Association Between Adolescents Abuse Exposure and the Risk of Suicide: A 15-Year Experience in Taiwan

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Article

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Abstract: Background/Objectives: According to 2023 Ministry of Health and Welfare statistics, the suicide rate among adolescents aged 15 to 24 has steadily increased since 2018, from 3.7 to 5.5 per 100,000 populations, reaching a recent high. Although previous studies have pointed out that the risk of suicide in the future of those who had suffered from abuse was higher than that of the general population, seldom the researches focused on adolescent groups. Therefore, this aim of the study was exploring the risk of suicide after youth abuse and the impact of subsequent comorbid mental illness and suicide risk. **Methods**: This retrospective matched-cohort study analyzed data from the NHIRD covering the period from 2000 to 2015.A total of 976 cases aged 10-18 who had experienced abuse. Controlled group was conducted by 1:10 matching based on gender, age and time of medical treatment, and a control group who had no experienced violence was selected for comparison. We used the Cox proportional hazards model to analyze the risk of suicide among adolescents after exposure to violence. **Results**: The suicide rate among adolescents who have experienced violence was significantly higher than that of the control group after 15 years of follow-up (1.0% vs. 0.5%). The prevalence of mental illness or disorders in adolescents exposed to violence was significantly higher than in the control group (45.2% vs. 40.1%). Among adolescents who had experienced violence, the methods of suicide included poisoning (solid and liquid) (53.6% vs. 43.2%), hanging (1.2% vs. 0.6%), firearms (2.4% vs. 0%), and cutting instruments (27.4% vs. 22.8%), all of which were significantly higher than in the control group. After adjusting for gender, age, residential area, and mental health comorbidities, the risk of suicide in those who had experienced Abuse was 1.475 times that of the control group (95% CI = 1.125–1.933; P = 0.005). **Conclusions**: In this study, female gender, younger age, comorbid depression, and substance abuse were identified as risk factors for suicide among adolescent victims of violence. Exposure to youth violence was associated with an increased prevalence of emotional disorders, including depression and social isolation, which subsequently elevated the suicide risk. These findings underscore the urgent need for governmental attention to the mental health of adolescent victims of violence. Implementing targeted psychological support and intervention programs could play a crucial role in mitigating the risk of suicide among this vulnerable population.

Keywords: abuse; adolescent suicide; suicide risk; National Health Insurance Research Database (NHIRD)

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1. Introduction

Child abuse remains a pervasive global concern, defined by the physical maltreatment of children by parents or adult household members through acts such as hitting, pushing, choking, shaking, throwing, biting, and burning. These harmful behaviors can lead to bruises or more severe physical injuries. The World Health Organization [1] reports that approximately one-quarter of all adults worldwide have experienced abuse during childhood. In the United States, the Department of Health and Human Services estimated that annually between 700,000 and 1.25 million children are subjected to abuse or neglect [2]. Similarly, Taiwan's Ministry of Health and Welfare reported that from 2004 to 2018, between 4,000 and 19,000 children were abused or neglected each year [3].

Preventing youth suicide is an urgent public health imperative. Suicide is the second leading cause of death among individuals aged 15 to 24, with reported cases of suicidal thoughts and behaviors increasing over the past decade [4,5]. Evidence from self-reported data and clinical assessments indicates that maltreated youth are significantly more likely to contemplate and attempt suicide [6,7]. A recent meta-analysis revealed that young people who have experienced any form of child abuse or neglect are 2.91 times more likely to attempt suicide and 2.36 times more likely to experience suicidal ideation compared to their non-maltreated peers [6]. The high prevalence of child maltreatment in the United States amplifies concerns about its impact on youth suicide rates. In 2019, over 3.4 million children were involved in child maltreatment investigations in the U.S. [8]. Furthermore, estimates suggest that 37.4% of U.S. youth will be involved in such investigations by the age of 18 [9]. Globally, the World Health Organization (2020) [10] estimates that approximately one billion children aged 2 to 17 experience violence, including child maltreatment, each year. These alarming statistics underscore the critical need for effective suicide prevention strategies targeting maltreated youth worldwide.

However, the relationship between adolescent abuse and suicide risk has not been thoroughly investigated. We hypothesized that adolescents who have experienced abuse are at a higher risk of future suicide. Therefore, we conducted a nationwide, population-based study to explore the association between adolescent abuse and subsequent suicide in Taiwan.

2. Materials and Methods

2.1. Data Sources

In this study, we used data from the Taiwan National Health Insurance Research Database (NHIRD) to investigate the association between adolescents abuse and the incidence of suicide over a 15-year period. Data regarding adolescents abuse events were extracted from the outpatient and hospitalization records in the Taiwan Longitudinal Health Insurance Database for the study period (2000–2015).The advantage, limitation, and details of the NHIRD have been documented elsewhere [11].

In Taiwan, the National Health Insurance Program (NHIP) was established in 1995. By June 2009, it had agreements with 97% of the country's medical service providers, encompassing approximately 23 million beneficiaries—over 99% of Taiwan's population [12]. The NHIRD records diagnoses using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes [13].

According to Taiwan's Protection of Children and Youths Welfare and Rights Act (2003) [14], clinicians who detect signs or symptoms of child and adolescents abuse are mandated to report their findings to authorized municipal or county agencies within 24 hours. Clinicians must exercise meticulous care when diagnosing adolescents abuse with the corresponding ICD-9-CM codes to avoid legal repercussions [15].

Furthermore, licensed medical record technicians review and verify diagnostic codes before hospital reimbursement claims are approved [14]. The NHIP administration also performs random audits of outpatient records and periodic reviews of inpatient claims to ensure diagnostic accuracy [16]. Consequently, data from the NHIRD are considered reliable. For this reason, we utilized NHIRD data to investigate the association between adolescents abuse and the incidence of suicide.

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2.2. Study Design and Sample

This study employed a retrospective matched-cohort design. Adolescents with a diagnosis of abuse, issued between January 1, 2000, and December 31, 2015, were enrolled as the adolescent abuse cohort (n = 976). Additionally, 29,511 controls with no history of adolescent abuse throughout the study period were age-, sex-, and index year-matched (1:10) to the adolescent abuse cohort. Individuals aged over 18 or under 10 years, and those with a history of adolescent abuse or suicide prior to the index date, were excluded (Figure 1).

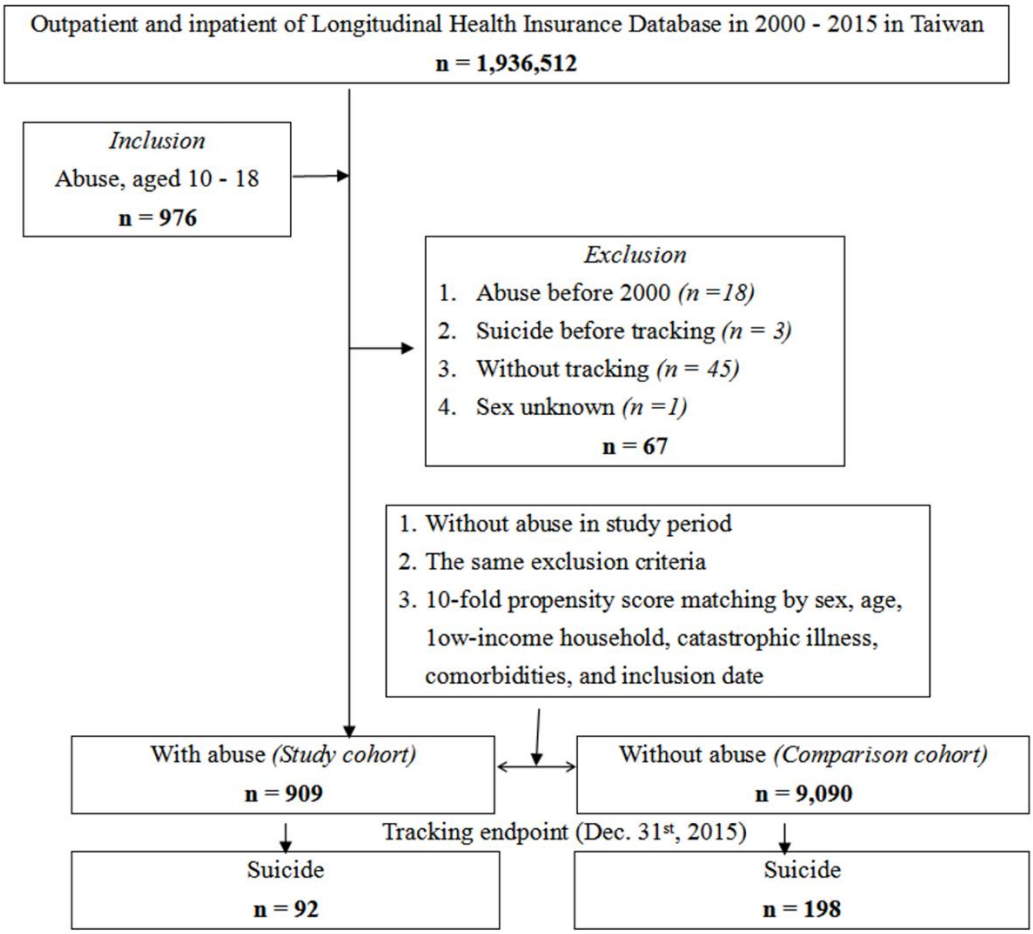

Figure 1. Flowchart of the study.

Covariates incorporated into the statistical analyses encompassed a comprehensive range of demographic, socioeconomic, and clinical factors. Demographic variables included sex and age, while geographic variables covered the region of residence—classified as northern, central, southern, or eastern Taiwan—and the urbanization level of the residential area, stratified into four tiers based on population density and development indicators. The type of healthcare facility accessed by participants was considered, categorized as medical centers, regional hospitals, or local hospitals. Socioeconomic status was evaluated by determining whether participants belonged to low-income households. clinical covariates included the presence of catastrophic illnesses and mental disorders, identified through relevant diagnostic codes. Additionally, the season during which data were collected—spring, summer, autumn, or winter—was included to control for potential seasonal variations affecting health outcomes. The urbanization level was defined according to population size and various indicators of development. Urbanization level 1 was defined as areas with a population of over 1,250,000 inhabitants and a specific designation of political, economic, cultural, and metropolitan development. Urbanization level 2 was defined as areas with a population between 500,000 and 1,249,999 inhabitants, playing an important role in the political system, economy, and culture. Urbanization levels 3 and 4 were defined as areas with populations of 149,999–499,999 and

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less than 149,999 inhabitants, respectively [17].Comorbidities included mental disorders. The Charlson comorbidity index(CCI) score was calculated based on the presence of relevant comorbidities (according to the ICD-9-CM codes) [18], with a score of zero indicating the absence of comorbidities and higher scores indicating a higher comorbidity burden [19].

All participants were followed from the index date until the occurrence of suicide, withdrawal from the NHIP, or the end of 2015. Suicide methods included ingestion of solids or liquids, exposure to gases used in domestic settings, other gases and vapors, hanging, drowning, firearms, cutting and piercing, jumping, and others. The ICD-9-CM codes used to classify adolescent abuse, comorbidities, and mental disorders are listed in Supplemental Table S1.

2.3. Statistical Analysis

All analyses were performed using SPSS software version 29(SPSS Inc., Chicago, IL, USA). Chi-squared (χ^2) and t-tests were used to evaluate the distributions of categorical and continuous variables, respectively. The Fisher exact test was employed to examine differences between the two cohorts in terms of categorical variables. Fine-Gray survival analysis was utilized to determine the risk of suicide, with results presented as hazard ratios (HRs) and 95% confidence intervals (CIs). The difference in suicide risk between adolescents who experienced violence and the control cohort was estimated using the Kaplan-Meier method with the log-rank test. Bonferroni-correction for multiple comparisons was applied. A two-tailed Bonferroni-corrected $p < 0.001$ was considered statistically significant.

2.4. Ethics Approvals

This study was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). The Institutional Review Board of the Tri-Service General Hospital approved this study (IRB No. 2-107-05-026).

3. Results

3.1. Baseline Characteristics

We identified 909 adolescents with a documented history of abuse and selected 9,090 matched controls without such a history. The demographic and clinical characteristics of both groups are summarized in Table 1. The mean age of adolescents in the abuse cohort was 14.18 ± 4.72 years, with a higher proportion of females than males. Notably, significant differences between the abuse and control cohorts were observed in terms of geographical location and urbanization levels.

Table 1. Characteristics of study in the baseline.

Abuse	Total		With		Without		*P*
Variables	**n**	**%**	**n**	**%**	**n**	**%**	
Total	9,999		909		9,090		
Sex							0.999
Male	253	2.53	23	2.53	230	2.53	
Female	9,746	97.47	886	97.47	8,860	97.47	
Age (years)	14.28 ± 4.85		14.18 ± 4.72		14.29 ± 4.86		0.514
Low-income household							0.948
Without	7,405	74.06	674	74.15	6,731	74.05	
With	2,594	25.94	235	25.85	2,359	25.95	
Catastrophic illness							0.704
Without	8,871	88.72	803	88.34	8,068	88.76	
With	1,128	11.28	106	11.66	1,022	11.24	
Mental disorders							0.999
Without	9,460	94.61	860	94.61	8,600	94.61	
With	539	5.39	49	5.39	490	5.39	

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CCI	0.74 ± 0.68		0.72 ± 0.65		0.74 ± 0.68		0.398
Season							0.999
Spring (Mar - May)	2,398	23.98	218	23.98	2,180	23.98	
Summer (Jun - Aug)	2,673	26.73	243	26.73	2,430	26.73	
Autumn (Sep - Nov)	2,552	25.52	232	25.52	2,320	25.52	
Winter (Dec - Feb)	2,376	23.76	216	23.76	2,160	23.76	
Location							< 0.001
Northern Taiwan	3,500	35.00	375	41.25	3,125	34.38	
Middle Taiwan	2,546	25.46	234	25.74	2,312	25.43	
Southern Taiwan	2,358	23.58	251	27.61	2,107	23.18	
Eastern Taiwan	1,072	10.72	49	5.39	1,023	11.25	
Outlets islands	523	5.23	0	0.00	523	5.75	
Urbanization level							< 0.001
1 (The highest)	2,922	29.22	298	32.78	2,624	28.87	
2	3,421	34.21	346	38.06	3,075	33.83	
3	1,638	16.38	112	12.32	1,526	16.79	
4 (The lowest)	2,018	20.18	153	16.83	1,865	20.52	
Level of care							0.701
Hospital center	5,252	52.53	489	53.80	4,763	52.40	
Regional hospital	3,331	33.31	297	32.67	3,034	33.38	
Local hospital	1,416	14.16	123	13.53	1,293	14.22	

P: Chi-square / Fisher exact test on category variables and t-test on continue variables.

3.2. Characteristics of the Study Population at Endpoint

By the end of the study period, 92 out of 909 adolescents who had experienced abuse (10.12%) died by suicide, compared to 198 out of 9,090 individuals in the control group (2.18%), demonstrating a statistically significant difference (P < 0.001; Table 2). Significant disparities were observed between the abuse-exposed and control groups concerning geographical location and urbanization level. In contrast, there were no significant differences between the two groups regarding sex, age, low-income household status, presence of catastrophic illnesses, mental disorders, CCI scores, season, or level of care. Comprehensive data are presented in Table 2.

Table 2. Characteristics of study in the endpoint.

Abuse	**Total**		**With**		**Without**		***P***
Variables	**n**	**%**	**n**	**%**	**n**	**%**	
Total	9,999		909		9,090		
Suicide							< 0.001
Without	9,709	97.10	817	89.88	8,892	97.82	
With	290	2.90	92	10.12	198	2.18	
Sex							0.999
Male	253	2.53	23	2.53	230	2.53	
Female	9,746	97.47	886	97.47	8,860	97.47	
Age (yrs)	21.99 ± 9.96		21.95 ± 9.86		22.00 ± 9.97		0.885
Low-income household							0.948
Without	7,401	74.02	672	73.93	6,729	74.03	
With	2,598	25.98	237	26.07	2,361	25.97	
Catastrophic illness							0.683
Without	8,863	88.64	802	88.23	8,061	88.68	
With	1,136	11.36	107	11.77	1,029	11.32	
Mental disorders							0.707
Without	9,454	94.55	857	94.28	8,597	94.58	
With	545	5.45	52	5.72	493	5.42	

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CCI	0.75 ± 0.69		0.74 ± 0.67		0.75 ± 0.69		0.676
Season							0.873
Spring	2,415	24.15	226	24.86	2,189	24.08	
Summer	2,673	26.73	247	27.17	2,426	26.69	
Autumn	2,547	25.47	230	25.30	2,317	25.49	
Winter	2,364	23.64	206	22.66	2,158	23.74	
Location							< 0.001
Northern Taiwan	3,411	34.11	372	40.92	3,039	33.43	
Middle Taiwan	2,550	25.50	246	27.06	2,304	25.35	
Southern Taiwan	2,341	23.41	223	24.53	2,118	23.30	
Eastern Taiwan	1,163	11.63	59	6.49	1,104	12.15	
Outlets islands	534	5.34	9	0.99	525	5.78	
Urbanization level							< 0.001
1 (The highest)	2,934	29.34	299	32.89	2,635	28.99	
2	3,374	33.74	342	37.62	3,032	33.36	
3	1,695	16.95	117	12.87	1,578	17.36	
4 (The lowest)	1,996	19.96	151	16.61	1,845	20.30	
Level of care							0.700
Hospital center	5,235	52.36	483	53.14	4,752	52.28	
Regional hospital	3,324	33.24	291	32.01	3,033	33.37	
Local hospital	1,440	14.40	135	14.85	1,305	14.36	

P: Chi-square / Fisher exact test on category variables and t-test on continue variables.

3.3. Risk of Suicide According to Adolescent Abuse Exposure

Kaplan-Meier survival analysis revealed that the adolescent abuse cohort exhibited a significantly higher cumulative incidence of suicide over the 15-year follow-up period compared to the matched control group (log-rank test, P < 0.001; Figure 2).

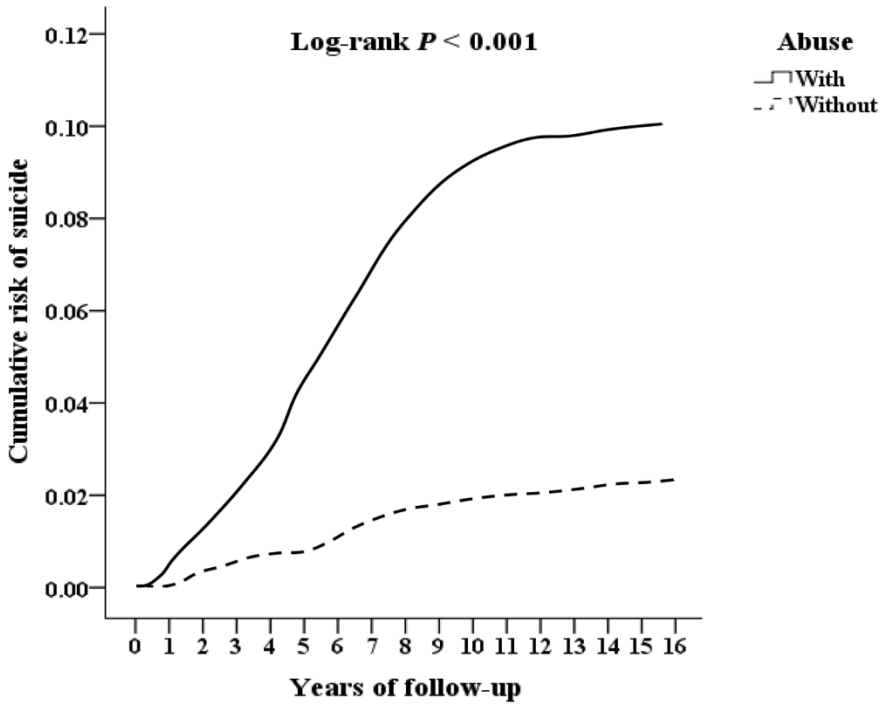

Figure 2. Kaplan-Meier for cumulative risk of suicide aged 10 – 18 stratified by abuse with log-rank test.

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3.4. Factors of Suicide by Using Cox Regression

Table 3 presents the results of the Cox proportional hazards regression analysis examining factors associated with suicide risk among adolescents who experienced abuse. The unadjusted hazard ratio (HR) for suicide in the abuse cohort was 1.787 (95% confidence interval [CI]: 1.246–2.033; $p < 0.001$), indicating a significantly elevated risk compared to the control group. After adjusting for multiple covariates—including sex, age group, low-income household status, presence of catastrophic illness, mental disorders, CCI score, season, geographic location, urbanization level, and level of care—the association remained significant. The adjusted hazard ratio (aHR) was 1.592 (95% CI: 1.137–1.993; $p < 0.001$), suggesting that adolescent abuse is independently associated with an increased risk of suicide. Several covariates were also significantly correlated with suicide risk. Notably, females exhibited a higher risk compared to males (aHR: 1.523; 95% CI: 1.072–1.831; $p = 0.012$). Additionally, the presence of mental disorders and higher levels of care were associated with an increased incidence of suicide ($p < 0.05$).

Table 3. Factors of suicide by using Cox regression.

Variables	Crude HR	95% CI	95% CI	*P*	aHR	95% CI	95% CI	*P*
Abuse								
Without	Reference				Reference			
With	1.787	1.246	2.033	< 0.001	1.592	1.137	1.993	< 0.001
Sex								
Male	Reference				Reference			
Female	2.098	1.358	2.886	< 0.001	1.523	1.072	1.831	0.012
Age (yrs)	0.894	0.589	1.182	0.486	0.971	0.632	1.289	0.570
Low-income household								
Without	Reference				Reference			
With	2.303	1.493	3.701	< 0.001	1.572	1.099	1.977	0.001
Catastrophic illness								
Without	Reference				Reference			
With	1.862	1.198	2.596	< 0.001	1.303	1.050	1.684	0.024
Mental disorders								
Without	Reference				Reference			
With	2.979	1.865	4.228	< 0.001	2.666	1.356	3.784	< 0.001
CCI	1.201	1.186	1.277	< 0.001	1.142	1.063	1.225	0.018
Season								
Spring	Reference				Reference			
Summer	1.779	1.287	2.074	< 0.001	1.440	1.088	1.720	0.006
Autumn	1.933	1.483	2.335	< 0.001	1.518	1.165	1.836	< 0.001
Winter	1.502	1.095	1.982	0.003	1.386	1.024	1.689	0.037
Location								
Northern Taiwan	Reference				**Multicollinearity with urbanization level**			
Middle Taiwan	0.842	0.301	1.378	0.672	**Multicollinearity with urbanization level**			
Southern Taiwan	0.986	0.389	1.460	0.573	**Multicollinearity with urbanization level**			
Eastern Taiwan	0.597	0.284	0.997	0.048	**Multicollinearity with urbanization level**			
Outlets islands	0.732	0.042	196.678	0.925	**Multicollinearity with urbanization level**			
Urbanization level								
1 (The highest)	2.135	1.487	2.865	< 0.001	1.795	1.194	2.512	< 0.001
2	1.911	1.374	2.784	< 0.001	1.783	1.113	2.505	< 0.001
3	1.506	1.010	1.701	0.045	1.322	0.807	1.571	0.189
4 (The lowest)	Reference				Reference			
Level of care								
Hospital center	2.785	2.013	3.389	< 0.001	2.106	1.370	2.864	< 0.001
Regional hospital	1.843	1.562	2.131	< 0.001	1.442	1.115	1.765	< 0.001
Local hospital	Reference				Reference			

HR= hazard ratio, CI = confidence interval, aHR = Adjusted HR: Adjusted variables listed in the table.

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3.5. Factors of Suicide Stratified by Variables Listed in the Table by Using Cox Regression and Bonferroni Correction for Multiple Comparisons

The patients were stratified by the variables presented in Table 3, and adjusted hazard ratios of different subgroups were calculated (Table 4). Over the course of the study, adolescents who had experienced abuse exhibited 92 suicide events over 7,074.36 person-years (PY) of observation, resulting in an incidence rate of 1,300.47 per 100,000 PYs. In contrast, the control group encountered 198 suicide events over 69,894.12 PYs, corresponding to an incidence rate of 283.29 per 100,000 PYs. After applying the Bonferroni correction for multiple comparisons, the risk of suicide was significantly higher among adolescents with a history of abuse compared to those without such a history. The aHR was1.592 (95% CI: 1.137–1.993; $p < 0.001$), indicating that abused adolescents had nearly a 1.5 fold increased risk of suicide. Notably, the presence of mental disorders and higher levels of care were significantly associated with an increased incidence of suicide, the aHR was2.369 (95% CI: 2.369 –2.972; $p < 0.001$).

Table 4. Factors of suicide stratified by variables listed in the table by using Cox regression and Bonferroni correction for multiple comparisons.

Abuse	**With**			**Without** *(Reference)*			**With *vs.* Without** *(Reference)*			
Strarified	**Events**	**PYs**	**Rate**	**Events**	**PYs**	**Rate**	**aHR**	**95% CI**	**95% CI**	***P***
Total	92	7,074.36	1,300.47	198	69,894.12	283.29	1.592	1.137	1.993	< 0.001
Sex										
Male	3	175.23	1,712.04	7	1,768.33	395.85	1.500	1.071	1.872	0.015
Female	89	6,899.13	1,290.02	191	68,125.79	280.36	1.596	1.401	1.998	< 0.001
Low-income household										
Without	67	5,230.01	1,281.07	146	51,734.81	282.21	1.574	1.121	1.963	< 0.001
With	25	1,844.35	1,355.49	52	18,159.31	286.35	1.642	1.178	2.059	< 0.001
Catastrophic illness										
Without	79	6,236.10	1,266.82	175	61,981.84	282.34	1.556	1.113	1.949	< 0.001
With	13	838.26	1,550.83	23	7,912.28	290.69	1.852	1.327	2.320	< 0.001
Mental disorders										
Without	84	6,669.75	1,259.42	187	66,103.87	282.89	1.542	1.104	1.913	< 0.001
With	8	404.61	1,977.21	11	3,790.25	290.22	2.369	1.688	2.972	< 0.001
Season										
Spring	20	1,758.82	1,137.13	45	16,831.25	267.36	1.475	1.053	1.849	0.022
Summer	27	1,992.33	1,355.20	53	18,653.31	284.13	1.656	1.180	2.072	< 0.001
Autumn	26	1,789.14	1,453.21	54	17,815.09	303.11	1.667	1.188	2.085	< 0.001
Winter	19	1,534.07	1,238.54	46	16,594.47	277.20	1.543	1.104	1.940	< 0.001
Urbanization level										
1 (The highest)	32	2,323.02	1,377.52	59	20,262.43	291.18	1.641	1.177	2.059	< 0.001
2	35	2,661.67	1,314.96	66	23,313.17	283.10	1.611	1.152	2.023	< 0.001
3	11	908.41	1,210.91	34	12,133.66	280.21	1.498	1.070	1.878	0.015
4 (The lowest)	14	1,181.26	1,185.18	39	14,184.86	274.94	1.494	1.067	1.870	0.017
Level of care										
Hospital center	52	3,758.98	1,383.35	107	36,538.04	292.85	1.647	1.173	2.066	< 0.001
Regional hospital	28	2,253.18	1,242.69	64	23,231.55	275.49	1.562	1.118	1.982	< 0.001
Local hospital	12	1,062.20	1,129.73	27	10,124.53	266.68	1.460	1.049	1.842	0.026

PYs = Person-years, Rate: per 100,000 PYs, aHR = Adjusted Hazard ratio: Adjusted for the variables listed in Table 3, CI = confidence interval.

3.6. Factors of Suicide Subgroups by Using Cox Regression and Bonferroni Correction for Multiple Comparisons

Abused adolescents exhibited a significantly elevated risk of suicide across various methods. Specifically, the adjusted hazard ratios (AHRs) for different suicide methods were as follows:

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ingestion of solids or liquids (AHR = 1.607), exposure to other gases and vapors (AHR = 1.714), hanging (AHR = 2.058), cutting and piercing (AHR = 1.656), and jumping (AHR = 1.523)(Table 5).

Table 5. Factors of suicide subgroups by using Cox regression and Bonferroni correction for multiple comparisons.

Abuse	**With**	**Without** *(Reference)*	**With *vs.* Without** *(Reference)*			
Suicide	**Events**	**Events**	**aHR**	**95% CI**	**95% CI**	***P***
Overall	92	198	1.592	1.137	1.993	< 0.001
Solid or liquid	38	81	1.607	1.148	2.012	< 0.001
Gases in domestic use	0	2	0.000	-	-	0.999
Other gases and vapors	12	24	1.714	1.223	2.145	< 0.001
Hanging	3	5	2.058	1.468	2.571	< 0.001
Drowning	0	2	0.000	-	-	0.999
Firearms	1	0	∞	-	-	0.997
Cutting and piercing	29	60	1.656	1.172	2.073	< 0.001
Jumping	4	9	1.523	1.081	1.909	0.009
Others	5	15	1.142	0.823	1.424	0.157

aHR = Adjusted Hazard ratio: Adjusted for the variables listed in Table 3, CI = confidence interval.

3.7. Factors of Suicide Stratified by Abuse and Mental Disorders by Using Cox Regression

The analysis of suicide risk factors using the Cox regression model indicates a significant impact of both abuse and mental disorders on suicide risk. In the reference group, which included individuals without a history of abuse or mental disorders, the aHR was set at 1.000. In comparison, individuals without abuse history but with mental disorders exhibited a significantly elevated risk of suicide, with an aHR of 1.465 (95% CI: 1.172-1.779, P < 0.001). Among those who experienced abuse but did not have mental disorders, the suicide risk increased further, with an aHR of 1.756 (95% CI: 1.340-2.075, P < 0.001). Furthermore, individuals who experienced both abuse and had mental disorders showed the highest risk of suicide, with an aHR of 3.586 (95% CI: 2.781-4.986, P < 0.001). Additionally, the interaction between abuse and mental disorders was significant, as indicated by the P for interaction value (P < 0.001), highlighting a notable synergistic effect that further elevated the risk of suicide (Table 6、Figure 3).

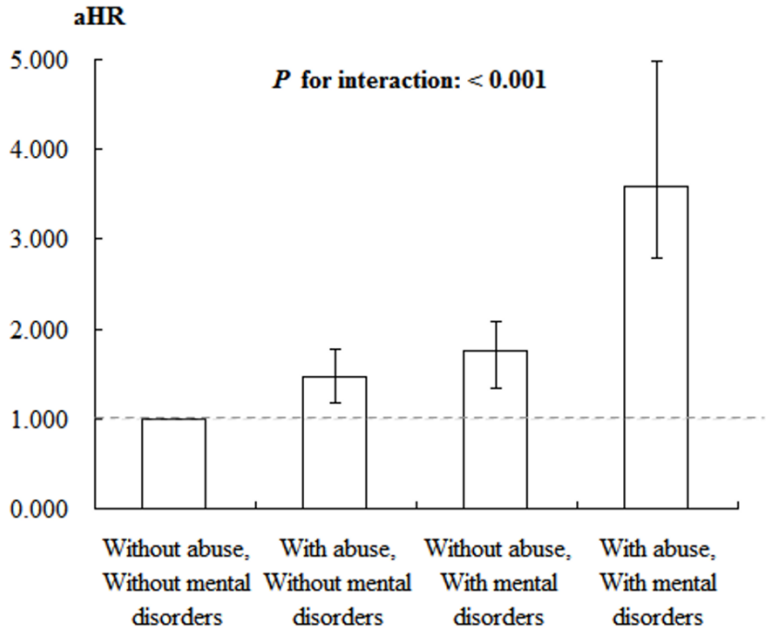

Figure 3. Joint effect for factors of suicide stratified by abuse and mental disorders by using Cox regression.

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Table 6. Factors of suicide stratified by abuse and mental disorders by using Cox regression.

Abuse	Mental disorders	aHR	95% CI	95% CI	*P*	*P* for interaction
Without	Without	1.000				< 0.001
With	Without	1.465	1.172	1.779	< 0.001	
Without	With	1.756	1.340	2.075	< 0.001	
With	With	3.586	2.781	4.986	< 0.001	

aHR = Adjusted Hazard ratio: Adjusted for the variables listed in Table 3.; CI = confidence interval.

4. Discussion

This study examined the relationship between adolescent abuse and suicidal behaviors, assessing whether all forms of adolescent abuse were associated with an increased risk of suicidality in both univariate logistic regression models and multivariable logistic regression models that controlled for covariates. In our study, we found that the suicide rate of adolescents who have experienced violence was significantly higher than that of the control group (10.12 % vs. 2.18 % ; P<0.001) with aHR 1.592 after 15 years of observation. The result is consistent with Zygo, et al. [20], which demonstrated that psychological, physical violence, and family violence were all the risk factor for not only suicide ideation but also suicide attempt and even suicide death. The findings of this study align with those of numerous other investigations [21–23]. However, an alternative study suggests that emotional abuse is the most significant predictor of suicide attempts, with physical abuse following closely behind [24]. Several theories may account for the relationship between childhood abuse and suicidality. The Schematic Appraisals Model for Suicide posits that negative childhood experiences can foster a growing sense of self-defeat, ultimately leading individuals to perceive suicidality as an escape mechanism [25,26]. From a biological standpoint, prior research has shown that individuals who experienced childhood abuse tend to have a reduced prefrontal cortex volume [27], which is associated with cognitive functions [28], and cognitive deficits, in turn, are linked to increased suicidality [29].

We observed that adolescent abuse victims committed suicide when they were 14 years old. In a study from America [20], the peak of suicide in rural or urban area was 16 to 18 years old, which was consistent to our research. Both the studies reminded us of closely monitoring and observing the mental and psychologic status for the youth in this period. Thus, concerns and caution should rise keenly for the adolescents in some situation, such as unusual wounds or bruises, rapid mood change, weird behavior, abnormal vaginal bleeding, and relationship with schoolmates. Besides, with the development of technology, electronic bully is worth being noticed. According to the study [30] with data collected by the Centers for Disease Control and Prevention in America, not only physical bullying but electronic bullying increased the risk for suicide ideation and attempt, pointing out the importance of education of internet politeness and online social contact for youth.The risk factors for suicide of adolescence and youth included history of violence, female, young age (10 to 24 years old), psychological disorders, depression, substance use in Taiwan, which was similar to the results in other regions around the world [20,30–35], indicating somewhat resemble biophysical mechanism crossing ethnics. However, in a study in America [30], Asian adolescents are more prone to have suicide ideation and attempt than other ethnics, making it important for Asian educators and family members to pay more attention for their adolescents, including Taiwan.

The methods and tools for adolescent suicide may be different in distinct countries or cultures. In our study, the most common methods were consumption of liquid or solid components in both the group with/without being the victims of violence, while in a review article in Iraq [33], the method of suicide is self-hanging, followed by firearms, self-burning, and self-poisoning. Thus, it is important for different countries to formulate policies exclusively, such as gun control, chemicals restriction for less accessibility, or prohibition for entrance to top floor in tall buildings.

Abuse is caused by the presence of multiple risk factors and a combination of very few protective factors. Abuse can be prevented by reducing risk factors and strengthening protective factors. Doing this requires comprehensive policies that form part of a so-called “integrated approach” to abuse prevention—in other words, an overall strategy that depends on the cooperation of many different

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sectors. Violence prevention, therefore, requires interventions at all levels of the ecological model and every stage of the abuse life cycle [36,37].

This study has several limitations. First, the potential for selection bias cannot be excluded. Additionally, the detection rate of child abuse is likely underestimated for younger children, who typically visit the hospital with a parent or caregiver. If the abuser is the parent or caregiver, the likelihood of bringing the child in for medical evaluation diminishes, meaning such incidents may not be recorded in the NHIRD. Consequently, the actual risk warrants further in-depth investigation. Second, other potential confounding factors, such as social support systems and family dynamics, should be considered in future studies. Third, the coding practices of clinicians could influence the study's outcomes, and it is possible that the results presented herein are an underestimation. Finally, in accordance with regulations set by the Health and Welfare Data Center (HWDC) of the Ministry of Health and Welfare (MOHW) of Taiwan, obtaining new analysis results in the short term is not feasible. Even if new data becomes available, it is unlikely to alter the direction of our findings. The primary aim of this study is to observe the trends in suicide of adolescents abuse victims in Taiwan over time. Notably, the dataset utilized represents a sample of 2 million individuals, a subset of Taiwan's 23 million population, which is sufficiently large to provide a robust reflection of the broader societal trends.

5. Conclusions

In this study, adolescents who experienced violence had a significantly higher risk of future suicide compared to the control group, with the suicide rate increasing by up to 1.592 times. Notably, among those with comorbid mental disorders, the suicide risk rose to 2.369 times that of the control group. Exposure to youth violence may lead to emotional disorders, including depression and social isolation, which subsequently elevate the risk of suicide. To reduce the occurrence of suicide, it is crucial not only to provide psychological support and pay closer attention to the mental state of youth violence victims but also for the government to implement more practical measures. These should include policy formulation, education on abuse prevention, and campus initiatives aimed at eradicating abuse.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Tri-Service General Hospital (TSGHIRB No.：E202416033).

Informed Consent Statement: Not applicable.

Data Availability Statement: This study uses third party data. Taiwan launched a single-payer National Health Insurance program on March 1, 1995. The database of this program contains registration files and original claim data for reimbursement. Large computerized databases derived from this system by the National Health Insurance Administration. Investigators interested may submit a formal proposal to NHIRD(https://dep.mohw.gov.tw/DOS/cp-5119-59201-113.html) The authors confirm they did not have any special access privileges..

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Appendix A

Table A1. Abbreviation, ICD-9-CM, and definition.

	Abbreviation	ICD-9-CM / Definition
Stduy population: Abuse		955.5, E967
Events: Suicide		E950 - E958
Solid or liquid		E950
Gases in domestic use		E951
Other gases and vapors		E952
Hanging		E953
Drowning		E954
Firearms		E955
Cutting and piercing		E956
Jumping		E957
Others		E958
Comorbidities:		
Mental disorders		290 - 319
Charlson comorbidity index	CCI	

Table A2. Years of follow-up.

Abuse	Min	Median	Max	Mean ± SD	*P*
With	0.02	7.34	15.72	7.78 ± 6.52	
Without	0.02	7.30	15.70	7.69 ± 6.68	
Total	0.02	7.32	15.72	7.70 ± 6.67	0.698

P: t-test.

Table A3. Years to suicide.

Abuse	Min	Median	Max	Mean ± SD	*P*
With	0.02	5.02	15.68	6.01 ± 6.38	
Without	0.03	5.29	15.69	6.48 ± 6.72	
Total	0.02	5.15	15.69	6.44 ± 6.69	0.044

P: t-test.

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