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

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

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] Yu-Ching Chiu,[10] Yen-Hsun Huang,[11] Yo-Ping Huang,[12] Shen-Ing Liu,[1,2,3,4,8]

[1]Department of Medicine, MacKay Medical College, New Taipei City, Taiwan

[2]Department of Psychiatry, MacKay Memorial Hospital, Taipei, Taiwan

[3]Suicide Prevention Center, MacKay Memorial Hospital, Taipei, Taiwan

[4]MacKay Junior College of Medicine, Nursing, and Management, Taipei, Taiwan

[5]Department of Psychiatry, En Chu Kong Hospital, New Taipei City, Taiwan

[6]Department of Psychiatry, College of Medicine, National Taiwan University, Taipei, Taiwan

[7]Department of Psychiatry, National Taiwan University Hospital, Taipei, Taiwan

[8]Department of Medical Research, MacKay Memorial Hospital, Taipei, Taiwan

[9]Department of Psychiatry, Taiwan Adventist Hospital, Taipei, Taiwan

[10] Department of Psychiatry, Cardinal Tien Hospital, New Taipei City, Taiwan

[11]Department of Psychiatry, Taipei City Psychiatric Center, Taipei City Hospital, Taipei, Taiwan

[12]Department of Electrical Engineering, National Taipei University of Technology, Taipei, Taiwan

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Corresponding author

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

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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

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those at risk and appropriate interventions may be helpful.

Key words: Adolescence, Deliberate self-harm, Impulsivity, Suicide, Suicidal ideation, Substance abuse disorders

Strengths and limitations of this study

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

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

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

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

●Although we considered a number of known risk factors for deliberate self-harm and suicide attempt, other possible moderators may have also accounted for the relationships among the study variables.

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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

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on the relationship among impulsivity, DSH and SA in adolescents have been conducted in Western countries.

Due to these inconsistent results and to bridge the gaps in current knowledge, we designed this study to investigate correlations among impulsivity, DSH and SA in Taiwanese adolescents. The study aimed to: (1) explore possible differences and similarities in risk factors among adolescents with DSH and SA, and (2) explore the role of impulsivity in these two groups.

METHODS

Subjects

This study was approved by the Institutional Review Board of MacKay Memorial Hospital. It was part of the Taiwanese Adolescent Self-Harm Project (TASP), a prospective study conducted to evaluate the one-year incidence of self-harm behavior and the associated risk factors among adolescents in Taiwan.[12] From October 2008 to March 2010, we recruited first-grade students from 14 senior high schools in Taipei and New Taipei City, Taiwan. The participating schools were chosen from different regions of Taipei, including urban, suburban, and rural areas, and accounted for 11.7% of all high schools in the Taipei area. After the aims of this study had been fully explained to both the students and their parents, written informed consent was obtained from all parents and participants. All of the participants completed the Chinese version of the Multidimensional Scale of Perceived Social Support (MDSS),[13] the Chinese version of the Patient Health Questionnaire

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(PHQ-9),[14] the Chinese version of the Barratt Impulsiveness Scale, Version 11 (BIS-11),[15] and the Rosenberg Self-Esteem Scale (RSES).[16] The students also reported all self-harm experiences, physical illnesses, and substance use. All of the measures were completed anonymously online at the participating schools, and a trained research assistant was also available. A subsample of the students also received diagnostic interviews conducted by child psychiatrists.[14] The data from the online questionnaires were collected by a computer engineer. The researchers had access to the data one day after the students had completed the questionnaires to ensure the quality of the data. We also provided each school with a list of students at high-risk of suicide for further referral and on-site counseling by a child psychiatrist or a psychologist at their school.

Online assessments

Suicidality: suicide ideation, suicide plan, deliberate self-harm, and suicide attempt

All subjects were asked if they had ever thought of killing themselves at any time in their life. They were then asked about ever having planned to kill themselves. Using the same scale, the students were then asked "Have you ever deliberately (not accidentally) hurt yourself?" and "How many times have you deliberately self-harmed?" The participants who responded positively to the main questions were then asked to elaborate on their actions (multiple choices including drug overdose, hanging, burning charcoal, jumping from a height, cutting themselves, and being hit by a car). They were then asked to describe the act, the number of episodes, the timing of each episode, and the

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consequences (e.g., need for medical intervention) and to endorse the motive behind the act. SAs were identified in all reports of self-harm according to the response to, "Have you ever really tried to kill yourself during these DSH episodes?" We also collected the number of SAs and the time of the first and last attempts. The subjects who reported having harmed themselves with/without suicidal intent were classified as "DSH." SA was defined as an intentional action to kill oneself.

The Chinese version of the BIS-11

The BIS-11 is a 30-item self-reported questionnaire designed to measure impulsivity. The total score ranges from 30 to 120, with a higher score indicating greater impulsivity.[17] The 25 items of the Chinese version of the BIS-11 have demonstrated good overall internal consistency in Taiwanese adolescents, with a Cronbach's alpha of 0.834.[15] The factor structure of the Chinese version of the BIS-11 consists of three factors: "inability to plan," "lack of self-control," and "novelty seeking."

Multi-dimensional Scale of Perceived Social Support (MDSS)

The MDSS is a self-reported measure of the availability and adequacy of social support from various sources.[13] We estimated four types of social support, including that from parents, other family members, friends, and teachers, with a higher score indicating greater social support. In our sample, the Cronbach's alpha was 0.63.

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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 (α = 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

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Disorders Identification Test-Consumption (AUDIT-C). The AUDIT-C includes the first three questions from the full AUDIT,[19] and assesses the amount and frequency of alcohol intake and frequency of alcohol misuse (defined as having six or more drinks). The optimal cut-off score of the Chinese AUDIT-C for hazardous drinking was 3/4, with good sensitivity (0.90) and specificity (0.92).[20] In this study, this was treated as a continuous variable, and a higher score indicated more alcohol use. A summary of illicit drug use was obtained from the participants who had used any form of illicit drug during the past month.

Face-to-face interviews with child psychiatrists using the Kiddie-Schedule for Affective Disorder and Schizophrenia Epidemiological Version (K-SADS-E)

The K-SADS-E is a semi-structured interview scale for the systematic assessment of both past and current episodes of psychiatric disorders in children and adolescents. The Chinese version has been shown to be a reliable and valid instrument.[21] Child psychiatrists blind to the results of the online assessments interviewed a subsample of the students (n = 272) using the K-SADS-E. Lifetime SA was assessed by the child psychiatrists according to the question, “Have you actually tried to kill yourself?”

Statistical analysis

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Descriptive and analytical statistics of the data obtained in this study were analyzed using SPSS version 21.0 for Windows (SPSS, IBM, Armonk, NY, USA). Risk factors for DSH and SA were first analyzed using univariate logistic regression analysis, with one variable at a time. Hierarchical multiple regression strategies (using a stepwise method) were then used to determine the risk factors for DSH/SA and to assess whether impulsivity played any role. The joint effect of the independent variables that showed significance in univariate analysis was assessed with hierarchical regression analysis. To examine the association between impulsivity and DSH/SA, all sociodemographic and personality (BIS-11, RSES) variables were introduced in the first step (model 1), followed by adding social support (MDSS) in the second step (model 2), alcohol/tobacco use in the third step (model 3), and depressive symptoms in the fourth step (model 4). Logistic regression was used to analyze the role of impulsivity and all other sociodemographic, clinical and personality trait variables with DSH/SA between genders. We further analyzed three subscales of the BIS-11 instead of the total score in the male and female students. We also examined the agreement (i.e. reliability) between the computer questionnaire assessments and face-to-face interviews (n = 272) with regards lifetime SA. This agreement was assessed by concordance rate and kappa statistics.[22]

RESULTS

Descriptive statistics and univariate analysis of lifetime DSH and lifetime SA

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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)

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Current smoker	226	(3.8)
Illicit drug use in the last month	10	(0.2)
MDSS score	20.8	(3.6)
RSES score	28.3	(5.4)
PHQ-9 score	5.7	(4.6)
AUDIT-C score	1.1	(1.9)

There was no statistical difference in BIS-11 score between the male and female students. Univariate analysis revealed that the risk factors associated with both lifetime DSH and SA were higher impulsivity, female gender, low school ranking, father's job status, not living with biological parents, family discord, low self-esteem, poor social support, currently smoking, more alcohol use, and more depressive symptoms (Table 2).

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

Variables	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)	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)

[a]Below the 70th percentile; *p<0.05, **p<0.01, ***p<0.001

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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).

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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 (095~0.98)***	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

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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

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We then added social support status (MDSS score) into model 2. Social support did not significantly alter the confidence intervals of the other variables in model 1 with regards to DSH, and it was also not significantly associated with DSH in model 2. However, social support was a protective factor for SA in adjusted model 2. Impulsivity, female gender, low self-esteem, low school ranking, and family discord retained significance in adjusted model 2 for SA.

In model 3 we added variables of substance use, and DSH and SA were still significantly associated with impulsivity, although the odds were attenuated (Tables 3 and 4). The other significant variables in model 2 persisted as risk factors for DSH/SA in model 3. Currently smoking and a higher level of alcohol use were strong risk factors for DSH/SA.

In model 4, we included all variables (including depressive symptoms). DSH was still significantly associated with impulsivity, although its odds were attenuated again. The effect of family discord was fully statistically mediated in the final model of DSH. Other significant variables in model 3 persisted as risk factors for DSH in the final model. Depressive symptoms was a risk factor for DSH, and for every 1 unit increase in PHQ score, the likelihood of reporting lifetime DSH increased by 12%. In addition, for every 1 unit increase in AUDIT-C score, the likelihood of reporting lifetime DSH increased by 15%.

Impulsivity, family discord, and social support lost their significance after adjusting for the aforementioned covariates in model 4 for the SA group (Table 4). Depressive symptoms and

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

We further analyzed the risk factors for DSH/SA by gender. For boys, impulsivity, low self-esteem, alcohol use and depressive symptoms were risk factors for DSH, compared to low school ranking, low self-esteem, smoking, alcohol use and depressive symptoms in girls (Table 3). For boys, low self-esteem, smoking and depressive symptoms were risk factors for SA, compared to low school ranking, low self-esteem, poor social support, smoking, alcohol use and depressive symptoms in girls, while their father's employment status was a protective factor (Table 4). Smoking status was an especially strong risk factor for SA in girls (OR = 5.24).

We used three subscales instead of BIS-11 total score in the multivariate logistic regression analysis to investigate the relationships among impulsivity subscales and DSH/SA (Table 5). For both genders, factor 3 of the BIS-11 scale, low self-esteem, alcohol use and depressive symptoms were risk factors for DSH. Low school ranking and smoking were additional risk factors for DSH in girls. For boys, risk factors for SA included factor 2 of the BIS-11 scale, low self-esteem, smoking and depressive symptoms. For girls with SA, impulsivity subscales were non-significant.

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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

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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 6). The kappa value was 0.59, which was in moderate agreement range.[22]

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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

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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 DSH[8] 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 27] 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

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self-esteem, depression, or substance use are warranted, and mental health interventions for depression, substance use and to enhance self-esteem are also needed.

Stress due to school studies is usually high in Chinese society, and academic performance (i.e. school ranking in this study) was a culturally specific factor for adolescent DSH and SA in this study. A previous study in Hong Kong reported that poor academic performance was related to adolescent non-suicidal self-harm and SA.[30] Several explanations for the relationship between academic performance and DSH/SA have been proposed. Academic problems may precede DSH/SA, or they may both be caused by the same set of underlying risk factors. Students with poor academic performance should receive more attention from their teachers, because Chinese society emphasizes academic performance and those with poor performance may have higher levels of frustration, poor self-esteem and hopelessness. Low ranking schools therefore need more counseling services and support from mental health professionals. Academic remediation activities may also be arranged to help students. Regular screening programs to early detect those who may need mental health services are also warranted. The education system and parents should also encourage other strengths rather than academic performance alone, such as studying at a vocational school. Further research should investigate the relationship between a student's academic high school performance and suicidality.

Impulsivity

There seems to be more evidence that impulsivity is associated with adolescent DSH than with SA.

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For example, previous studies in Europe and the US have reported higher impulsiveness on self-reported scales as a risk factor for adolescent DSH,[8 31] which is consistent with our findings. However, in contrast to previous studies,[7 8] our results do not support an association between overall impulsivity score and SA. Impulsivity could characterize the suicidal adolescents in models 1, 2, and 3, but it became non-significant after adding covariates of depressive symptoms (Table 4). However, some studies have also reported no relationship between impulsivity and SA. In a case-control study comparing suicidal completers and community control adolescents, impulsivity was related to suicide in univariate analysis but not in multivariate analysis.[32] In another study surveying suicidal and non-suicidal adolescent inpatients, the self-reported Impulse Control Scale score was not different between the two groups.[33]

Among the BIS subscales, BIS-11 factor 3 (novelty seeking and acting without thinking) was associated with DSH in both boys and girls in multivariate analysis (Table 5). A previous study in England found that impulsivity was a risk factor for DSH in girls,[10] whereas other studies in Ireland found that impulsivity was a risk factor for DSH in boys.[11 34] Sensation seekers (i.e. high factor 3) have been shown to pursue novelty even at the cost of self-harm,[35] and this may explain our findings that factor 3 was correlated with DSH in both genders. We also found that BIS-11 factor 2 (lack of perseverance and self-control) characterized SA in boys in multivariate analysis (Table 5), which is consistent with prior studies.[36 37] A previous Taiwanese study found that male adults with a history of SA exhibited higher BIS-11 factor 2 scores,[36] and Horesh et al. also found an association between

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impulsivity and SA among male adolescent inpatients.[37] Since BIS-11 factor 2 is considered to reflect long-standing behavioral patterns,[38] it is plausible that boys with a lack of self-control and low self-esteem may be prone to suicidal behavior. Impulsive boys under stress such as depression or substance use may also be predisposed to have a lower threshold for SA without contemplating the possible consequences. A neuroimaging study confirmed that BIS-11 subscales were correlated with different brain regions in adolescents.[39] Another study of young adults found gender-specific differences in BIS-11-LGI (local gyrification index) correlations in the middle and inferior frontal gyrus,[40] which may explain our findings of a gender difference in impulsivity. Our results may support the stress-diathesis theory that dispositionally impulsive adolescents and those with low self-esteem with mental illnesses such as depression are more likely to have SA. In a French study, impulsive traits of adolescents were related to the use of fewer appropriate and more inappropriate regulation strategies and depression.[41] Psychological interventions to decrease impulsivity are also needed.

Other psychosocial dimensions

In hierarchical regression analysis of SA, social support was present in models 2 and 3, but disappeared after adjusting for substance use and depressive symptoms in model 4 (Table 4). However, social support remained a risk factor for SA in the final model among girls. This may reflect that girls are affected by relationships with peers, family and teachers more than boys. A

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previous study also showed that social connectedness or family support[26] was associated with adolescent suicide risk. Social support in our study included that from family, peers and teachers, which may have contributed to the negative findings. Our results suggest that particular attention should be paid to high-risk girls with poor social support, and that active interventions should be arranged. Perceived family discord was a risk factor for DSH and SA in models 1, 2, and 3 of the current study, implying that family plays a role in adolescents' suicidality. This is consistent with previous DSH[42] and SA studies.[26] However, its effects on DSH and SA disappeared after adding depressive symptoms. A longitudinal study had similar findings in that after controlling for mental health disorders and adverse life events, the influence of parental and family factors on adolescent suicide was attenuated.[43]

Strengths and limitations

This study used a large community sample of adolescents from different areas of Taipei, which is a strength when it comes to generalization. A further strength in the present study is that well-established self-reported measures and a broad array of relevant psychosocial measures were used. Finally, few studies not based in Western countries have investigated the risk factors for DSH and SA in a community sample.

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

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self-reported, and thus may reflect bias. However, data from large school surveys by Hawton et al were also self-reported,[10] and they found that the majority of respondents reporting lifetime DSH were also classified as having DSH by expert evaluation.[44] This is similar to the findings of the current study in that the agreement between online assessments and interviews with regards to lifetime SA was moderate. In addition we conducted the tests in a group setting, and the students could preview the online questionnaires and review and change their answers to decrease a social desirability effect and yield more reliable data.[45] Self-reports using online questionnaires have been shown to allow students to report more sensitive risky behavior than using paper-and-pencil questionnaires.[46] Second, we did not use multiple assessments such as lab-measured impulsivity. However, a previous study showed a significant correlation between the self-reported form and the Test of Variables of Attention (TOVA) measure of impulsivity ($r = 0.34$; $p < 0.05$).[33] Third, this study was cross-sectional, precluding conclusions regarding causality. Finally, although we considered a number of known risk factors of DSH or SA, other possible moderators may also account for the relationships among the study variables. Future longitudinal studies examining alternative moderators are needed.

CONCLUSIONS

We found a number of similarities and differences in certain risk factors between adolescents with DSH and those with SA. Poor impulsivity and other factors such as female gender, low self-esteem,

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poor academic performance, depression and tobacco/alcohol use were significant risk factors in the final model of adolescent DSH. Similar factors were associated with SA in the final model except for impulsivity, although its subscale was associated with SA in boys. These shared and unique risk factors are important to understand the mechanism behind DSH and SA, and to allow for incorporation of these risk factors into future research on prevention programs for these two behaviors among vulnerable adolescents across different settings.

Given the high prevalence rates and low consultation rates of these two behaviors, we suggest that these high-risk behaviors should be considered as a public health problem. Mental health professionals in schools should routinely assess DSH and SA, and self-reported screening questionnaires should be conducted along with routine physical examinations in school to help identify adolescents at risk. Paying attention to the mental health of adolescents at school may help to prevent the consequences associated with unidentified and untreated mental health problems.

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Contributors

YH Huang contributed to data collection, performed the data analysis and drafted the article. HC Liu

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drafted the study protocol and helped in the data collection process. FJ Tsai helped in the diagnostic interview process. FJ Sun contributed in statistical analyses. KY Huang contributed in the diagnostic interview process. YC Chiu contributed in counseling of at-risk adolescents, reviewing the article and revising it critically for important intellectual content. YH Huang contributed in the diagnostic interview process. YP Huang contributed to reviewing the article and revising it critically for important intellectual content. SI Liu monitored and guided the designing and implementation of the study, data collection, statistical analyses, interpreting findings, and revising the article. All authors approved the manuscript submission for publication.

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

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

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] Yu-Ching Chiu,[10] Yen-Hsun Huang,[11] Yo-Ping Huang,[12] Shen-Ing Liu,[1,2,3,4,8]

[1]Department of Medicine, MacKay Medical College, New Taipei City, Taiwan

[2]Department of Psychiatry, MacKay Memorial Hospital, Taipei, Taiwan

[3]Suicide Prevention Center, MacKay Memorial Hospital, Taipei, Taiwan

[4]MacKay Junior College of Medicine, Nursing, and Management, Taipei, Taiwan

[5]Department of Psychiatry, En Chu Kong Hospital, New Taipei City, Taiwan

[6]Department of Psychiatry, College of Medicine, National Taiwan University, Taipei, Taiwan

[7]Department of Psychiatry, National Taiwan University Hospital, Taipei, Taiwan

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[8]Department of Medical Research, MacKay Memorial Hospital, Taipei, Taiwan

[9]Department of Psychiatry, Taiwan Adventist Hospital, Taipei, Taiwan

[10] Department of Psychiatry, Cardinal Tien Hospital, New Taipei City, Taiwan

[11]Department of Psychiatry, Taipei City Psychiatric Center, Taipei City Hospital, Taipei, Taiwan

[12]Department of Electrical Engineering, National Taipei University of Technology, Taipei, Taiwan

Corresponding author

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

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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.

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

Key words: Adolescence, Deliberate self-harm, Impulsivity, Suicide, Suicidal ideation, Substance abuse disorders

Strengths and limitations of this study

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

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

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

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

●Gender is a moderator between the relationship of impulsivity and adolescent

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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] hanging[5]) 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

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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.

Regarding etiology, there is a bio-psychosocial model for self-harm. Higher levels of endogenous opioids and higher level of pain tolerance have been found in self-harming people. Interactions between environmental and genetic factors may also contribute to self-harm.[9] There is also a stress-diathesis or a psychobiological model for SA.[10] Deficits in serotonergic neurotransmission, low CSF 5-hydroxyindoleacetic acid (5-HIAA) levels, low platelet 5-hydroxytryptamine and a decreased number of binding sites in platelets have been found in people with SA.[11] A potential link between low plasma 5□HIAA levels and impulsivity/severity of the SA has also been postulated.[11] Different etiologies may differentiate between DSH and SA; we were also interested in the role of impulsivity in these two groups.

Impulsivity has frequently been reported to be a risk factor for both DSH and SA,[4 12] although the results are somewhat inconsistent. In one study, the association with SA was non-significant after controlling for hopelessness, neuroticism, external

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locus of control, self-esteem, and extroversion.[13] In addition, Hawton et al.[14] 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.[15] These inconsistent findings imply that impulsivity may be important in identifying high-risk subgroups. To date, most previous studies on the relationship among impulsivity, DSH and SA in adolescents have been conducted in Western countries.

Due to these inconsistent results and to bridge the gaps in current knowledge, we designed this study to investigate correlations among impulsivity, DSH and SA in Taiwanese adolescents. The study aimed to: (1) explore possible differences and similarities in risk factors among adolescents with DSH and SA, and (2) explore the role of impulsivity in these two groups.

METHODS

Subjects

This study was approved by the Institutional Review Board of MacKay Memorial

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Hospital. It was part of the Taiwanese Adolescent Self-Harm Project (TASP), a prospective study conducted to evaluate the one-year incidence of self-harm behavior and the associated risk factors among adolescents in Taiwan.[16] From October 2008 to March 2010, we recruited first-grade students from 14 senior high schools in Taipei and New Taipei City, Taiwan by purposive sampling. The participating schools were chosen from different regions of Taipei, including urban, suburban, and rural areas, and accounted for 11.7% of all high schools in the Taipei area. After the aims of this study had been fully explained to both the students and their parents, written informed consent was obtained from all parents and participants.

Online assessments

All of the participants completed the Chinese version of the Multidimensional Scale of Perceived Social Support (MDSS),[17] the Chinese version of the Patient Health Questionnaire (PHQ-9),[18] the Chinese version of the Barratt Impulsiveness Scale, Version 11 (BIS-11),[19] and the Rosenberg Self-Esteem Scale (RSES).[20] The students also reported all self-harm experiences, physical illnesses, and substance use. All of

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the measures were completed anonymously online at the participating schools, and a trained research assistant was also available. A subsample of the students also received diagnostic interviews conducted by child psychiatrists.[18] The data from the online questionnaires were collected by a computer engineer. The researchers had access to the data one day after the students had completed the questionnaires to ensure the quality of the data. We also provided each school with a list of students at high-risk of suicide for further referral and on-site counseling by a child psychiatrist or a psychologist at their school.

Suicidality: suicide ideation, suicide plan, deliberate self-harm, and suicide attempt

All subjects were asked if they had ever thought of killing themselves at any time in their life. They were then asked about ever having planned to kill themselves. Using the same scale, the students were then asked "Have you ever deliberately (not accidentally) hurt yourself?" and "How many times have you deliberately self-harmed?" The participants who responded positively to the main questions were

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then asked to elaborate on their actions (multiple choices including drug overdose, hanging, burning charcoal, jumping from a height, cutting themselves, and being hit by a car). They were then asked to describe the act, the number of episodes, the timing of each episode, and the consequences (e.g., need for medical intervention) and to endorse the motive behind the act. SAs were identified in all reports of self-harm according to the response to, "Have you ever really tried to kill yourself during these DSH episodes?" We also collected the number of SAs and the time of the first and last attempts. The subjects who reported having harmed themselves with/without suicidal intent were classified as "DSH." SA was defined as an intentional action to kill oneself.

The Chinese version of the BIS-11

The BIS-11 is a 30-item self-reported questionnaire designed to measure impulsivity. The total score ranges from 30 to 120, with a higher score indicating greater impulsivity.[21] The 25 items of the Chinese version of the BIS-11 have demonstrated good overall internal consistency in Taiwanese adolescents, with a Cronbach's alpha

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of 0.834.[19] The factor structure of the Chinese version of the BIS-11 consists of three factors: "inability to plan," "lack of self-control," and "novelty-seeking."

Multi-dimensional Scale of Perceived Social Support (MDSS)

The MDSS is a self-reported measure of the availability and adequacy of social support from various sources.[17] We estimated four types of social support, including that from parents, other family members, friends, and teachers, with a higher score indicating greater social support. In our sample, the Cronbach's alpha was 0.63.

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 (α = 0.84) and acceptable

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test-retest reliability (intra-class correlation coefficient = 0.80) among adolescents in the community.[18] 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.[22] 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.[20]

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]

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and assesses the amount and frequency of alcohol intake and frequency of alcohol misuse (defined as having six or more drinks). The optimal cut-off score of the Chinese AUDIT-C for hazardous drinking was 3/4, with good sensitivity (0.90) and specificity (0.92).[24] In this study, this was treated as a continuous variable, and a higher score indicated more alcohol use. A summary of illicit drug use was obtained from the participants who had used any form of illicit drug during the past month.

Face-to-face interviews with child psychiatrists using the Kiddie-Schedule for Affective Disorder and Schizophrenia Epidemiological Version (K-SADS-E)

The K-SADS-E is a semi-structured interview scale for the systematic assessment of both past and current episodes of psychiatric disorders in children and adolescents. The Chinese version has been shown to be a reliable and valid instrument.[25] Child psychiatrists blind to the results of the online assessments interviewed a subsample of the students (n = 272) using the K-SADS-E. After 12 months of the initial assessment, the students completed the same questionnaires. All of the students with new occurrences

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of self-harm in the past year (i.e., the students who did not report self-harm at entry but did the next year) were enrolled for face-to-face interviews. The students who did not report any occurrences of self-harm at both years were randomly selected on a 1:1 ratio, frequency matched by class and gender. For the students who reported occurrences of self-harm in both years, one in two received face-to-face interviews. The response rate was 94.8%. Lifetime SA was assessed by the child psychiatrists according to the question, “Have you actually tried to kill yourself?”

Statistical analysis

Descriptive and analytical statistics of the data obtained in this study were analyzed using SPSS version 21.0 for Windows (SPSS, IBM, Armonk, NY, USA). Risk factors for DSH and SA were first analyzed using univariate logistic regression analysis, with one variable at a time. Hierarchical multiple regression strategies (using a stepwise method) were then used to determine the risk factors for DSH/SA and to assess whether impulsivity played any role. The joint effect of the independent variables that showed significance in univariate analysis was assessed with hierarchical regression

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analysis. To examine the association between impulsivity and DSH/SA, all sociodemographic and personality (BIS-11, RSES) variables were introduced in the first step (model 1), followed by adding social support (MDSS) in the second step (model 2), alcohol/tobacco use in the third step (model 3), and depressive symptoms in the fourth step (model 4). We then examined the interaction between gender and BIS-11 among logistic regression analyses to see whether the relationship between impulsivity and DSH/SA was moderated by gender (model 5).[26] Logistic regression was used to analyze the role of impulsivity and all other sociodemographic, clinical and personality trait variables with DSH/SA between genders (model 6). We further analyzed three subscales of the BIS-11 instead of the total score in the male and female students.

We also examined the agreement (i.e. reliability) between the computer questionnaire assessments and face-to-face interviews (n = 272) with regards lifetime SA assessed at the second year. This agreement was assessed by concordance rate and kappa statistics.[27]

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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.

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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)
With 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)

[a]Below the 70th percentile; [b]inability to plan; [c]lack of self-control; [d]novelty-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

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There was no statistical difference in BIS-11 score between the male and female students. Univariate analysis revealed that the risk factors associated with both lifetime DSH and SA were higher impulsivity, female gender, low school ranking, father's job status, not living with biological parents, family discord, low self-esteem, poor social support, currently smoking, more alcohol use, and more depressive symptoms (Table 1). Students in schools located in suburban areas compared to those in urban area had a higher risk of DSH.

Hierarchical regression of lifetime DSH and lifetime SA

The results of the hierarchical approach are presented in Tables 2 and 3. The adjusted model 1 including sociodemographic variables and personality traits (RSES, BIS-11) showed that similar 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, school district 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, school district, family discord, school ranking, and self-esteem factors attenuated the effect of impulsivity on the odds ratio (OR = 1.04) (Tables 2 and 3).

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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 (095~0.98)***	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-11×gender					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

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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

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We then added social support status (MDSS score) into model 2. Social support did not significantly alter the confidence intervals of the other variables in model 1 with regards to DSH, and it was also not significantly associated with DSH in model 2. However, social support was a protective factor for SA in adjusted model 2. Impulsivity, female gender, low self-esteem, low school ranking, and family discord retained significance in adjusted model 2 for SA.

In model 3 we added variables of substance use, and DSH and SA were still significantly associated with impulsivity, although the odds were attenuated (Tables 2 and 3). The other significant variables in model 2 persisted as risk factors for DSH/SA in model 3. Currently smoking and a higher level of alcohol use were strong risk factors for DSH/SA.

In model 4, we included all variables (including depressive symptoms). DSH was still significantly associated with impulsivity, although its odds were attenuated again. The effect of family discord was fully statistically mediated in the final model of DSH. Other significant variables in model 3 persisted as risk factors for DSH in the final model. Depressive symptoms was a risk factor for DSH, and for every 1 unit increase in PHQ score, the likelihood of reporting lifetime DSH increased by 12%. In addition, for every 1 unit increase in AUDIT-C score, the likelihood of reporting lifetime DSH increased by 15%.

Impulsivity, family discord, and social support lost their significance after adjusting for the aforementioned covariates in model 4 for the SA group (Table 3). Depressive symptoms and

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

When we added the interaction term of BIS-11 and gender in model 5, we found that they were significant in both Tables 2 and 3. This meant that gender modulated the association between impulsivity and DSH/SA. Other risk factors besides gender remained significance in both Tables 2 and 3.

We further analyzed the risk factors for DSH/SA by gender in model 6. For boys, impulsivity, low self-esteem, alcohol use and depressive symptoms were risk factors for DSH, compared to low school ranking, low self-esteem, smoking, alcohol use and depressive symptoms in girls (Table 2). Impulsive boys tended to have DSH, where as total impulsivity scores were not associated with SA in either gender. For boys, low self-esteem, smoking and depressive symptoms were risk factors for SA, compared to low school ranking, low self-esteem, poor social support, smoking, alcohol use and depressive symptoms in girls, while their father's employment status was a protective factor (Table 3). Smoking status was an especially strong risk factor for SA in girls (OR = 5.24).

We used three subscales instead of BIS-11 total score in the multivariate logistic regression

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analysis to investigate the relationships among impulsivity subscales and DSH/SA (Table 4). For both genders, factor 3 of the BIS-11 scale (novelty-seeking and acting without thinking), low self-esteem, alcohol use and depressive symptoms were risk factors for DSH. Low school ranking and smoking were additional risk factors for DSH in girls. For boys, risk factors for SA included factor 2 of the BIS-11 scale (lack of perseverance and self-control), low self-esteem, smoking and depressive symptoms. For girls with SA, impulsivity subscales were non-significant.

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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)***

[a]inability to plan or look ahead; [b]lack of perseverance and self-control; [c]novelty-seeking and acting without thinking; *p<0.05; **p<0.01; ***p<0.001

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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]

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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

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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 DSH[4] 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

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respectively, girls as the reference group).[34] Female smokers or alcohol users may be more pathological and have a lower threshold for DSH/SA. 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 self-esteem, depression, or substance use are warranted, and mental health interventions for depression, substance use and to enhance self-esteem are also needed.

Stress due to school studies is usually high in Chinese society, and academic performance (i.e. school ranking in this study) was a culturally specific factor for adolescent DSH and SA in this study. A previous study in Hong Kong reported that poor academic performance was related to adolescent non-suicidal self-harm and SA.[35] Several explanations for the relationship between academic performance and DSH/SA have been proposed. Academic problems may precede DSH/SA, or they may both be caused by the same set of underlying risk factors. Students with poor academic performance should receive more attention from their teachers, because Chinese society emphasizes academic performance and those with poor performance may have higher levels of frustration, poor self-esteem and hopelessness. Mental health and education policy makers may need to provide low ranking schools with more counseling services and support from mental health professionals; especially in girls' schools. Academic remediation activities may also be arranged to help students. Regular screening programs to early detect those who may need mental health services are also

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warranted. The education system and parents should also encourage other strengths rather than academic performance alone, such as studying at a vocational school. Further research should investigate the relationship between a student's academic high school performance and suicidality.

Impulsivity

There seems to be more evidence that impulsivity is associated with adolescent DSH than with SA. For example, previous studies in Europe and the US have reported higher impulsiveness on self-reported scales as a risk factor for adolescent DSH,[4 36] which is consistent with our findings. However, in contrast to previous studies,[4 12] our results do not support an association between overall impulsivity score and SA. Impulsivity could characterize the suicidal adolescents in models 1, 2, and 3, but it became non-significant after adding covariates of depressive symptoms (Table 3). However, some studies have also reported no relationship between impulsivity and SA. In a case-control study comparing suicidal completers and community control adolescents, impulsivity was related to suicide in univariate analysis but not in multivariate analysis.[37] In another study surveying suicidal and non-suicidal adolescent inpatients, the self-reported Impulse Control Scale score was not different between the two groups.[38]

When we focused on the moderating effects of gender, we found that total impulsivity score (OR = 1.03) was correlated with DSH only in boys (model 6 of Table 2). The odds ratio was slightly higher compared to impulsivity among all students (OR = 1.02, model 5 of Table 2). Previous studies

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in Ireland also found that impulsivity was a risk factor for DSH only in boys.[15 39] Gender also modulated the association between impulsivity and SA (model 5 of Table 3). However impulsivity lost its significance in model 6 in both genders. We postulate that the moderating effect was weak.

Among the BIS subscales, BIS-11 factor 3 (novelty seeking and acting without thinking) was associated with DSH in both boys and girls in multivariate analysis (Table 4). Inconsistent results regarding the relationship between impulsivity and DSH have been reported. Impulsivity, like suicidality, is a complicated construct consisting of many factors, rather than a unidimensional measure.[40] Thus the subscale analysis was warranted. Sensation seekers (i.e. high factor 3) have been shown to pursue novelty even at the cost of self-harm,[41] and this may explain our findings that factor 3 was correlated with DSH in both genders.

We also found that BIS-11 factor 2 (lack of perseverance and self-control) characterized SA in boys in multivariate analysis (Table 4), which is consistent with prior studies.[42 43] A previous Taiwanese study found that male adults with a history of SA exhibited higher BIS-11 factor 2 scores,[42] and Horesh et al. also found an association between impulsivity and SA among male adolescent inpatients.[43] A study using neuropsychological tests and brain imaging found that prepotent motor responses are more easily evoked in men, which is a tendency that could predispose them to impulse control disorders.[44] In addition, suicidal male adolescents are more likely to exhibit an impulsive presentation than suicidal females.[45] Since BIS-11 factor 2 is considered to reflect long-standing behavioral patterns,[46] it is plausible that boys with a lack of self-control and low

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

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

Our results may support the stress-diathesis theory that dispositionally impulsive adolescents and those with low self-esteem with mental illnesses such as depression are more likely to have SA. In a French study, impulsive traits of adolescents were related to the use of fewer appropriate and more inappropriate regulation strategies and depression.[49] Psychological interventions to decrease impulsivity are also needed.

Other psychosocial dimensions

In hierarchical regression analysis of SA, social support was present in models 2 and 3, but disappeared after adjusting for substance use and depressive symptoms in model 4 (Table 3). However, social support remained a risk factor for SA in the final model among girls. This may reflect that girls are affected by relationships with peers, family and teachers more than boys. A

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previous study also showed that social connectedness or family support[30] was associated with adolescent suicide risk. Social support in our study included that from family, peers and teachers, which may have contributed to the negative findings. Our results suggest that particular attention should be paid to high-risk girls with poor social support, and that active interventions should be arranged. Perceived family discord was a risk factor for DSH and SA in models 1, 2, and 3 of the current study, implying that family plays a role in adolescents' suicidality. This is consistent with previous DSH[50] and SA studies.[30] However, its effects on DSH and SA disappeared after adding depressive symptoms. A longitudinal study had similar findings in that after controlling for mental health disorders and adverse life events, the influence of parental and family factors on adolescent suicide was attenuated.[51]

Strengths and limitations

This study used a large community sample of adolescents from different areas of Taipei, which is a strength when it comes to generalization. A further strength in the present study is that well-established self-reported measures and a broad array of relevant psychosocial measures were used. Finally, few studies not based in Western countries have investigated the risk factors for DSH and SA in a community sample.

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

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self-reported, and thus may reflect bias. However, data from large school surveys by Hawton et al were also self-reported,[14] and they found that the majority of respondents reporting lifetime DSH were also classified as having DSH by expert evaluation.[52] This is similar to the findings of the current study in that the agreement between online assessments and interviews with regards to lifetime SA was moderate. In addition we conducted the tests in a group setting, and the students could preview the online questionnaires and review and change their answers to decrease a social desirability effect and yield more reliable data.[53] Self-reports using online questionnaires have been shown to allow students to report more sensitive risky behavior than using paper-and-pencil questionnaires.[54] Second, we did not use multiple assessments such as lab-measured impulsivity. However, a previous study showed a significant correlation between the self-reported form and the Test of Variables of Attention (TOVA) measure of impulsivity ($r = 0.34$; $p < 0.05$).[38] Third, BIS-11 did not assess emotional impulsivity. However one meta-analysis found negative urgency, a form of emotional impulsivity, was significantly related to a composite of suicidality, and the effect size for negative urgency was larger than those reported for other forms of impulsivity.[55] Emotional-relevant impulsivity needs to be assessed in future work. Fourth, this study was cross-sectional, precluding conclusions regarding causality. Future longitudinal studies examining alternative moderators are needed.

CONCLUSIONS

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We found a number of similarities and differences in certain risk factors between adolescents with DSH and those with SA. Poor impulsivity and other factors such as female gender, low self-esteem, poor academic performance, depression and tobacco/alcohol use were significant risk factors in the final model of adolescent DSH. Gender modulated the relationship between impulsivity and DSH, and the impulsive boys tended to have DSH. Similar factors were associated with SA in the final model except for impulsivity, although its subscale was associated with SA in boys. Gender was also a moderator for the association between impulsivity and SA. These shared and unique risk factors are important to understand the mechanism behind DSH and SA, and to allow for incorporation of these risk factors into future research on prevention programs for these two behaviors among vulnerable adolescents across different settings.

Given the high prevalence rates and low consultation rates of these two behaviors, we suggest that these high-risk behaviors should be considered as a public health problem. Mental health professionals in schools should routinely assess DSH and SA, and self-reported screening questionnaires should be conducted along with routine physical examinations in school to help identify adolescents at risk. Paying attention to the mental health of adolescents at school may help to prevent the consequences associated with unidentified and untreated mental health problems.

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Contributors

YH Huang contributed to data collection, performed the data analysis and drafted the article. HC Liu drafted the study protocol and helped in the data collection process. FJ Tsai helped in the diagnostic interview process. FJ Sun contributed in statistical analyses. KY Huang contributed in the diagnostic interview process. YC Chiu contributed in counseling of at-risk adolescents, reviewing the article and revising it critically for important intellectual content. YH Huang contributed in the diagnostic interview process. YP Huang contributed to reviewing the article and revising it critically for important intellectual content. SI Liu monitored and guided the designing and implementation of the study, data collection, statistical analyses, interpreting findings, and revising the article. All authors approved the manuscript submission for publication.

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

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] Yu-Ching Chiu,[10] Yen-Hsun Huang,[11] Yo-Ping Huang,[12] Shen-Ing Liu,[1,2,3,4,8]

[1]Department of Medicine, MacKay Medical College, New Taipei City, Taiwan

[2]Department of Psychiatry, MacKay Memorial Hospital, Taipei, Taiwan

[3]Suicide Prevention Center, MacKay Memorial Hospital, Taipei, Taiwan

[4]MacKay Junior College of Medicine, Nursing, and Management, Taipei, Taiwan

[5]Department of Psychiatry, En Chu Kong Hospital, New Taipei City, Taiwan

[6]Department of Psychiatry, College of Medicine, National Taiwan University, Taipei, Taiwan

[7]Department of Psychiatry, National Taiwan University Hospital, Taipei, Taiwan

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[8]Department of Medical Research, MacKay Memorial Hospital, Taipei, Taiwan

[9]Department of Psychiatry, Taiwan Adventist Hospital, Taipei, Taiwan

[10] Department of Psychiatry, Cardinal Tien Hospital, New Taipei City, Taiwan

[11]Department of Psychiatry, Taipei City Psychiatric Center, Taipei City Hospital, Taipei, Taiwan

[12]Department of Electrical Engineering, National Taipei University of Technology, Taipei, Taiwan

Corresponding author

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

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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

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impulsivity and DSH and SA were particularly strong among boys.

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

Key words: Adolescence, Deliberate self-harm, Impulsivity, Suicide, Suicidal ideation, Substance abuse disorders

Strengths and limitations of this study

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

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

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

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

●Gender is a moderator between the relationship of impulsivity and adolescent

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deliberate self-harm/suicide attempt.

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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] hanging[5]) 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

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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.

Regarding etiology, there is a bio-psychosocial model for self-harm. Higher levels of endogenous opioids and higher level of pain tolerance have been found in self-harming people. Interactions between environmental and genetic factors may also contribute to self-harm.[9] There is also a stress-diathesis or a psychobiological model for SA.[10] Deficits in serotonergic neurotransmission, low CSF 5-hydroxyindoleacetic acid (5-HIAA) levels, low platelet 5-hydroxytryptamine and a decreased number of binding sites in platelets have been found in people with SA.[11] A potential link between low plasma 5□HIAA levels and impulsivity/severity of the SA has also been postulated.[11] Different etiologies may differentiate between DSH and SA; we were also interested in the role of impulsivity in these two groups.

Impulsivity has frequently been reported to be a risk factor for both DSH and SA,[4 12] although the results are somewhat inconsistent. In one study, the association with SA was non-significant after controlling for hopelessness, neuroticism, external

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locus of control, self-esteem, and extroversion.[13] In addition, Hawton et al.[14] 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.[15] These inconsistent findings imply that impulsivity may be important in identifying high-risk subgroups. To date, most previous studies on the relationship among impulsivity, DSH and SA in adolescents have been conducted in Western countries.

Due to these inconsistent results and to bridge the gaps in current knowledge, we designed this study to investigate correlations among impulsivity, DSH and SA in Taiwanese adolescents. The study aimed to: (1) explore possible differences and similarities in risk factors among adolescents with DSH and SA, and (2) explore the role of impulsivity in these two groups.

METHODS

Subjects

This study was approved by the Institutional Review Board of MacKay Memorial

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Hospital. It was part of the Taiwanese Adolescent Self-Harm Project (TASP), a prospective study conducted to evaluate the one-year incidence of self-harm behavior and the associated risk factors among adolescents in Taiwan.[16] From October 2008 to March 2010, we recruited first-grade students from 14 senior high schools in Taipei and New Taipei City, Taiwan by purposive sampling. The participating schools were chosen from different regions of Taipei, including urban, suburban, and rural areas, and accounted for 11.7% of all high schools in the Taipei area. After the aims of this study had been fully explained to both the students and their parents, written informed consent was obtained from all parents and participants.

Online assessments

All of the participants completed the Chinese version of the Multidimensional Scale of Perceived Social Support (MDSS),[17] the Chinese version of the Patient Health Questionnaire (PHQ-9),[18] the Chinese version of the Barratt Impulsiveness Scale, Version 11 (BIS-11),[19] and the Rosenberg Self-Esteem Scale (RSES).[20] The students also reported all self-harm experiences, physical illnesses, and substance use. All of

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the measures were completed anonymously online at the participating schools, and a trained research assistant was also available. A subsample of the students also received diagnostic interviews conducted by child psychiatrists.[18] The data from the online questionnaires were collected by a computer engineer. The researchers had access to the data one day after the students had completed the questionnaires to ensure the quality of the data. We also provided each school with a list of students at high-risk of suicide for further referral and on-site counseling by a child psychiatrist or a psychologist at their school.

Suicidality: suicide ideation, suicide plan, deliberate self-harm, and suicide attempt

All subjects were asked if they had ever thought of killing themselves at any time in their life. They were then asked about ever having planned to kill themselves. Using the same scale, the students were then asked "Have you ever deliberately (not accidentally) hurt yourself?" and "How many times have you deliberately self-harmed?" The participants who responded positively to the main questions were

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then asked to elaborate on their actions (multiple choices including drug overdose, hanging, burning charcoal, jumping from a height, cutting themselves, and being hit by a car). They were then asked to describe the act, the number of episodes, the timing of each episode, and the consequences (e.g., need for medical intervention) and to endorse the motive behind the act. SAs were identified in all reports of self-harm according to the response to, "Have you ever really tried to kill yourself during these DSH episodes?" We also collected the number of SAs and the time of the first and last attempts. The subjects who reported having harmed themselves with/without suicidal intent were classified as "DSH." SA was defined as an intentional action to kill oneself.

The Chinese version of the BIS-11

The BIS-11 is a 30-item self-reported questionnaire designed to measure impulsivity. The total score ranges from 30 to 120, with a higher score indicating greater impulsivity.[21] The 25 items of the Chinese version of the BIS-11 have demonstrated good overall internal consistency in Taiwanese adolescents, with a Cronbach's alpha

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of 0.834.[19] The factor structure of the Chinese version of the BIS-11 consists of three factors: "inability to plan," "lack of self-control," and "novelty-seeking."

Multi-dimensional Scale of Perceived Social Support (MDSS)

The MDSS is a self-reported measure of the availability and adequacy of social support from various sources.[17] We estimated four types of social support, including that from parents, other family members, friends, and teachers, with a higher score indicating greater social support. In our sample, the Cronbach's alpha was 0.63.

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 (α = 0.84) and acceptable

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test-retest reliability (intra-class correlation coefficient = 0.80) among adolescents in the community.[18] 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.[22] 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.[20]

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]

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and assesses the amount and frequency of alcohol intake and frequency of alcohol misuse (defined as having six or more drinks). The optimal cut-off score of the Chinese AUDIT-C for hazardous drinking was 3/4, with good sensitivity (0.90) and specificity (0.92).[24] In this study, this was treated as a continuous variable, and a higher score indicated more alcohol use. A summary of illicit drug use was obtained from the participants who had used any form of illicit drug during the past month.

Face-to-face interviews with child psychiatrists using the Kiddie-Schedule for Affective Disorder and Schizophrenia Epidemiological Version (K-SADS-E)

The K-SADS-E is a semi-structured interview scale for the systematic assessment of both past and current episodes of psychiatric disorders in children and adolescents. The Chinese version has been shown to be a reliable and valid instrument.[25] Child psychiatrists blind to the results of the online assessments interviewed a subsample of the students (n = 272) using the K-SADS-E. After 12 months of the initial assessment, the students completed the same questionnaires. All of the students with new occurrences

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of self-harm in the past year (i.e., the students who did not report self-harm at entry but did the next year) were enrolled for face-to-face interviews. The students who did not report any occurrences of self-harm at both years were randomly selected on a 1:1 ratio, frequency matched by class and gender. For the students who reported occurrences of self-harm in both years, one in two received face-to-face interviews. The response rate was 94.8%. Lifetime SA was assessed by the child psychiatrists according to the question, “Have you actually tried to kill yourself?”

Statistical analysis

Descriptive and analytical statistics of the data obtained in this study were analyzed using SPSS version 21.0 for Windows (SPSS, IBM, Armonk, NY, USA). Risk factors for DSH and SA were first analyzed using univariate logistic regression analysis, with one variable at a time. Hierarchical multiple regression strategies (using a stepwise method) were then used to determine the risk factors for DSH/SA and to assess whether impulsivity played any role. The joint effect of the independent variables that showed significance in univariate analysis was assessed with hierarchical regression

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analysis. To examine the association between impulsivity and DSH/SA, all sociodemographic and personality (BIS-11, RSES) variables were introduced in the first step (model 1), followed by adding social support (MDSS) in the second step (model 2), alcohol/tobacco use in the third step (model 3), and depressive symptoms in the fourth step (model 4). We then examined the interaction between gender and BIS-11 among logistic regression analyses to see whether the relationship between impulsivity and DSH/SA was moderated by gender (model 5).[26] Logistic regression was used to analyze the role of impulsivity and all other sociodemographic, clinical and personality trait variables with DSH/SA between genders (model 6). We further analyzed three subscales of the BIS-11 instead of the total score in the male and female students.

We also examined the agreement (i.e. reliability) between the computer questionnaire assessments and face-to-face interviews (n = 272) with regards lifetime SA assessed at the second year. This agreement was assessed by concordance rate and kappa statistics.[27]

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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.

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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)
With 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)

[a]Below the 70th percentile; [b]inability to plan; [c]lack of self-control; [d]novelty-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

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There was no statistical difference in BIS-11 score between the male and female students. Univariate analysis revealed that the risk factors associated with both lifetime DSH and SA were higher impulsivity, female gender, low school ranking, father's job status, not living with biological parents, family discord, low self-esteem, poor social support, currently smoking, more alcohol use, and more depressive symptoms (Table 1). Students in schools located in suburban areas compared to those in urban area had a higher risk of DSH.

Hierarchical regression of lifetime DSH and lifetime SA

The results of the hierarchical approach are presented in Tables 2 and 3. The adjusted model 1 including sociodemographic variables and personality traits (RSES, BIS-11) showed that similar 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, school district 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, school district, family discord, school ranking, and self-esteem factors attenuated the effect of impulsivity on the odds ratio (OR = 1.04) (Tables 2 and 3).

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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 (095~0.98)***	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-11×gender					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

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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

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We then added social support status (MDSS score) into model 2. Social support did not significantly alter the confidence intervals of the other variables in model 1 with regards to DSH, and it was also not significantly associated with DSH in model 2. However, social support was a protective factor for SA in adjusted model 2. Impulsivity, female gender, low self-esteem, low school ranking, and family discord retained significance in adjusted model 2 for SA.

In model 3 we added variables of substance use, and DSH and SA were still significantly associated with impulsivity, although the odds were attenuated (Tables 2 and 3). The other significant variables in model 2 persisted as risk factors for DSH/SA in model 3. Currently smoking and a higher level of alcohol use were strong risk factors for DSH/SA.

In model 4, we included all variables (including depressive symptoms). DSH was still significantly associated with impulsivity, although its odds were attenuated again. The effect of family discord was fully statistically mediated in the final model of DSH. Other significant variables in model 3 persisted as risk factors for DSH in the final model. Depressive symptoms was a risk factor for DSH, and for every 1 unit increase in PHQ score, the likelihood of reporting lifetime DSH increased by 12%. In addition, for every 1 unit increase in AUDIT-C score, the likelihood of reporting lifetime DSH increased by 15%.

Impulsivity, family discord, and social support lost their significance after adjusting for the aforementioned covariates in model 4 for the SA group (Table 3). Depressive symptoms and

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

When we added the interaction term of BIS-11 and gender in model 5, we found that they were significant in both Tables 2 and 3. This meant that gender modulated the association between impulsivity and DSH/SA. Other risk factors besides gender remained significance in both Tables 2 and 3.

We further analyzed the risk factors for DSH/SA by gender in model 6. For boys, impulsivity, low self-esteem, alcohol use and depressive symptoms were risk factors for DSH, compared to low school ranking, low self-esteem, smoking, alcohol use and depressive symptoms in girls (Table 2). The association between impulsivity and DSH was particularly strong among boys, whereas total impulsivity scores were not associated with SA in either gender. For boys, low self-esteem, smoking and depressive symptoms were risk factors for SA, compared to low school ranking, low self-esteem, poor social support, smoking, alcohol use and depressive symptoms in girls, while their father's employment status was a protective factor (Table 3). Smoking status was an especially strong risk factor for SA in girls (OR = 5.24).

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We used three subscales instead of BIS-11 total score in the multivariate logistic regression analysis to investigate the relationships among impulsivity subscales and DSH/SA (Table 4). For both genders, factor 3 of the BIS-11 scale (novelty-seeking and acting without thinking), low self-esteem, alcohol use and depressive symptoms were risk factors for DSH. Low school ranking and smoking were additional risk factors for DSH in girls. For boys, risk factors for SA included factor 2 of the BIS-11 scale (lack of perseverance and self-control), low self-esteem, smoking and depressive symptoms. For girls with SA, impulsivity subscales were non-significant.

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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)***

[a]inability to plan or look ahead; [b]lack of perseverance and self-control; [c]novelty-seeking and acting without thinking; *p<0.05; **p<0.01; ***p<0.001

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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]

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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

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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 DSH[4] 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

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respectively, girls as the reference group).[34] Female smokers or alcohol users may be more pathological and have a lower threshold for DSH/SA. 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 self-esteem, depression, or substance use are warranted, and mental health interventions for depression, substance use and to enhance self-esteem are also needed.

Stress due to school studies is usually high in Chinese society, and academic performance (i.e. school ranking in this study) was a culturally specific factor for adolescent DSH and SA in this study. A previous study in Hong Kong reported that poor academic performance was related to adolescent non-suicidal self-harm and SA.[35] Several explanations for the relationship between academic performance and DSH/SA have been proposed. Academic problems may precede DSH/SA, or they may both be caused by the same set of underlying risk factors. Students with poor academic performance should receive more attention from their teachers, because Chinese society emphasizes academic performance and those with poor performance may have higher levels of frustration, poor self-esteem and hopelessness. Mental health and education policy makers may need to provide low ranking schools with more counseling services and support from mental health professionals; especially in girls' schools. Academic remediation activities may also be arranged to help students. Regular screening programs to early detect those who may need mental health services are also

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warranted. The education system and parents should also encourage other strengths rather than academic performance alone, such as studying at a vocational school. Further research should investigate the relationship between a student's academic high school performance and suicidality.

Impulsivity

There seems to be more evidence that impulsivity is associated with adolescent DSH than with SA. For example, previous studies in Europe and the US have reported higher impulsiveness on self-reported scales as a risk factor for adolescent DSH,[4 36] which is consistent with our findings. However, in contrast to previous studies,[4 12] our results do not support an association between overall impulsivity score and SA. Impulsivity could characterize the suicidal adolescents in models 1, 2, and 3, but it became non-significant after adding covariates of depressive symptoms (Table 3). However, some studies have also reported no relationship between impulsivity and SA. In a case-control study comparing suicidal completers and community control adolescents, impulsivity was related to suicide in univariate analysis but not in multivariate analysis.[37] In another study surveying suicidal and non-suicidal adolescent inpatients, the self-reported Impulse Control Scale score was not different between the two groups.[38]

When we focused on the moderating effects of gender, we found that total impulsivity score (OR = 1.03) was correlated with DSH only in boys (model 6 of Table 2). The odds ratio was slightly higher compared to impulsivity among all students (OR = 1.02, model 5 of Table 2). Previous studies

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in Ireland also found that impulsivity was a risk factor for DSH only in boys.[15 39] Gender also modulated the association between impulsivity and SA (model 5 of Table 3). However impulsivity lost its significance in model 6 in both genders. We postulate that the moderating effect was weak.

Among the BIS subscales, BIS-11 factor 3 (novelty seeking and acting without thinking) was associated with DSH in both boys and girls in multivariate analysis (Table 4). Inconsistent results regarding the relationship between impulsivity and DSH have been reported. Impulsivity, like suicidality, is a complicated construct consisting of many factors, rather than a unidimensional measure.[40] Thus the subscale analysis was warranted. Sensation seekers (i.e. high factor 3) have been shown to pursue novelty even at the cost of self-harm,[41] and this may explain our findings that factor 3 was correlated with DSH in both genders.

We also found that BIS-11 factor 2 (lack of perseverance and self-control) characterized SA in boys in multivariate analysis (Table 4), which is consistent with prior studies.[42 43] A previous Taiwanese study found that male adults with a history of SA exhibited higher BIS-11 factor 2 scores,[42] and Horesh et al. also found an association between impulsivity and SA among male adolescent inpatients.[43] A study using neuropsychological tests and brain imaging found that prepotent motor responses are more easily evoked in men, which is a tendency that could predispose them to impulse control disorders.[44] In addition, suicidal male adolescents are more likely to exhibit an impulsive presentation than suicidal females.[45] Since BIS-11 factor 2 is considered to reflect long-standing behavioral patterns,[46] it is plausible that boys with a lack of self-control and low

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

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

Our results may support the stress-diathesis theory that dispositionally impulsive adolescents and those with low self-esteem with mental illnesses such as depression are more likely to have SA. In a French study, impulsive traits of adolescents were related to the use of fewer appropriate and more inappropriate regulation strategies and depression.[49] Psychological interventions to decrease impulsivity are also needed.

Other psychosocial dimensions

In hierarchical regression analysis of SA, social support was present in models 2 and 3, but disappeared after adjusting for substance use and depressive symptoms in model 4 (Table 3). However, social support remained a risk factor for SA in the final model among girls. This may reflect that girls are affected by relationships with peers, family and teachers more than boys. A

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previous study also showed that social connectedness or family support[30] was associated with adolescent suicide risk. Social support in our study included that from family, peers and teachers, which may have contributed to the negative findings. Our results suggest that particular attention should be paid to high-risk girls with poor social support, and that active interventions should be arranged. Perceived family discord was a risk factor for DSH and SA in models 1, 2, and 3 of the current study, implying that family plays a role in adolescents' suicidality. This is consistent with previous DSH[50] and SA studies.[30] However, its effects on DSH and SA disappeared after adding depressive symptoms. A longitudinal study had similar findings in that after controlling for mental health disorders and adverse life events, the influence of parental and family factors on adolescent suicide was attenuated.[51]

Strengths and limitations

This study used a large community sample of adolescents from different areas of Taipei, which is a strength when it comes to generalization. A further strength in the present study is that well-established self-reported measures and a broad array of relevant psychosocial measures were used. Finally, few studies not based in Western countries have investigated the risk factors for DSH and SA in a community sample.

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

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worked together with school staff but we do not force students to participate the study. Adolescents often are not interested in activities arranged by adults and that maybe one of the reasons that our response rate was not very high. We mentioned on the inform consents that we would select some students (less than 10%) for diagnostic interview; maybe some students feel it's too time-consuming. Second, conducting a large-scale survey with such a large sample does not allow for individual in-depth interviews. Measures in the present study were self-reported, and thus may reflect bias. However, data from large school surveys by Hawton et al were also self-reported,[14] and they found that the majority of respondents reporting lifetime DSH were also classified as having DSH by expert evaluation.[52] This is similar to the findings of the current study in that the agreement between online assessments and interviews with regards to lifetime SA was moderate. In addition we conducted the tests in a group setting, and the students could preview the online questionnaires and review and change their answers to decrease a social desirability effect and yield more reliable data.[53] Self-reports using online questionnaires have been shown to allow students to report more sensitive risky behavior than using paper-and-pencil questionnaires.[54] Third, we did not use multiple assessments such as lab-measured impulsivity. However, a previous study showed a significant correlation between the self-reported form and the Test of Variables of Attention (TOVA) measure of impulsivity ($r = 0.34$; $p < 0.05$).[38] Fourth, BIS-11 did not assess emotional impulsivity. However one meta-analysis found negative urgency, a form of emotional impulsivity, was significantly related to a composite of suicidality, and the effect size for negative urgency was larger than those reported

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for other forms of impulsivity.[55] Emotional-relevant impulsivity needs to be assessed in future work. Fifth, this study was cross-sectional, precluding conclusions regarding causality. Future longitudinal studies examining alternative moderators are needed.

CONCLUSIONS

We found a number of similarities and differences in certain risk factors between adolescents with DSH and those with SA. Poor impulsivity and other factors such as female gender, low self-esteem, poor academic performance, depression and tobacco/alcohol use were significant risk factors in the final model of adolescent DSH. Gender modulated the relationship between impulsivity and DSH; associations between impulsivity and DSH were particularly strong among boys. Similar factors were associated with SA in the final model except for impulsivity, although its subscale was associated with SA in boys. Gender was also a moderator for the association between impulsivity and SA. These shared and unique risk factors are important to understand the mechanism behind DSH and SA, and to allow for incorporation of these risk factors into future research on prevention programs for these two behaviors among vulnerable adolescents across different settings.

Given the high prevalence rates and low consultation rates of these two behaviors, we suggest that these high-risk behaviors should be considered as a public health problem. Mental health professionals in schools should routinely assess DSH and SA, and self-reported screening questionnaires should be conducted along with routine physical examinations in school to help

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identify adolescents at risk. Paying attention to the mental health of adolescents at school may help to prevent the consequences associated with unidentified and untreated mental health problems.

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Contributors

YH Huang contributed to data collection, performed the data analysis and drafted the article. HC Liu drafted the study protocol and helped in the data collection process. FJ Tsai helped in the diagnostic interview process. FJ Sun contributed in statistical analyses. KY Huang contributed in the diagnostic interview process. YC Chiu contributed in counseling of at-risk adolescents, reviewing the article and revising it critically for important intellectual content. YH Huang contributed in the diagnostic interview process. YP Huang contributed to reviewing the article and revising it critically for important intellectual content. SI Liu monitored and guided the designing and implementation of the study, data collection, statistical analyses, interpreting findings, and revising the article. All authors approved the manuscript submission for publication.

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