
Male	17.7 (17.3; 18.1)	30.8 (29.8; 31.8)	12.7 (11.7; 13.8)
Female	23.9 (23.3; 24.6)	35.2 (33.5; 36.9)	10.1 (8.3; 11.8)
<b>Age (years)</b>			
<44	14.3 (13.8; 14.8)	25.7 (24.3; 27.1)	10.9 (9.4; 12.3)
45–61	17.3 (16.7; 17.8)	31.1 (29.6; 32.6)	13.3 (11.8; 14.9)
62–	26.7 (26.1; 27.3)	39.2 (37.6; 40.7)	12.4 (10.7; 14.0)
<b>Year of index date</b>			
1997–2001	17.7 (17.2; 18.3)	30.6 (29.1; 32.1)	12.4 (10.8; 13.9)
2002–2007	20.2 (19.6; 20.8)	32.3 (30.8; 33.8)	11.6 (10.1; 13.2)
2008–2013	20.4 (19.8; 20.9)	33.1 (31.6; 34.6)	11.9 (10.4; 13.5)
<b>Number of comorbid somatic diseases</b>			
0	13.0 (12.7; 13.4)	25.8 (24.7; 27.0)	12.9 (11.7; 14.1)
1	22.8 (22.1; 23.6)	34.0 (32.1; 35.9)	11.5 (9.4; 13.5)
≥2	34.2 (33.3; 35.0)	42.2 (40.5; 44.0)	8.5 (6.5; 10.4)
<b>Educational level (years)</b>			
≤10	21.8 (21.2; 22.3)	33.0 (31.8; 34.3)	11.9 (10.5; 13.1)
11–15	18.2 (17.7; 18.7)	30.7 (29.4; 32.1)	11.8 (10.4; 13.2)
≥16	16.8 (16.1; 17.6)	32.1 (29.6; 34.6)	13.0 (10.5; 15.6)
<b>Cohabitation status</b>			
Single	19.2 (18.7; 19.8)	29.3 (28.1; 30.4)	9.8 (8.6; 11.1)
Recently bereaved	24.1 (19.7; 28.5)	41.2 (34.6; 47.9)	15.9 (8.5; 23.4)
Cohabiting	16.4 (15.5; 17.3)	29.2 (26.3; 32.0)	11.3 (8.3; 14.2)
Married	20.1 (19.6; 20.5)	36.3 (34.8; 37.8)	15.2 (13.7; 16.7)

<sup>a</sup>Mutually adjusted

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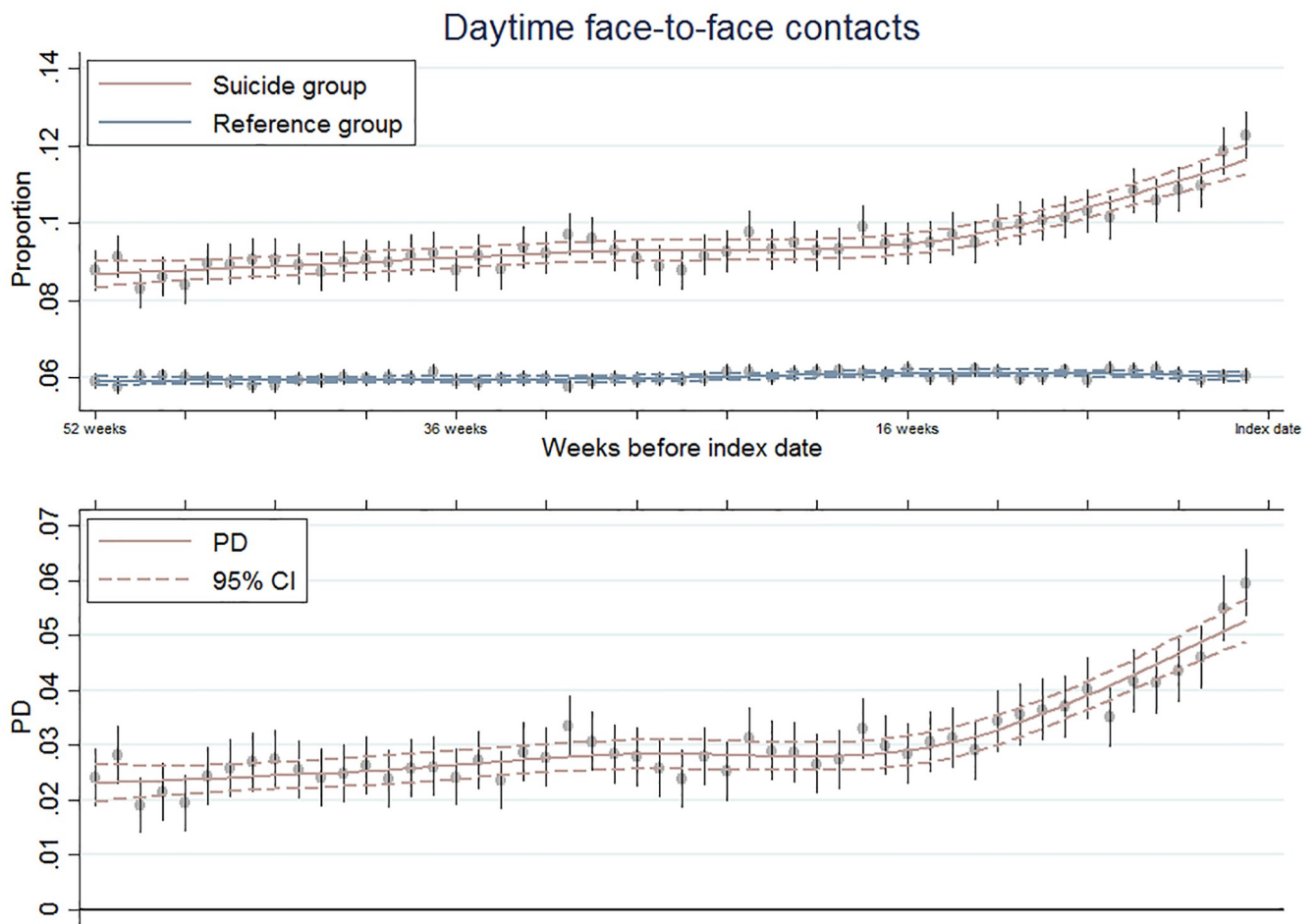
we did not have access to the actual treatment date, but only to the week in which the GP requested remuneration. Given that some GPs chose to request remuneration less frequently than once a week, we opted to test this in a sensitivity analysis. Yet, the results did not change when we excluded persons registered with one of these GPs.

A potential pitfall when analyzing attendance is that one has to be ‘at risk’ of attendance. One might suspect that a higher proportion in the suicide group than in the reference group are hospitalized during the year before index date. However, when we excluded individuals who had been hospitalized at some time point in the year before index date, the results did change a bit towards the null.

### Comparison with other studies

Our findings on the proportion of individuals attending the GP in the year and month before suicide are in line with the findings of previous studies and adds to the body of work. Ahmedani et al. [6] found that 83% had a health care visit in the year before suicide, and Pearson et al. [10] found that 91% attended the GP in the year prior to suicide. The latter study was, however, restricted to include only individuals who had first been in contact with a mental health institute. A Danish register-based study by Andersen et al. showed that a large





**Fig 2. Raw proportion attending the GP and adjusted PD as a function of time.** The PD estimates are adjusted for age, sex, calendar period, socioeconomic status, and comorbid somatic diseases.

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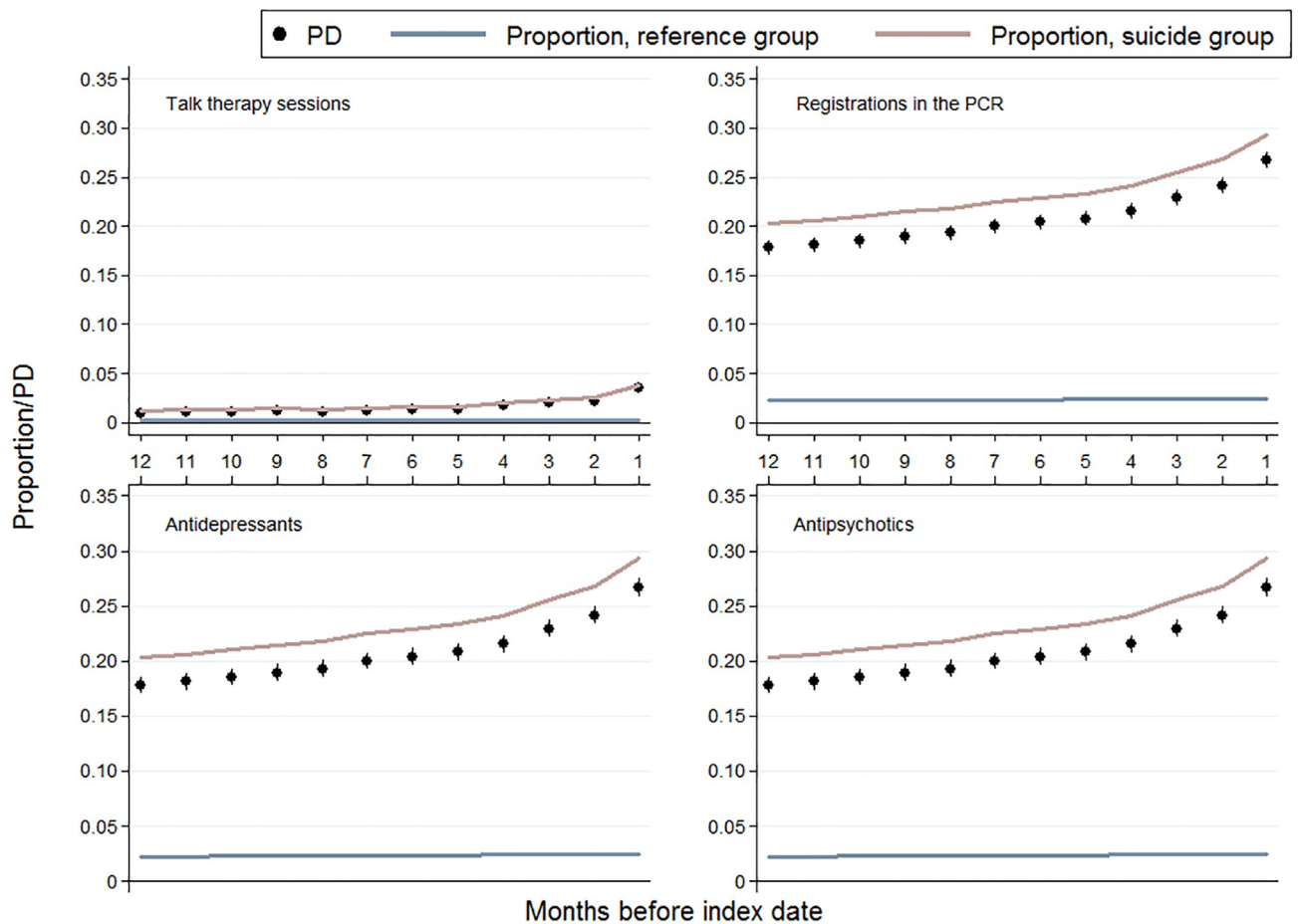
proportion did have contacts to different health care providers in the year prior to suicide. This study was, however, geographically restricted to the county of Funen between 1991 and 1995 [12]. Unlike our study, none of the above mentioned studies included data from the background population. Hochman et al. included a reference group, but they restricted their study to males dying by suicide in the Israeli military. They found that 38.3% attended the GP in the month prior to dying by suicide vs. 33.8% in the control group [8].

### External validity

The results from this nationwide study are likely to be generalizable to other countries with a similar type of population demography and a free-of-charge health care system with the GP acting as gatekeeper to secondary care.

### Implications of findings

Previous studies have provided some support for GP-based suicide interventions [29], particularly with respect to identification of depression. Unützer et al. reported a lower rate of suicidal

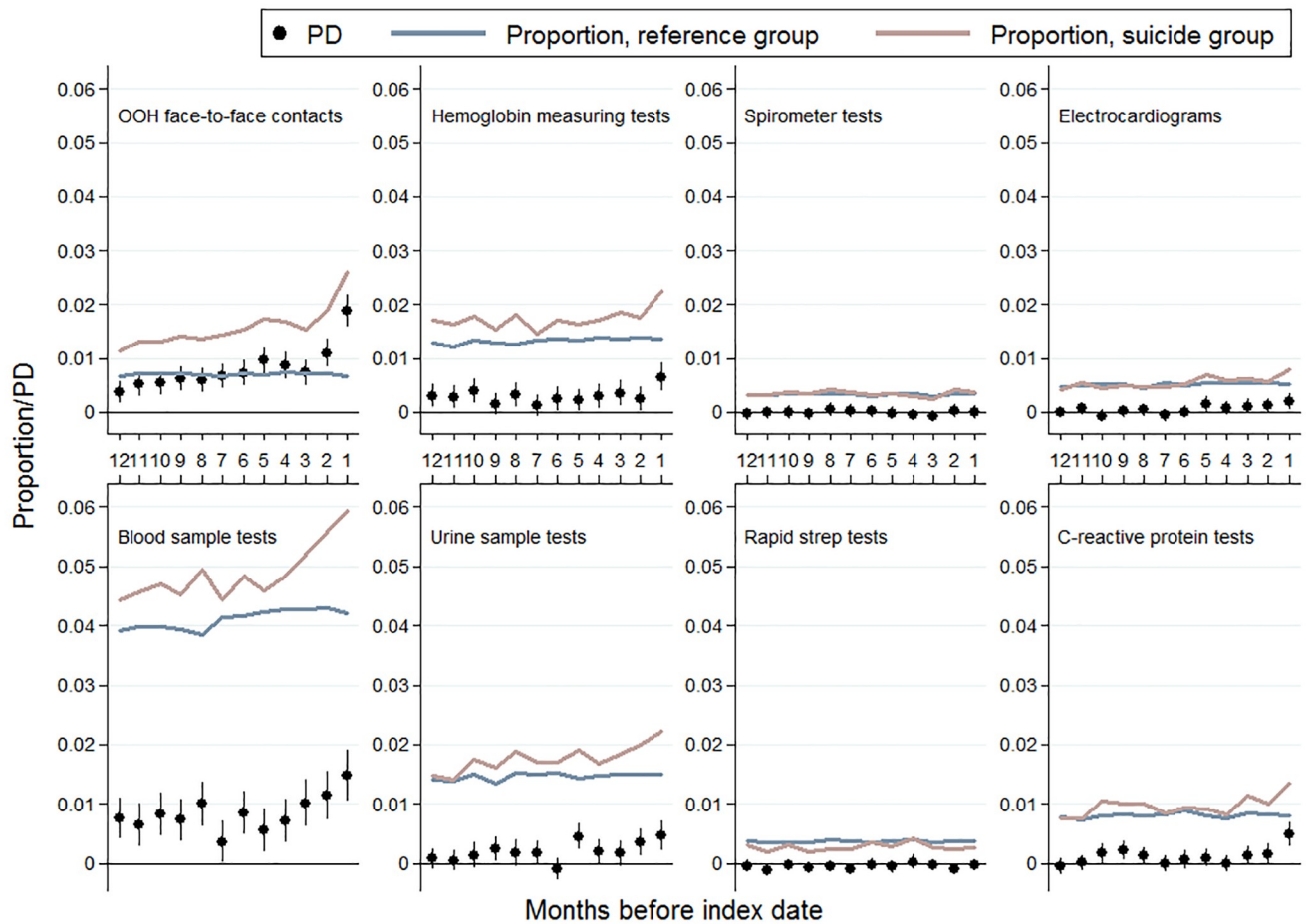


**Fig 3. Talk therapy sessions, registrations in the PCR, and redeemed prescriptions for antidepressants, and antipsychotics stratified on months before suicide.** All PD estimates are adjusted for age, sex, and calendar period.

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ideation among depressed older adults randomized to collaborative care in a primary care setting [30]. A recent meta-analysis by Milner et al. however found no clear statistical evidence of the effectiveness of suicide prevention delivered solely by GPs [31]. On the contrary a recent Danish register based study by Fenger-Grøn et al. found that the group of people who was recently bereaved had a significantly lower risk of e.g. suicide, if they were treated with talk therapy by their GP right after the loss [32]. The review by Milner et al. found conflicting results across the different studies on the effectiveness of GP-interventions for men and women.

Although attending the GP in general is conceived to be a beneficial act, it cannot be excluded that the patient may for example become suicidal after receiving unfavorable health news from their GP. Hence, some bidirectional effects might be assumed. We found that more persons from the suicide group attended the GP during the year before suicide, even after adjusting for socioeconomic characteristics and somatic comorbidity time-dependently, and that an increase in the difference was noted during the last four months; this suggest that the GPs do see people with suicidal ideation. The GPs should be encouraged to ask about suicidal thoughts when these seem to be present. Furthermore, it would be important to ensure



**Fig 4. Out-of-hours face-to-face contacts and different types of contacts and tests taken in general practice stratified on months before suicide.** All PD estimates are adjusted for age, sex, and calendar period.

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that GPs have options for referrals to indicated interventions, such as psychosocial therapy [2,33].

### Conclusion

The findings from this study indicate that the GP potentially could play a role in the identification and intervention of susceptible individuals. Thus, it seems important to ensure that GPs have easy access to effective suicide prevention programs for patients at risk of suicide. However, it is important to note that the differences in GP utilization were small in our study and that only 32 percent of the individuals who died by suicide had seen a GP during the last month before dying. Combined, this evidence supports the notion that GP utilization is not a clinically relevant predictor of suicide in itself. Still, it would be recommendable to encourage persons at risk of suicide to contact the GP when having suicidal thoughts or plans.

### Supporting information

**S1 Appendix.**  
(DOCX)

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## Author Contributions

**Conceptualization:** Henrik Schou Pedersen, Mogens Vestergaard.

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## References

1. WHO | Suicide prevention [Internet]. WHO. World Health Organization; 2017 [cited 2017 Aug 24]. Available from: [http://www.who.int/mental\\_health/suicide-prevention/en/](http://www.who.int/mental_health/suicide-prevention/en/)
2. Erlangsen A, Lind BD, Stuart EA, Qin P, Stenager E, Larsen KJ, et al. Short-term and long-term effects of psychosocial therapy for people after deliberate self-harm: a register-based, nationwide multicentre study using propensity score matching. *The Lancet Psychiatry*. 2015; 2(1):49–58. Available from: <http://www.sciencedirect.com/science/article/pii/S2215036614000832> [https://doi.org/10.1016/S2215-0366\(14\)00083-2](https://doi.org/10.1016/S2215-0366(14)00083-2) PMID: 26359612
3. Zalsman G, Hawton K, Wasserman D, van Heeringen K, Arensman E, Sarchiapone M, et al. Suicide prevention strategies revisited: 10-year systematic review. *The Lancet Psychiatry*. 2016 Jul; 3(7):646–59. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27289303> [https://doi.org/10.1016/S2215-0366\(16\)30030-X](https://doi.org/10.1016/S2215-0366(16)30030-X) PMID: 27289303
4. Mann JJ, Apter A, Bertolote J, Beautrais A, Currier D, Haas A, et al. Suicide Prevention Strategies. *JAMA*. 2005 Oct 26; 294(16):2064. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/16249421> <https://doi.org/10.1001/jama.294.16.2064> PMID: 16249421
5. Sahl Andersen J, De Fine Olivarius N, Krasnik A. The Danish National Health Service Register. *Scand J Public Health*. 2011 Jul 1; 39(7 Suppl):34–7. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21775348> <https://doi.org/10.1177/1403494810394718> PMID: 21775348
6. Ahmedani BK, Simon GE, Stewart C, Beck A, Waitzfelder BE, Rossom R, et al. Health care contacts in the year before suicide death. *J Gen Intern Med*. 2014 Jun 25; 29(6):870–7. Available from: <https://doi.org/10.1007/s11606-014-2767-3> PMID: 24567199
7. O'Neill S, Corry C V, Murphy S, Brady S, Bunting BP. Characteristics of deaths by suicide in Northern Ireland from 2005 to 2011 and use of health services prior to death. *J Affect Disord*. 2014 Oct; 168:466–71. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0165032714004662> <https://doi.org/10.1016/j.jad.2014.07.028> PMID: 25113960
8. Hochman E, Shelef L, Mann JJ, Portugese S, Krivoy A, Shoval G, et al. Primary health care utilization prior to suicide: a retrospective case-control study among active-duty military personnel. *J Clin Psychiatry*. 2014 Aug 26; 75(8):e817–23. Available from: <http://www.psychiatrist.com/JCP/article/Pages/2014/v75n08/v75n0806.aspx> <https://doi.org/10.4088/JCP.13m08823> PMID: 25191919
9. Leavey G, Rosato M, Galway K, Hughes L, Mallon S, Rondon J. Patterns and predictors of help-seeking contacts with health services and general practitioner detection of suicidality prior to suicide: a cohort analysis of suicides occurring over a two-year period. *BMC Psychiatry*. 2016 Apr 30; 16(1):120. Available from: <http://bmcp psychiatry.biomedcentral.com/articles/10.1186/s12888-016-0824-7>
10. Pearson A, Saini P, Da Cruz D, Miles C, While D, Swinson N, et al. Primary care contact prior to suicide in individuals with mental illness. *Br J Gen Pract*. 2009 Nov 1; 59(568):825–32. Available from: <https://doi.org/10.3399/bjgp09X472881> PMID: 19861027

11. Stark CR, Vaughan S, Huc S, O'Neill N. Service contacts prior to death in people dying by suicide in the Scottish Highlands. *Rural Remote Health*. 2012; 12:1876. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22856505> PMID: 22856505
12. Andersen UA, Andersen M, Rosholm JU, Gram LF. Contacts to the health care system prior to suicide: a comprehensive analysis using registers for general and psychiatric hospital admissions, contacts to general practitioners and practising specialists and drug prescriptions. *Acta Psychiatr Scand*. 2000 Aug; 102(2):126–34. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/10937785> PMID: 10937785
13. Power K, Davies C, Swanson V, Gordon D, Carter H. Case-control study of GP attendance rates by suicide cases with or without a psychiatric history. *Br J Gen Pract*. 1997 Apr; 47(417):211–5. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9196962> PMID: 9196962
14. Power K, Davies C, Swanson V, Gordon D, Carter H. Case-control study of GP attendance rates by suicide cases with or without a psychiatric history. *Br J Gen Pract*. 1997 Apr; 47(417):211–5. PMID: 9196962
15. Erlangsen A, Fedyszyn I. Danish nationwide registers for public health and health-related research. *Scand J Public Health*. 2015 Jun 10; 43(4):333–9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25759376> <https://doi.org/10.1177/1403494815575193> PMID: 25759376
16. Hawton K, van Heeringen K. Suicide. *Lancet*. 2009 Apr 18; 373(9672):1372–81. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/19376453> [https://doi.org/10.1016/S0140-6736\(09\)60372-X](https://doi.org/10.1016/S0140-6736(09)60372-X) PMID: 19376453
17. Helweg-Larsen K. The Danish Register of Causes of Death. *Scand J Public Health*. 2011 Jul 1; 39(7 Suppl):26–9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21775346> <https://doi.org/10.1177/1403494811399958> PMID: 21775346
18. Schmidt M, Pedersen L, Sørensen HT. The Danish Civil Registration System as a tool in epidemiology. *Eur J Epidemiol*. 2014 Aug 26; 29(8):541–9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24965263> <https://doi.org/10.1007/s10654-014-9930-3> PMID: 24965263
19. Wallach Kildemoes H, Toft Sorensen H, Hallas J. The Danish National Prescription Registry. *Scand J Public Health*. 2011 Jul 1; 39(7 Suppl):38–41. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21775349> <https://doi.org/10.1177/1403494810394717> PMID: 21775349
20. Mors O, Perto GP, Mortensen PB. The Danish Psychiatric Central Research Register. *Scand J Public Health*. 2011 Jul 20; 39(7\_suppl):54–7. Available from: <https://doi.org/10.1177/1403494810395825> PMID: 21775352
21. Prior A, Fenger-Grøn M, Larsen KK, Larsen FB, Robinson KM, Nielsen MG, et al. The Association Between Perceived Stress and Mortality Among People With Multimorbidity: A Prospective Population-Based Cohort Study. *Am J Epidemiol*. 2016 Aug 1; 184(3):199–210. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27407085> <https://doi.org/10.1093/aje/kwv324> PMID: 27407085
22. Schmidt M, Schmidt SAJ, Sandegaard JL, Ehrenstein V, Pedersen L, Sørensen HT. The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol*. 2015; 7:449–90. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/26604824> <https://doi.org/10.2147/CLEP.S91125> PMID: 26604824
23. Gjerstorff ML. The Danish Cancer Registry. *Scand J Public Health*. 2011 Jul 20; 39(7 Suppl):42–5. Available from: <https://doi.org/10.1177/1403494810393562> PMID: 21775350
24. Carstensen B, Kristensen JK, Marcussen MM, Borch-Johnsen K. The National Diabetes Register. *Scand J Public Health*. 2011 Jul 20; 39(7\_suppl):58–61. Available from: <https://doi.org/10.1177/1403494811404278> PMID: 21775353
25. Jensen VM, Rasmussen AW. Danish education registers. *Scand J Public Health*. 2011 Jul 1; 39(7 Suppl):91–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21775362> <https://doi.org/10.1177/1403494810394715> PMID: 21775362
26. Williams RL. A note on robust variance estimation for cluster-correlated data. *Biometrics*. 2000 Jun; 56(2):645–6. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/10877330> PMID: 10877330
27. Harrell FE. *Regression Modeling Strategies*. New York, NY: Springer New York; 2001. (Springer Series in Statistics).
28. Kjaersgaard MIS, Vedsted P, Parner ET, Bech BH, Vestergaard M, Flarup KR, et al. Algorithm linking patients and general practices in Denmark using the Danish National Health Service Register. *Clin Epidemiol*. 2016 Aug; 8:273–83. Available from: <https://www.dovepress.com/algorithm-linking-patients-and-general-practices-in-denmark-using-the-peer-reviewed-article-CLEP> <https://doi.org/10.2147/CLEP.S108307> PMID: 27563255
29. Schulberg HC, Bruce ML, Lee PW, Williams JW, Dietrich AJ. Preventing suicide in primary care patients: the primary care physician's role. *Gen Hosp Psychiatry*. 2004 Sep 1; 26(5):337–45. Available from: <https://www.sciencedirect.com/science/article/pii/S016383430400088X#bib6> <https://doi.org/10.1016/j.genhosppsy.2004.06.007> PMID: 15474633

30. Unützer J, Tang L, Oishi S, Katon W, Williams JW, Hunkeler E, et al. Reducing Suicidal Ideation in Depressed Older Primary Care Patients. *J Am Geriatr Soc*. 2006 Oct; 54(10):1550–6. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17038073> <https://doi.org/10.1111/j.1532-5415.2006.00882.x> PMID: 17038073
31. Milner A, Witt K, Pirkis J, Hetrick S, Robinson J, Currier D, et al. The effectiveness of suicide prevention delivered by GPs: A systematic review and meta-analysis. *J Affect Disord*. 2017 Mar; 210:294–302. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0165032716318067> <https://doi.org/10.1016/j.jad.2016.12.035> PMID: 28068618
32. Fenger-Grøn M, Kjaersgaard MIS, Parner ET, Guldin M-B, Vedsted P, Vestergaard M. Early treatment with talk therapy or antidepressants in severely bereaved people and risk of suicidal behavior and psychiatric illness: an instrumental variable analysis. *Clin Epidemiol*. 2018 Aug 24; Volume 10:1013–26. Available from: <https://www.dovepress.com/early-treatment-with-talk-therapy-or-antidepressants-in-severely-berea-peer-reviewed-article-CLEP> <https://doi.org/10.2147/CLEP.S157996> PMID: 30197539
33. Hawton K, Witt KG, Taylor Salisbury TL, Arensman E, Gunnell D, Hazell P, et al. Psychosocial interventions for self-harm in adults. *Cochrane Database Syst Rev*. 2016 May 12; Available from: <http://doi.wiley.com/10.1002/14651858.CD012189>