

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email editorial.bmjopen@bmj.com

BMJ Open

The correlation of impulsivity with self-harm and suicide attempt: an online study of adolescents in Taiwan

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-017949
Article Type:	Research
Date Submitted by the Author:	30-May-2017
Complete List of Authors:	Huang, Yu-Hsin; MacKay Medical College, Department of Medicine; MacKay Memorial Hospital, Department of Psychiatry Liu, Hui-Ching; MacKay Memorial Hospital, Department of Psychiatry; MacKay Memorial Hospital, Suicide Prevention Centre Tsai, Fang-Ju ; En Chu Kong Hospital, Department of Psychiatry; College of Medicine, National Taiwan University, Department of Psychiatry Sun, Fang-Ju; MacKay Junior College of Medicine, Nursing, and Management; MacKay Memorial Hospital, Department of Medical Research Huang, Kuo-Yang; Taiwan Adventist Hospital, Department of Psychiatry Chiu, Yu-Ching; Cardinal Tien Hospital, Department of Psychiatry Huang, Yen-Hsun; Taipei City Psychiatric Center, Department of Psychiatry Huang, Yo-Ping; National Taipei University of Technology, Department of Electrical Engineering Liu, Shen-Ing; MacKay Medical College, Department of Medicine; MacKay Memorial Hospital, Department of Psychiatry
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, Paediatrics, Public health, Smoking and tobacco
Keywords:	adolescence, deliberate self-harm, impulsivity, suicide, suicidal ideation, substance use disorders

SCHOLARONE™
Manuscripts

1
2
3
4 **Title Page**

5
6 **Manuscript category:** research article
7
8
9

10
11 The correlation of impulsivity with self-harm and suicide attempt: an online study of adolescents in
12
13
14 Taiwan

15
16 Yu-Hsin Huang,^{1,2,3,4} Hui-Ching Liu,^{2,3,4} Fang-Ju Tsai,^{5,6,7} Fang-Ju Sun,^{4,8} Kuo-Yang Huang,⁹

17
18
19 Yu-Ching Chiu,¹⁰ Yen-Hsun Huang,¹¹ Yo-Ping Huang,¹² Shen-Ing Liu,^{1,2,3,4,8}
20
21
22
23
24

25
26 ¹Department of Medicine, MacKay Medical College, New Taipei City, Taiwan
27

28
29 ²Department of Psychiatry, MacKay Memorial Hospital, Taipei, Taiwan
30

31
32 ³Suicide Prevention Center, MacKay Memorial Hospital, Taipei, Taiwan
33

34
35 ⁴MacKay Junior College of Medicine, Nursing, and Management, Taipei, Taiwan
36

37
38 ⁵Department of Psychiatry, En Chu Kong Hospital, New Taipei City, Taiwan
39

40
41 ⁶Department of Psychiatry, College of Medicine, National Taiwan University, Taipei, Taiwan
42

43
44 ⁷Department of Psychiatry, National Taiwan University Hospital, Taipei, Taiwan
45

46
47 ⁸Department of Medical Research, MacKay Memorial Hospital, Taipei, Taiwan
48

49
50 ⁹Department of Psychiatry, Taiwan Adventist Hospital, Taipei, Taiwan
51

52
53 ¹⁰Department of Psychiatry, Cardinal Tien Hospital, New Taipei City, Taiwan
54

55
56 ¹¹Department of Psychiatry, Taipei City Psychiatric Center, Taipei City Hospital, Taipei, Taiwan
57

58
59 ¹²Department of Electrical Engineering, National Taipei University of Technology, Taipei, Taiwan
60

1
2
3
4
5
6
7 **Corresponding author**
8

9
10 Shen-Ing Liu, M.D., Ph.D., Department of Psychiatry, MacKay Memorial Hospital, No. 92, Section
11
12 2, Chung-Shan North Rd, Taipei, Taiwan. Telephone number: 886-2-25433535-3685; Fax number:
13
14 886-2-28098746; E-mail: maryliuyip@gmail.com
15
16

17
18
19
20
21 Word Count : 4,241
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

The correlation of impulsivity with self-harm and suicide attempt: an online study of adolescents in Taiwan

ABSTRACT

Objectives: The aim of this study was to investigate differences and similarities in risk factors for deliberate self-harm (DSH) and suicide attempt (SA), and the role of impulsivity among a group of community adolescents.

Setting: This is a cross-sectional study conducted at high schools in northern Taiwan.

Data and participants: We recruited grade 1 students from 14 high schools.

Outcome measures: Participants completed online questionnaires about sociodemographic data, suicidality, depressed mood, self-esteem, social support, family discord, impulsivity (Barratt Impulsiveness Scale Version 11 [BIS-11]), and the use of alcohol, tobacco and illicit drugs. A subsample was interviewed about lifetime SA, and the results were compared to those from the online questionnaires.

Results: A total of 5,879 participants (mean age 16.02 years, female: 57.7%) completed the online assessment, of whom 25% had lifetime DSH and 3.5% had lifetime SA. Two hundred and seventy-two students received face-to-face interviews. The agreement between the online questionnaires and interviews was moderate (concordance rate 82.76%; kappa value 0.59). Similar risk factors for DSH/SA among the whole sample included female gender, lower academic performance, depression, substance use (tobacco and alcohol), and low self-esteem. The BIS-11 score was correlated with DSH. Factor 3 score of the BIS-11 (novelty seeking) was correlated with DSH in both boys and girls, whereas factor 2 score (lack of self-control) was correlated with SA in boys. Social support was a protective factor for female adolescents with SA.

Conclusions: Risk factors for DSH and SA were similar, but not identical. Early identification of

1
2
3 those at risk and appropriate interventions may be helpful.
4
5
6

7 Key words: Adolescence, Deliberate self-harm, Impulsivity, Suicide, Suicidal ideation, Substance
8
9
10 abuse disorders
11
12
13

14 15 16 **Strengths and limitations of this study** 17

18
19 ● This study used a large community sample of adolescents from different areas of Taipei, which is
20
21 a strength when it comes to generalization.
22
23

24
25 ● A further strength of the present study is that well-established self-reported measures and a broad
26
27 array of relevant psychosocial measures were used.
28
29

30
31 ● Few studies based in Asian countries have investigated the relationship between impulsivity and
32
33 deliberate self-harm and suicide attempt in a community sample.
34
35

36
37 ● The agreement between online assessments and interviews with regards to lifetime suicide attempt
38
39 was moderate, which showed that an online study is a reliable way to investigate suicidality.
40
41

42
43 ● Although we considered a number of known risk factors for deliberate self-harm and suicide
44
45 attempt, other possible moderators may have also accounted for the relationships among the study
46
47 variables.
48
49
50
51
52
53
54
55
56
57
58
59
60

INTRODUCTION

According to the World Health Organization, suicide was the second leading cause of death worldwide in 2012 among people aged 15 to 29 years.¹ In addition, a systemic review reported a strong association between self-harm and later suicide, with the risk of suicide among patients with deliberate self-harm (DSH) being hundreds of times higher than that in the general population.² The terminology surrounding DSH is, however, complex. In this study, we defined DSH as self-harmful behavior, regardless of an individual's intention to die.³

Suicide attempt (SA), that is, self-harm with the intent to die, is less common than DSH. The estimated lifetime prevalence of SA among adolescents ranges from 3.0% to 8.4%⁴⁻⁶ compared to 4.0% to 30% for DSH.⁶ Despite increased awareness and research on DSH and SA among adolescents, few studies have investigated the extent to which risk factors for DSH and SA overlap in a community setting, especially in Asian countries.

Impulsivity has frequently been reported to be a risk factor for both DSH and SA,^{7,8} although the results are somewhat inconsistent. In one study, the association with SA was non-significant after controlling for hopelessness, neuroticism, external locus of control, self-esteem, and extroversion.⁹ In addition, Hawton et al.¹⁰ found that impulsivity was an independent risk factor for self-harm among adolescent girls but not among adolescent boys. In contrast, another study in Ireland reported that impulsivity was a risk factor for DSH among boys but not girls.¹¹ These inconsistent findings imply that impulsivity may be important in identifying high-risk subgroups. To date, most previous studies

1
2
3
4 on the relationship among impulsivity, DSH and SA in adolescents have been conducted in Western
5
6
7 countries.

8
9
10 Due to these inconsistent results and to bridge the gaps in current knowledge, we designed this
11
12 study to investigate correlations among impulsivity, DSH and SA in Taiwanese adolescents. The
13
14 study aimed to: (1) explore possible differences and similarities in risk factors among adolescents
15
16 with DSH and SA, and (2) explore the role of impulsivity in these two groups.
17
18
19

20 21 22 23 24 **METHODS**

25 26 27 **Subjects**

28
29
30 This study was approved by the Institutional Review Board of MacKay Memorial Hospital. It was
31
32 part of the Taiwanese Adolescent Self-Harm Project (TASP), a prospective study conducted to
33
34 evaluate the one-year incidence of self-harm behavior and the associated risk factors among
35
36 adolescents in Taiwan.¹² From October 2008 to March 2010, we recruited first-grade students from
37
38 14 senior high schools in Taipei and New Taipei City, Taiwan. The participating schools were
39
40 chosen from different regions of Taipei, including urban, suburban, and rural areas, and accounted
41
42 for 11.7% of all high schools in the Taipei area. After the aims of this study had been fully explained
43
44 to both the students and their parents, written informed consent was obtained from all parents and
45
46 participants. All of the participants completed the Chinese version of the Multidimensional Scale of
47
48 Perceived Social Support (MDSS),¹³ the Chinese version of the Patient Health Questionnaire
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 (PHQ-9),¹⁴ the Chinese version of the Barratt Impulsiveness Scale, Version 11 (BIS-11),¹⁵ and the
5
6
7 Rosenberg Self-Esteem Scale (RSES).¹⁶ The students also reported all self-harm experiences,
8
9
10 physical illnesses, and substance use. All of the measures were completed anonymously online at the
11
12 participating schools, and a trained research assistant was also available. A subsample of the students
13
14 also received diagnostic interviews conducted by child psychiatrists.¹⁴ The data from the online
15
16 questionnaires were collected by a computer engineer. The researchers had access to the data one day
17
18 after the students had completed the questionnaires to ensure the quality of the data. We also
19
20 provided each school with a list of students at high-risk of suicide for further referral and on-site
21
22 counseling by a child psychiatrist or a psychologist at their school.
23
24
25
26
27
28
29
30
31
32

33 **Online assessments**

34
35
36 **Suicidality: suicide ideation, suicide plan, deliberate self-harm, and suicide attempt**

37
38 All subjects were asked if they had ever thought of killing themselves at any time in their life. They
39
40 were then asked about ever having planned to kill themselves. Using the same scale, the students
41
42 were then asked “Have you ever deliberately (not accidentally) hurt yourself?” and “How many
43
44 times have you deliberately self-harmed?” The participants who responded positively to the main
45
46 questions were then asked to elaborate on their actions (multiple choices including drug overdose,
47
48 hanging, burning charcoal, jumping from a height, cutting themselves, and being hit by a car). They
49
50 were then asked to describe the act, the number of episodes, the timing of each episode, and the
51
52
53
54
55
56
57
58
59
60

1
2
3
4 consequences (e.g., need for medical intervention) and to endorse the motive behind the act. SAs
5
6
7 were identified in all reports of self-harm according to the response to, “Have you ever really tried to
8
9
10 kill yourself during these DSH episodes?” We also collected the number of SAs and the time of the
11
12 first and last attempts. The subjects who reported having harmed themselves with/without suicidal
13
14 intent were classified as “DSH.” SA was defined as an intentional action to kill oneself.
15
16
17
18
19
20

21 The Chinese version of the BIS-11

22
23
24 The BIS-11 is a 30-item self-reported questionnaire designed to measure impulsivity. The total score
25
26 ranges from 30 to 120, with a higher score indicating greater impulsivity.¹⁷ The 25 items of the
27
28 Chinese version of the BIS-11 have demonstrated good overall internal consistency in Taiwanese
29
30 adolescents, with a Cronbach’s alpha of 0.834.¹⁵ The factor structure of the Chinese version of the
31
32 BIS-11 consists of three factors: “inability to plan,” “lack of self-control,” and “novelty seeking.”
33
34
35
36
37
38
39
40

41 Multi-dimensional Scale of Perceived Social Support (MDSS)

42
43
44 The MDSS is a self-reported measure of the availability and adequacy of social support from various
45
46 sources.¹³ We estimated four types of social support, including that from parents, other family
47
48 members, friends, and teachers, with a higher score indicating greater social support. In our sample,
49
50
51 the Cronbach’s alpha was 0.63.
52
53
54
55
56
57
58
59
60

The Chinese version of the Patient Health Questionnaire-9 item (PHQ-9)

The PHQ-9 consists of nine items evaluating the presence of one of the nine *Diagnostic and Statistical Manual of Mental Disorders (Fourth edition) [DSM-IV]* criteria of major depressive episodes during the past 2 weeks. The total score ranges from 0 to 27, with higher scores indicating an increased likelihood of major depressive disorder (MDD). The Chinese version of the PHQ-9 has been validated for detecting MDD, and has shown good internal consistency ($\alpha = 0.84$) and acceptable test-retest reliability (intra-class correlation coefficient = 0.80) among adolescents in the community.¹⁴ A PHQ-9 score ≥ 15 had a sensitivity of 0.72 and a specificity of 0.95 for recognizing MDD.

The Chinese version of the Rosenberg Self-Esteem Scale (RSES)

The RSES consists of 10 items that refer to self-respect and self-acceptance.¹⁸ The Chinese version of the RSES has demonstrated acceptable internal consistency. The reliability and validity of the Chinese version of the RSES have also been demonstrated.¹⁶

Substance use variables

Data on substance use included information on cigarette smoking, high-risk alcohol use and any illicit drug use. The participants who reported that they smoked currently were classified as current cigarette smokers. High-risk alcohol use was assessed using the Chinese version of the Alcohol Use

1
2
3
4 Disorders Identification Test-Consumption (AUDIT-C). The AUDIT-C includes the first three
5
6 questions from the full AUDIT,¹⁹ and assesses the amount and frequency of alcohol intake and
7
8 frequency of alcohol misuse (defined as having six or more drinks). The optimal cut-off score of the
9
10 Chinese AUDIT-C for hazardous drinking was 3/4, with good sensitivity (0.90) and specificity
11
12 (0.92).²⁰ In this study, this was treated as a continuous variable, and a higher score indicated more
13
14 alcohol use. A summary of illicit drug use was obtained from the participants who had used any form
15
16 of illicit drug during the past month.
17
18
19
20
21
22
23
24
25
26

27 **Face-to-face interviews with child psychiatrists using the** 28 29 30 **Kiddie-Schedule for Affective Disorder and Schizophrenia** 31 32 **Epidemiological Version (K-SADS-E)**

33
34
35 The K-SADS-E is a semi-structured interview scale for the systematic assessment of both past and
36
37 current episodes of psychiatric disorders in children and adolescents. The Chinese version has been
38
39 shown to be a reliable and valid instrument.²¹ Child psychiatrists blind to the results of the online
40
41 assessments interviewed a subsample of the students (n = 272) using the K-SADS-E. Lifetime SA was
42
43 assessed by the child psychiatrists according to the question, “Have you actually tried to kill
44
45 yourself?”
46
47
48
49
50
51
52
53
54
55

56 **Statistical analysis**

57
58
59
60

1
2
3
4 Descriptive and analytical statistics of the data obtained in this study were analyzed using SPSS
5
6
7 version 21.0 for Windows (SPSS, IBM, Armonk, NY, USA). Risk factors for DSH and SA were first
8
9
10 analyzed using univariate logistic regression analysis, with one variable at a time. Hierarchical
11
12
13 multiple regression strategies (using a stepwise method) were then used to determine the risk factors
14
15
16 for DSH/SA and to assess whether impulsivity played any role. The joint effect of the independent
17
18
19 variables that showed significance in univariate analysis was assessed with hierarchical regression
20
21
22 analysis. To examine the association between impulsivity and DSH/SA, all sociodemographic and
23
24
25 personality (BIS-11, RSES) variables were introduced in the first step (model 1), followed by adding
26
27
28 social support (MDSS) in the second step (model 2), alcohol/tobacco use in the third step (model 3),
29
30
31 and depressive symptoms in the fourth step (model 4). Logistic regression was used to analyze the
32
33
34 role of impulsivity and all other sociodemographic, clinical and personality trait variables with
35
36
37 DSH/SA between genders. We further analyzed three subscales of the BIS-11 instead of the total
38
39
40 score in the male and female students. We also examined the agreement (i.e. reliability) between the
41
42
43 computer questionnaire assessments and face-to-face interviews (n = 272) with regards lifetime SA.
44
45
46 This agreement was assessed by concordance rate and kappa statistics.²²
47
48

49 50 **RESULTS**

51 52 53 **Descriptive statistics and univariate analysis of lifetime DSH and** 54 55 56 **lifetime SA**

We recruited 5,879 students with a mean age of 16.02 years (standard deviation 0.52). The overall response rate was 60.61%. Table 1 shows the sociodemographic data of the students along with scores on the MDSS, PHQ-9, BIS-11, RSES, and AUDIT-C. Twenty-five percent of the students (n = 1,472) reported self-harm behavior, with a mean of 4.06 times (standard deviation: 3.33). Two hundred and six students (3.5%) reported that their self-harm behavior was actually a suicide attempt. The mean BIS-11 score was 62.9 for the students with lifetime DSH, and 64.2 for those with lifetime SA.

Table 1 Sociodemographic and descriptive data

Variables		Number (%) or mean (SD)
Gender	Female	3,335 (56.7)
School district	Urban	2,501 (42.5)
	Suburbs	3,005 (51.1)
	Rural	373 (6.3)
School ranking	Above the 70th percentile	1,724 (29.3)
Father's job status	Employed	5,179 (88.1)
	Unemployed	497 (8.5)
	Unknown	203 (3.5)
Mother's job status	Employed	4,197 (71.4)
	Unemployed	1,535 (26.1)
	Unknown	147 (2.5)
Live with biological parents	Yes	4,824 (82.1)
BIS-11 score		60.1 (8.5)
	Factor 1 (inability to plan or look ahead)	19.9 (3.9)
	Factor 2 (lack of perseverance and self-control)	24.5 (4.5)
	Factor 3 (novelty-seeking and acting without thinking)	15.7 (3.0)
With family discord		558 (9.5)

1		
2		
3	Current smoker	226 (3.8)
4	Illicit drug use in the last month	10 (0.2)
5		
6	MDSS score	20.8 (3.6)
7	RSES score	28.3 (5.4)
8		
9	PHQ-9 score	5.7 (4.6)
10	AUDIT-C score	1.1 (1.9)
11	<hr/>	
12		
13		

14 There was no statistical difference in BIS-11 score between the male and female students.

15
16
17 Univariate analysis revealed that the risk factors associated with both lifetime DSH and SA were
18
19
20 higher impulsivity, female gender, low school ranking, father's job status, not living with biological
21
22
23 parents, family discord, low self-esteem, poor social support, currently smoking, more alcohol use,
24
25
26 and more depressive symptoms (Table 2).

Table 2 Variables significantly associated with lifetime deliberate self-harm (DSH) and suicide attempt (SA)

Variables	Ever had DSH	Univariate logistic	Ever had SA	Univariate logistic	No DSH history
	(n = 1,472)	regression	(n = 206)	regression	(n = 4,407)
	N (%) or mean (SD)	OR (95% CI)	N (%) or mean (SD)	OR (95% CI)	N (%) or mean (SD)
Female gender	966 (65.6)	1.64 (1.45~1.86)***	145 (70.4)	2.05 (1.51~2.77)***	2,369 (53.8)
Low school ranking ^a	1,152 (78.3)	1.68 (1.47~1.93)***	191 (92.7)	5.95 (3.51~10.11)***	3,003 (68.1)
Father is employed	1,258 (85.5)	0.73 (0.61~0.87)***	169 (82.0)	0.57 (0.39~0.82)**	3,921 (89.0)
Not live with biological parents	333 (22.6)	1.49 (1.29~1.73)***	58 (28.2)	2.00 (1.46~2.74)***	722 (16.4)
BIS-11 score	62.9 (8.4)	1.06 (1.05~1.07)***	64.2 (8.8)	1.07 (1.06~1.09)***	59.1 (8.3)
Factor 1	20.4 (3.9)	1.05 (1.03~1.07)***	20.5 (4.1)	1.06 (1.02~1.10)**	19.7 (3.9)
Factor 2	26.1 (4.6)	1.11 (1.09~1.13)***	27.0 (4.7)	1.16 (1.12~1.20)***	24.0 (4.3)
Factor 3	16.4 (3.0)	1.12 (1.09~1.15)***	16.6 (3.0)	1.13 (1.08~1.19)***	15.4 (3.0)
With family discord	221 (15.0)	2.13 (1.78~2.56)***	48 (23.3)	3.67 (2.61~5.16)***	337 (7.6)
Current smoker	113 (7.7)	3.16 (2.42~4.13)***	26 (12.6)	5.49 (3.49~8.62)***	113 (2.6)
MDSS score	20.1 (3.6)	0.93 (0.92~0.95)***	19.5 (3.6)		21.1 (3.6)
PHQ-9 score	8.2 (5.5)	1.16 (1.15~1.18)***	10.5 (5.7)		4.9 (4.0)
AUDIT-C score	0.9 (5.2)	1.26 (1.23~1.30)***	2.1 (2.4)		1.8 (2.3)
RSES score	26.2 (5.5)	0.91 (0.90~0.92)***	23.9 (5.4)		29.0 (5.2)

^aBelow the 70th percentile; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Hierarchical regression of lifetime DSH and lifetime SA

The results of the hierarchical approach are presented in Tables 3 and 4. The adjusted model 1 including sociodemographic variables and personality traits (RSES, BIS-11) showed that the same risk factors were associated with both DSH and SA. These included high impulsivity, low self-esteem, female gender, family discord and low school ranking. The factors of father's job status and living with one's biological parents ceased to be significant predictors, indicating that these variables were fully statistically mediated by factors of gender, self-esteem, impulsivity, family discord and school ranking. In an unadjusted model, as the impulsivity score (BIS) increased by 1 unit, the likelihood of reporting a lifetime DSH and SA increased by approximately 6% and 7%, respectively. The addition of gender, family discord, school ranking, and self-esteem factors attenuated the effect of impulsivity on the odds ratio (OR = 1.04) (Tables 3 and 4).

Table 3 Summary of hierarchical multiple regression analyses (stepwise method) examining multivariate correlates of deliberate self-harm

	Model 1	Model 2	Model 3	Model 4	Model 4 (Male)	Model 4 (Female)
	OR (95% CI)					
BIS-11 score	1.04 (1.03~1.05)***	1.04 (1.03~1.05)***	1.03 (1.02~1.04)***	1.02 (1.01~1.03)***	1.03 (1.02~1.05)***	
Female gender	1.67 (1.41~1.97)***	1.67 (1.41~1.97)***	1.95 (1.64~2.32)***	1.86 (1.56~2.22)***		
Low school ranking	1.49 (1.17~1.91)**	1.49 (1.17~1.91)**	1.33 (1.04~1.71)*	1.36 (1.06~1.75)*		1.84 (1.30~2.61)**
Father is employed						
Not live with biological parents						
With family discord	1.57 (1.24~2.00)***	1.57 (1.24~2.00)***	1.52 (1.19~1.95)**			
RSES score	0.93 (0.91~0.94)***	0.93 (0.91~0.94)***	0.93 (0.91~0.94)***	0.96 (0.95~0.98)***	0.96 (0.93~0.99)**	0.96 (0.94~0.98)**
MDSS score						
Current smokers			1.88 (1.30~2.72)**	1.78 (1.22~2.60)**		3.44 (1.52~7.78)**
AUDIT-C score			1.19 (1.14~1.23)***	1.15 (1.11~1.20)***	1.09 (1.03~1.15)**	1.28 (1.19~1.36)***
PHQ-9 score				1.12 (1.10~1.15)***	1.11 (1.08~1.14)***	1.14 (1.11~1.17)***

Model 1 adjusted for all sociodemographic variables and personality (RSES, BIS-11)

Model 2 adjusted for Model 1 and social support (MDSS)

Model 3 adjusted for Model 2 and substance use

Model 4 adjusted for Model 3 and depressive symptoms

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

Table 4 Summary of hierarchical multiple regression analyses (stepwise method) examining multivariate correlates of suicide attempt

	Model 1	Model 2	Model 3	Model 4	Model 4 (Male)	Model 4 (Female)
	OR (95% CI)					
BIS-11 score	1.04 (1.02~1.06)***	1.04 (1.02~1.06)***	1.03 (1.004~1.05)*			
Female gender	2.11 (1.53~2.92)***	2.18 (1.58~3.02)***	2.99 (2.09~4.27)***	2.91 (2.01~4.20)***		
Low school ranking	2.03 (1.17~3.54)*	1.97 (1.13~3.44)*	1.80 (1.02~3.17)*	2.03 (1.14~3.63)*		2.13 (1.02~4.47)*
Father is employed						0.57 (0.34~0.98)*
Not live with biological parents						
With family discord	2.17 (1.48~3.18)***	1.99 (1.35~2.93)**	2.01 (1.35~2.99)**			
RSES score	0.86 (0.84~0.89)***	0.87 (0.84~0.90)***	0.87 (0.84~0.90)***	0.91 (0.88~0.94)***	0.92 (0.87~0.97)**	0.90 (0.87~0.94)***
MDSS score		0.94 (0.90~0.98)**	0.95 (0.91~0.995)*			0.94 (0.89~1.00)*
Current smokers			2.93 (1.62~5.32)***	3.02 (1.63~5.60)***	3.52 (1.72~7.19)**	5.24 (1.76~15.7)**
AUDIT-C score			1.23 (1.15~1.32)***	1.17 (1.09~1.26)***		1.26 (1.13~1.40)***
PHQ-9 score				1.19 (1.15~1.23)***	1.17 (1.12~1.23)***	1.20 (1.15~1.26)***

Model 1 adjusted for all sociodemographic variables and personality (RSES, BIS-11)

Model 2 adjusted for Model 1 and social support (MDSS)

Model 3 adjusted for Model 2, and substance use

Model 4 adjust for Model 3 and depressive symptoms.

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

1
2
3
4
5
6
7 We then added social support status (MDSS score) into model 2. Social support did not
8
9
10 significantly alter the confidence intervals of the other variables in model 1 with regards to DSH, and
11
12 it was also not significantly associated with DSH in model 2. However, social support was a
13
14 protective factor for SA in adjusted model 2. Impulsivity, female gender, low self-esteem, low school
15
16 ranking, and family discord retained significance in adjusted model 2 for SA.
17
18
19

20
21 In model 3 we added variables of substance use, and DSH and SA were still significantly
22
23 associated with impulsivity, although the odds were attenuated (Tables 3 and 4). The other
24
25 significant variables in model 2 persisted as risk factors for DSH/SA in model 3. Currently smoking
26
27 and a higher level of alcohol use were strong risk factors for DSH/SA.
28
29
30
31

32
33 In model 4, we included all variables (including depressive symptoms). DSH was still
34
35 significantly associated with impulsivity, although its odds were attenuated again. The effect of
36
37 family discord was fully statistically mediated in the final model of DSH. Other significant variables
38
39 in model 3 persisted as risk factors for DSH in the final model. Depressive symptoms was a risk
40
41 factor for DSH, and for every 1 unit increase in PHQ score, the likelihood of reporting lifetime DSH
42
43 increased by 12%. In addition, for every 1 unit increase in AUDIT-C score, the likelihood of
44
45 reporting lifetime DSH increased by 15%.
46
47
48
49
50
51

52
53 Impulsivity, family discord, and social support lost their significance after adjusting for the
54
55 aforementioned covariates in model 4 for the SA group (Table 4). Depressive symptoms and
56
57
58
59
60

1
2
3
4 substance use (alcohol and tobacco use) were stronger risk factors for SA than impulsivity. For every
5
6
7 1 unit increase in PHQ score, the likelihood of reporting lifetime SA increased by 19%, and for every
8
9
10 1 unit increase in AUDIT-C score, the likelihood of reporting lifetime SA increased by 17%. The
11
12 effects of depression and alcohol use on SA were stronger than those on DSH. In addition, smoking
13
14 had the strongest effect on SA, with current smokers having a 3-fold higher risk of SA compared to
15
16
17 nonsmokers.
18
19

20
21 We further analyzed the risk factors for DSH/SA by gender. For boys, impulsivity, low
22
23 self-esteem, alcohol use and depressive symptoms were risk factors for DSH, compared to low
24
25 school ranking, low self-esteem, smoking, alcohol use and depressive symptoms in girls (Table 3).
26
27 For boys, low self-esteem, smoking and depressive symptoms were risk factors for SA, compared to
28
29 low school ranking, low self-esteem, poor social support, smoking, alcohol use and depressive
30
31 symptoms in girls, while their father's employment status was a protective factor (Table 4). Smoking
32
33 status was an especially strong risk factor for SA in girls (OR = 5.24).
34
35
36
37
38
39
40

41 We used three subscales instead of BIS-11 total score in the multivariate logistic regression
42
43 analysis to investigate the relationships among impulsivity subscales and DSH/SA (Table 5). For
44
45 both genders, factor 3 of the BIS-11 scale, low self-esteem, alcohol use and depressive symptoms
46
47 were risk factors for DSH. Low school ranking and smoking were additional risk factors for DSH in
48
49 girls. For boys, risk factors for SA included factor 2 of the BIS-11 scale, low self-esteem, smoking
50
51 and depressive symptoms. For girls with SA, impulsivity subscales were non-significant.
52
53
54
55
56
57
58
59
60

Table 5 Multiple regression analyses (stepwise method) examining multivariate correlates of deliberate self-harm (DSH) and suicide attempt (SA), focusing on three subscales of the BIS-11

	DSH (Male)	DSH (Female)	SA (Male)	SA (Female)
	OR (95% CI)			
BIS-11 score factor 1				
BIS-11 score factor 2			1.07 (1.01~1.14)*	
BIS-11 score factor 3	1.10 (1.05~1.16)***	1.04 (1.002~1.08)*		
Low school ranking		1.79 (1.26~2.54)**		2.13 (1.02~4.47)*
Father is employed				0.57 (0.34~0.98)*
Not live with biological parents				
With family discord				
RSES score	0.94 (0.92~0.97)***	0.96 (0.93~0.98)***	0.93 (0.88~0.99)*	0.90 (0.87~0.94)***
MDSS score				0.94 (0.89~1.00)*
Current smokers		3.46 (1.54~7.81)**	2.95 (1.42~6.13)**	5.24 (1.76~15.65)**
AUDIT-C score	1.08 (1.02~1.14)**	1.26 (1.18~1.35)***		1.26 (1.13~1.40)***
PHQ-9 score	1.10 (1.06~1.13)***	1.13 (1.10~1.16)***	1.15 (1.10~1.21)***	1.20 (1.15~1.26)***

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

1
2
3
4 **Agreement between online assessment and face-to-face interviews**
5
6
7 **(concordance rate and kappa statistics)**
8

9
10 The concordance rate was the proportion of the same status of lifetime SA comparing the results of
11
12 the online assessments and face-to-face interviews, which was 82.76% [(89+31)/145] (Table 6). The
13
14
15 kappa value was 0.59, which was in moderate agreement range.²²
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 6 Comparison of online assessments vs. face-to-face interviews of lifetime suicide attempt (SA)

		Interview assessment		
		Lifetime SA (-)	Lifetime SA (+)	Total
Online assessment	Lifetime SA (-)	89	9	98
	Lifetime SA (+)	16	31	47
	Total	105	40	145

DISCUSSION

The findings of the current study show that the risk factors associated with DSH and SA were similar, but not identical, in our cohort of adolescent school students. The same risk factors for both DSH and SA included female gender, low school ranking, depression, substance (tobacco and alcohol) use, and low self-esteem. These risk factors associated with DSH/SA can therefore be targeted in future prevention strategies. After adjusting for demographic factors and all other psychosocial factors, impulsivity was an independent risk factor for DSH but not for SA. However, factor 2 of the BIS was significantly associated with SA in boys.

Common risk factors

The results of the current study with regards to gender differences in adolescent DSH/SA are consistent with previous findings, in that adolescent girls showed a higher prevalence of DSH^{23 24} and SA.^{5 25 26} With respect to the personality characteristics, low self-esteem has been associated with both DSH⁸ and SA.²⁵ Cross-sectional surveys of adolescents have consistently found that depression is strongly correlated with DSH^{8 24} and SA.^{25 26} Tobacco smoking has also been previously identified to be a risk factor for DSH^{24 27} and SA,^{28 29} along with alcohol use for DSH^{23 24} and SA.^{28 29} The risk factors in the current study are in good agreement with the existing literature, which underscores the need to offer preventive interventions by addressing each of these risk factors to reduce DSH/SA and alleviate current distress. School surveys to identify adolescents with low

1
2
3
4 self-esteem, depression, or substance use are warranted, and mental health interventions for
5
6
7 depression, substance use and to enhance self-esteem are also needed.
8

9
10 Stress due to school studies is usually high in Chinese society, and academic performance (i.e.
11
12 school ranking in this study) was a culturally specific factor for adolescent DSH and SA in this study.
13
14 A previous study in Hong Kong reported that poor academic performance was related to adolescent
15
16 non-suicidal self-harm and SA.³⁰ Several explanations for the relationship between academic
17
18 performance and DSH/SA have been proposed. Academic problems may precede DSH/SA, or they
19
20 may both be caused by the same set of underlying risk factors. Students with poor academic
21
22 performance should receive more attention from their teachers, because Chinese society emphasizes
23
24 academic performance and those with poor performance may have higher levels of frustration, poor
25
26 self-esteem and hopelessness. Low ranking schools therefore need more counseling services and
27
28 support from mental health professionals. Academic remediation activities may also be arranged to
29
30 help students. Regular screening programs to early detect those who may need mental health services
31
32 are also warranted. The education system and parents should also encourage other strengths rather
33
34 than academic performance alone, such as studying at a vocational school. Further research should
35
36 investigate the relationship between a student's academic high school performance and suicidality.
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52

53 **Impulsivity**

54
55
56 There seems to be more evidence that impulsivity is associated with adolescent DSH than with SA.
57
58
59
60

1
2
3
4 For example, previous studies in Europe and the US have reported higher impulsiveness on
5
6 self-reported scales as a risk factor for adolescent DSH,^{8 31} which is consistent with our findings.
7
8
9 However, in contrast to previous studies,^{7 8} our results do not support an association between overall
10
11 impulsivity score and SA. Impulsivity could characterize the suicidal adolescents in models 1, 2, and
12
13 3, but it became non-significant after adding covariates of depressive symptoms (Table 4). However,
14
15 some studies have also reported no relationship between impulsivity and SA. In a case-control study
16
17 comparing suicidal completers and community control adolescents, impulsivity was related to
18
19 suicide in univariate analysis but not in multivariate analysis.³² In another study surveying suicidal
20
21 and non-suicidal adolescent inpatients, the self-reported Impulse Control Scale score was not
22
23 different between the two groups.³³
24
25
26
27
28
29
30
31
32

33 Among the BIS subscales, BIS-11 factor 3 (novelty seeking and acting without thinking) was
34
35 associated with DSH in both boys and girls in multivariate analysis (Table 5). A previous study in
36
37 England found that impulsivity was a risk factor for DSH in girls,¹⁰ whereas other studies in Ireland
38
39 found that impulsivity was a risk factor for DSH in boys.^{11 34} Sensation seekers (i.e. high factor 3)
40
41 have been shown to pursue novelty even at the cost of self-harm,³⁵ and this may explain our findings
42
43 that factor 3 was correlated with DSH in both genders. We also found that BIS-11 factor 2 (lack of
44
45 perseverance and self-control) characterized SA in boys in multivariate analysis (Table 5), which is
46
47 consistent with prior studies.^{36 37} A previous Taiwanese study found that male adults with a history of
48
49 SA exhibited higher BIS-11 factor 2 scores,³⁶ and Horesh et al. also found an association between
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 impulsivity and SA among male adolescent inpatients.³⁷ Since BIS-11 factor 2 is considered to reflect
5
6 long-standing behavioral patterns,³⁸ it is plausible that boys with a lack of self-control and low
7
8 self-esteem may be prone to suicidal behavior. Impulsive boys under stress such as depression or
9
10 substance use may also be predisposed to have a lower threshold for SA without contemplating the
11
12 possible consequences. A neuroimaging study confirmed that BIS-11 subscales were correlated with
13
14 different brain regions in adolescents.³⁹ Another study of young adults found gender-specific
15
16 differences in BIS-11-LGI (local gyrification index) correlations in the middle and inferior frontal
17
18 gyrus,⁴⁰ which may explain our findings of a gender difference in impulsivity. Our results may
19
20 support the stress-diathesis theory that dispositionally impulsive adolescents and those with low
21
22 self-esteem with mental illnesses such as depression are more likely to have SA. In a French study,
23
24 impulsive traits of adolescents were related to the use of fewer appropriate and more inappropriate
25
26 regulation strategies and depression.⁴¹ Psychological interventions to decrease impulsivity are also
27
28 needed.
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43

44 **Other psychosocial dimensions**

45
46
47 In hierarchical regression analysis of SA, social support was present in models 2 and 3, but
48
49 disappeared after adjusting for substance use and depressive symptoms in model 4 (Table 4).
50
51
52
53 However, social support remained a risk factor for SA in the final model among girls. This may
54
55 reflect that girls are affected by relationships with peers, family and teachers more than boys. A
56
57
58
59
60

1
2
3
4 previous study also showed that social connectedness or family support²⁶ was associated with
5
6 adolescent suicide risk. Social support in our study included that from family, peers and teachers,
7
8 which may have contributed to the negative findings. Our results suggest that particular attention
9
10 should be paid to high-risk girls with poor social support, and that active interventions should be
11
12 arranged. Perceived family discord was a risk factor for DSH and SA in models 1, 2, and 3 of the
13
14 current study, implying that family plays a role in adolescents' suicidality. This is consistent with
15
16 previous DSH⁴² and SA studies.²⁶ However, its effects on DSH and SA disappeared after adding
17
18 depressive symptoms. A longitudinal study had similar findings in that after controlling for mental
19
20 health disorders and adverse life events, the influence of parental and family factors on adolescent
21
22 suicide was attenuated.⁴³
23
24
25
26
27
28
29
30
31
32
33
34
35

36 **Strengths and limitations**

37
38 This study used a large community sample of adolescents from different areas of Taipei, which is a
39
40 strength when it comes to generalization. A further strength in the present study is that
41
42 well-established self-reported measures and a broad array of relevant psychosocial measures were
43
44 used. Finally, few studies not based in Western countries have investigated the risk factors for DSH
45
46 and SA in a community sample.
47
48
49
50
51

52
53 There are also several limitations to this study. First, conducting a large-scale survey with such
54
55 a large sample does not allow for individual in-depth interviews. Measures in the present study were
56
57
58
59
60

1
2
3
4 self-reported, and thus may reflect bias. However, data from large school surveys by Hawton et al
5
6 were also self-reported,¹⁰ and they found that the majority of respondents reporting lifetime DSH
7
8 were also classified as having DSH by expert evaluation.⁴⁴ This is similar to the findings of the
9
10 current study in that the agreement between online assessments and interviews with regards to
11
12 lifetime SA was moderate. In addition we conducted the tests in a group setting, and the students
13
14 could preview the online questionnaires and review and change their answers to decrease a social
15
16 desirability effect and yield more reliable data.⁴⁵ Self-reports using online questionnaires have been
17
18 shown to allow students to report more sensitive risky behavior than using paper-and-pencil
19
20 questionnaires.⁴⁶ Second, we did not use multiple assessments such as lab-measured impulsivity.
21
22 However, a previous study showed a significant correlation between the self-reported form and the
23
24 Test of Variables of Attention (TOVA) measure of impulsivity ($r = 0.34$; $p < 0.05$).³³ Third, this
25
26 study was cross-sectional, precluding conclusions regarding causality. Finally, although we
27
28 considered a number of known risk factors of DSH or SA, other possible moderators may also
29
30 account for the relationships among the study variables. Future longitudinal studies examining
31
32 alternative moderators are needed.
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

50 CONCLUSIONS

51
52
53 We found a number of similarities and differences in certain risk factors between adolescents with
54
55 DSH and those with SA. Poor impulsivity and other factors such as female gender, low self-esteem,
56
57
58
59
60

1
2
3
4 poor academic performance, depression and tobacco/alcohol use were significant risk factors in the
5
6
7 final model of adolescent DSH. Similar factors were associated with SA in the final model except for
8
9
10 impulsivity, although its subscale was associated with SA in boys. These shared and unique risk
11
12 factors are important to understand the mechanism behind DSH and SA, and to allow for
13
14 incorporation of these risk factors into future research on prevention programs for these two
15
16 behaviors among vulnerable adolescents across different settings.
17
18
19

20
21 Given the high prevalence rates and low consultation rates of these two behaviors, we suggest
22
23 that these high-risk behaviors should be considered as a public health problem. Mental health
24
25 professionals in schools should routinely assess DSH and SA, and self-reported screening
26
27 questionnaires should be conducted along with routine physical examinations in school to help
28
29 identify adolescents at risk. Paying attention to the mental health of adolescents at school may help
30
31 to prevent the consequences associated with unidentified and untreated mental health problems.
32
33
34
35
36
37
38
39
40

41 **Funding statement** Supported by grants from the Ministry of Science and Technology,
42
43 Taiwan, R.O.C. (NSC 9802314-B-195-011 MY3) and Mackay Memorial Hospital (9838,
44
45 9880), Taiwan.
46
47
48

49
50 **Competing interest statement** None declared.
51

52 **Contributors**

53
54
55
56 YH Huang contributed to data collection, performed the data analysis and drafted the article. HC Liu
57
58
59
60

1
2
3
4 drafted the study protocol and helped in the data collection process. FJ Tsai helped in the diagnostic
5
6
7 interview process. FJ Sun contributed in statistical analyses. KY Huang contributed in the diagnostic
8
9
10 interview process. YC Chiu contributed in counseling of at-risk adolescents, reviewing the article
11
12 and revising it critically for important intellectual content. YH Huang contributed in the diagnostic
13
14 interview process. YP Huang contributed to reviewing the article and revising it critically for
15
16 important intellectual content. SI Liu monitored and guided the designing and implementation of the
17
18 study, data collection, statistical analyses, interpreting findings, and revising the article. All authors
19
20 approved the manuscript submission for publication.
21
22
23
24
25
26
27
28
29

30 **Data sharing statement** No additional data available
31
32
33
34

35 REFERENCES

- 36
37
38 1. World Health Organization. First WHO report on suicide prevention. 2014.
39
40 <http://www.who.int/mediacentre/news/releases/2014/suicide-prevention-report/en/> (accessed
41
42 2017 May 26).
43
44
45
46
47 2. Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm. Systematic review. *Br*
48
49 *J Psychiatry* 2002;181:193-9.
50
51
52
53 3. Hawton K, Bergen H, Casey D, *et al*. Self-harm in England: a tale of three cities. Multicentre
54
55 study of self-harm. *Soc Psychiatry Psychiatr Epidemiol* 2007;42:513-21.
56
57
58
59
60

- 1
2
3
4 4. Fergusson DM, Lynskey MT. Suicide attempts and suicidal ideation in a birth cohort of
5
6
7 16-year-old New Zealanders. *J Am Acad Child Adolesc Psychiatry* 1995;34:1308-17.
8
- 9
10 5. Andrews JA, Lewinsohn PM. Suicidal attempts among older adolescents: prevalence and
11
12 co-occurrence with psychiatric disorders. *J Am Acad Child Adolesc Psychiatry*
13
14 1992;31:655-62.
15
16
- 17
18 6. Evans E, Hawton K, Rodham K, *et al.* The prevalence of suicidal phenomena in adolescents: a
19
20 systematic review of population-based studies. *Suicide Life Threat Behav* 2005;35:239-50.
21
22
- 23
24 7. Kashden J, Fremouw WJ, Callahan TS, *et al.* Impulsivity in suicidal and nonsuicidal adolescents. *J*
25
26 *Abnorm Child Psychol* 1993;21:339-53.
27
28
- 29
30 8. Madge N, Hawton K, McMahon EM, *et al.* Psychological characteristics, stressful life events and
31
32 deliberate self-harm: findings from the Child & Adolescent Self-harm in Europe (CASE)
33
34 Study. *Eur Child Adolesc Psychiatry* 2011;20:499-508.
35
36
- 37
38 9. Beautrais AL, Joyce PR, Mulder RT. Personality traits and cognitive styles as risk factors for
39
40 serious suicide attempts among young people. *Suicide Life Threat Behav* 1999;29:37-47.
41
42
- 43
44 10. Hawton K, Rodham K, Evans E, *et al.* Deliberate self harm in adolescents: self report survey in
45
46 schools in England. *BMJ* 2002;325:1207-11.
47
48
- 49
50 11. O'Connor RC, Rasmussen S, Hawton K. Adolescent self-harm: A school-based study in Northern
51
52 Ireland. *J Affect Disord* 2014;159:46-52.
53
54
- 55
56 12. Huang YH, Liu HC, Sun FJ, *et al.* Relationship Between Predictors of Incident Deliberate
57
58

- 1
2
3
4 Self-Harm and Suicide Attempts Among Adolescents. *J Adolesc Health*.
5
6
7 13. Winefield HR, Winefield AH, Tiggemann M. Social support and psychological well-being in
8
9 young adults: the multi-dimensional support scale. *J Pers Assess* 1992;58:198-210.
10
11
12 14. Tsai FJ, Huang YH, Liu HC, *et al*. Patient Health Questionnaire for school-based depression
13
14 screening among Chinese adolescents. *Pediatrics* 2014;133:e402-e09.
15
16
17 15. Li CS, Chen SH. Obsessive-compulsiveness and impulsivity in a non-clinical population of
18
19 adolescent males and females. *Psychiatry Res* 2007;149:129-38.
20
21
22 16. Lin RC. Reliability and validity of the Rosenberg Self-esteem Scale on Chinese children. *Journal*
23
24 *of National Chung Cheng University* 1990;1:29-46.
25
26
27 17. Patton JH, Stanford MS, Barrat ES. Factor structure of the Barratt Impulsiveness Scale. *J Clin*
28
29 *Psychol* 1995;51:768-74.
30
31
32 18. Rosenberg M. *Conceiving the self*. New York: Basic Books, 1979.
33
34
35 19. Conigrave KM, Hall WD, Saunders JB. The AUDIT questionnaire: choosing a cut-off score.
36
37 Alcohol use disorder identification test. *Addiction* 1995;90:1349-56.
38
39
40 20. Wu SI, Huang HC, Liu SI, *et al*. Validation and comparison of alcohol-screening instruments for
41
42 identifying hazardous drinking in hospitalized patients in Taiwan. *Alcohol Alcohol*
43
44 2008;43:577-82.
45
46
47 21. Gau SF, Soong WT. Psychiatric comorbidity of adolescents with sleep terrors or sleepwalking: a
48
49 case-control study. *Aust N Z J Psychiatry* 1999;33:734-9.
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3
4 22. Rosner B. *Fundamentals of Biostatistics*. Boston: Duxbruy, 2006.
5
6
7 23. Tsai MH, Chen YH, Chen CD, *et al*. Deliberate self-harm by Taiwanese adolescents. *Acta*
8
9 *Paediatr* 2011;100:e223-26.
10
11
12 24. Moran P, Coffey C, Romaniuk H, *et al*. The natural history of self-harm from adolescence to
13
14 young adulthood: a population-based cohort study. *Lancet* 2012;379:236-43.
15
16
17 25. Bridge JA, Goldstein TR, Brent DA. Adolescent suicide and suicidal behavior. *J Child Psychol*
18
19 *Psychiatry* 2006;47:372-94.
20
21
22 26. Chen CH, Chen YH, Chen CY, *et al*. Factors associated with suicide ideations and attempts in
23
24 adolescents. *Taiwanese J Psychiatry* 2008;22:57-66.
25
26
27 27. Toprak S, Cetin I, Guven T, *et al*. Self-harm, suicidal ideation and suicide attempts among
28
29 college students. *Psychiatry Res* 2011;187:140-44.
30
31
32 28. Kokkevi A, Richardson C, Olszewski D, *et al*. Multiple substance use and self-reported suicide
33
34 attempts by adolescents in 16 European countries. *Eur Child Adolesc Psychiatry*
35
36 2012;21:443-50.
37
38
39 29. Wong SS, Zhou B, Goebert D, *et al*. The risk of adolescent suicide across patterns of drug use: a
40
41 nationally representative study of high school students in the United States from 1999 to 2009.
42
43 *Soc Psychiatry Psychiatr Epidemiol* 2013;48:1611-20.
44
45
46 30. Shek DT, Yu L. Self-harm and suicidal behaviors in Hong Kong adolescents: prevalence and
47
48 psychosocial correlates. *ScientificWorldJournal* 2012;2012:932540.
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3
4 31. Janis IB, Nock MK. Are self-injurers impulsive?: Results from two behavioral laboratory studies.
5
6
7 *Psychiatry Res* 2009;169:261-67.
8
9
10 32. Renaud J, Berlim MT, McGirr A, *et al.* Current psychiatric morbidity, aggression/impulsivity, and
11
12 personality dimensions in child and adolescent suicide: a case-control study. *J Affect Disord*
13
14 2008;105:221-28.
15
16
17 33. Horesh N. Self-report vs. computerized measures of impulsivity as a correlate of suicidal
18
19 behavior. *Crisis* 2001;22:27-31.
20
21
22
23 34. McMahon EM, Reulbach U, Corcoran P, *et al.* Factors associated with deliberate self-harm
24
25 among Irish adolescents. *Psychol Med* 2010;40:1811-9.
26
27
28
29 35. Mujica-Parodi LR, Carlson JM, Cha J, *et al.* The fine line between 'brave' and 'reckless':
30
31 amygdala reactivity and regulation predict recognition of risk. *Neuroimage* 2014;103:1-9.
32
33
34
35 36. Wu CS, Liao S, C., Lin KM, *et al.* Multidimensional assessments of impulsivity in subjects with
36
37 history of suicidal attempts. *Compr Psychiatry* 2009;50:315-21.
38
39
40
41 37. Horesh N, Gothelf D, Ofek H, *et al.* Impulsivity as a correlate of suicidal behavior in adolescent
42
43 psychiatric inpatients. *Crisis* 1999;20:8-14.
44
45
46
47 38. Moeller FG, Barratt ES, Dougherty DM, *et al.* Psychiatric aspects of impulsivity. *Am J*
48
49 *Psychiatry* 2001;158:1783-93.
50
51
52
53 39. Fradkin Y, Khadka S, Bessette KL, *et al.* The relationship of impulsivity and cortical thickness in
54
55 depressed and non-depressed adolescents. *Brain Imaging Behav* 2016.
56
57
58
59
60

- 1
2
3
4 40. Hirjak D, Thomann AK, Kubera KM, *et al.* Cortical folding patterns are associated with
5
6 impulsivity in healthy young adults. *Brain Imaging Behav* 2016.
7
8
9
10 41. d'Acremonta M, Van der Linden M. How is impulsivity related to depression in adolescence?
11
12 Evidence from a French validation of the cognitive emotion regulation questionnaire. *J*
13
14 *Adolesc* 2007;30:271-82.
15
16
17
18 42. de Kloet L, Starling J, Hainsworth C, *et al.* Risk factors for self-harm in children and adolescents
19
20 admitted to a mental health inpatient unit. *Aust N Z J Psychiatry* 2011;45:749-55.
21
22
23
24 43. Fergusson DM, Woodward LJ, Horwood LJ. Risk factors and life processes associated with the
25
26 onset of suicidal behaviour during adolescence and early adulthood. *Psychol Med*
27
28
29 2000;30:23-39.
30
31
32
33 44. Hawton K, Rodham K, Evans E. *By their own young hand: Deliberate self-harm and suicidal*
34
35 *ideas*. London: Jessica Kingsley Publishers, 2006.
36
37
38
39 45. Whitener EM, Klein HJ. Equivalence of computerized and traditional research methods: The
40
41 roles of scanning, social environment, and social desirability. *Compute Human Behav*
42
43 1995;11:65-75.
44
45
46
47 46. Booth-Kewley S, Larson GE, Miyoshi DK. Social desirability effects on computerized and
48
49 paper-and-pencil questionnaires. *Compute Human Behav* 2007;23:463-77.
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 1 Author information: We provided author information and title
4 page.
5
6
7 2 Manuscript length and formatting: Have you checked that your
8 manuscript doesn't exceed the requirements for word
9 count, number of tables and/or figures, and number of
10 references? Have you provided your abstract in the correct
11 format? (Yes) Have you supplied any required additional
12 information for your article type, such as key messages.
13 (Yes)
14
15
16
17 3 Tables: Have you embedded any tables into the main
18 text?(Yes) Have they been cited in the text? (Yes)Have
19 you provided appropriate table legends? (Yes)Have you
20 uploaded any lengthy tables as supplementary files for
21 online publication? (NO)
22
23
24
25
26
27 4 Figures: No figures
28
29 5 References: Have all of the references been cited in the text?
30 (Yes)
31
32 6 Supplementary files and appendices: Have you supplied these
33 in an acceptable format? Have they been cited in the main
34 text?
35
36
37 7 Statements: Have you included the necessary statements
38 relating to contributorship, competing interests, funding,
39 data sharing and ethical approval? (Yes)
40
41
42 8 Research reporting checklists: Have you either provided the
43 appropriate statement for your study type, or explained
44 why a checklist isn't required? (Yes)
45
46
47 9 Permissions: Have you obtained from the copyright holder to
48 re-use any previously published material? Has the source
49 been acknowledged? (Yes)
50
51
52 Reviewers: Have you provided the names of any preferred and
53 non-preferred reviewers? (Yes)
54
55
56
57
58
59
60

BMJ Open

The correlation of impulsivity with self-harm and suicide attempt: a community study of adolescents in Taiwan

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-017949.R1
Article Type:	Research
Date Submitted by the Author:	24-Aug-2017
Complete List of Authors:	Huang, Yu-Hsin; Mckay Medical Colledge, Department of Medicine; MacKay Memorial Hospital, Department of Psychiatry Liu, Hui-Ching; MacKay Memorial Hospital, Department of Psychiatry; MacKay Memorial Hospital, Suicide Prevention Centre Tsai, Fang-Ju ; En Chu Kong Hospital, Department of Psychiatry; College of Medicine, National Taiwan University, Department of Psychiatry Sun, Fang-Ju; MacKay Junior College of Medicine, Nursing, and Management; MacKay Memorial Hospital, Department of Medical Research Huang, Kuo-Yang; Taiwan Adventist Hospital, Department of Psychiatry Chiu, Yu-Ching; Cardinal Tien Hospital, Department of Psychiatry Huang, Yen-Hsun; Taipei City Psychiatric Center, Department of Psychiatry Huang, Yo-Ping; National Taipei University of Technology, Department of Electrical Engineering Liu, Shen-Ing; MacKay Medical Colledge, Department of Medicine; MacKay Memorial Hospital, Department of Psychiatry
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, Paediatrics, Public health, Smoking and tobacco
Keywords:	adolescence, deliberate self-harm, impulsivity, suicide, suicidal ideation, substance use disorders

SCHOLARONE™
Manuscripts

1
2
3
4 **Title Page**
5

6 **Manuscript category:** research article
7
8
9

10
11
12 The correlation of impulsivity with self-harm and suicide attempt: a community study
13
14
15
16 of adolescents in Taiwan
17

18
19 Yu-Hsin Huang,^{1,2,3,4} Hui-Ching Liu,^{2,3,4} Fang-Ju Tsai,^{5,6,7} Fang-Ju Sun,^{4,8}
20

21
22
23 Kuo-Yang Huang,⁹ Yu-Ching Chiu,¹⁰ Yen-Hsun Huang,¹¹ Yo-Ping Huang,¹²
24

25
26 Shen-Ing Liu,^{1,2,3,4,8}
27
28
29
30
31
32

33 ¹Department of Medicine, MacKay Medical College, New Taipei City, Taiwan
34

35
36 ²Department of Psychiatry, MacKay Memorial Hospital, Taipei, Taiwan
37
38

39
40 ³Suicide Prevention Center, MacKay Memorial Hospital, Taipei, Taiwan
41
42

43 ⁴MacKay Junior College of Medicine, Nursing, and Management, Taipei, Taiwan
44
45

46
47 ⁵Department of Psychiatry, En Chu Kong Hospital, New Taipei City, Taiwan
48
49

50 ⁶Department of Psychiatry, College of Medicine, National Taiwan University, Taipei,
51

52
53
54 Taiwan
55

56
57 ⁷Department of Psychiatry, National Taiwan University Hospital, Taipei, Taiwan
58
59

1
2
3
4⁸Department of Medical Research, MacKay Memorial Hospital, Taipei, Taiwan
5
6

7⁹Department of Psychiatry, Taiwan Adventist Hospital, Taipei, Taiwan
8
9

10¹⁰Department of Psychiatry, Cardinal Tien Hospital, New Taipei City, Taiwan
11
12

13
14¹¹Department of Psychiatry, Taipei City Psychiatric Center, Taipei City Hospital,
15
16

17
18 Taipei, Taiwan
19

20
21¹²Department of Electrical Engineering, National Taipei University of Technology,
22
23

24
25 Taipei, Taiwan
26
27
28
29
30

31 **Corresponding author**
32
33

34 Shen-Ing Liu, M.D., Ph.D., Department of Psychiatry, MacKay Memorial Hospital,
35
36

37
38 No. 92, Section 2, Chung-Shan North Rd, Taipei, Taiwan. Telephone number:
39
40

41
42 886-2-25433535-3685; Fax number: 886-2-28098746; E-mail:
43
44

45 maryliuyip@gmail.com
46
47
48
49
50

51
52 Word Count : 4,858
53
54
55
56
57
58
59
60

ABSTRACT

Objectives: The aim of this study was to investigate differences and similarities in risk factors for deliberate self-harm (DSH) and suicide attempt (SA), and the role of impulsivity among a group of community adolescents.

Setting: This is a cross-sectional study conducted at high schools in northern Taiwan.

Data and participants: We recruited grade 1 students from 14 high schools. A total of 5,879 participants (mean age 16.02 years, female: 57.7%) completed the online assessment.

Outcome measures: Participants completed online questionnaires about sociodemographic data, suicidality, history of DSH and SA, depressed mood, self-esteem, social support, family discord, impulsivity (Barratt Impulsiveness Scale Version 11 [BIS-11]), and the use of alcohol, tobacco and illicit drugs. A subsample was interviewed about lifetime SA, and the results were compared to those from the online questionnaires.

Results: In our sample, 25% of the students had lifetime DSH and 3.5% had lifetime SA. Two hundred and seventy-two students received face-to-face interviews. The agreement of lifetime SA between the online questionnaires and interviews was moderate (concordance rate 82.76%; kappa value 0.59). Similar risk factors for DSH/SA among the whole sample included female gender, lower academic performance, depression, substance use (tobacco and alcohol), and low self-esteem. The BIS-11 score was correlated with DSH. Factor 3 score of the BIS-11 (novelty-seeking) was correlated with DSH in both boys and girls, whereas factor 2 score (lack of self-control) was correlated with SA in boys. Social support was a protective factor against SA among the female adolescents. Gender modulated the association of impulsivity and DSH/SA. Impulsive boys tended to have DSH or SA.

1
2
3 **Conclusions:** Risk factors for DSH and SA were similar, but not identical. Early
4
5 identification of those at risk and appropriate interventions may be helpful.
6
7

8
9
10 Key words: Adolescence, Deliberate self-harm, Impulsivity, Suicide, Suicidal ideation,
11

12
13
14 Substance abuse disorders
15

16 17 18 19 20 **Strengths and limitations of this study** 21

22
23
24 ● This study used a large community sample of adolescents from different areas of
25
26
27 Taipei, which is a strength when it comes to generalization.
28

29
30
31 ● A further strength of the present study is that well-established self-reported
32
33
34 measures and a broad array of relevant psychosocial measures were used.
35

36
37
38 ● Few studies based in Asian countries have investigated the relationship between
39
40
41 impulsivity and deliberate self-harm and suicide attempt in a community sample.
42

43
44
45 ● The agreement between online assessments and interviews with regards to lifetime
46
47
48 suicide attempt was moderate, which showed that an online study is a reliable way to
49
50
51 investigate suicidality.
52

53
54
55 ● Gender is a moderator between the relationship of impulsivity and adolescent
56
57
58

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

deliberate self-harm/suicide attempt.

For peer review only

INTRODUCTION

According to the World Health Organization, suicide was the second leading cause of death worldwide in 2012 among people aged 15 to 29 years.¹ In addition, a systemic review reported a strong association between self-harm and later suicide, with the risk of suicide among patients with deliberate self-harm (DSH) being hundreds of times higher than that in the general population.² The terminology surrounding DSH is, however, complex. In this study, we defined DSH as self-harmful behavior, regardless of an individual's intention to die.³ The following behaviors are examples of DSH: initiating a behavior (e.g. self-cutting,³ jumping from a height,⁴ burning,⁵ hanging⁵) intended to cause self-harm; ingesting a substance in excess of the prescribed or generally recognized therapeutic dose;³⁻⁵ ingesting a recreational or illicit drug that was an act that the person regarded as being self-harm;^{4 5} and ingesting a non-ingestible substance or object.⁴

Suicide attempt (SA), that is, self-harm with the intent to die, is less common than DSH. The estimated lifetime prevalence of SA among adolescents ranges from 3.0% to 8.4%⁶⁻⁸ compared to 4.0% to 30% for DSH.⁸ Despite increased awareness

1
2
3
4 and research on DSH and SA among adolescents, few studies have investigated the
5
6
7
8 extent to which risk factors for DSH and SA overlap in a community setting,
9
10
11 especially in Asian countries.

12
13
14 Regarding etiology, there is a bio-psychosocial model for self-harm. Higher
15
16
17 levels of endogenous opioids and higher level of pain tolerance have been found in
18
19
20 self-harming people. Interactions between environmental and genetic factors may also
21
22
23 contribute to self-harm.⁹ There is also a stress-diathesis or a psychobiological model
24
25
26 for SA.¹⁰ Deficits in serotonergic neurotransmission, low CSF 5-hydroxyindoleacetic
27
28
29 acid (5-HIAA) levels, low platelet 5-hydroxytryptamine and a decreased number of
30
31
32 binding sites in platelets have been found in people with SA.¹¹ A potential link
33
34
35 between low plasma 5-HIAA levels and impulsivity/severity of the SA has also been
36
37
38 postulated.¹¹ Different etiologies may differentiate between DSH and SA; we were
39
40
41 also interested in the role of impulsivity in these two groups.
42
43
44
45
46
47

48 Impulsivity has frequently been reported to be a risk factor for both DSH and
49
50
51 SA,^{4 12} although the results are somewhat inconsistent. In one study, the association
52
53
54 with SA was non-significant after controlling for hopelessness, neuroticism, external
55
56
57
58
59
60

1
2
3
4 locus of control, self-esteem, and extroversion.¹³ In addition, Hawton et al.¹⁴ found
5
6
7 that impulsivity was an independent risk factor for self-harm among adolescent girls
8
9
10 but not among adolescent boys. In contrast, another study in Ireland reported that
11
12
13 impulsivity was a risk factor for DSH among boys but not girls.¹⁵ These inconsistent
14
15
16 findings imply that impulsivity may be important in identifying high-risk subgroups.
17
18
19 To date, most previous studies on the relationship among impulsivity, DSH and SA in
20
21
22 adolescents have been conducted in Western countries.
23
24
25
26
27

28 Due to these inconsistent results and to bridge the gaps in current knowledge, we
29
30
31 designed this study to investigate correlations among impulsivity, DSH and SA in
32
33
34 Taiwanese adolescents. The study aimed to: (1) explore possible differences and
35
36
37 similarities in risk factors among adolescents with DSH and SA, and (2) explore the
38
39
40 role of impulsivity in these two groups.
41
42
43
44
45
46
47

48 **METHODS**

49 **Subjects**

50
51
52 This study was approved by the Institutional Review Board of MacKay Memorial
53
54
55
56
57
58
59
60

1
2
3
4 Hospital. It was part of the Taiwanese Adolescent Self-Harm Project (TASP), a
5
6
7
8 prospective study conducted to evaluate the one-year incidence of self-harm behavior
9
10
11 and the associated risk factors among adolescents in Taiwan.¹⁶ From October 2008 to
12
13
14 March 2010, we recruited first-grade students from 14 senior high schools in Taipei
15
16
17 and New Taipei City, Taiwan by purposive sampling. The participating schools were
18
19
20 chosen from different regions of Taipei, including urban, suburban, and rural areas,
21
22
23 and accounted for 11.7% of all high schools in the Taipei area. After the aims of this
24
25
26 study had been fully explained to both the students and their parents, written informed
27
28
29 consent was obtained from all parents and participants.
30
31
32
33
34
35
36
37

38 **Online assessments**

39
40
41 All of the participants completed the Chinese version of the Multidimensional Scale
42
43
44 of Perceived Social Support (MDSS),¹⁷ the Chinese version of the Patient Health
45
46
47 Questionnaire (PHQ-9),¹⁸ the Chinese version of the Barratt Impulsiveness Scale,
48
49
50 Version 11 (BIS-11),¹⁹ and the Rosenberg Self-Esteem Scale (RSES).²⁰ The students
51
52
53
54
55 also reported all self-harm experiences, physical illnesses, and substance use. All of
56
57
58
59
60

1
2
3
4 the measures were completed anonymously online at the participating schools, and a
5
6
7
8 trained research assistant was also available. A subsample of the students also
9
10
11 received diagnostic interviews conducted by child psychiatrists.¹⁸ The data from the
12
13
14 online questionnaires were collected by a computer engineer. The researchers had
15
16
17
18 access to the data one day after the students had completed the questionnaires to
19
20
21 ensure the quality of the data. We also provided each school with a list of students at
22
23
24 high-risk of suicide for further referral and on-site counseling by a child psychiatrist
25
26
27
28 or a psychologist at their school.
29
30
31
32
33
34

35 Suicidality: suicide ideation, suicide plan, deliberate self-harm, and
36
37
38 suicide attempt
39

40
41 All subjects were asked if they had ever thought of killing themselves at any time in
42
43
44 their life. They were then asked about ever having planned to kill themselves. Using
45
46
47
48 the same scale, the students were then asked “Have you ever deliberately (not
49
50
51 accidentally) hurt yourself?” and “How many times have you deliberately
52
53
54
55 self-harmed?” The participants who responded positively to the main questions were
56
57
58
59
60

1
2
3
4 then asked to elaborate on their actions (multiple choices including drug overdose,
5
6
7 hanging, burning charcoal, jumping from a height, cutting themselves, and being hit
8
9
10 by a car). They were then asked to describe the act, the number of episodes, the
11
12 timing of each episode, and the consequences (e.g., need for medical intervention)
13
14 and to endorse the motive behind the act. SAs were identified in all reports of
15
16 self-harm according to the response to, “Have you ever really tried to kill yourself
17
18 during these DSH episodes?” We also collected the number of SAs and the time of
19
20 the first and last attempts. The subjects who reported having harmed themselves
21
22 with/without suicidal intent were classified as “DSH.” SA was defined as an
23
24 intentional action to kill oneself.
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42

43 The Chinese version of the BIS-11

44
45 The BIS-11 is a 30-item self-reported questionnaire designed to measure impulsivity.
46
47
48 The total score ranges from 30 to 120, with a higher score indicating greater
49
50 impulsivity.²¹ The 25 items of the Chinese version of the BIS-11 have demonstrated
51
52
53
54
55 good overall internal consistency in Taiwanese adolescents, with a Cronbach’s alpha
56
57
58
59
60

1
2
3
4 of 0.834.¹⁹ The factor structure of the Chinese version of the BIS-11 consists of three
5
6
7 factors: “inability to plan,” “lack of self-control,” and “novelty-seeking.”
8
9

14 Multi-dimensional Scale of Perceived Social Support (MDSS)

15
16
17 The MDSS is a self-reported measure of the availability and adequacy of social
18
19 support from various sources.¹⁷ We estimated four types of social support, including
20
21 that from parents, other family members, friends, and teachers, with a higher score
22
23 indicating greater social support. In our sample, the Cronbach’s alpha was 0.63.
24
25
26
27
28
29
30
31
32
33

34 The Chinese version of the Patient Health Questionnaire-9 item (PHQ-9)

35
36 The PHQ-9 consists of nine items evaluating the presence of one of the nine
37
38 *Diagnostic and Statistical Manual of Mental Disorders (Fourth edition) [DSM-IV]*
39
40 criteria of major depressive episodes during the past 2 weeks. The total score ranges
41
42 from 0 to 27, with higher scores indicating an increased likelihood of major
43
44 depressive disorder (MDD). The Chinese version of the PHQ-9 has been validated for
45
46 detecting MDD, and has shown good internal consistency ($\alpha = 0.84$) and acceptable
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 test-retest reliability (intra-class correlation coefficient = 0.80) among adolescents in
5
6
7 the community.¹⁸ A PHQ-9 score ≥ 15 had a sensitivity of 0.72 and a specificity of
8
9
10
11 0.95 for recognizing MDD.
12
13

14 15 16 17 18 The Chinese version of the Rosenberg Self-Esteem Scale (RSES) 19

20
21 The RSES consists of 10 items that refer to self-respect and self-acceptance.²² The
22
23
24 Chinese version of the RSES has demonstrated acceptable internal consistency. The
25
26
27
28 reliability and validity of the Chinese version of the RSES have also been
29
30
31 demonstrated.²⁰
32
33
34
35
36
37

38 Substance use variables 39

40
41 Data on substance use included information on cigarette smoking, high-risk alcohol
42
43
44 use and any illicit drug use. The participants who reported that they smoked currently
45
46
47
48 were classified as current cigarette smokers. High-risk alcohol use was assessed using
49
50
51
52 the Chinese version of the Alcohol Use Disorders Identification Test-Consumption
53
54
55 (AUDIT-C). The AUDIT-C includes the first three questions from the full AUDIT,²³
56
57
58
59
60

1
2
3
4 and assesses the amount and frequency of alcohol intake and frequency of alcohol
5
6
7
8 misuse (defined as having six or more drinks). The optimal cut-off score of the
9
10
11 Chinese AUDIT-C for hazardous drinking was 3/4, with good sensitivity (0.90) and
12
13
14 specificity (0.92).²⁴ In this study, this was treated as a continuous variable, and a
15
16
17
18 higher score indicated more alcohol use. A summary of illicit drug use was obtained
19
20
21 from the participants who had used any form of illicit drug during the past month.
22
23
24
25
26
27

28 **Face-to-face interviews with child psychiatrists using the**

29

30

31 **Kiddie-Schedule for Affective Disorder and Schizophrenia**

32

33

34 **Epidemiological Version (K-SADS-E)**

35

36

37

38 The K-SADS-E is a semi-structured interview scale for the systematic assessment of
39
40
41 both past and current episodes of psychiatric disorders in children and adolescents.
42
43
44

45 The Chinese version has been shown to be a reliable and valid instrument.²⁵ Child
46
47
48 psychiatrists blind to the results of the online assessments interviewed a subsample of the
49
50
51 students (n = 272) using the K-SADS-E. After 12 months of the initial assessment, the
52
53
54
55 students completed the same questionnaires. All of the students with new occurrences
56
57
58
59
60

1
2
3
4 of self-harm in the past year (i.e., the students who did not report self-harm at entry
5
6
7 but did the next year) were enrolled for face-to-face interviews. The students who did
8
9
10 not report any occurrences of self-harm at both years were randomly selected on a 1:1
11
12
13 ratio, frequency matched by class and gender. For the students who reported
14
15
16 occurrences of self-harm in both years, one in two received face-to-face interviews.
17
18
19 The response rate was 94.8%. Lifetime SA was assessed by the child psychiatrists
20
21
22 according to the question, "Have you actually tried to kill yourself?"
23
24
25
26
27
28
29
30

31 **Statistical analysis**

32
33
34 Descriptive and analytical statistics of the data obtained in this study were analyzed
35
36
37 using SPSS version 21.0 for Windows (SPSS, IBM, Armonk, NY, USA). Risk factors
38
39
40 for DSH and SA were first analyzed using univariate logistic regression analysis, with
41
42
43 one variable at a time. Hierarchical multiple regression strategies (using a stepwise
44
45
46 method) were then used to determine the risk factors for DSH/SA and to assess
47
48
49 whether impulsivity played any role. The joint effect of the independent variables that
50
51
52 showed significance in univariate analysis was assessed with hierarchical regression
53
54
55
56
57
58
59
60

1
2
3
4 analysis. To examine the association between impulsivity and DSH/SA, all
5
6
7
8 sociodemographic and personality (BIS-11, RSES) variables were introduced in the
9
10
11 first step (model 1), followed by adding social support (MDSS) in the second step
12
13
14 (model 2), alcohol/tobacco use in the third step (model 3), and depressive symptoms
15
16
17 in the fourth step (model 4). We then examined the interaction between gender and
18
19
20 BIS-11 among logistic regression analyses to see whether the relationship between
21
22
23 impulsivity and DSH/SA was moderated by gender (model 5).²⁶ Logistic regression
24
25
26 was used to analyze the role of impulsivity and all other sociodemographic, clinical
27
28
29 and personality trait variables with DSH/SA between genders (model 6). We further
30
31
32 analyzed three subscales of the BIS-11 instead of the total score in the male and
33
34
35 female students.
36
37
38
39
40

41 We also examined the agreement (i.e. reliability) between the computer
42
43
44 questionnaire assessments and face-to-face interviews (n = 272) with regards lifetime
45
46
47 SA assessed at the second year. This agreement was assessed by concordance rate and
48
49
50 kappa statistics.²⁷
51
52
53
54
55
56
57
58
59
60

RESULTS

Descriptive statistics and univariate analysis of lifetime DSH and lifetime SA

We recruited 5,879 students with a mean age of 16.02 years (standard deviation 0.52).

The overall response rate was 60.61%. Students in Taiwan have heavy study stress

and that may hinder their motivation to participate. Table 1 shows the

sociodemographic data of the students along with scores on the MDSS, PHQ-9,

BIS-11, RSES, and AUDIT-C. Twenty-five percent of the students (n = 1,472)

reported self-harm behavior, with a mean of 4.06 times (standard deviation: 3.33).

Two hundred and six students (3.5%) reported that their self-harm behavior was

actually a suicide attempt. The mean BIS-11 score was 62.9 for the students with

lifetime DSH, and 64.2 for those with lifetime SA.

Table 1 Sociodemographic data and variables significantly associated with lifetime deliberate self-harm (DSH) and suicide attempt (SA)

Variables	All students (n = 5,879)	Ever had DSH (n = 1,472)	Univariate logistic regression	Ever had SA (n = 206)	Univariate logistic regression	No DSH history (n = 4,407)
	N (%) or mean (SD)	N (%) or mean (SD)	OR (95% CI)	N (%) or mean (SD)	OR (95% CI)	N (%) or mean (SD)
Female gender	3,335 (56.7)	966 (65.6)	1.64 (1.45~1.86)***	145 (70.4)	2.05 (1.51~2.77)***	2,369 (53.8)
School district (urban)	2,501 (42.5)	551 (37.4)	referent	86 (41.7)	referent	1,950 (44.2)
(suburbs)	3,005 (51.1)	823 (55.9)	1.34 (1.18~1.51)***	111 (53.9)	1.15 (0.87~1.54)	2,182 (49.5)
(rural)	373 (0.3)	98 (6.7)	1.26 (0.98~1.62)	9 (4.4)	0.74 (0.37~1.49)	275 (6.2)
Low school ranking ^a	4,155 (70.7)	1,152 (78.3)	1.68 (1.47~1.93)***	191 (92.7)	5.95 (3.51~10.11)***	3,003 (68.1)
Father is employed	5,179 (88.1)	1,258 (85.5)	0.73 (0.61~0.87)***	169 (82.0)	0.57 (0.39~0.82)**	3,921 (89.0)
Mother is employed	4,197 (71.4)	1,080 (73.4)	1.14 (0.99~1.30)	148 (71.8)	1.06 (0.77~1.44)	3,117 (70.7)
Not live with biological parents	1,055 (17.9)	333 (22.6)	1.49 (1.29~1.73)***	58 (28.2)	2.00 (1.46~2.74)***	722 (16.4)
BIS-11 score	60.1 (8.5)	62.9 (8.4)	1.06 (1.05~1.07)***	64.2 (8.8)	1.07 (1.06~1.09)***	59.1 (8.3)
Factor 1 ^b	19.9 (3.9)	20.4 (3.9)	1.05 (1.03~1.07)***	20.5 (4.1)	1.06 (1.02~1.10)**	19.7 (3.9)
Factor 2 ^c	24.5 (4.5)	26.1 (4.6)	1.11 (1.09~1.13)***	27.0 (4.7)	1.16 (1.12~1.20)***	24.0 (4.3)
Factor 3 ^d	15.7 (3.0)	16.4 (3.0)	1.12 (1.09~1.15)***	16.6 (3.0)	1.13 (1.08~1.19)***	15.4 (3.0)
Within family discord	558 (9.5)	221 (15.0)	2.13 (1.78~2.56)***	48 (23.3)	3.67 (2.61~5.16)***	337 (7.6)
Current smoker	226 (3.8)	113 (7.7)	3.16 (2.42~4.13)***	26 (12.6)	5.49 (3.49~8.62)***	113 (2.6)
MDSS score	20.8 (3.6)	20.1 (3.6)	0.93 (0.92~0.95)***	19.5 (3.6)	0.89 (0.86~0.92)***	21.1 (3.6)
PHQ-9 score	5.7 (4.6)	8.2 (5.5)	1.16 (1.15~1.18)***	10.5 (5.7)	1.24 (1.21~1.27)***	4.9 (4.0)
AUDIT-C score	1.1 (1.9)	0.9 (5.2)	1.26 (1.23~1.30)***	2.1 (2.4)	1.29 (1.22~1.36)***	1.8 (2.3)
RSES score	28.3 (5.4)	26.2 (5.5)	0.91 (0.90~0.92)***	23.9 (5.4)	0.84 (0.82~0.86)***	29.0 (5.2)

^aBelow the 70th percentile; ^binability to plan; ^clack of self-control; ^dnovelty-seeking * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; BIS-11: Barratt Impulsiveness Scale, version 11; MDSS: Multi-dimensional Scale of Perceived Social Support; PHQ-9: Patient Health Questionnaire-9 item; AUDIT-C: Alcohol Use Disorders Identification Test-Consumption; RSES: Rosenberg Self-Esteem Scale

1
2
3
4 There was no statistical difference in BIS-11 score between the male and female students.
5
6
7 Univariate analysis revealed that the risk factors associated with both lifetime DSH and SA were
8
9
10 higher impulsivity, female gender, low school ranking, father's job status, not living with biological
11
12
13 parents, family discord, low self-esteem, poor social support, currently smoking, more alcohol use,
14
15
16 and more depressive symptoms (Table 1). Students in schools located in suburban areas compared to
17
18
19 those in urban area had a higher risk of DSH.
20
21
22
23

24 **Hierarchical regression of lifetime DSH and lifetime SA**

25
26
27 The results of the hierarchical approach are presented in Tables 2 and 3. The adjusted model 1
28
29
30 including sociodemographic variables and personality traits (RSES, BIS-11) showed that similar risk
31
32
33 factors were associated with both DSH and SA. These included high impulsivity, low self-esteem,
34
35
36 female gender, family discord and low school ranking. The factors of father's job status, school
37
38
39 district and living with one's biological parents ceased to be significant predictors, indicating that
40
41
42 these variables were fully statistically mediated by factors of gender, self-esteem, impulsivity, family
43
44
45 discord and school ranking. In an unadjusted model, as the impulsivity score (BIS) increased by 1
46
47
48 unit, the likelihood of reporting a lifetime DSH and SA increased by approximately 6% and 7%,
49
50
51 respectively. The addition of gender, school district, family discord, school ranking, and self-esteem
52
53
54 factors attenuated the effect of impulsivity on the odds ratio (OR = 1.04) (Tables 2 and 3).
55
56
57
58
59
60

Table 2 Summary of hierarchical multiple regression analyses (stepwise method) examining multivariate correlates of deliberate self-harm

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6 (Male)	Model 6 (Female)
	OR (95% CI)						
BIS-11 score	1.04 (1.03~1.05)***	1.04 (1.03~1.05)***	1.03 (1.02~1.04)***	1.02 (1.01~1.03)***	1.02 (1.003~1.03)*	1.03 (1.02~1.05)***	
Female gender	1.67 (1.41~1.97)***	1.67 (1.41~1.97)***	1.95 (1.64~2.32)***	1.86 (1.56~2.22)***			
School district							
Low school ranking	1.49 (1.17~1.91)**	1.49 (1.17~1.91)**	1.33 (1.04~1.71)*	1.36 (1.06~1.75)*	1.36 (1.05~1.75)*		1.84 (1.30~2.61)**
Father is employed							
Not live with biological parents							
With family discord	1.57 (1.24~2.00)***	1.57 (1.24~2.00)***	1.52 (1.19~1.95)**				
RSES score	0.93 (0.91~0.94)***	0.93 (0.91~0.94)***	0.93 (0.91~0.94)***	0.96 (0.95~0.98)***	0.96 (0.95~0.98)***	0.96 (0.93~0.99)**	0.96 (0.94~0.98)**
MDSS score							
Current smokers			1.88 (1.30~2.72)**	1.78 (1.22~2.60)**	1.80 (1.23~2.63)**		3.44 (1.52~7.78)**
AUDIT-C score			1.19 (1.14~1.23)***	1.15 (1.11~1.20)***	1.15 (1.10~1.20)***	1.09 (1.03~1.15)**	1.28 (1.19~1.36)***
PHQ-9 score				1.12 (1.10~1.15)***	1.12 (1.10~1.15)***	1.11 (1.08~1.14)***	1.14 (1.11~1.17)***
BIS-11xgender					1.01 (1.007~1.013)***		

Model 1 adjusted for all sociodemographic variables and personality (RSES, BIS-11 score)

Model 2 adjusted for Model 1 and social support (MDSS score)

Model 3 adjusted for Model 2 and substance use (current smokers, AUDIT-C score)

Model 4 adjusted for Model 3 and depressive symptoms (PHQ-9 score)

Model 5 interaction term of BIS-11 and gender was added

Model 6: analyzed by different gender

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

Table 3 Summary of hierarchical multiple regression analyses (stepwise method) examining multivariate correlates of suicide attempt

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6 (Male)	Model 6 (Female)
	OR (95% CI)						
BIS-11 score	1.04 (1.02~1.06)***	1.04 (1.02~1.06)***	1.03 (1.004~1.05)*				
Female gender	2.11 (1.53~2.92)***	2.18 (1.58~3.02)***	2.99 (2.09~4.27)***	2.91 (2.01~4.20)***			
Low school ranking	2.03 (1.17~3.54)*	1.97 (1.13~3.44)*	1.80 (1.02~3.17)*	2.03 (1.14~3.63)*	1.92 (1.08~3.44)*		2.13 (1.02~4.47)*
Father is employed							0.57 (0.34~0.98)*
Not live with biological parents							
With family discord	2.17 (1.48~3.18)***	1.99 (1.35~2.93)**	2.01 (1.35~2.99)**				
RSES score	0.86 (0.84~0.89)***	0.87 (0.84~0.90)***	0.87 (0.84~0.90)***	0.91 (0.88~0.94)***	0.91 (0.88~0.94)***	0.92 (0.87~0.97)**	0.90 (0.87~0.94)***
MDSS score		0.94 (0.90~0.98)**	0.95 (0.91~0.995)*				0.94 (0.89~1.00)*
Current smokers			2.93 (1.62~5.32)***	3.02 (1.63~5.60)***	2.96 (1.61~5.46)**	3.52 (1.72~7.19)**	5.24 (1.76~15.7)**
AUDIT-C score			1.23 (1.15~1.32)***	1.17 (1.09~1.26)***	1.16 (1.08~1.25)***		1.26 (1.13~1.40)***
PHQ-9 score				1.19 (1.15~1.23)***	1.19 (1.15~1.23)***	1.17 (1.12~1.23)***	1.20 (1.15~1.26)***
BIS-11×gender							1.02 (1.01~1.02)***

Model 1 adjusted for all sociodemographic variables and personality (RSES, BIS-11 score)

Model 2 adjusted for Model 1 and social support (MDSS score)

Model 3 adjusted for Model 2, and substance use (current smokers, AUDIT-C score)

Model 4 adjust for Model 3 and depressive symptoms (PHQ-9 score)

Model 5 interaction term of BIS-11 and gender was added

Model 6: analyzed by different gender

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

1
2
3
4
5
6
7 We then added social support status (MDSS score) into model 2. Social support did not
8
9
10 significantly alter the confidence intervals of the other variables in model 1 with regards to DSH, and
11
12 it was also not significantly associated with DSH in model 2. However, social support was a
13
14 protective factor for SA in adjusted model 2. Impulsivity, female gender, low self-esteem, low school
15
16 ranking, and family discord retained significance in adjusted model 2 for SA.
17
18
19

20
21 In model 3 we added variables of substance use, and DSH and SA were still significantly
22
23 associated with impulsivity, although the odds were attenuated (Tables 2 and 3). The other
24
25 significant variables in model 2 persisted as risk factors for DSH/SA in model 3. Currently smoking
26
27 and a higher level of alcohol use were strong risk factors for DSH/SA.
28
29
30
31

32
33 In model 4, we included all variables (including depressive symptoms). DSH was still
34
35 significantly associated with impulsivity, although its odds were attenuated again. The effect of
36
37 family discord was fully statistically mediated in the final model of DSH. Other significant variables
38
39 in model 3 persisted as risk factors for DSH in the final model. Depressive symptoms was a risk
40
41 factor for DSH, and for every 1 unit increase in PHQ score, the likelihood of reporting lifetime DSH
42
43 increased by 12%. In addition, for every 1 unit increase in AUDIT-C score, the likelihood of
44
45 reporting lifetime DSH increased by 15%.
46
47
48
49
50
51
52

53 Impulsivity, family discord, and social support lost their significance after adjusting for the
54
55 aforementioned covariates in model 4 for the SA group (Table 3). Depressive symptoms and
56
57
58
59
60

1
2
3
4 substance use (alcohol and tobacco use) were stronger risk factors for SA than impulsivity. For every
5
6
7 1 unit increase in PHQ score, the likelihood of reporting lifetime SA increased by 19%, and for every
8
9
10 1 unit increase in AUDIT-C score, the likelihood of reporting lifetime SA increased by 17%. The
11
12 effects of depression and alcohol use on SA were stronger than those on DSH. In addition, smoking
13
14 had the strongest effect on SA, with current smokers having a 3-fold higher risk of SA compared to
15
16
17 nonsmokers.
18
19

20
21 When we added the interaction term of BIS-11 and gender in model 5, we found that they were
22
23 significant in both Tables 2 and 3. This meant that gender modulated the association between
24
25 impulsivity and DSH/SA. Other risk factors besides gender remained significance in both Tables 2
26
27 and 3.
28
29
30
31

32
33 We further analyzed the risk factors for DSH/SA by gender in model 6. For boys, impulsivity,
34
35 low self-esteem, alcohol use and depressive symptoms were risk factors for DSH, compared to low
36
37 school ranking, low self-esteem, smoking, alcohol use and depressive symptoms in girls (Table 2).
38
39 Impulsive boys tended to have DSH, where as total impulsivity scores were not associated with SA
40
41 in either gender. For boys, low self-esteem, smoking and depressive symptoms were risk factors for
42
43 SA, compared to low school ranking, low self-esteem, poor social support, smoking, alcohol use and
44
45 depressive symptoms in girls, while their father's employment status was a protective factor (Table
46
47
48
49
50
51
52
53 3). Smoking status was an especially strong risk factor for SA in girls (OR = 5.24).
54
55

56 We used three subscales instead of BIS-11 total score in the multivariate logistic regression
57
58
59
60

1
2
3
4 analysis to investigate the relationships among impulsivity subscales and DSH/SA (Table 4). For
5
6
7 both genders, factor 3 of the BIS-11 scale (novelty-seeking and acting without thinking), low
8
9
10 self-esteem, alcohol use and depressive symptoms were risk factors for DSH. Low school ranking
11
12
13 and smoking were additional risk factors for DSH in girls. For boys, risk factors for SA included
14
15
16 factor 2 of the BIS-11 scale (lack of perseverance and self-control), low self-esteem, smoking and
17
18
19 depressive symptoms. For girls with SA, impulsivity subscales were non-significant.
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 4 Multiple regression analyses (stepwise method) examining multivariate correlates of deliberate self-harm (DSH) and suicide attempt (SA), focusing on three subscales of the BIS-11

	DSH (Male)	DSH (Female)	SA (Male)	SA (Female)
	OR (95% CI)			
BIS-11 score factor 1 ^a				
BIS-11 score factor 2 ^b			1.07 (1.01~1.14)*	
BIS-11 score factor 3 ^c	1.10 (1.05~1.16)***	1.04 (1.002~1.08)*		
Low school ranking		1.79 (1.26~2.54)**		2.13 (1.02~4.47)*
Father is employed				0.57 (0.34~0.98)*
Not live with biological parents				
With family discord				
RSES score	0.94 (0.92~0.97)***	0.96 (0.93~0.98)***	0.93 (0.88~0.99)*	0.90 (0.87~0.94)***
MDSS score				0.94 (0.89~1.00)*
Current smokers		3.46 (1.54~7.81)**	2.95 (1.42~6.13)**	5.24 (1.76~15.65)**
AUDIT-C score	1.08 (1.02~1.14)**	1.26 (1.18~1.35)***		1.26 (1.13~1.40)***
PHQ-9 score	1.10 (1.06~1.13)***	1.13 (1.10~1.16)***	1.15 (1.10~1.21)***	1.20 (1.15~1.26)***

^ainability to plan or look ahead; ^black of perseverance and self-control; ^cnovelty-seeking and acting without thinking; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

1
2
3
4 **Agreement between online assessment and face-to-face interviews**
5
6
7 **(concordance rate and kappa statistics)**
8

9
10 The concordance rate was the proportion of the same status of lifetime SA comparing the results of
11
12 the online assessments and face-to-face interviews, which was 82.76% [(89+31)/145] (Table 5). The
13
14 kappa value was 0.59, which was in moderate agreement range.²⁷
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Table 5 Comparison of online assessments vs. face-to-face interviews of lifetime suicide attempt (SA)

		Interview assessment		
		Lifetime SA (-)	Lifetime SA (+)	Total
Online assessment	Lifetime SA (-)	89	9	98
	Lifetime SA (+)	16	31	47
	Total	105	40	145

DISCUSSION

The findings of the current study show that the risk factors associated with DSH and SA were similar, but not identical, in our cohort of adolescent school students. The same risk factors for both DSH and SA included female gender, low school ranking, depression, substance (tobacco and alcohol) use, and low self-esteem. These risk factors associated with DSH/SA can therefore be targeted in future prevention strategies. After adjusting for demographic factors and all other psychosocial factors, impulsivity was an independent risk factor for DSH but not for SA. However, factor 2 of the BIS (lack of perseverance and self-control) was significantly associated with SA in boys.

Common risk factors

The results of the current study with regards to gender differences in adolescent DSH/SA are consistent with previous findings, in that adolescent girls showed a higher prevalence of DSH^{5,28} and SA.^{7,29,30} With respect to the personality characteristics, low self-esteem has been associated with both DSH⁴ and SA.²⁹ Cross-sectional surveys of adolescents have consistently found that depression is strongly correlated with DSH^{4,5} and SA.^{29,30} Tobacco smoking has also been previously identified to be a risk factor for DSH^{5,31} and SA,^{32,33} along with alcohol use for DSH^{5,28,31} and SA.^{32,33} When we analyzed the data according to gender, we found that tobacco smoking and alcohol use were especially important risk factors for DSH/SA in girls (Tables 2 and 3). Compared to boys, the prevalence of smoking and alcohol use are relatively low in Taiwanese girls (OR = 5.5 and 5.8

1
2
3
4 respectively, girls as the reference group).³⁴ Female smokers or alcohol users may be more
5
6
7 pathological and have a lower threshold for DSH/SA. The risk factors in the current study are in
8
9
10 good agreement with the existing literature, which underscores the need to offer preventive
11
12 interventions by addressing each of these risk factors to reduce DSH/SA and alleviate current distress.
13
14 School surveys to identify adolescents with low self-esteem, depression, or substance use are
15
16 warranted, and mental health interventions for depression, substance use and to enhance self-esteem
17
18 are also needed.
19
20
21
22
23

24 Stress due to school studies is usually high in Chinese society, and academic performance (i.e.
25
26 school ranking in this study) was a culturally specific factor for adolescent DSH and SA in this study.
27
28
29 A previous study in Hong Kong reported that poor academic performance was related to adolescent
30
31 non-suicidal self-harm and SA.³⁵ Several explanations for the relationship between academic
32
33 performance and DSH/SA have been proposed. Academic problems may precede DSH/SA, or they
34
35 may both be caused by the same set of underlying risk factors. Students with poor academic
36
37 performance should receive more attention from their teachers, because Chinese society emphasizes
38
39 academic performance and those with poor performance may have higher levels of frustration, poor
40
41 self-esteem and hopelessness. Mental health and education policy makers may need to provide low
42
43 ranking schools with more counseling services and support from mental health professionals;
44
45 especially in girls' schools. Academic remediation activities may also be arranged to help students.
46
47
48 Regular screening programs to early detect those who may need mental health services are also
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 warranted. The education system and parents should also encourage other strengths rather than
4
5
6 academic performance alone, such as studying at a vocational school. Further research should
7
8
9 investigate the relationship between a student's academic high school performance and suicidality.
10
11

12 13 14 15 **Impulsivity**

16
17
18 There seems to be more evidence that impulsivity is associated with adolescent DSH than with SA.
19
20
21 For example, previous studies in Europe and the US have reported higher impulsiveness on
22
23
24 self-reported scales as a risk factor for adolescent DSH,^{4 36} which is consistent with our findings.
25
26
27 However, in contrast to previous studies,^{4 12} our results do not support an association between overall
28
29
30 impulsivity score and SA. Impulsivity could characterize the suicidal adolescents in models 1, 2, and
31
32
33 3, but it became non-significant after adding covariates of depressive symptoms (Table 3). However,
34
35
36 some studies have also reported no relationship between impulsivity and SA. In a case-control study
37
38
39 comparing suicidal completers and community control adolescents, impulsivity was related to
40
41
42 suicide in univariate analysis but not in multivariate analysis.³⁷ In another study surveying suicidal
43
44
45 and non-suicidal adolescent inpatients, the self-reported Impulse Control Scale score was not
46
47
48 different between the two groups.³⁸

49
50 When we focused on the moderating effects of gender, we found that total impulsivity score (OR
51
52
53 = 1.03) was correlated with DSH only in boys (model 6 of Table 2). The odds ratio was slightly
54
55
56 higher compared to impulsivity among all students (OR = 1.02, model 5 of Table 2). Previous studies
57
58
59
60

1
2
3
4 in Ireland also found that impulsivity was a risk factor for DSH only in boys.^{15 39} Gender also
5
6
7 modulated the association between impulsivity and SA (model 5 of Table 3). However impulsivity
8
9
10 lost its significance in model 6 in both genders. We postulate that the moderating effect was weak.

11
12 Among the BIS subscales, BIS-11 factor 3 (novelty seeking and acting without thinking) was
13
14 associated with DSH in both boys and girls in multivariate analysis (Table 4). Inconsistent results
15
16 regarding the relationship between impulsivity and DSH have been reported. Impulsivity, like
17
18 suicidality, is a complicated construct consisting of many factors, rather than a unidimensional
19
20 measure.⁴⁰ Thus the subscale analysis was warranted. Sensation seekers (i.e. high factor 3) have been
21
22 shown to pursue novelty even at the cost of self-harm,⁴¹ and this may explain our findings that factor
23
24 3 was correlated with DSH in both genders.
25
26
27
28
29
30
31

32
33 We also found that BIS-11 factor 2 (lack of perseverance and self-control) characterized SA in
34
35 boys in multivariate analysis (Table 4), which is consistent with prior studies.^{42 43} A previous
36
37 Taiwanese study found that male adults with a history of SA exhibited higher BIS-11 factor 2
38
39 scores,⁴² and Horesh et al. also found an association between impulsivity and SA among male
40
41 adolescent inpatients.⁴³ A study using neuropsychological tests and brain imaging found that
42
43 prepotent motor responses are more easily evoked in men, which is a tendency that could predispose
44
45 them to impulse control disorders.⁴⁴ In addition, suicidal male adolescents are more likely to exhibit
46
47 an impulsive presentation than suicidal females.⁴⁵ Since BIS-11 factor 2 is considered to reflect
48
49 long-standing behavioral patterns,⁴⁶ it is plausible that boys with a lack of self-control and low
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 self-esteem may be prone to suicidal behavior. Gender modulated the association between
5
6
7 impulsivity and SA, and that may explain why BIS factor 2 score was significant in boys only.
8
9

10 Impulsive boys under stress such as those with depression or substance use may be less tolerant
11
12 of complex thinking and lack of flexibility, and hence are predisposed to having a lower threshold for
13
14 SA without contemplating the possible consequences.⁴² A neuroimaging study confirmed that BIS-11
15
16 subscales were correlated with different brain regions in adolescents.⁴⁷ Another study of young adults
17
18 found gender-specific differences in BIS-11-LGI (local gyrification index) correlations in the middle
19
20 and inferior frontal gyrus,⁴⁸ which may explain our findings of a gender difference in impulsivity.
21
22
23
24
25
26

27 Our results may support the stress-diathesis theory that dispositionally impulsive adolescents
28
29 and those with low self-esteem with mental illnesses such as depression are more likely to have SA.
30
31 In a French study, impulsive traits of adolescents were related to the use of fewer appropriate and
32
33 more inappropriate regulation strategies and depression.⁴⁹ Psychological interventions to decrease
34
35
36 impulsivity are also needed.
37
38
39
40
41
42
43

44 **Other psychosocial dimensions**

45
46
47 In hierarchical regression analysis of SA, social support was present in models 2 and 3, but
48
49 disappeared after adjusting for substance use and depressive symptoms in model 4 (Table 3).
50
51
52
53 However, social support remained a risk factor for SA in the final model among girls. This may
54
55 reflect that girls are affected by relationships with peers, family and teachers more than boys. A
56
57
58
59
60

1
2
3
4 previous study also showed that social connectedness or family support³⁰ was associated with
5
6 adolescent suicide risk. Social support in our study included that from family, peers and teachers,
7
8 which may have contributed to the negative findings. Our results suggest that particular attention
9
10 should be paid to high-risk girls with poor social support, and that active interventions should be
11
12 arranged. Perceived family discord was a risk factor for DSH and SA in models 1, 2, and 3 of the
13
14 current study, implying that family plays a role in adolescents' suicidality. This is consistent with
15
16 previous DSH⁵⁰ and SA studies.³⁰ However, its effects on DSH and SA disappeared after adding
17
18 depressive symptoms. A longitudinal study had similar findings in that after controlling for mental
19
20 health disorders and adverse life events, the influence of parental and family factors on adolescent
21
22 suicide was attenuated.⁵¹
23
24
25
26
27
28
29
30
31
32
33
34
35

36 **Strengths and limitations**

37
38 This study used a large community sample of adolescents from different areas of Taipei, which is a
39
40 strength when it comes to generalization. A further strength in the present study is that
41
42 well-established self-reported measures and a broad array of relevant psychosocial measures were
43
44 used. Finally, few studies not based in Western countries have investigated the risk factors for DSH
45
46 and SA in a community sample.
47
48
49
50
51
52

53 There are also several limitations to this study. First, conducting a large-scale survey with such
54
55 a large sample does not allow for individual in-depth interviews. Measures in the present study were
56
57
58
59
60

1
2
3
4 self-reported, and thus may reflect bias. However, data from large school surveys by Hawton et al
5
6
7 were also self-reported,¹⁴ and they found that the majority of respondents reporting lifetime DSH
8
9
10 were also classified as having DSH by expert evaluation.⁵² This is similar to the findings of the
11
12
13 current study in that the agreement between online assessments and interviews with regards to
14
15
16 lifetime SA was moderate. In addition we conducted the tests in a group setting, and the students
17
18
19 could preview the online questionnaires and review and change their answers to decrease a social
20
21
22 desirability effect and yield more reliable data.⁵³ Self-reports using online questionnaires have been
23
24
25 shown to allow students to report more sensitive risky behavior than using paper-and-pencil
26
27
28 questionnaires.⁵⁴ Second, we did not use multiple assessments such as lab-measured impulsivity.
29
30
31 However, a previous study showed a significant correlation between the self-reported form and the
32
33
34 Test of Variables of Attention (TOVA) measure of impulsivity ($r = 0.34$; $p < 0.05$).³⁸ Third, BIS-11
35
36
37 did not assess emotional impulsivity. However one meta-analysis found negative urgency, a form of
38
39
40 emotional impulsivity, was significantly related to a composite of suicidality, and the effect size for
41
42
43 negative urgency was larger than those reported for other forms of impulsivity.⁵⁵ Emotional-relevant
44
45
46 impulsivity needs to be assessed in future work. Fourth, this study was cross-sectional, precluding
47
48
49 conclusions regarding causality. Future longitudinal studies examining alternative moderators are
50
51
52 needed.

53 54 55 56 **CONCLUSIONS**

1
2
3
4 We found a number of similarities and differences in certain risk factors between adolescents with
5
6
7 DSH and those with SA. Poor impulsivity and other factors such as female gender, low self-esteem,
8
9
10 poor academic performance, depression and tobacco/alcohol use were significant risk factors in the
11
12
13 final model of adolescent DSH. Gender modulated the relationship between impulsivity and DSH,
14
15
16 and the impulsive boys tended to have DSH. Similar factors were associated with SA in the final
17
18
19 model except for impulsivity, although its subscale was associated with SA in boys. Gender was also
20
21
22 a moderator for the association between impulsivity and SA. These shared and unique risk factors are
23
24
25 important to understand the mechanism behind DSH and SA, and to allow for incorporation of these
26
27
28 risk factors into future research on prevention programs for these two behaviors among vulnerable
29
30
31 adolescents across different settings.

32
33 Given the high prevalence rates and low consultation rates of these two behaviors, we suggest
34
35
36 that these high-risk behaviors should be considered as a public health problem. Mental health
37
38
39 professionals in schools should routinely assess DSH and SA, and self-reported screening
40
41
42 questionnaires should be conducted along with routine physical examinations in school to help
43
44
45 identify adolescents at risk. Paying attention to the mental health of adolescents at school may help
46
47
48 to prevent the consequences associated with unidentified and untreated mental health problems.

49
50
51
52
53 **Funding statement** Supported by grants from the Ministry of Science and Technology,
54
55
56 Taiwan, R.O.C. (NSC 9802314-B-195-011 MY3) and Mackay Memorial Hospital (9838,
57
58
59

1
2
3
4 9880), Taiwan.
5
6

7 **Competing interest statement** None declared.
8

9
10 **Contributors**

11
12 YH Huang contributed to data collection, performed the data analysis and drafted the article. HC Liu
13 drafted the study protocol and helped in the data collection process. FJ Tsai helped in the diagnostic
14 interview process. FJ Sun contributed in statistical analyses. KY Huang contributed in the diagnostic
15 interview process. YC Chiu contributed in counseling of at-risk adolescents, reviewing the article
16 and revising it critically for important intellectual content. YH Huang contributed in the diagnostic
17 interview process. YP Huang contributed to reviewing the article and revising it critically for
18 important intellectual content. SI Liu monitored and guided the designing and implementation of the
19 study, data collection, statistical analyses, interpreting findings, and revising the article. All authors
20 approved the manuscript submission for publication.
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42

43 **Data sharing statement** No additional data available
44
45
46

47 **REFERENCES**
48

49
50 1. W.H.O. First WHO report on suicide prevention. 2014.
51

52
53 <http://www.who.int/mediacentre/news/releases/2014/suicide-prevention-report/en/> (accessed
54
55
56 2017 May 26).
57
58
59
60

- 1
2
3
4 2. Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm. Systematic review. *Br*
5
6
7 *J Psychiatry* 2002;181:193-9.
8
- 9
10 3. Hawton K, Bergen H, Casey D, *et al.* Self-harm in England: a tale of three cities. Multicentre
11
12 study of self-harm. *Soc Psychiatry Psychiatr Epidemiol* 2007;42:513-21.
13
- 14
15 4. Madge N, Hawton K, McMahon EM, *et al.* Psychological characteristics, stressful life events and
16
17 deliberate self-harm: findings from the Child & Adolescent Self-harm in Europe (CASE)
18
19 Study. *Eur Child Adolesc Psychiatry* 2011;20:499-508.
20
21
- 22
23 5. Moran P, Coffey C, Romaniuk H, *et al.* The natural history of self-harm from adolescence to
24
25 young adulthood: a population-based cohort study. *Lancet* 2012;379:236-43.
26
27
- 28
29 6. Fergusson DM, Lynskey MT. Suicide attempts and suicidal ideation in a birth cohort of
30
31 16-year-old New Zealanders. *J Am Acad Child Adolesc Psychiatry* 1995;34:1308-17.
32
33
- 34
35 7. Andrews JA, Lewinsohn PM. Suicidal attempts among older adolescents: prevalence and
36
37 co-occurrence with psychiatric disorders. *J Am Acad Child Adolesc Psychiatry*
38
39 1992;31:655-62.
40
41
- 42
43 8. Evans E, Hawton K, Rodham K, *et al.* The prevalence of suicidal phenomena in adolescents: a
44
45 systematic review of population-based studies. *Suicide Life Threat Behav* 2005;35:239-50.
46
47
- 48
49 9. Lenkiewicz K, Racicka E, Brynska A. Self-injury - placement in mental disorders classifications,
50
51 risk factors and primary mechanisms. Review of the literature. *Psychiatr Pol* 2017;51:323-34.
52
53
- 54
55 10. van Heeringen K. The neurobiology of suicide and suicidality. *Can J Psychiatry*
56
57

- 2003;48:292-300.
11. Kim S, Lee KU. Research on potential biomarker correlates for suicidal behavior: A review. *Asia Pac Psychiatry* 2017.
12. Kashden J, Fremouw WJ, Callahan TS, *et al.* Impulsivity in suicidal and nonsuicidal adolescents. *J Abnorm Child Psychol* 1993;21:339-53.
13. Beautrais AL, Joyce PR, Mulder RT. Personality traits and cognitive styles as risk factors for serious suicide attempts among young people. *Suicide Life Threat Behav* 1999;29:37-47.
14. Hawton K, Rodham K, Evans E, *et al.* Deliberate self harm in adolescents: self report survey in schools in England. *BMJ* 2002;325:1207-11.
15. O'Connor RC, Rasmussen S, Hawton K. Adolescent self-harm: A school-based study in Northern Ireland. *J Affect Disord* 2014;159:46-52.
16. Huang YH, Liu HC, Sun FJ, *et al.* Relationship Between Predictors of Incident Deliberate Self-Harm and Suicide Attempts Among Adolescents. *J Adolesc Health* 2017;60:612-18.
17. Winefield HR, Winefield AH, Tiggemann M. Social support and psychological well-being in young adults: the multi-dimensional support scale. *J Pers Assess* 1992;58:198-210.
18. Tsai FJ, Huang YH, Liu HC, *et al.* Patient Health Questionnaire for school-based depression screening among Chinese adolescents. *Pediatrics* 2014;133:e402-e09.
19. Li CS, Chen SH. Obsessive-compulsiveness and impulsivity in a non-clinical population of adolescent males and females. *Psychiatry Res* 2007;149:129-38.

- 1
2
3
4 20. Lin RC. Reliability and validity of the Rosenberg Self-esteem Scale on Chinese children. *Journal*
5
6
7 *of National Chung Cheng University* 1990;1:29-46.
8
9
10 21. Patton JH, Stanford MS, Barrat ES. Factor structure of the Barratt Impulsiveness Scale. *J Clin*
11
12 *Psychol* 1995;51:768-74.
13
14
15 22. Rosenberg M. *Conceiving the self*. New York: Basic Books, 1979.
16
17
18 23. Conigrave KM, Hall WD, Saunders JB. The AUDIT questionnaire: choosing a cut-off score.
19
20
21 Alcohol use disorder identification test. *Addiction* 1995;90:1349-56.
22
23
24 24. Wu SI, Huang HC, Liu SI, *et al*. Validation and aomparison of alcohol-screening instruments for
25
26
27 identifying hazardous drinking in hospitalized patients in Taiwan. *Alcohol Alcohol*
28
29
30 2008;43:577-82.
31
32
33 25. Gau SF, Soong WT. Psychiatric comorbidity of adolescents with sleep terrors or sleepwalking: a
34
35
36 case-control study. *Aust N Z J Psychiatry* 1999;33:734-9.
37
38
39 26. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological
40
41
42 research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol*
43
44
45 1986;51:1173-82.
46
47
48 27. Rosner B. *Fundamentals of Biostatistics*. Boston: Duxbroy, 2006.
49
50
51 28. Tsai MH, Chen YH, Chen CD, *et al*. Deliberate self-harm by Taiwanese adolescents. *Acta*
52
53 *Paediatr* 2011;100:e223-26.
54
55
56 29. Bridge JA, Goldstein TR, Brent DA. Adolescent suicide and suicidal behavior. *J Child Psychol*
57
58
59

- 1
2
3
4 *Psychiatry* 2006;47:372-94.
5
6
7 30. Chen CH, Chen YH, Chen CY, *et al.* Factors associated with suicide ideations and attempts in
8
9 adolescents. *Taiwanese J Psychiatry* 2008;22:57-66.
10
11
12 31. Toprak S, Cetin I, Guven T, *et al.* Self-harm, suicidal ideation and suicide attempts among
13
14 college students. *Psychiatry Res* 2011;187:140-44.
15
16
17 32. Kokkevi A, Richardson C, Olszewski D, *et al.* Multiple substance use and self-reported suicide
18
19 attempts by adolescents in 16 European countries. *Eur Child Adolesc Psychiatry*
20
21 2012;21:443-50.
22
23
24
25
26 33. Wong SS, Zhou B, Goebert D, *et al.* The risk of adolescent suicide across patterns of drug use: a
27
28 nationally representative study of high school students in the United States from 1999 to 2009.
29
30
31
32
33 *Soc Psychiatry Psychiatr Epidemiol* 2013;48:1611-20.
34
35
36 34. Gau SS, Chong MY, Chen TH, *et al.* A 3-year panel study of mental disorders among adolescents
37
38 in Taiwan. *Am J Psychiatry* 2005;162:1344-50.
39
40
41 35. Shek DT, Yu L. Self-harm and suicidal behaviors in Hong Kong adolescents: prevalence and
42
43 psychosocial correlates. *ScientificWorldJournal* 2012;2012:932540.
44
45
46
47 36. Janis IB, Nock MK. Are self-injurers impulsive?: Results from two behavioral laboratory studies.
48
49
50
51 *Psychiatry Res* 2009;169:261-67.
52
53
54 37. Renaud J, Berlim MT, McGirr A, *et al.* Current psychiatric morbidity, aggression/impulsivity, and
55
56 personality dimensions in child and adolescent suicide: a case-control study. *J Affect Disord*
57
58
59
60

- 1
2
3
4 2008;105:221-28.
5
6
7 38. Horesh N. Self-report vs. computerized measures of impulsivity as a correlate of suicidal
8
9
10 behavior. *Crisis* 2001;22:27-31.
11
12 39. McMahon EM, Reulbach U, Corcoran P, *et al.* Factors associated with deliberate self-harm
13
14 among Irish adolescents. *Psychol Med* 2010;40:1811-9.
15
16
17 40. Wang YG, Chen S, Xu ZM, *et al.* Family history of suicide and high motor impulsivity
18
19 distinguish suicide attempters from suicide ideators among college students. *J Psychiatr Res*
20
21 2017;90:21-25.
22
23
24
25
26 41. Mujica-Parodi LR, Carlson JM, Cha J, *et al.* The fine line between 'brave' and 'reckless':
27
28 amygdala reactivity and regulation predict recognition of risk. *Neuroimage* 2014;103:1-9.
29
30
31
32 42. Wu CS, Liao S, C., Lin KM, *et al.* Multidimensional assessments of impulsivity in subjects with
33
34 history of suicidal attempts. *Compr Psychiatry* 2009;50:315-21.
35
36
37
38 43. Horesh N, Gothelf D, Ofek H, *et al.* Impulsivity as a correlate of suicidal behavior in adolescent
39
40 psychiatric inpatients. *Crisis* 1999;20:8-14.
41
42
43
44 44. Li CS, Zhang S, Duann JR, *et al.* Gender Differences in Cognitive Control: an Extended
45
46 Investigation of the Stop Signal Task. *Brain Imaging Behav* 2009;3:262-76.
47
48
49
50 45. Rice TR. Violence among young men: the importance of a gender-specific developmental
51
52 approach to adolescent male suicide and homicide. *Int J Adolesc Med Health*
53
54 2015;27:177-81.
55
56
57
58
59
60

- 1
2
3
4 46. Moeller FG, Barratt ES, Dougherty DM, *et al.* Psychiatric aspects of impulsivity. *Am J*
5
6
7 *Psychiatry* 2001;158:1783-93.
8
9
10 47. Fradkin Y, Khadka S, Bessette KL, *et al.* The relationship of impulsivity and cortical thickness in
11
12 depressed and non-depressed adolescents. *Brain Imaging Behav* 2016.
13
14
15 48. Hirjak D, Thomann AK, Kubera KM, *et al.* Cortical folding patterns are associated with
16
17 impulsivity in healthy young adults. *Brain Imaging Behav* 2016.
18
19
20
21 49. d'Acremonta M, Van der Linden M. How is impulsivity related to depression in adolescence?
22
23 Evidence from a French validation of the cognitive emotion regulation questionnaire. *J*
24
25 *Adolesc* 2007;30:271-82.
26
27
28
29
30 50. de Kloet L, Starling J, Hainsworth C, *et al.* Risk factors for self-harm in children and adolescents
31
32 admitted to a mental health inpatient unit. *Aust N Z J Psychiatry* 2011;45:749-55.
33
34
35
36 51. Fergusson DM, Woodward LJ, Horwood LJ. Risk factors and life processes associated with the
37
38 onset of suicidal behaviour during adolescence and early adulthood. *Psychol Med*
39
40
41 2000;30:23-39.
42
43
44 52. Hawton K, Rodham K, Evans E. *By their own young hand: Deliberate self-harm and suicidal*
45
46
47 *ideas*. London: Jessica Kingsley Publishers, 2006.
48
49
50 53. Whitener EM, Klein HJ. Equivalence of computerized and traditional research methods: The
51
52 roles of scanning, social environment, and social desirability. *Compute Human Behav*
53
54
55 1995;11:65-75.
56
57
58
59
60

1
2
3
4 54. Booth-Kewley S, Larson GE, Miyoshi DK. Social desirability effects on computerized and
5
6 paper-and-pencil questionnaires. *Compute Human Behav* 2007;23:463-77.
7
8

9
10 55. Berg JM, Latzman RD, Bliwise NG, *et al.* Parsing the heterogeneity of impulsivity: A
11
12 meta-analytic review of the behavioral implications of the UPPS for psychopathology.
13
14 *Psychol Assess* 2015;27:1129-46.
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 1 Author information: We provided author information and title
4 page.
5
6
7 2 Manuscript length and formatting: Have you checked that your
8 manuscript doesn't exceed the requirements for word
9 count, number of tables and/or figures, and number of
10 references? Have you provided your abstract in the correct
11 format? (Yes) Have you supplied any required additional
12 information for your article type, such as key messages.
13 (Yes)
14
15
16
17 3 Tables: Have you embedded any tables into the main
18 text?(Yes) Have they been cited in the text? (Yes)Have
19 you provided appropriate table legends? (Yes)Have you
20 uploaded any lengthy tables as supplementary files for
21 online publication? (NO)
22
23
24
25
26
27 4 Figures: No figures
28
29 5 References: Have all of the references been cited in the text?
30 (Yes)
31
32 6 Supplementary files and appendices: Have you supplied these
33 in an acceptable format? Have they been cited in the main
34 text?
35
36
37 7 Statements: Have you included the necessary statements
38 relating to contributorship, competing interests, funding,
39 data sharing and ethical approval? (Yes)
40
41
42 8 Research reporting checklists: Have you either provided the
43 appropriate statement for your study type, or explained
44 why a checklist isn't required? (Yes)
45
46
47 9 Permissions: Have you obtained from the copyright holder to
48 re-use any previously published material? Has the source
49 been acknowledged? (Yes)
50
51
52 Reviewers: Have you provided the names of any preferred and
53 non-preferred reviewers? (Yes)
54
55
56
57
58
59
60

BMJ Open

The correlation of impulsivity with self-harm and suicide attempt: a community study of adolescents in Taiwan

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-017949.R2
Article Type:	Research
Date Submitted by the Author:	19-Oct-2017
Complete List of Authors:	Huang, Yu-Hsin; Mckay Medical Colledge, Department of Medicine; MacKay Memorial Hospital, Department of Psychiatry Liu, Hui-Ching; MacKay Memorial Hospital, Department of Psychiatry; MacKay Memorial Hospital, Suicide Prevention Centre Tsai, Fang-Ju ; En Chu Kong Hospital, Department of Psychiatry; College of Medicine, National Taiwan University, Department of Psychiatry Sun, Fang-Ju; MacKay Junior College of Medicine, Nursing, and Management; MacKay Memorial Hospital, Department of Medical Research Huang, Kuo-Yang; Taiwan Adventist Hospital, Department of Psychiatry Chiu, Yu-Ching; Cardinal Tien Hospital, Department of Psychiatry Huang, Yen-Hsun; Taipei City Psychiatric Center, Department of Psychiatry Huang, Yo-Ping; National Taipei University of Technology, Department of Electrical Engineering Liu, Shen-Ing; MacKay Medical Colledge, Department of Medicine; MacKay Memorial Hospital, Department of Psychiatry
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, Paediatrics, Public health, Smoking and tobacco
Keywords:	adolescence, deliberate self-harm, impulsivity, suicide, suicidal ideation, substance use disorders

SCHOLARONE™
Manuscripts

1
2
3
4 **Title Page**
5

6 **Manuscript category:** research article
7
8
9
10

11
12 The correlation of impulsivity with self-harm and suicide attempt: a community study
13
14 of adolescents in Taiwan
15

16
17
18
19 Yu-Hsin Huang,^{1,2,3,4} Hui-Ching Liu,^{2,3,4} Fang-Ju Tsai,^{5,6,7} Fang-Ju Sun,^{4,8}
20

21
22
23 Kuo-Yang Huang,⁹ Yu-Ching Chiu,¹⁰ Yen-Hsun Huang,¹¹ Yo-Ping Huang,¹²
24

25
26 Shen-Ing Liu,^{1,2,3,4,8}
27
28
29
30
31
32

33 ¹Department of Medicine, MacKay Medical College, New Taipei City, Taiwan
34

35
36 ²Department of Psychiatry, MacKay Memorial Hospital, Taipei, Taiwan
37
38

39
40 ³Suicide Prevention Center, MacKay Memorial Hospital, Taipei, Taiwan
41
42

43 ⁴MacKay Junior College of Medicine, Nursing, and Management, Taipei, Taiwan
44
45

46 ⁵Department of Psychiatry, En Chu Kong Hospital, New Taipei City, Taiwan
47
48

49
50 ⁶Department of Psychiatry, College of Medicine, National Taiwan University, Taipei,
51

52
53
54 Taiwan
55

56
57 ⁷Department of Psychiatry, National Taiwan University Hospital, Taipei, Taiwan
58
59

1
2
3
4⁸Department of Medical Research, MacKay Memorial Hospital, Taipei, Taiwan
5
6

7⁹Department of Psychiatry, Taiwan Adventist Hospital, Taipei, Taiwan
8
9

10¹⁰ Department of Psychiatry, Cardinal Tien Hospital, New Taipei City, Taiwan
11
12

13
14¹¹Department of Psychiatry, Taipei City Psychiatric Center, Taipei City Hospital,
15
16

17
18 Taipei, Taiwan
19

20
21¹²Department of Electrical Engineering, National Taipei University of Technology,
22
23

24
25 Taipei, Taiwan
26
27
28
29
30

31 **Corresponding author**
32
33

34 Shen-Ing Liu, M.D., Ph.D., Department of Psychiatry, MacKay Memorial Hospital,
35
36

37
38 No. 92, Section 2, Chung-Shan North Rd, Taipei, Taiwan. Telephone number:
39
40

41
42 886-2-25433535-3685; Fax number: 886-2-28098746; E-mail:
43
44

45 maryliuyip@gmail.com
46
47
48
49
50

51
52 Word Count : 4,938
53
54
55
56
57
58
59
60

ABSTRACT

Objectives: The aim of this study was to investigate differences and similarities in risk factors for deliberate self-harm (DSH) and suicide attempt (SA), and the role of impulsivity among a group of community adolescents.

Setting: This is a cross-sectional study conducted at high schools in northern Taiwan.

Data and participants: We recruited grade 1 students from 14 high schools. A total of 5,879 participants (mean age 16.02 years, female: 57.7%) completed the online assessment.

Outcome measures: Participants completed online questionnaires about sociodemographic data, suicidality, history of DSH and SA, depressed mood, self-esteem, social support, family discord, impulsivity (Barratt Impulsiveness Scale Version 11 [BIS-11]), and the use of alcohol, tobacco and illicit drugs. A subsample was interviewed about lifetime SA, and the results were compared to those from the online questionnaires.

Results: In our sample, 25% of the students had lifetime DSH and 3.5% had lifetime SA. Two hundred and seventy-two students received face-to-face interviews. The concordance between the online questionnaires and interviews in terms of ascertaining cases of suicide attempt was moderate (concordance rate 82.76%; kappa value 0.59). Similar risk factors for DSH/SA among the whole sample included female gender, lower academic performance, depression, substance use (tobacco and alcohol), and low self-esteem. The BIS-11 score was correlated with DSH. Factor 3 score of the BIS-11 (novelty-seeking) was correlated with DSH in both boys and girls, whereas factor 2 score (lack of self-control) was correlated with SA in boys. Social support was a protective factor against SA among the female adolescents. Gender modulated the association of impulsivity and DSH/SA. Associations between

1
2
3 impulsivity and DSH and SA were particularly strong among boys.
4

5 **Conclusions:** Risk factors for DSH and SA were similar, but not identical. Early
6
7 identification of those at risk and appropriate interventions may be helpful.
8
9

10
11
12 Key words: Adolescence, Deliberate self-harm, Impulsivity, Suicide, Suicidal ideation,
13

14
15
16 Substance abuse disorders
17
18
19
20
21
22

23 **Strengths and limitations of this study**

24
25
26 ● This study used a large community sample of adolescents from different areas of
27

28
29 Taipei, which is a strength when it comes to generalization.
30
31

32
33 ● A further strength of the present study is that well-established self-reported
34

35
36 measures and a broad array of relevant psychosocial measures were used.
37
38

39
40 ● Few studies based in Asian countries have investigated the relationship between
41

42
43 impulsivity and deliberate self-harm and suicide attempt in a community sample.
44
45

46
47 ● The agreement between online assessments and interviews with regards to lifetime
48

49
50 suicide attempt was moderate, which showed that an online study is a reliable way to
51

52
53 investigate suicidality.
54
55

56
57 ● Gender is a moderator between the relationship of impulsivity and adolescent
58
59

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

deliberate self-harm/suicide attempt.

For peer review only

INTRODUCTION

According to the World Health Organization, suicide was the second leading cause of death worldwide in 2012 among people aged 15 to 29 years.¹ In addition, a systemic review reported a strong association between self-harm and later suicide, with the risk of suicide among patients with deliberate self-harm (DSH) being hundreds of times higher than that in the general population.² The terminology surrounding DSH is, however, complex. In this study, we defined DSH as self-harmful behavior, regardless of an individual's intention to die.³ The following behaviors are examples of DSH: initiating a behavior (e.g. self-cutting,³ jumping from a height,⁴ burning,⁵ hanging⁵) intended to cause self-harm; ingesting a substance in excess of the prescribed or generally recognized therapeutic dose;³⁻⁵ ingesting a recreational or illicit drug that was an act that the person regarded as being self-harm;^{4 5} and ingesting a non-ingestible substance or object.⁴

Suicide attempt (SA), that is, self-harm with the intent to die, is less common than DSH. The estimated lifetime prevalence of SA among adolescents ranges from 3.0% to 8.4%⁶⁻⁸ compared to 4.0% to 30% for DSH.⁸ Despite increased awareness

1
2
3
4 and research on DSH and SA among adolescents, few studies have investigated the
5
6
7
8 extent to which risk factors for DSH and SA overlap in a community setting,
9
10
11 especially in Asian countries.

12
13
14 Regarding etiology, there is a bio-psychosocial model for self-harm. Higher
15
16
17 levels of endogenous opioids and higher level of pain tolerance have been found in
18
19
20 self-harming people. Interactions between environmental and genetic factors may also
21
22
23 contribute to self-harm.⁹ There is also a stress-diathesis or a psychobiological model
24
25
26 for SA.¹⁰ Deficits in serotonergic neurotransmission, low CSF 5-hydroxyindoleacetic
27
28
29 acid (5-HIAA) levels, low platelet 5-hydroxytryptamine and a decreased number of
30
31
32 binding sites in platelets have been found in people with SA.¹¹ A potential link
33
34
35 between low plasma 5-HIAA levels and impulsivity/severity of the SA has also been
36
37
38 postulated.¹¹ Different etiologies may differentiate between DSH and SA; we were
39
40
41 also interested in the role of impulsivity in these two groups.
42
43
44
45
46
47

48 Impulsivity has frequently been reported to be a risk factor for both DSH and
49
50
51 SA,^{4 12} although the results are somewhat inconsistent. In one study, the association
52
53
54 with SA was non-significant after controlling for hopelessness, neuroticism, external
55
56
57
58
59
60

1
2
3
4 locus of control, self-esteem, and extroversion.¹³ In addition, Hawton et al.¹⁴ found
5
6
7 that impulsivity was an independent risk factor for self-harm among adolescent girls
8
9
10 but not among adolescent boys. In contrast, another study in Ireland reported that
11
12
13 impulsivity was a risk factor for DSH among boys but not girls.¹⁵ These inconsistent
14
15
16 findings imply that impulsivity may be important in identifying high-risk subgroups.
17
18
19 To date, most previous studies on the relationship among impulsivity, DSH and SA in
20
21
22 adolescents have been conducted in Western countries.
23
24
25
26
27

28 Due to these inconsistent results and to bridge the gaps in current knowledge, we
29
30
31 designed this study to investigate correlations among impulsivity, DSH and SA in
32
33
34 Taiwanese adolescents. The study aimed to: (1) explore possible differences and
35
36
37 similarities in risk factors among adolescents with DSH and SA, and (2) explore the
38
39
40 role of impulsivity in these two groups.
41
42
43
44
45
46
47

48 **METHODS**

49 **Subjects**

50
51
52 This study was approved by the Institutional Review Board of MacKay Memorial
53
54
55
56
57
58
59
60

1
2
3
4 Hospital. It was part of the Taiwanese Adolescent Self-Harm Project (TASP), a
5
6
7 prospective study conducted to evaluate the one-year incidence of self-harm behavior
8
9
10 and the associated risk factors among adolescents in Taiwan.¹⁶ From October 2008 to
11
12
13 March 2010, we recruited first-grade students from 14 senior high schools in Taipei
14
15
16 and New Taipei City, Taiwan by purposive sampling. The participating schools were
17
18
19 chosen from different regions of Taipei, including urban, suburban, and rural areas,
20
21
22 and accounted for 11.7% of all high schools in the Taipei area. After the aims of this
23
24
25 study had been fully explained to both the students and their parents, written informed
26
27
28 consent was obtained from all parents and participants.
29
30
31
32
33
34
35
36
37

38 **Online assessments**

39
40
41 All of the participants completed the Chinese version of the Multidimensional Scale
42
43
44 of Perceived Social Support (MDSS),¹⁷ the Chinese version of the Patient Health
45
46
47 Questionnaire (PHQ-9),¹⁸ the Chinese version of the Barratt Impulsiveness Scale,
48
49
50 Version 11 (BIS-11),¹⁹ and the Rosenberg Self-Esteem Scale (RSES).²⁰ The students
51
52
53
54
55 also reported all self-harm experiences, physical illnesses, and substance use. All of
56
57
58
59
60

1
2
3
4 the measures were completed anonymously online at the participating schools, and a
5
6
7
8 trained research assistant was also available. A subsample of the students also
9
10
11 received diagnostic interviews conducted by child psychiatrists.¹⁸ The data from the
12
13
14 online questionnaires were collected by a computer engineer. The researchers had
15
16
17 access to the data one day after the students had completed the questionnaires to
18
19
20 ensure the quality of the data. We also provided each school with a list of students at
21
22
23 high-risk of suicide for further referral and on-site counseling by a child psychiatrist
24
25
26 or a psychologist at their school.
27
28
29
30
31
32
33

34
35 Suicidality: suicide ideation, suicide plan, deliberate self-harm, and
36
37
38 suicide attempt
39

40
41 All subjects were asked if they had ever thought of killing themselves at any time in
42
43
44 their life. They were then asked about ever having planned to kill themselves. Using
45
46
47 the same scale, the students were then asked “Have you ever deliberately (not
48
49
50 accidentally) hurt yourself?” and “How many times have you deliberately
51
52
53 self-harmed?” The participants who responded positively to the main questions were
54
55
56
57
58
59
60

1
2
3
4 then asked to elaborate on their actions (multiple choices including drug overdose,
5
6
7 hanging, burning charcoal, jumping from a height, cutting themselves, and being hit
8
9
10 by a car). They were then asked to describe the act, the number of episodes, the
11
12 timing of each episode, and the consequences (e.g., need for medical intervention)
13
14 and to endorse the motive behind the act. SAs were identified in all reports of
15
16 self-harm according to the response to, “Have you ever really tried to kill yourself
17
18 during these DSH episodes?” We also collected the number of SAs and the time of
19
20 the first and last attempts. The subjects who reported having harmed themselves
21
22 with/without suicidal intent were classified as “DSH.” SA was defined as an
23
24 intentional action to kill oneself.
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42

43 The Chinese version of the BIS-11

44
45 The BIS-11 is a 30-item self-reported questionnaire designed to measure impulsivity.
46
47

48 The total score ranges from 30 to 120, with a higher score indicating greater
49
50 impulsivity.²¹ The 25 items of the Chinese version of the BIS-11 have demonstrated
51
52 good overall internal consistency in Taiwanese adolescents, with a Cronbach’s alpha
53
54
55
56
57
58
59
60

1
2
3
4 of 0.834.¹⁹ The factor structure of the Chinese version of the BIS-11 consists of three
5
6
7 factors: “inability to plan,” “lack of self-control,” and “novelty-seeking.”
8
9

10 11 12 13 14 Multi-dimensional Scale of Perceived Social Support (MDSS)

15
16
17 The MDSS is a self-reported measure of the availability and adequacy of social
18
19 support from various sources.¹⁷ We estimated four types of social support, including
20
21 that from parents, other family members, friends, and teachers, with a higher score
22
23 indicating greater social support. In our sample, the Cronbach’s alpha was 0.63.
24
25
26
27
28
29
30
31
32
33

34 35 The Chinese version of the Patient Health Questionnaire-9 item (PHQ-9)

36
37 The PHQ-9 consists of nine items evaluating the presence of one of the nine
38
39 *Diagnostic and Statistical Manual of Mental Disorders (Fourth edition) [DSM-IV]*
40
41 criteria of major depressive episodes during the past 2 weeks. The total score ranges
42
43 from 0 to 27, with higher scores indicating an increased likelihood of major
44
45 depressive disorder (MDD). The Chinese version of the PHQ-9 has been validated for
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60 detecting MDD, and has shown good internal consistency ($\alpha = 0.84$) and acceptable

1
2
3
4 test-retest reliability (intra-class correlation coefficient = 0.80) among adolescents in
5
6
7 the community.¹⁸ A PHQ-9 score ≥ 15 had a sensitivity of 0.72 and a specificity of
8
9
10
11 0.95 for recognizing MDD.
12
13

14 15 16 17 18 The Chinese version of the Rosenberg Self-Esteem Scale (RSES) 19

20
21 The RSES consists of 10 items that refer to self-respect and self-acceptance.²² The
22
23
24 Chinese version of the RSES has demonstrated acceptable internal consistency. The
25
26
27
28 reliability and validity of the Chinese version of the RSES have also been
29
30
31 demonstrated.²⁰
32
33
34
35
36
37

38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

Substance use variables

Data on substance use included information on cigarette smoking, high-risk alcohol
use and any illicit drug use. The participants who reported that they smoked currently
were classified as current cigarette smokers. High-risk alcohol use was assessed using
the Chinese version of the Alcohol Use Disorders Identification Test-Consumption
(AUDIT-C). The AUDIT-C includes the first three questions from the full AUDIT,²³

1
2
3
4 and assesses the amount and frequency of alcohol intake and frequency of alcohol
5
6
7
8 misuse (defined as having six or more drinks). The optimal cut-off score of the
9
10
11 Chinese AUDIT-C for hazardous drinking was 3/4, with good sensitivity (0.90) and
12
13
14 specificity (0.92).²⁴ In this study, this was treated as a continuous variable, and a
15
16
17
18 higher score indicated more alcohol use. A summary of illicit drug use was obtained
19
20
21 from the participants who had used any form of illicit drug during the past month.
22
23
24
25
26
27

28 **Face-to-face interviews with child psychiatrists using the**
29
30
31 **Kiddie-Schedule for Affective Disorder and Schizophrenia**
32
33
34 **Epidemiological Version (K-SADS-E)**
35
36
37

38 The K-SADS-E is a semi-structured interview scale for the systematic assessment of
39
40
41 both past and current episodes of psychiatric disorders in children and adolescents.
42
43
44

45 The Chinese version has been shown to be a reliable and valid instrument.²⁵ Child
46
47
48 psychiatrists blind to the results of the online assessments interviewed a subsample of the
49
50
51 students (n = 272) using the K-SADS-E. After 12 months of the initial assessment, the
52
53
54
55 students completed the same questionnaires. All of the students with new occurrences
56
57
58
59
60

1
2
3
4 of self-harm in the past year (i.e., the students who did not report self-harm at entry
5
6
7
8 but did the next year) were enrolled for face-to-face interviews. The students who did
9
10
11 not report any occurrences of self-harm at both years were randomly selected on a 1:1
12
13
14 ratio, frequency matched by class and gender. For the students who reported
15
16
17 occurrences of self-harm in both years, one in two received face-to-face interviews.
18
19
20
21 The response rate was 94.8%. Lifetime SA was assessed by the child psychiatrists
22
23
24 according to the question, “Have you actually tried to kill yourself?”
25
26
27
28
29
30

31 **Statistical analysis**

32
33
34 Descriptive and analytical statistics of the data obtained in this study were analyzed
35
36
37 using SPSS version 21.0 for Windows (SPSS, IBM, Armonk, NY, USA). Risk factors
38
39
40 for DSH and SA were first analyzed using univariate logistic regression analysis, with
41
42
43 one variable at a time. Hierarchical multiple regression strategies (using a stepwise
44
45
46 method) were then used to determine the risk factors for DSH/SA and to assess
47
48
49 whether impulsivity played any role. The joint effect of the independent variables that
50
51
52 showed significance in univariate analysis was assessed with hierarchical regression
53
54
55
56
57
58
59
60

1
2
3
4 analysis. To examine the association between impulsivity and DSH/SA, all
5
6
7
8 sociodemographic and personality (BIS-11, RSES) variables were introduced in the
9
10
11 first step (model 1), followed by adding social support (MDSS) in the second step
12
13
14 (model 2), alcohol/tobacco use in the third step (model 3), and depressive symptoms
15
16
17 in the fourth step (model 4). We then examined the interaction between gender and
18
19
20 BIS-11 among logistic regression analyses to see whether the relationship between
21
22
23 impulsivity and DSH/SA was moderated by gender (model 5).²⁶ Logistic regression
24
25
26 was used to analyze the role of impulsivity and all other sociodemographic, clinical
27
28
29 and personality trait variables with DSH/SA between genders (model 6). We further
30
31
32 analyzed three subscales of the BIS-11 instead of the total score in the male and
33
34
35 female students.
36
37
38
39
40

41 We also examined the agreement (i.e. reliability) between the computer
42
43
44 questionnaire assessments and face-to-face interviews (n = 272) with regards lifetime
45
46
47 SA assessed at the second year. This agreement was assessed by concordance rate and
48
49
50 kappa statistics.²⁷
51
52
53
54
55
56
57
58
59
60

RESULTS

Descriptive statistics and univariate analysis of lifetime DSH and lifetime SA

We recruited 5,879 students with a mean age of 16.02 years (standard deviation 0.52).

The overall response rate was 60.61%. Table 1 shows the sociodemographic data of the students along with scores on the MDSS, PHQ-9, BIS-11, RSES, and AUDIT-C.

Twenty-five percent of the students (n = 1,472) reported self-harm behavior, with a mean of 4.06 times (standard deviation: 3.33). Two hundred and six students (3.5%)

reported that their self-harm behavior was actually a suicide attempt. The mean

BIS-11 score was 62.9 for the students with lifetime DSH, and 64.2 for those with

lifetime SA.

1
2
3
4
5
6

Table 1 Sociodemographic data and variables significantly associated with lifetime deliberate self-harm (DSH) and suicide attempt (SA)

Variables	All students (n = 5,879)	Ever had DSH (n = 1,472)	Univariate logistic regression	Ever had SA (n = 206)	Univariate logistic regression	No DSH history (n = 4,407)
	N (%) or mean (SD)	N (%) or mean (SD)	OR (95% CI)	N (%) or mean (SD)	OR (95% CI)	N (%) or mean (SD)
Female gender	3,335 (56.7)	966 (65.6)	1.64 (1.45~1.86)***	145 (70.4)	2.05 (1.51~2.77)***	2,369 (53.8)
School district (urban)	2,501 (42.5)	551 (37.4)	referent	86 (41.7)	referent	1,950 (44.2)
(suburbs)	3,005 (51.1)	823 (55.9)	1.34 (1.18~1.51)***	111 (53.9)	1.15 (0.87~1.54)	2,182 (49.5)
(rural)	373 (0.3)	98 (6.7)	1.26 (0.98~1.62)	9 (4.4)	0.74 (0.37~1.49)	275 (6.2)
Low school ranking ^a	4,155 (70.7)	1,152 (78.3)	1.68 (1.47~1.93)***	191 (92.7)	5.95 (3.51~10.11)***	3,003 (68.1)
Father is employed	5,179 (88.1)	1,258 (85.5)	0.73 (0.61~0.87)***	169 (82.0)	0.57 (0.39~0.82)**	3,921 (89.0)
Mother is employed	4,197 (71.4)	1,080 (73.4)	1.14 (0.99~1.30)	148 (71.8)	1.06 (0.77~1.44)	3,117 (70.7)
Not live with biological parents	1,055 (17.9)	333 (22.6)	1.49 (1.29~1.73)***	58 (28.2)	2.00 (1.46~2.74)***	722 (16.4)
BIS-11 score	60.1 (8.5)	62.9 (8.4)	1.06 (1.05~1.07)***	64.2 (8.8)	1.07 (1.06~1.09)***	59.1 (8.3)
Factor 1 ^b	19.9 (3.9)	20.4 (3.9)	1.05 (1.03~1.07)***	20.5 (4.1)	1.06 (1.02~1.10)**	19.7 (3.9)
Factor 2 ^c	24.5 (4.5)	26.1 (4.6)	1.11 (1.09~1.13)***	27.0 (4.7)	1.16 (1.12~1.20)***	24.0 (4.3)
Factor 3 ^d	15.7 (3.0)	16.4 (3.0)	1.12 (1.09~1.15)***	16.6 (3.0)	1.13 (1.08~1.19)***	15.4 (3.0)
Within family discord	558 (9.5)	221 (15.0)	2.13 (1.78~2.56)***	48 (23.3)	3.67 (2.61~5.16)***	337 (7.6)
Current smoker	226 (3.8)	113 (7.7)	3.16 (2.42~4.13)***	26 (12.6)	5.49 (3.49~8.62)***	113 (2.6)
MDSS score	20.8 (3.6)	20.1 (3.6)	0.93 (0.92~0.95)***	19.5 (3.6)	0.89 (0.86~0.92)***	21.1 (3.6)
PHQ-9 score	5.7 (4.6)	8.2 (5.5)	1.16 (1.15~1.18)***	10.5 (5.7)	1.24 (1.21~1.27)***	4.9 (4.0)
AUDIT-C score	1.1 (1.9)	0.9 (5.2)	1.26 (1.23~1.30)***	2.1 (2.4)	1.29 (1.22~1.36)***	1.8 (2.3)
RSES score	28.3 (5.4)	26.2 (5.5)	0.91 (0.90~0.92)***	23.9 (5.4)	0.84 (0.82~0.86)***	29.0 (5.2)

^aBelow the 70th percentile; ^binability to plan; ^clack of self-control; ^dnovelty-seeking **p*<0.05, ***p*<0.01, ****p*<0.001; BIS-11: Barratt Impulsiveness Scale, version 11; MDSS: Multi-dimensional Scale of Perceived Social Support; PHQ-9: Patient Health Questionnaire-9 item; AUDIT-C: Alcohol Use Disorders Identification Test-Consumption; RSES: Rosenberg Self-Esteem Scale

40
41
42
43
44
45
46
47
48
49

1
2
3
4 There was no statistical difference in BIS-11 score between the male and female students.
5
6
7 Univariate analysis revealed that the risk factors associated with both lifetime DSH and SA were
8
9
10 higher impulsivity, female gender, low school ranking, father's job status, not living with biological
11
12
13 parents, family discord, low self-esteem, poor social support, currently smoking, more alcohol use,
14
15
16 and more depressive symptoms (Table 1). Students in schools located in suburban areas compared to
17
18
19 those in urban area had a higher risk of DSH.
20
21
22
23

24 **Hierarchical regression of lifetime DSH and lifetime SA**

25
26
27 The results of the hierarchical approach are presented in Tables 2 and 3. The adjusted model 1
28
29
30 including sociodemographic variables and personality traits (RSES, BIS-11) showed that similar risk
31
32
33 factors were associated with both DSH and SA. These included high impulsivity, low self-esteem,
34
35
36 female gender, family discord and low school ranking. The factors of father's job status, school
37
38
39 district and living with one's biological parents ceased to be significant predictors, indicating that
40
41
42 these variables were fully statistically mediated by factors of gender, self-esteem, impulsivity, family
43
44
45 discord and school ranking. In an unadjusted model, as the impulsivity score (BIS) increased by 1
46
47
48 unit, the likelihood of reporting a lifetime DSH and SA increased by approximately 6% and 7%,
49
50
51 respectively. The addition of gender, school district, family discord, school ranking, and self-esteem
52
53
54 factors attenuated the effect of impulsivity on the odds ratio (OR = 1.04) (Tables 2 and 3).
55
56
57
58
59
60

Table 2 Summary of hierarchical multiple regression analyses (stepwise method) examining multivariate correlates of deliberate self-harm

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6 (Male)	Model 6 (Female)
	OR (95% CI)						
BIS-11 score	1.04 (1.03~1.05)***	1.04 (1.03~1.05)***	1.03 (1.02~1.04)***	1.02 (1.01~1.03)***	1.02 (1.003~1.03)*	1.03 (1.02~1.05)***	
Female gender	1.67 (1.41~1.97)***	1.67 (1.41~1.97)***	1.95 (1.64~2.32)***	1.86 (1.56~2.22)***			
School district							
Low school ranking	1.49 (1.17~1.91)**	1.49 (1.17~1.91)**	1.33 (1.04~1.71)*	1.36 (1.06~1.75)*	1.36 (1.05~1.75)*		1.84 (1.30~2.61)**
Father is employed							
Not live with biological parents							
With family discord	1.57 (1.24~2.00)***	1.57 (1.24~2.00)***	1.52 (1.19~1.95)**				
RSES score	0.93 (0.91~0.94)***	0.93 (0.91~0.94)***	0.93 (0.91~0.94)***	0.96 (0.95~0.98)***	0.96 (0.95~0.98)***	0.96 (0.93~0.99)**	0.96 (0.94~0.98)**
MDSS score							
Current smokers			1.88 (1.30~2.72)**	1.78 (1.22~2.60)**	1.80 (1.23~2.63)**		3.44 (1.52~7.78)**
AUDIT-C score			1.19 (1.14~1.23)***	1.15 (1.11~1.20)***	1.15 (1.10~1.20)***	1.09 (1.03~1.15)**	1.28 (1.19~1.36)***
PHQ-9 score				1.12 (1.10~1.15)***	1.12 (1.10~1.15)***	1.11 (1.08~1.14)***	1.14 (1.11~1.17)***
BIS-11xgender					1.01 (1.007~1.013)***		

Model 1 adjusted for all sociodemographic variables and personality (RSES, BIS-11 score)

Model 2 adjusted for Model 1 and social support (MDSS score)

Model 3 adjusted for Model 2 and substance use (current smokers, AUDIT-C score)

Model 4 adjusted for Model 3 and depressive symptoms (PHQ-9 score)

Model 5 interaction term of BIS-11 and gender was added

Model 6: analyzed by different gender

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

Table 3 Summary of hierarchical multiple regression analyses (stepwise method) examining multivariate correlates of suicide attempt

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6 (Male)	Model 6 (Female)
	OR (95% CI)						
BIS-11 score	1.04 (1.02~1.06)***	1.04 (1.02~1.06)***	1.03 (1.004~1.05)*				
Female gender	2.11 (1.53~2.92)***	2.18 (1.58~3.02)***	2.99 (2.09~4.27)***	2.91 (2.01~4.20)***			
Low school ranking	2.03 (1.17~3.54)*	1.97 (1.13~3.44)*	1.80 (1.02~3.17)*	2.03 (1.14~3.63)*	1.92 (1.08~3.44)*		2.13 (1.02~4.47)*
Father is employed							0.57 (0.34~0.98)*
Not live with biological parents							
With family discord	2.17 (1.48~3.18)***	1.99 (1.35~2.93)**	2.01 (1.35~2.99)**				
RSES score	0.86 (0.84~0.89)***	0.87 (0.84~0.90)***	0.87 (0.84~0.90)***	0.91 (0.88~0.94)***	0.91 (0.88~0.94)***	0.92 (0.87~0.97)**	0.90 (0.87~0.94)***
MDSS score		0.94 (0.90~0.98)**	0.95 (0.91~0.995)*				0.94 (0.89~1.00)*
Current smokers			2.93 (1.62~5.32)***	3.02 (1.63~5.60)***	2.96 (1.61~5.46)**	3.52 (1.72~7.19)**	5.24 (1.76~15.7)**
AUDIT-C score			1.23 (1.15~1.32)***	1.17 (1.09~1.26)***	1.16 (1.08~1.25)***		1.26 (1.13~1.40)***
PHQ-9 score				1.19 (1.15~1.23)***	1.19 (1.15~1.23)***	1.17 (1.12~1.23)***	1.20 (1.15~1.26)***
BIS-11×gender							1.02 (1.01~1.02)***

Model 1 adjusted for all sociodemographic variables and personality (RSES, BIS-11 score)

Model 2 adjusted for Model 1 and social support (MDSS score)

Model 3 adjusted for Model 2, and substance use (current smokers, AUDIT-C score)

Model 4 adjust for Model 3 and depressive symptoms (PHQ-9 score)

Model 5 interaction term of BIS-11 and gender was added

Model 6: analyzed by different gender

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

1
2
3
4
5
6
7 We then added social support status (MDSS score) into model 2. Social support did not
8
9
10 significantly alter the confidence intervals of the other variables in model 1 with regards to DSH, and
11
12 it was also not significantly associated with DSH in model 2. However, social support was a
13
14 protective factor for SA in adjusted model 2. Impulsivity, female gender, low self-esteem, low school
15
16 ranking, and family discord retained significance in adjusted model 2 for SA.
17
18
19

20
21 In model 3 we added variables of substance use, and DSH and SA were still significantly
22
23 associated with impulsivity, although the odds were attenuated (Tables 2 and 3). The other
24
25 significant variables in model 2 persisted as risk factors for DSH/SA in model 3. Currently smoking
26
27 and a higher level of alcohol use were strong risk factors for DSH/SA.
28
29
30
31

32
33 In model 4, we included all variables (including depressive symptoms). DSH was still
34
35 significantly associated with impulsivity, although its odds were attenuated again. The effect of
36
37 family discord was fully statistically mediated in the final model of DSH. Other significant variables
38
39 in model 3 persisted as risk factors for DSH in the final model. Depressive symptoms was a risk
40
41 factor for DSH, and for every 1 unit increase in PHQ score, the likelihood of reporting lifetime DSH
42
43 increased by 12%. In addition, for every 1 unit increase in AUDIT-C score, the likelihood of
44
45 reporting lifetime DSH increased by 15%.
46
47
48
49
50
51

52
53 Impulsivity, family discord, and social support lost their significance after adjusting for the
54
55 aforementioned covariates in model 4 for the SA group (Table 3). Depressive symptoms and
56
57
58
59
60

1
2
3
4 substance use (alcohol and tobacco use) were stronger risk factors for SA than impulsivity. For every
5
6
7 1 unit increase in PHQ score, the likelihood of reporting lifetime SA increased by 19%, and for every
8
9
10 1 unit increase in AUDIT-C score, the likelihood of reporting lifetime SA increased by 17%. The
11
12 effects of depression and alcohol use on SA were stronger than those on DSH. In addition, smoking
13
14 had the strongest effect on SA, with current smokers having a 3-fold higher risk of SA compared to
15
16
17 nonsmokers.
18
19

20
21 When we added the interaction term of BIS-11 and gender in model 5, we found that they were
22
23
24 significant in both Tables 2 and 3. This meant that gender modulated the association between
25
26
27 impulsivity and DSH/SA. Other risk factors besides gender remained significance in both Tables 2
28
29
30 and 3.
31

32
33 We further analyzed the risk factors for DSH/SA by gender in model 6. For boys, impulsivity,
34
35
36 low self-esteem, alcohol use and depressive symptoms were risk factors for DSH, compared to low
37
38
39 school ranking, low self-esteem, smoking, alcohol use and depressive symptoms in girls (Table 2).
40
41
42 The association between impulsivity and DSH was particularly strong among boys, whereas total
43
44
45 impulsivity scores were not associated with SA in either gender. For boys, low self-esteem, smoking
46
47
48 and depressive symptoms were risk factors for SA, compared to low school ranking, low self-esteem,
49
50
51 poor social support, smoking, alcohol use and depressive symptoms in girls, while their father's
52
53
54 employment status was a protective factor (Table 3). Smoking status was an especially strong risk
55
56
57 factor for SA in girls (OR = 5.24).
58
59
60

1
2
3
4 We used three subscales instead of BIS-11 total score in the multivariate logistic regression
5
6 analysis to investigate the relationships among impulsivity subscales and DSH/SA (Table 4). For
7
8 both genders, factor 3 of the BIS-11 scale (novelty-seeking and acting without thinking), low
9
10 self-esteem, alcohol use and depressive symptoms were risk factors for DSH. Low school ranking
11
12 and smoking were additional risk factors for DSH in girls. For boys, risk factors for SA included
13
14 factor 2 of the BIS-11 scale (lack of perseverance and self-control), low self-esteem, smoking and
15
16 depressive symptoms. For girls with SA, impulsivity subscales were non-significant.
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 4 Multiple regression analyses (stepwise method) examining multivariate correlates of deliberate self-harm (DSH) and suicide attempt (SA), focusing on three subscales of the BIS-11

	DSH (Male)	DSH (Female)	SA (Male)	SA (Female)
	OR (95% CI)			
BIS-11 score factor 1 ^a				
BIS-11 score factor 2 ^b			1.07 (1.01~1.14)*	
BIS-11 score factor 3 ^c	1.10 (1.05~1.16)***	1.04 (1.002~1.08)*		
Low school ranking		1.79 (1.26~2.54)**		2.13 (1.02~4.47)*
Father is employed				0.57 (0.34~0.98)*
Not live with biological parents				
With family discord				
RSES score	0.94 (0.92~0.97)***	0.96 (0.93~0.98)***	0.93 (0.88~0.99)*	0.90 (0.87~0.94)***
MDSS score				0.94 (0.89~1.00)*
Current smokers		3.46 (1.54~7.81)**	2.95 (1.42~6.13)**	5.24 (1.76~15.65)**
AUDIT-C score	1.08 (1.02~1.14)**	1.26 (1.18~1.35)***		1.26 (1.13~1.40)***
PHQ-9 score	1.10 (1.06~1.13)***	1.13 (1.10~1.16)***	1.15 (1.10~1.21)***	1.20 (1.15~1.26)***

^ainability to plan or look ahead; ^black of perseverance and self-control; ^cnovelty-seeking and acting without thinking; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Agreement between online assessment and face-to-face interviews (concordance rate and kappa statistics)

The concordance rate was the proportion of the same status of lifetime SA comparing the results of the online assessments and face-to-face interviews, which was 82.76% $[(89+31)/145]$ (Table 5). The kappa value was 0.59, which was in moderate agreement range.²⁷

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Table 5 Comparison of online assessments vs. face-to-face interviews of lifetime suicide attempt (SA)

		Interview assessment		
		Lifetime SA (-)	Lifetime SA (+)	Total
Online assessment	Lifetime SA (-)	89	9	98
	Lifetime SA (+)	16	31	47
	Total	105	40	145

DISCUSSION

The findings of the current study show that the risk factors associated with DSH and SA were similar, but not identical, in our cohort of adolescent school students. The same risk factors for both DSH and SA included female gender, low school ranking, depression, substance (tobacco and alcohol) use, and low self-esteem. These risk factors associated with DSH/SA can therefore be targeted in future prevention strategies. After adjusting for demographic factors and all other psychosocial factors, impulsivity was an independent risk factor for DSH but not for SA. However, factor 2 of the BIS (lack of perseverance and self-control) was significantly associated with SA in boys.

Common risk factors

The results of the current study with regards to gender differences in adolescent DSH/SA are consistent with previous findings, in that adolescent girls showed a higher prevalence of DSH^{5 28} and SA.^{7 29 30} With respect to the personality characteristics, low self-esteem has been associated with both DSH⁴ and SA.²⁹ Cross-sectional surveys of adolescents have consistently found that depression is strongly correlated with DSH^{4 5} and SA.^{29 30} Tobacco smoking has also been previously identified to be a risk factor for DSH^{5 31} and SA,^{32 33} along with alcohol use for DSH^{5 28 31} and SA.^{32 33} When we analyzed the data according to gender, we found that tobacco smoking and alcohol use were especially important risk factors for DSH/SA in girls (Tables 2 and 3). Compared to boys, the prevalence of smoking and alcohol use are relatively low in Taiwanese girls (OR = 5.5 and 5.8

1
2
3
4 respectively, girls as the reference group).³⁴ Female smokers or alcohol users may be more
5
6
7 pathological and have a lower threshold for DSH/SA. The risk factors in the current study are in
8
9
10 good agreement with the existing literature, which underscores the need to offer preventive
11
12 interventions by addressing each of these risk factors to reduce DSH/SA and alleviate current distress.
13
14 School surveys to identify adolescents with low self-esteem, depression, or substance use are
15
16 warranted, and mental health interventions for depression, substance use and to enhance self-esteem
17
18 are also needed.
19
20
21
22
23

24 Stress due to school studies is usually high in Chinese society, and academic performance (i.e.
25
26 school ranking in this study) was a culturally specific factor for adolescent DSH and SA in this study.
27
28
29 A previous study in Hong Kong reported that poor academic performance was related to adolescent
30
31 non-suicidal self-harm and SA.³⁵ Several explanations for the relationship between academic
32
33 performance and DSH/SA have been proposed. Academic problems may precede DSH/SA, or they
34
35 may both be caused by the same set of underlying risk factors. Students with poor academic
36
37 performance should receive more attention from their teachers, because Chinese society emphasizes
38
39 academic performance and those with poor performance may have higher levels of frustration, poor
40
41 self-esteem and hopelessness. Mental health and education policy makers may need to provide low
42
43 ranking schools with more counseling services and support from mental health professionals;
44
45 especially in girls' schools. Academic remediation activities may also be arranged to help students.
46
47
48 Regular screening programs to early detect those who may need mental health services are also
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 warranted. The education system and parents should also encourage other strengths rather than
4
5
6 academic performance alone, such as studying at a vocational school. Further research should
7
8
9 investigate the relationship between a student's academic high school performance and suicidality.
10
11

12 13 14 15 **Impulsivity**

16
17
18 There seems to be more evidence that impulsivity is associated with adolescent DSH than with SA.
19
20
21 For example, previous studies in Europe and the US have reported higher impulsiveness on
22
23
24 self-reported scales as a risk factor for adolescent DSH,^{4 36} which is consistent with our findings.
25
26
27 However, in contrast to previous studies,^{4 12} our results do not support an association between overall
28
29
30 impulsivity score and SA. Impulsivity could characterize the suicidal adolescents in models 1, 2, and
31
32
33 3, but it became non-significant after adding covariates of depressive symptoms (Table 3). However,
34
35
36 some studies have also reported no relationship between impulsivity and SA. In a case-control study
37
38
39 comparing suicidal completers and community control adolescents, impulsivity was related to
40
41
42 suicide in univariate analysis but not in multivariate analysis.³⁷ In another study surveying suicidal
43
44
45 and non-suicidal adolescent inpatients, the self-reported Impulse Control Scale score was not
46
47
48 different between the two groups.³⁸

49
50 When we focused on the moderating effects of gender, we found that total impulsivity score (OR
51
52
53 = 1.03) was correlated with DSH only in boys (model 6 of Table 2). The odds ratio was slightly
54
55
56 higher compared to impulsivity among all students (OR = 1.02, model 5 of Table 2). Previous studies
57
58
59
60

1
2
3
4 in Ireland also found that impulsivity was a risk factor for DSH only in boys.^{15 39} Gender also
5
6 modulated the association between impulsivity and SA (model 5 of Table 3). However impulsivity
7
8 lost its significance in model 6 in both genders. We postulate that the moderating effect was weak.
9
10

11
12 Among the BIS subscales, BIS-11 factor 3 (novelty seeking and acting without thinking) was
13
14 associated with DSH in both boys and girls in multivariate analysis (Table 4). Inconsistent results
15
16 regarding the relationship between impulsivity and DSH have been reported. Impulsivity, like
17
18 suicidality, is a complicated construct consisting of many factors, rather than a unidimensional
19
20 measure.⁴⁰ Thus the subscale analysis was warranted. Sensation seekers (i.e. high factor 3) have been
21
22 shown to pursue novelty even at the cost of self-harm,⁴¹ and this may explain our findings that factor
23
24 3 was correlated with DSH in both genders.
25
26
27
28
29
30
31

32
33 We also found that BIS-11 factor 2 (lack of perseverance and self-control) characterized SA in
34
35 boys in multivariate analysis (Table 4), which is consistent with prior studies.^{42 43} A previous
36
37 Taiwanese study found that male adults with a history of SA exhibited higher BIS-11 factor 2
38
39 scores,⁴² and Horesh et al. also found an association between impulsivity and SA among male
40
41 adolescent inpatients.⁴³ A study using neuropsychological tests and brain imaging found that
42
43 prepotent motor responses are more easily evoked in men, which is a tendency that could predispose
44
45 them to impulse control disorders.⁴⁴ In addition, suicidal male adolescents are more likely to exhibit
46
47 an impulsive presentation than suicidal females.⁴⁵ Since BIS-11 factor 2 is considered to reflect
48
49 long-standing behavioral patterns,⁴⁶ it is plausible that boys with a lack of self-control and low
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 self-esteem may be prone to suicidal behavior. Gender modulated the association between
5
6
7 impulsivity and SA, and that may explain why BIS factor 2 score was significant in boys only.
8

9
10 Impulsive boys under stress such as those with depression or substance use may be less tolerant
11
12 of complex thinking and lack of flexibility, and hence are predisposed to having a lower threshold for
13
14 SA without contemplating the possible consequences.⁴² A neuroimaging study confirmed that BIS-11
15
16 subscales were correlated with different brain regions in adolescents.⁴⁷ Another study of young adults
17
18 found gender-specific differences in BIS-11-LGI (local gyrification index) correlations in the middle
19
20 and inferior frontal gyrus,⁴⁸ which may explain our findings of a gender difference in impulsivity.
21
22
23
24
25
26

27 Our results may support the stress-diathesis theory that dispositionally impulsive adolescents
28
29 and those with low self-esteem with mental illnesses such as depression are more likely to have SA.
30
31 In a French study, impulsive traits of adolescents were related to the use of fewer appropriate and
32
33 more inappropriate regulation strategies and depression.⁴⁹ Psychological interventions to decrease
34
35
36 impulsivity are also needed.
37
38
39
40
41
42
43

44 **Other psychosocial dimensions**

45
46
47 In hierarchical regression analysis of SA, social support was present in models 2 and 3, but
48
49 disappeared after adjusting for substance use and depressive symptoms in model 4 (Table 3).
50
51
52 However, social support remained a risk factor for SA in the final model among girls. This may
53
54 reflect that girls are affected by relationships with peers, family and teachers more than boys. A
55
56
57
58
59
60

1
2
3
4 previous study also showed that social connectedness or family support³⁰ was associated with
5
6 adolescent suicide risk. Social support in our study included that from family, peers and teachers,
7
8 which may have contributed to the negative findings. Our results suggest that particular attention
9
10 should be paid to high-risk girls with poor social support, and that active interventions should be
11
12 arranged. Perceived family discord was a risk factor for DSH and SA in models 1, 2, and 3 of the
13
14 current study, implying that family plays a role in adolescents' suicidality. This is consistent with
15
16 previous DSH⁵⁰ and SA studies.³⁰ However, its effects on DSH and SA disappeared after adding
17
18 depressive symptoms. A longitudinal study had similar findings in that after controlling for mental
19
20 health disorders and adverse life events, the influence of parental and family factors on adolescent
21
22 suicide was attenuated.⁵¹
23
24
25
26
27
28
29
30
31
32
33
34
35

36 **Strengths and limitations**

37
38 This study used a large community sample of adolescents from different areas of Taipei, which is a
39
40 strength when it comes to generalization. A further strength in the present study is that
41
42 well-established self-reported measures and a broad array of relevant psychosocial measures were
43
44 used. Finally, few studies not based in Western countries have investigated the risk factors for DSH
45
46 and SA in a community sample.
47
48
49
50
51
52

53 There are also several limitations to this study. First, the overall response rate was only 60.61%.
54
55
56 Students in Taiwan have heavy study stress and that may hinder their motivation to participate. We
57
58
59
60

1
2
3
4 worked together with school staff but we do not force students to participate the study. Adolescents
5
6
7 often are not interested in activities arranged by adults and that maybe one of the reasons that our
8
9
10 response rate was not very high. We mentioned on the inform consents that we would select some
11
12
13 students (less than 10%) for diagnostic interview; maybe some students feel it's too time-consuming.
14
15
16 Second, conducting a large-scale survey with such a large sample does not allow for individual
17
18 in-depth interviews. Measures in the present study were self-reported, and thus may reflect bias.
19
20
21 However, data from large school surveys by Hawton et al were also self-reported,¹⁴ and they found
22
23
24 that the majority of respondents reporting lifetime DSH were also classified as having DSH by
25
26
27 expert evaluation.⁵² This is similar to the findings of the current study in that the agreement between
28
29
30 online assessments and interviews with regards to lifetime SA was moderate. In addition we
31
32
33 conducted the tests in a group setting, and the students could preview the online questionnaires and
34
35
36 review and change their answers to decrease a social desirability effect and yield more reliable
37
38
39 data.⁵³ Self-reports using online questionnaires have been shown to allow students to report more
40
41
42 sensitive risky behavior than using paper-and-pencil questionnaires.⁵⁴ Third, we did not use multiple
43
44
45 assessments such as lab-measured impulsivity. However, a previous study showed a significant
46
47
48 correlation between the self-reported form and the Test of Variables of Attention (TOVA) measure
49
50
51 of impulsivity ($r = 0.34$; $p < 0.05$).³⁸ Fourth, BIS-11 did not assess emotional impulsivity. However
52
53
54 one meta-analysis found negative urgency, a form of emotional impulsivity, was significantly related
55
56
57 to a composite of suicidality, and the effect size for negative urgency was larger than those reported
58
59
60

1
2
3
4 for other forms of impulsivity.⁵⁵ Emotional-relevant impulsivity needs to be assessed in future work.

5
6
7 Fifth, this study was cross-sectional, precluding conclusions regarding causality. Future longitudinal
8
9
10 studies examining alternative moderators are needed.

11 12 13 14 15 **CONCLUSIONS**

16
17
18 We found a number of similarities and differences in certain risk factors between adolescents with
19
20
21 DSH and those with SA. Poor impulsivity and other factors such as female gender, low self-esteem,
22
23
24 poor academic performance, depression and tobacco/alcohol use were significant risk factors in the
25
26
27 final model of adolescent DSH. Gender modulated the relationship between impulsivity and DSH;
28
29
30 associations between impulsivity and DSH were particularly strong among boys. Similar factors
31
32
33 were associated with SA in the final model except for impulsivity, although its subscale was
34
35
36 associated with SA in boys. Gender was also a moderator for the association between impulsivity
37
38
39 and SA. These shared and unique risk factors are important to understand the mechanism behind
40
41
42 DSH and SA, and to allow for incorporation of these risk factors into future research on prevention
43
44
45 programs for these two behaviors among vulnerable adolescents across different settings.

46
47 Given the high prevalence rates and low consultation rates of these two behaviors, we suggest
48
49
50 that these high-risk behaviors should be considered as a public health problem. Mental health
51
52
53 professionals in schools should routinely assess DSH and SA, and self-reported screening
54
55
56 questionnaires should be conducted along with routine physical examinations in school to help
57
58
59
60

1
2
3
4 identify adolescents at risk. Paying attention to the mental health of adolescents at school may help
5
6
7 to prevent the consequences associated with unidentified and untreated mental health problems.
8
9

10
11
12 **Funding statement** Supported by grants from the Ministry of Science and Technology,
13
14 Taiwan, R.O.C. (NSC 9802314-B-195-011 MY3) and Mackay Memorial Hospital (9838,
15
16 9880), Taiwan.
17
18
19

20
21 **Competing interest statement** None declared.
22
23

24 **Contributors**

25
26
27 YH Huang contributed to data collection, performed the data analysis and drafted the article. HC Liu
28
29 drafted the study protocol and helped in the data collection process. FJ Tsai helped in the diagnostic
30
31 interview process. FJ Sun contributed in statistical analyses. KY Huang contributed in the diagnostic
32
33 interview process. YC Chiu contributed in counseling of at-risk adolescents, reviewing the article
34
35 and revising it critically for important intellectual content. YH Huang contributed in the diagnostic
36
37 interview process. YP Huang contributed to reviewing the article and revising it critically for
38
39 important intellectual content. SI Liu monitored and guided the designing and implementation of the
40
41 study, data collection, statistical analyses, interpreting findings, and revising the article. All authors
42
43 approved the manuscript submission for publication.
44
45
46
47
48
49
50
51

52
53
54
55
56 **Data sharing statement** No additional data available
57
58
59
60

REFERENCES

1. W.H.O. First WHO report on suicide prevention. 2014.
<http://www.who.int/mediacentre/news/releases/2014/suicide-prevention-report/en/> (accessed 2017 May 26).
2. Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm. Systematic review. *Br J Psychiatry* 2002;181:193-9.
3. Hawton K, Bergen H, Casey D, *et al.* Self-harm in England: a tale of three cities. Multicentre study of self-harm. *Soc Psychiatry Psychiatr Epidemiol* 2007;42:513-21.
4. Madge N, Hawton K, McMahon EM, *et al.* Psychological characteristics, stressful life events and deliberate self-harm: findings from the Child & Adolescent Self-harm in Europe (CASE) Study. *Eur Child Adolesc Psychiatry* 2011;20:499-508.
5. Moran P, Coffey C, Romaniuk H, *et al.* The natural history of self-harm from adolescence to young adulthood: a population-based cohort study. *Lancet* 2012;379:236-43.
6. Fergusson DM, Lynskey MT. Suicide attempts and suicidal ideation in a birth cohort of 16-year-old New Zealanders. *J Am Acad Child Adolesc Psychiatry* 1995;34:1308-17.
7. Andrews JA, Lewinsohn PM. Suicidal attempts among older adolescents: prevalence and co-occurrence with psychiatric disorders. *J Am Acad Child Adolesc Psychiatry* 1992;31:655-62.

- 1
2
3
4 8. Evans E, Hawton K, Rodham K, *et al*. The prevalence of suicidal phenomena in adolescents: a
5
6 systematic review of population-based studies. *Suicide Life Threat Behav* 2005;35:239-50.
7
8
9
10 9. Lenkiewicz K, Racicka E, Brynska A. Self-injury - placement in mental disorders classifications,
11
12 risk factors and primary mechanisms. Review of the literature. *Psychiatr Pol* 2017;51:323-34.
13
14
15 10. van Heeringen K. The neurobiology of suicide and suicidality. *Can J Psychiatry*
16
17 2003;48:292-300.
18
19
20
21 11. Kim S, Lee KU. Research on potential biomarker correlates for suicidal behavior: A review. *Asia*
22
23 *Pac Psychiatry* 2017.
24
25
26
27 12. Kashden J, Fremouw WJ, Callahan TS, *et al*. Impulsivity in suicidal and nonsuicidal adolescents.
28
29 *J Abnorm Child Psychol* 1993;21:339-53.
30
31
32
33 13. Beautrais AL, Joyce PR, Mulder RT. Personality traits and cognitive styles as risk factors for
34
35 serious suicide attempts among young people. *Suicide Life Threat Behav* 1999;29:37-47.
36
37
38
39 14. Hawton K, Rodham K, Evans E, *et al*. Deliberate self harm in adolescents: self report survey in
40
41 schools in England. *BMJ* 2002;325:1207-11.
42
43
44
45 15. O'Connor RC, Rasmussen S, Hawton K. Adolescent self-harm: A school-based study in Northern
46
47 Ireland. *J Affect Disord* 2014;159:46-52.
48
49
50
51 16. Huang YH, Liu HC, Sun FJ, *et al*. Relationship Between Predictors of Incident Deliberate
52
53 Self-Harm and Suicide Attempts Among Adolescents. *J Adolesc Health* 2017;60:612-18.
54
55
56
57 17. Winefield HR, Winefield AH, Tiggemann M. Social support and psychological well-being in
58
59
60

- 1
2
3
4 young adults: the multi-dimensional support scale. *J Pers Assess* 1992;58:198-210.
5
6
7 18. Tsai FJ, Huang YH, Liu HC, *et al.* Patient Health Questionnaire for school-based depression
8
9 screening among Chinese adolescents. *Pediatrics* 2014;133:e402-e09.
10
11
12 19. Li CS, Chen SH. Obsessive-compulsiveness and impulsivity in a non-clinical population of
13
14 adolescent males and females. *Psychiatry Res* 2007;149:129-38.
15
16
17 20. Lin RC. Reliability and validity of the Rosenberg Self-esteem Scale on Chinese children. *Journal*
18
19 *of National Chung Cheng University* 1990;1:29-46.
20
21
22 21. Patton JH, Stanford MS, Barrat ES. Factor structure of the Barratt Impulsiveness Scale. *J Clin*
23
24 *Psychol* 1995;51:768-74.
25
26
27
28
29 22. Rosenberg M. *Conceiving the self*. New York: Basic Books, 1979.
30
31
32 23. Conigrave KM, Hall WD, Saunders JB. The AUDIT questionnaire: choosing a cut-off score.
33
34 Alcohol use disorder identification test. *Addiction* 1995;90:1349-56.
35
36
37
38 24. Wu SI, Huang HC, Liu SI, *et al.* Validation and aomparison of alcohol-screening instruments for
39
40 identifying hazardous drinking in hospitalized patients in Taiwan. *Alcohol Alcohol*
41
42 2008;43:577-82.
43
44
45
46
47 25. Gau SF, Soong WT. Psychiatric comorbidity of adolescents with sleep terrors or sleepwalking: a
48
49 case-control study. *Aust N Z J Psychiatry* 1999;33:734-9.
50
51
52
53 26. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological
54
55 research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol*
56
57
58
59
60

- 1
2
3
4 1986;51:1173-82.
5
6
7 27. Rosner B. *Fundamentals of Biostatistics*. Boston: Duxbury, 2006.
8
9
10 28. Tsai MH, Chen YH, Chen CD, *et al*. Deliberate self-harm by Taiwanese adolescents. *Acta*
11
12 *Paediatr* 2011;100:e223-26.
13
14
15 29. Bridge JA, Goldstein TR, Brent DA. Adolescent suicide and suicidal behavior. *J Child Psychol*
16
17 *Psychiatry* 2006;47:372-94.
18
19
20 30. Chen CH, Chen YH, Chen CY, *et al*. Factors associated with suicide ideations and attempts in
21
22 adolescents. *Taiwanese J Psychiatry* 2008;22:57-66.
23
24
25 31. Toprak S, Cetin I, Guven T, *et al*. Self-harm, suicidal ideation and suicide attempts among
26
27 college students. *Psychiatry Res* 2011;187:140-44.
28
29
30 32. Kokkevi A, Richardson C, Olszewski D, *et al*. Multiple substance use and self-reported suicide
31
32 attempts by adolescents in 16 European countries. *Eur Child Adolesc Psychiatry*
33
34 2012;21:443-50.
35
36
37 33. Wong SS, Zhou B, Goebert D, *et al*. The risk of adolescent suicide across patterns of drug use: a
38
39 nationally representative study of high school students in the United States from 1999 to 2009.
40
41 *Soc Psychiatry Psychiatr Epidemiol* 2013;48:1611-20.
42
43
44 34. Gau SS, Chong MY, Chen TH, *et al*. A 3-year panel study of mental disorders among adolescents
45
46 in Taiwan. *Am J Psychiatry* 2005;162:1344-50.
47
48
49 35. Shek DT, Yu L. Self-harm and suicidal behaviors in Hong Kong adolescents: prevalence and
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3
4 psychosocial correlates. *ScientificWorldJournal* 2012;2012:932540.
5
6
7 36. Janis IB, Nock MK. Are self-injurers impulsive?: Results from two behavioral laboratory studies.
8
9
10 *Psychiatry Res* 2009;169:261-67.
11
12
13 37. Renaud J, Berlim MT, McGirr A, *et al.* Current psychiatric morbidity, aggression/impulsivity, and
14
15 personality dimensions in child and adolescent suicide: a case-control study. *J Affect Disord*
16
17 2008;105:221-28.
18
19
20
21 38. Horesh N. Self-report vs. computerized measures of impulsivity as a correlate of suicidal
22
23 behavior. *Crisis* 2001;22:27-31.
24
25
26
27 39. McMahon EM, Reulbach U, Corcoran P, *et al.* Factors associated with deliberate self-harm
28
29 among Irish adolescents. *Psychol Med* 2010;40:1811-9.
30
31
32
33 40. Wang YG, Chen S, Xu ZM, *et al.* Family history of suicide and high motor impulsivity
34
35 distinguish suicide attempters from suicide ideators among college students. *J Psychiatr Res*
36
37 2017;90:21-25.
38
39
40
41 41. Mujica-Parodi LR, Carlson JM, Cha J, *et al.* The fine line between 'brave' and 'reckless':
42
43 amygdala reactivity and regulation predict recognition of risk. *Neuroimage* 2014;103:1-9.
44
45
46
47 42. Wu CS, Liao S, C., Lin KM, *et al.* Multidimensional assessments of impulsivity in subjects with
48
49 history of suicidal attempts. *Compr Psychiatry* 2009;50:315-21.
50
51
52
53 43. Horesh N, Gothelf D, Ofek H, *et al.* Impulsivity as a correlate of suicidal behavior in adolescent
54
55 psychiatric inpatients. *Crisis* 1999;20:8-14.
56
57
58
59
60

- 1
2
3
4 44. Li CS, Zhang S, Duann JR, *et al.* Gender Differences in Cognitive Control: an Extended
5
6 Investigation of the Stop Signal Task. *Brain Imaging Behav* 2009;3:262-76.
7
8
9
10 45. Rice TR. Violence among young men: the importance of a gender-specific developmental
11
12 approach to adolescent male suicide and homicide. *Int J Adolesc Med Health*
13
14 2015;27:177-81.
15
16
17
18 46. Moeller FG, Barratt ES, Dougherty DM, *et al.* Psychiatric aspects of impulsivity. *Am J*
19
20 *Psychiatry* 2001;158:1783-93.
21
22
23
24 47. Fradkin Y, Khadka S, Bessette KL, *et al.* The relationship of impulsivity and cortical thickness in
25
26 depressed and non-depressed adolescents. *Brain Imaging Behav* 2016.
27
28
29
30 48. Hirjak D, Thomann AK, Kubera KM, *et al.* Cortical folding patterns are associated with
31
32 impulsivity in healthy young adults. *Brain Imaging Behav* 2016.
33
34
35
36 49. d'Acremonta M, Van der Linden M. How is impulsivity related to depression in adolescence?
37
38 Evidence from a French validation of the cognitive emotion regulation questionnaire. *J*
39
40 *Adolesc* 2007;30:271-82.
41
42
43
44 50. de Kloet L, Starling J, Hainsworth C, *et al.* Risk factors for self-harm in children and adolescents
45
46 admitted to a mental health inpatient unit. *Aust N Z J Psychiatry* 2011;45:749-55.
47
48
49
50 51. Fergusson DM, Woodward LJ, Horwood LJ. Risk factors and life processes associated with the
51
52 onset of suicidal behaviour during adolescence and early adulthood. *Psychol Med*
53
54 2000;30:23-39.
55
56
57
58
59
60

1
2
3
4 52. Hawton K, Rodham K, Evans E. *By their own young hand: Deliberate self-harm and suicidal*
5
6
7 *ideas*. London: Jessica Kingsley Publishers, 2006.

8
9
10 53. Whitener EM, Klein HJ. Equivalence of computerized and traditional research methods: The
11
12 roles of scanning, social environment, and social desirability. *Compute Human Behav*
13
14 1995;11:65-75.

15
16
17
18 54. Booth-Kewley S, Larson GE, Miyoshi DK. Social desirability effects on computerized and
19
20 paper-and-pencil questionnaires. *Compute Human Behav* 2007;23:463-77.

21
22
23
24 55. Berg JM, Latzman RD, Bliwise NG, *et al*. Parsing the heterogeneity of impulsivity: A
25
26 meta-analytic review of the behavioral implications of the UPPS for psychopathology.
27
28
29
30 *Psychol Assess* 2015;27:1129-46.

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- 1 Author information: We provided author information and title page.
 - 2 Manuscript length and formatting: Have you checked that your manuscript doesn't exceed the requirements for word count, number of tables and/or figures, and number of references? Have you provided your abstract in the correct format? (Yes) Have you supplied any required additional information for your article type, such as key messages. (Yes)
 - 3 Tables: Have you embedded any tables into the main text?(Yes) Have they been cited in the text? (Yes)Have you provided appropriate table legends? (Yes)Have you uploaded any lengthy tables as supplementary files for online publication? (NO)
 - 4 Figures: No figures
 - 5 References: Have all of the references been cited in the text? (Yes)
 - 6 Supplementary files and appendices: Have you supplied these in an acceptable format? Have they been cited in the main text?
 - 7 Statements: Have you included the necessary statements relating to contributorship, competing interests, funding, data sharing and ethical approval? (Yes)
 - 8 Research reporting checklists: Have you either provided the appropriate statement for your study type, or explained why a checklist isn't required? (Yes)
 - 9 Permissions: Have you obtained from the copyright holder to re-use any previously published material? Has the source been acknowledged? (Yes)
- Reviewers: Have you provided the names of any preferred and non-preferred reviewers? (Yes)