

The association between premorbid cognitive ability and social functioning and suicide among young men: a historical-prospective cohort study

Running title: Risk Factors for Completed Suicide

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Abstract

Previous studies have found associations between low cognitive ability and later completed suicide. The aim of this study was to examine the association between cognitive ability and social functioning in adolescence, and later completed suicide in a large population-based longitudinal study. Data from the Israeli Draft Board Register for 634,655 Israeli male adolescents aged 16-17 was linked to a causes-of-death data registry, with a mean follow-up of 10.6 years for completed suicide. Our results show that in males without a psychiatric diagnosis, both low (adjusted HR=1.51, 95% CI: 1.19-1.92) and high (adjusted HR=1.36, 95% CI: 1.04-1.77) cognitive ability, and very poor (adjusted HR=2.30, 95% CI: 1.34-3.95) and poor (adjusted HR=1.64, 95% CI: 1.34-2.07) social functioning were associated with increased risk for later completed suicide; however positive predictive values were low (PPVs= 0.09% and 0.10%, for low cognitive ability and very poor or poor social functioning, respectively). No association between cognitive ability or social functioning and risk for suicide was found in males with a psychiatric diagnosis. These data do not support the clinical utility of screening for such potential predictors.

1. Introduction

Suicide is the third most common cause of death among adolescents and young adults in Western countries (Haas et al., 2010; Pompili et al., 2010), and is complex outcome of multiple, inter-related genetic and environmental factors (Mann, 2002; Moscicki, 1997). This highlights the importance of attempting to characterize adolescent who later died by suicide. Adolescents at high risk for suicide might then be the focus for interventions aimed to decrease risk.

Studies on the relationship between pre-morbid intelligence and risk for completed suicide have demonstrated both higher (Gunnell et al., 2005; Osler et al., 2008; Sörberg et al., 2013) and lower intelligence (Apter et al., 2008; Voracek, 2013) associated with later suicide. Previous research has emphasized the importance of social aspects in understanding suicidal behavior of adolescents, however most work in this context examined suicide attempts or suicidal ideation and not completed suicides (King and Merchant, 2008). Studies assessing the role of social factors in completed suicides are sparse, and were all retrospective, relying on psychological autopsies (Manoranjitham et al., 2010; Zhang et al., 2010) or did not include a control group (Heikkinen et al., 1995). To date, there has not been a large prospective, longitudinal study of the association between social functioning and completed suicide in a general population sample. Since suicide is a rare event, our inquiry of risk factors for suicide needs large samples, in order to include a significant number of suicides, and therefore it is of extreme importance to utilize large population-based cohorts when possible.

The Israeli military routinely screens all Jewish male adolescents in the population, as part of their assessment for eligibility to serve. Using a historical-prospective method, we utilized those data on almost 1 million Israeli male adolescents, and followed them

(mean follow up of 10 years) for suicide using the national registry of causes of death. As far as we know, this is the first large study to use truly prospective data to examine the association between social functioning and completed suicide.

2. Experimental Procedures

Study population

Baseline data was available for 988,847 Israeli male adolescents who were consecutively screened by the Israeli Draft Board. After the exclusion of 351,986 adolescents with missing data on cognitive (n=96,219), social functioning (n=195,253) or SES measures

(n=170,427), and the exclusion of 4455 adolescents who had died for reasons other than suicide, the final sample included 634,655 conscripts with complete data (some conscripts had missing data and died for reasons other than suicide). The mean age of the final sample at the draft boards was 16.97 (SD=0.52). Over a mean follow-up time of 10.6 years (SD=5.9 years), 482 (0.1%) of the 634,655 were identified in the Central Bureau of Statistics as having died by definite suicide and 113 (0.02%) died of undetermined causes of death. As suicide is strongly associated with mental disorders (Bolton et al., 2015), we stratified the analyses in this study according to the presence or absence of psychiatric illness at the draft board assessment.

Assessment of Cognitive ability

All 16 to 17 year old Israeli males undergo cognitive, behavioural, medical and psychiatric assessments by the Draft Board in order to determine their eligibility and aptitude for military service. The cognitive assessment has four sub-tests: (a) Arithmetic - R, which assesses cognitive reasoning, concentration, and concept manipulation. This sub-test is similar to the 'arithmetic' sub-test from the Wechsler Intelligence Scales. (b) Similarities - R, which assesses verbal abstraction and categorization (i.e. the ability to understand the relationship between words and the use of this relationship in several contexts). This test is a revised version of the 'similarities' sub-test from the Wechsler Intelligence Scale. Unlike the Wechsler test, subjects are requested not only to identify and report the semantics of causal relationships between the test items, but also to apply these relations to target items; (c) A spatial analogies test, which measures non-verbal abstract reasoning and problem-solving abilities. This test is also a multiple-choice test; (d) OTIS - R, a modified, Otis-type verbal intelligence test adapted from the US Army Alpha Instructions Test, which measures the ability to understand and carry out verbal instructions (Lezak, 1995). All the subtests are progressive, beginning with relatively

simple items and becoming more difficult, are group-administered and time-limited. The sum of the four scores is a validated measure of IQ, scoring on a nine-point scale between 10 (low) and 90 (high), with a 10-point increment at each score. The 95th percentile of the total cognitive score was equivalent to an IQ above 135, and its correlation with the WAIS total IQ was above 0.90 (Gal, 1986).

Assessment of social functioning

After the cognitive assessment male conscripts are assessed by trained personnel using a semi-structured interview to assess personality and behavioural traits that might affect their suitability for military service (Gal, 1986). This assessment includes a subscale assessing social functioning, including of social abilities and desire for interpersonal closeness. Social functioning is then scored on a scale of 1-5: 1) Very poor: complete withdrawal, 2) Poor: weak interpersonal contacts, 3) Adequate: can form relationships with individuals and in a group, 4) Good: good interpersonal relationships and 5) Exceptional: superior interpersonal relatedness. The test-retest reliability of the behavioural assessment for inductees interviewed after several days by different interviewers is above 0.8, and population-based norms are available (Gal, 1986; Reeb, 1968).

Other variables

Socio-economic status (SES) was derived from census data, based on the number of persons/room in the home, number of computers per household, number of motor vehicles per household, and per capita income level (Weiser et al., 2007b). This measure ranges between 1 (low) and 20 (high), where the mean SES of the final sample was 11.64 (SD=4.11).

Immigration status was determined according to country of birth (born in Israel vs. born in any other country). Sixteen percent of the final sample were not born in Israel.

Psychiatric assessment

Based on this interview and a physician's examination, adolescents suspected of any behavioral or mental disorders are referred to an in-depth clinical interview. In this clinical assessment, the recruit is examined by a clinical social worker or psychologist, who inquires about personal and family history, previous psychological and psychiatric treatments, interpersonal relationships, self-esteem, self-injurious and anti-social acts, and functioning within the family and in school. If the clinician suspects that the adolescent has a psychiatric disorder, the adolescent is then referred for evaluation by a board-certified psychiatrist who assigns a psychiatric diagnosis based on ICD criteria when warranted. In the final sample examined in this study, 29,998 (4.7%) were assigned a psychiatric diagnosis by the Draft Board psychiatrist.

Ascertainment of suicide

In Israel, following every death, a physician must make a determination of death and the presumed antecedent causes. The Central Bureau of Statistics receives these reports and encodes the causes of death, including suicide, using standard ICD criteria (Weiser et al., 2016). We analysed both definite cases of suicide (deaths which were officially classified as suicide/intentional self-harm; ICD9 E950-959; ICD10 X60-84) and performed an additional analysis of more broadly defined suicide that included deaths which were officially classified as suicide/intentional self-harm (ICD9 E950-959; ICD10 X60-84) **and** also deaths 'undetermined whether accidentally or purposely inflicted' (ICD9 E980-989; ICD10 Y10-34) because of doubts about the sensitivity of suicide statistics.

Statistical analyses

Conscripts with mental illness and those without mental illness were analysed separately using Cox regression. Survivors were censored on the last day of follow-up, (the date when the Draft Board data were merged with the Death Registry). Cognitive

ability was categorized into three groups: 1 SD or more below population mean (low), within 1 SD of population mean (average), and 1 SD or more above population mean (high). Social function was coded as very poor, poor, adequate, good and exceptional. Cognitive ability and social function were entered into a Cox regression model with and without the controlling variables of SES and immigration status. For both cognitive ability and social functioning, the intermediate groups, average cognitive ability and adequate social functioning were used as the reference category. Analysis comparing means of cognitive ability, social functioning and SES among those with missing data and those compiling the final sample was performed using independent samples t-test and Cohen's d effect size (ES).

Analyses were performed using SPSS 21.0.

3. Results

Of the 604,657 without psychiatric disorders, 427 (0.07%) died by suicide, while 55/29,998 (0.18%) of those with any psychiatric disorder died by suicide ($\chi^2(1)= 47.86$, $p<0.001$), confirming the association between mental illness and suicide in this cohort. The association between mental illness and definite suicide persisted after adjustment for SES and immigration (HR=2.22, 95% CI=1.71-2.87).

Among mentally healthy males, those with low or high cognitive ability were at increased risk for completed suicide compared to those with average cognitive ability. This association persisted after adjusting for SES and immigration (HR=1.51, 95% CI: 1.19-1.92 and HR=1.36, 95% CI: 1.04-1.77, respectively) (Table 1). Very poor or poor social functioning was associated with increased risk for completed suicide compared to adequate social functioning after adjusting for SES and immigration (HR=2.30, 95% CI: 1.34-3.95 and HR=1.64, 95% CI: 1.30-2.07, respectively) (Table 2). No additive effect was found when examining the risk for suicide among adolescents with both very poor or poor social functioning and low cognitive ability (HR=1.87, 95% CI=0.77-4.53), compared to those with very poor or poor social functioning and normal or high cognitive ability. The positive predictive values (PPVs) of low cognitive ability and very poor or poor social functioning were very low (0.09% and 0.10%, respectively). In males with a psychiatric diagnosis, no associations were found between cognitive or social functioning and risk for suicide (Tables 1, 2).

Missing analysis

Over the same period, 639 (0.2%) of the 351,986 who were excluded from further analysis because of missing data, also completed suicide. Those with missing data on cognitive ability had lower social functioning mean ($p<0.01$, ES=0.19) and came from lower mean SES ($p<0.01$, ES=0.43), compared to those with full data. The same pattern

was found among those with missing data on social functioning, with lower mean cognitive ability ($p < 0.01$, $ES = 0.26$) and lower mean SES ($p < 0.01$, $ES = 0.53$), compared to those with full data.

4. Discussion

The findings of this study suggest that although high and low cognitive ability and poor social functioning are associated with statistically increased risk for suicide in mentally healthy males, the positive predictive values of these characteristics are very low. Thus, although these factors may be relevant to the challenge of determining suicidal potential, this study does not support their current clinical significance as predictors.

The U-shape relationship we found between cognitive ability and suicide supports and better explains presumed "inconsistencies" in previous studies where both low (Gunnell et al., 2005; O'Toole and Cantor, 1995; Osler et al., 2008; Sörberg et al., 2013) and high (Gunnell et al., 2005; Osler et al., 2008; Sörberg et al., 2013) intelligence were associated with risk of suicide. Other authors (deCatanzaro and Lykken, 1981; Voracek, 2006) suggested that because there may be a minimum intelligence needed to commit suicide, there will be a positive correlation between IQ and suicide. On the other hand, others interpret the association between low IQ and risk for suicide as reflecting neurodevelopmental problems or the lack of appropriate problem-solving and coping skills in situations with emotional distress (Gunnell et al., 2005; Osler et al., 2008;

Sörberg et al., 2013). However, these investigators did not report the positive predictive value of their findings.

Poor social functioning in young males also increased the risk for completed suicide. According to the interpersonal-psychological theory of suicide (Joiner, 2005), both perceived burdensomeness and the feeling of alienation from social circles are associated with suicidality. The feeling of social alienation could be the precursor, as well as the result, of impaired social functioning. Previous studies reported that having low levels of social support (Zhang et al., 2010) or living by oneself and the ending of a steady relationship within the past year (Manoranjitham et al., 2010), were associated with increased risk of completed suicide. Problematic relationships with parents, peers and in school (Kidd et al., 2006) and poor social competence (King et al., 2001) were found to be associated with suicide attempts. Both social integration and social isolation are pertinent constructs in adolescent suicidal ideation and suicide attempts (King and Merchant, 2008). Although these social variables are not identical to the one assessed in this study, interpersonal difficulties, poor social support, poor social skills and poor social functioning are all intertwined, affecting relationships with others and sense of belonging.

Although cognitive ability and social functioning were significantly associated with completed suicide, the low HRs and low PPVs suggest these premorbid factors alone are not clinically relevant in the prediction of suicide.

We found an increased risk for suicide among young males with a psychiatric diagnosis, but no association was found between intelligence or social functioning and later risk for suicide in this group. Identical to these findings, Osler et al. (Osler et al., 2008) found that males with low IQ at age 18 were at increased risk for later suicide; when the authors controlled for mental illness at age 18, this association was not statistically

significant, suggesting a mediating effect of a psychiatric diagnosis on intelligence and suicide risk. Another study, in psychiatric inpatients found no difference in IQ between those who died by suicide and those who did not make a suicide attempt (Park et al., 2015). The mediating effect of a psychiatric diagnosis on social functioning has also been demonstrated in suicidal behavior, showing that social competence was not significant in predicting suicide attempts or suicidal ideation after controlling for the presence of mood, anxiety or disruptive disorder (King et al., 2001).

Our findings suggest that in people with a psychiatric diagnosis, poor cognitive and social functioning do not increase risk for completed suicide. Psychiatric disorder confers a great, if not the greatest risk for suicidal behavior (Beautrais, 2000; Bolton et al., 2015; Mortensen et al., 2000). As intelligence is associated with increased risk for current or future psychiatric disorder disorders (Mortensen et al., 2005; Rajput et al., 2011; Reichenberg et al., 2006; Weiser et al., 2007a) and impairments in social functioning are core features of most psychiatric disorders (APA, 2013), in most cases, impairments in cognitive and social functioning are apparently incorporated into the factors that warranted the psychiatric diagnosis to begin with.

This study uses data collected from adolescent men being inducted into the military; thus, lower functioning adolescents considered not fit to be drafted, including those with very severe psychiatric disorders, are not included in these data. However, these excluded adolescents have lower scores on the cognitive and social tests administered by the draft board (data not shown), and higher risk of suicide (Westermeyer et al., 1991); hence their exclusion probably leads to an underestimation of the association between cognitive and social abilities and later suicide. In addition, since the information we have on the subjects was collected at ages 16-17, we only know of cognition, social functioning and psychiatric illness recorded during this period. It is

probable that some of these individuals were later diagnosed with mental illness, which we could not control for. Moreover, although the cognitive measure used in this study is considered highly reliable, with high correlation to the WAIS total IQ score, this measure might have not captured all aspects of cognitive functioning. While it is possible some conscripts intentionally perform worse on the cognitive ability test, we believe this will be a minority of conscripts, as low cognitive ability (that is not mental retardation) does not preclude one from military service, but can affect the military job placement. Moreover, we do not believe the decision to intentionally under-perform on these tests relates to a person's likelihood to die by suicide". The psychiatric diagnoses in this study are limited by them being based on clinical interviews, rather than based on research tools (e.g., SCID). The small numbers in some of the cells examining social functioning in those with a psychiatric disorder and the rarity of completed suicides also limits these data.

Analysis of those with missing data who were not included in the final sample, showed they had significantly lower means of cognitive ability, social functioning and SES. Nonetheless, due to the large groups, these comparisons were statistically significant, however with very small effect sizes for cognitive ability and social functioning. This further supports our results showing an association between poor cognitive ability and low cognitive ability and risk for later suicide. The group of subjects with missing data, also came from lower SES, however because our analyses were controlled for SES, we do not believe this affected our results.

Lastly, this study examined only males, as assessment of social functioning is only consistently performed in male conscripts, and therefore we cannot report on the effects of cognitive and social functioning and risk for completed suicide in females.

In summary, in this large longitudinal study assessing cognitive and social functioning and risk for completed suicide, both low and high IQ and poor social functioning at age 17 were associated with increased risk for suicide in mentally healthy males. Given the low odds ratios and PPVs, the data do not support the clinical importance of premorbid cognitive and social abilities as forerunners for later completed suicide.

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Contributors: Study concept and design- MW, AR, MD, GL

Data acquisition-EF, GL

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Interpretation of the data- MW, DF, NW, SG, AR, ML, MD

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Table 1. Association between cognitive ability and risk for suicide – stratified by psychiatric illness

Cognitive ability	Mentally healthy conscripts (n=604,657)				Mentally ill conscripts (n=29,998)			
	Definite suicide			Definite suicide + undetermined deaths	Definite suicide			Definite suicide + undetermined deaths
	N (%) who died by definite suicide	HR (95% CI)	Adjusted* HR (95% CI)	Adjusted* HR (95% CI)	N (%) who died by definite suicide	HR (95% CI)	Adjusted* HR (95% CI)	Adjusted* HR (95% CI)
Low	97 (0.1%)	1.55 (1.23-1.96)**	1.51 (1.19-1.92)**	1.51 (1.22-1.87) **	22 (0.2%)	1.03 (0.59 - 1.79)	1.12 (0.63-2.00)	1.05 (0.62-1.78)
Average	256 (0.1%)	1	1	1	29 (0.2%)	1	1	1
High	74 (0.1%)	1.33 (1.03-1.72) **	1.36 (1.04-1.77) **	1.27 (0.96-1.61)	4 (0.2%)	1.46 (0.51 - 4.15)	1.28 (0.44-3.70)	1.09 (0.38-3.10)

*Adjusted for SES and immigration

** Significant at p<0.05 level.

Table 2. Association between social functioning and risk for suicide– stratified by psychiatric illness

Social functioning	Mentally healthy conscripts (n=604,657)				Mentally ill conscripts (n=29,998)			
	Definite suicides			Definite suicides + undetermined deaths	Definite suicides			Definite suicides + undetermined deaths
	N (%) who died by definite suicide	HR (95% CI)	Adjusted* HR (95% CI)	Adjusted* HR (95% CI)	N (%) who died by definite suicide	HR (95% CI)	Adjusted* HR (95% CI)	Adjusted* HR (95% CI)
Very poor	14 (0.1%)	2.39 (1.39-4.10) **	2.30 (1.34-3.95) **	2.23 (1.37-3.65) **	3 (0.1%)	0.36 (0.11-1.19)	0.34 (0.10-1.14)	0.51 (0.20-1.32)
Poor	106 (0.1%)	1.68 (1.33-2.11) **	1.64 (1.30-2.07) **	1.63 (1.32-2.01) **	25 (0.2%)	0.95 (0.54-1.67)	0.92 (0.52-1.66)	0.95 (0.56-1.62)
Adequate	223 (0.1%)	1	1	1	23 (0.2%)	1	1	1
Good	77 (0.1%)	1.08 (0.83-1.40)	1.09 (0.84-1.42)	1.13 (0.90-1.42)	3 (0.1%)	0.56 (0.17-1.87)	0.57 (0.17-1.89)	0.50 (0.15-1.65)
Exceptional	7 (0.1%)	1.24 (0.58-2.63)	1.26 (0.59-2.67)	1.46 (0.77-2.74)	1 (0.3%)	1.83 (0.25-13.58)	1.81 (0.24-13.41)	1.60 (0.22-11.78)

*Adjusted for SES and immigration

** Significant at p<0.05 level.