

Risk of adolescent offspring's completed suicide increases with prior history of their same-sex parents' death by suicide

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Background. To investigate the risk of completed suicide in offspring during adolescence in relation to prior history of the same-sex parent's death by suicide and other causes.

Method. A total of 500 adolescents who died by suicide at age 15–19 years between 1997 and 2007 were identified from the Taiwan Mortality Registration (TMR). For each case, 30 age- and time-matched controls were selected randomly from all adolescents registered in the Taiwan Birth Registry (TBR). A multivariate conditional logistic regression model was used to assess the risk of adolescent completed suicide in relation to their same-sex parent.

Results. Adolescent suicide risk was positively associated with both paternal [odds ratio (OR) 5.38, 95% confidence interval (CI) 2.17–13.33] and maternal suicide (OR 6.59, 95% CI 1.82–23.91). The corresponding risk estimates associated with paternal and maternal deaths from non-suicidal causes were much lower, at 1.88 and 1.94 respectively. The risk of suicide in male adolescents was significantly associated with prior history of paternal death by suicide (OR 8.23, 95% CI 2.96–22.90) but not of maternal death by suicide (OR 3.50, 95% CI 0.41–30.13). On the other contrary, the risk of suicidal death in female adolescents was significantly associated with prior history of maternal suicide (OR 9.71, 95% CI 1.89–49.94) but not of paternal suicide (OR 2.42, 95% CI 0.30–19.57). However, these differences did not reach statistical significance.

Conclusions. Although limited by sample size, our study indicates that adolescent offspring suicidal death is associated with prior history of their same-sex parent's death by suicide.

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Key words: Adolescent, case-control studies, parent, suicide.

Introduction

It has been well documented that suicidal behavior runs in families. Mounting evidence suggests that individuals with a family history of suicide are at increased risk of suicidal behavior. However, familial transmission of suicide seems to be independent of transmission of psychiatric disorder *per se* (Qin *et al.* 2002; Runeson & Åsberg, 2003; Kim *et al.* 2005; Brent &

Melhem, 2008; Sørensen *et al.* 2009). Both genetic disposition and shared environment are found to be related to suicidal clustering in families (Brent & Mann, 2005; Brent & Melhem, 2008).

Many studies have found that parental death, especially from suicide, is a significant risk factor for psychosocial maladjustment, psychiatric disorder and suicidal behavior in children and adolescents. Compared to those who lost a parent to non-suicidal causes, offspring of a parent who died by suicide were more vulnerable to depression, anxiety, psychological distress, bipolar disorder and personality disorder, all leading to an increased risk of suicide attempts and completion (Pfeffer *et al.* 2000; Agerbo *et al.* 2002; Tsuchiya *et al.* 2005; Brent *et al.* 2009;

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Wilcox *et al.* 2010). However, other studies have reported little difference in child or adolescent outcomes resulting from various causes of parental death (Cerel *et al.* 1999; Melhem *et al.* 2008).

In addition to finding familial clustering of suicidal behavior, previous studies indicate that gender of parents may be associated with differential risk of offspring suicide. Mothers who died of either suicide or other causes were found to have a greater impact on risks of offspring psychiatric disorders and suicide than were fathers (Agerbo *et al.* 2002; Qin *et al.* 2002; Lawrence *et al.* 2005–2006; Tsuchiya *et al.* 2005; Brent *et al.* 2009). Some studies also found that youth who lost a parent, especially their mother, to suicide at a younger age tended to experience a greater risk for suicide and suicidal behavior (Agerbo *et al.* 2002; Tsuchiya *et al.* 2005; Brent *et al.* 2009; Wilcox *et al.* 2010; Garssen *et al.* 2011). Previous studies have suggested that maternal loss, especially to suicide, conveyed higher risks to offspring maladjustment and suicide (Agerbo *et al.* 2002; Tsuchiya *et al.* 2005; Brent *et al.* 2009; Kuramoto *et al.* 2010). Authors of those previous reports argued that loss of mother might mean loss of a primary caregiver and a significant source of support. Deprivation of adequate care and of an affectionate attachment figure may result in an increase in risk of suicide in youth.

Studies have found that father and mother play differential roles in the development of boys and girls (Steinberg, 1987; Russell & Saebel, 1997). Each of the dyads of mother–daughter, mother–son, father–daughter and father–son may be distinct in terms of characteristics of the relationships and child outcomes associated with the relationships. Theoretical accounts such as social learning theory and psychoanalytic theory (Bandura, 1975; Washburn, 1994) often suggest that the same-sex parent is usually the model of identification, from whom a child learns not only outward behavior but also development of an inward sense of self. The sameness of the relationships also closely bonds each to the other (Russell & Saebel, 1997). One study conducted on incarcerated adolescents found that the number of male suicidal attempts was significantly related to affectionless bonding style of the father and not to the bonding style of the mother (McGarvey *et al.* 1999). Abdelnoor & Hollins (2004) reported that females who lost their mothers through death were more likely to undergo a traumatic bereavement process than those who lost their fathers. Thompson *et al.* (2012) found that the same-sex parent was a primary source of help for children and adolescents, who tended to choose their same-sex parent as a target of help-seeking whenever needed. Despite this evidence, little is known concerning the gender-specific association of suicidality between parents

and offspring (Lieb *et al.* 2005; Mittendorfer-Rutz *et al.* 2008). Specifically, it is not clear whether the loss of same-sex parental attachment, in comparison with opposite-sex parental attachment, may carry a higher risk for young suicide.

The current study sought to assess whether risk of adolescent completed suicide was associated more with their parent's death by suicide than with death by other causes in Taiwan. We also aimed to investigate whether there is a gender-specific association of offspring's suicidal death during adolescence with a prior history of their same-sex parent's suicide by death.

Method

Source of data

In Taiwan, it is required by law that all live births and deaths be registered within 10 days. Various birth characteristics including gender, birthweight, gestational age, single/multiple births, birth order, parental age, education, marital status, employment and place of birth are available for each live birth from the Taiwan Birth Registry (TBR), which has been evaluated and is considered valid and complete (Chen *et al.* 2010). Mortality data were obtained from the Taiwan Mortality Registry (TMR). The TMR is considered accurate and complete; it is mandatory to register all deaths in Taiwan and for physicians to complete all death certificates (Directorate-General of Budget, Accounting and Statistics, 1993). We retrieved the information on the date of death and underlying cause of death (UCOD) for each deceased individual.

Selection of cases and controls

Between 1997 and 2007, a total of 500 Taiwanese adolescents aged 15–19 years (307 males, 193 females) died by suicide [International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes: E950–E959] and were registered in the TMR. These death records were deselected and were then linked, using scrambled personal identification numbers (PINs), to the 1978–1992 TBR, searching for the birth records of these deceased adolescents. All suicidal cases were successfully linked and served as cases in this case–control analysis of Taiwan's adolescent population aged 15–19 years. The number of cases who died at each age from 15 to 19 years respectively was 39, 63, 88, 138 and 172. There was no significant ($p=0.351$) difference in age distribution between male and female cases at the time of death by suicide.

For each case, we randomly selected from the TBR, using individual matching, 30 control subjects who were from the same birth cohort as the case and

were alive on the date of the case's death. If a subject was selected more than once, only the first-time selection was retained, and the subsequent selections were replaced with another random selection until another eligible control was found.

Birth characteristics and family socio-economic factors

For each case we retrieved information from the TMR on their PIN, date of birth, date of death and UCOD. We linked a case's PIN to the TBR, searching for their birth characteristics, including sex, birth order, singleton/multiple births, gestational week and birth-weight. Information on family socio-economic factors was also retrieved from the TBR, including location and urbanization level of residential districts, marital status of parents, parental ages and educational attainment at the time of delivery. The same information for the controls was also obtained from the TBR. We also calculated the age difference of the parents as a family socio-economic indicator (Chen *et al.* 2010). The level of urbanization was categorized according to the National Statistics of Regional Standard Classification (Hung & Rabin, 2009).

Information on the death of parents

Each parent's PIN was retrieved from the TBR for both cases and controls. Parental deaths prior to the index date (i.e. the date of a case's death), if any, were identified by linking parental PINs to the TMR from 1978 to 2007. Once a parent was found to be deceased, the UCOD of the deceased parent was recorded.

Statistical analysis

Both birth demographic characteristics and family socio-economic factors were compared between cases and controls, and differences were tested using Pearson's χ^2 or Fisher's exact statistic for categorical data, and the Student *t* test with equal variance assumed for continuous data. Only the variables significantly different between cases and controls were included in the multivariate conditional logistic regression model to control for their potential confounding.

Using the multivariate conditional logistic regression model, we first analyzed the association of adolescent suicidal death with the death of their parents, with the focus on examining the relative importance of the parent's death by suicide and death by other causes on the risk of adolescent completed suicide. Second, we used two separate models to investigate the association of male offspring suicidal death with the suicidal death of his father or mother (i.e. father-son and

mother-son dyads), and also as the association of female offspring suicidal death with the suicidal death of her father or mother (i.e. father-daughter and mother-daughter dyads). We used the method proposed by Breslow & Day (1980) to test the heterogeneity between odds ratios (ORs) of offspring completed suicide in relation to suicidal and other causes, and between ORs of offspring completed suicide associated with paternal and maternal deaths. A similar method was also used to test the heterogeneity of ORs between father-son and mother-son dyads, and between father-daughter and mother-daughter dyads. A *p* value of <0.05 was considered statistically significant, and all analyses were performed with SAS version 9.1 (SAS Institute, USA). Access to the vital statistics data was approved by the Department of Health. This study was exempt from Institutional Review as all PINs were encrypted while data linkage was performed.

Results

Cases and controls differed in several demographic characteristics and social factors. There were more males among cases than controls (61.4% *v.* 52.1%). Mothers of cases tended to be significantly younger, and the proportions of younger (<20 years; 2.2% *v.* 0.8%) and older (≥ 30 years; 46.9% *v.* 42.0%) fathers were higher in cases than in controls. Additionally, a significantly smaller proportion of cases than controls were born in hospitals (81.9% *v.* 86.6%) and delivered by physicians (80.9% *v.* 86.2%). The age difference of parents tended to be greater in cases than in controls. Although there was no significant difference in the distribution of maternal education at the time of delivery between cases and controls, the education level was significantly higher in fathers of cases (Table 1).

Table 2 shows ORs and 95% confidence intervals (CIs) of adolescent completed suicide in relation to prior history of deaths of parents. After controlling for potential confounders, significantly increased ORs were observed in the study subjects with paternal or maternal death (OR 2.20, 95% CI 1.68–2.89), paternal death only (OR 2.11, 95% CI 1.54–2.89) and maternal death only (OR 2.41, 95% CI 1.45–4.01). An increased but insignificant OR (2.76, 95% CI 0.82–9.36) was also observed for death of both parents. After adjustment for birth characteristics and social factors, we noted a stronger association of completed suicide in adolescents with paternal death by suicide (OR 5.38, 95% CI 2.17–13.33) than with paternal death by non-suicidal causes (OR 1.88, 95% CI 1.35–2.60, *p* = 0.0152). Similar findings were observed for the association of offspring completed suicide with maternal death (OR 6.59, 95% CI 1.82–23.91 *v.* OR 1.94, 95% CI

Table 1. Characteristics of cases and controls

	Cases	Controls	<i>p</i> ^a
Demographic characteristics			
Sex			
Male	307 (61.4)	7813 (52.1)	<0.0001
Female	193 (38.6)	7187 (47.9)	
Birth order			
1	190 (37.9)	5803 (38.7)	0.8910
2	171 (34.3)	5154 (34.4)	
≥3	139 (27.9)	4043 (27.0)	
No. of births			
Singleton	497 (99.4)	14851 (99.0)	0.4934
Other	3 (0.6)	149 (1.0)	
Gestational age (weeks)			
<37	39.7±1.4	39.6±1.4	0.7598
≥37	14 (2.9)	440 (3.0)	
	486 (97.1)	14560 (97.0)	
Birthweight (g)			
<2500	3256±455	3261±475	0.8300
≥2500	17 (3.5)	593 (4.0)	
	483 (96.5)	14407 (96.0)	
Mother's delivery age (years)			
<20	24.4±4.3	26.0±4.2	0.0064
20–24	36 (7.2)	677 (4.5)	
25–29	185 (37.1)	5054 (33.7)	
≥30	196 (39.1)	6497 (43.3)	
	83 (16.6)	2772 (18.5)	
Father's delivery age (years)			
<20	29.3±4.9	29.2±4.6	0.0001
20–24	11 (2.2)	137 (0.8)	
25–29	61 (12.1)	1616 (10.8)	
≥30	194 (38.8)	6955 (46.4)	
	234 (46.9)	6292 (42.0)	
Place of birth			
Hospital	410 (81.9)	12996 (86.6)	0.0034
Midwife unit	55 (11.1)	1364 (9.1)	
Others	35 (7.1)	650 (4.4)	
Delivered by			
Physician	403 (80.9)	12930 (86.2)	0.0001
Midwife	87 (17.5)	1995 (13.3)	
Others	10 (1.6)	75 (0.5)	
Socio-economic factors^b			
Marital status of parents			
Married	498 (99.6)	14989 (99.9)	0.0642
Otherwise	2 (0.4)	11 (0.1)	
Urbanization of residence			
Metropolis	171 (34.2)	4656 (31.0)	0.2647
Satellite city	153 (30.6)	4623 (30.8)	
Rural area	176 (35.2)	5721 (38.1)	
Age difference of parents (years)			
≤1	128 (25.7)	4089 (27.3)	<0.0001
>1–3	113 (22.6)	4475 (29.9)	
>3–5	114 (22.8)	3405 (22.7)	
>5	145 (28.9)	3031 (20.2)	
Maternal education			
Elementary or less	194 (38.8)	5688 (37.9)	0.1655
Junior high	141 (28.2)	3699 (24.7)	
Senior high	126 (25.2)	4272 (28.5)	
College or more	39 (7.8)	1341 (8.9)	

Table 1 (cont.)

	Cases	Controls	<i>p</i> ^a
Paternal education			
Elementary or less	182 (36.4)	4342 (28.9)	0.0044
Junior high	114 (22.8)	3747 (25.0)	
Senior high	130 (26.0)	4453 (29.7)	
College or more	74 (14.8)	2458 (16.4)	
Total	500 (100.0)	15 000 (100.0)	

^aBased on the χ^2 test, Fisher's exact test or the two independent samples *t* test.

^bBased on information from the Taiwan Birth Registry (TBR).

Values given as number (percentage) or mean \pm standard deviation.

1.16–3.24), but the difference in ORs was not statistically significant ($p=0.0841$). In addition, maternal death by suicide conveyed a slightly higher, but insignificant ($p=0.9309$), risk for offspring suicide than did paternal death by suicide (OR 6.59 *v.* OR 5.38).

With regard to offspring gender, analyses were first limited to male cases and their corresponding controls. We noted that male offspring death by suicide was substantially and significantly associated with prior history of paternal death by suicide (OR 8.23, 95% CI 2.96–22.90) but not with prior history of maternal death by suicide (OR 3.50, 95% CI 0.41–30.13) (Table 3). For female offspring, deaths by suicide were significantly and positively associated with prior history of maternal death by suicide (OR 9.71, 95% CI 1.89–49.94) but not with prior history of paternal suicidal death (OR 2.42, 95% CI 0.30–19.57) (Table 4). Despite these differences in ORs between father–son and mother–son dyads, and between father–daughter and mother–daughter dyads, the observed differences were not statistically significant, with *p* values of 0.5527 and 0.3139 respectively.

Discussion

Our study found that offspring completed suicide was significantly associated with prior history of maternal and paternal deaths, especially from death by suicide. Consistent with previous research (Agerbo *et al.* 2002; Qin *et al.* 2002; Sørensen *et al.* 2009; Garssen *et al.* 2011), our study also tended to suggest that offspring suicide risk was associated more with maternal suicide than with paternal suicide. Despite a lack of significant difference, our findings suggest that an offspring's suicidal death was significantly and positively associated with a prior history of suicidal death of their same-sex parent but not with that of their opposite-sex parent.

Parental death is one of the most traumatic life events for children and adolescents. Early deprivation of parental care and the changing environment

associated with parental loss, such as economic hardship or inadequate care by the surviving parent, might result in child maladjustment (Hung & Rabin, 2009; Kuramoto *et al.* 2009). Furthermore, the impact of parental death by suicide on youth might be more traumatic and damaging than that of parental death by other causes. Past research found that youth bereaved by parental suicide had a higher risk of developing post-traumatic stress disorder, depression, anxiety and suicidal behavior, compared to those bereaved by non-suicidal causes (Brent *et al.* 1996; Pfeffer *et al.* 2000; Agerbo *et al.* 2002; Tsuchiya *et al.* 2005; Wilcox *et al.* 2010). Hung & Rabin (2009) argued that suicide-bereaved children not only need to adjust to parental loss but also have to make meaning of the self-directed nature of suicide in their parents. The grief process might be disastrous and enduring. Children bereaved by parental suicide usually undergo a devastating feeling of being abandoned, shame, self-blame or hatred (Ratnarajah & Schofield, 2011). In addition, the aftermath associated with suicide, such as social stigma, the unspoken secret in the family or social isolation, tend to make children's adjustment particularly difficult. These factors all pose heightened risks for maladjustment.

The size of the OR estimated in our research tends to be larger than that in previous studies. In the study by Agerbo *et al.* (2002), in which the age range of the participants was comparable to that in our study, the covariate adjusted ORs of youth suicide completion with maternal and paternal suicide completion were 4.75 and 2.30 respectively, whereas they were 6.59 and 5.38 in our study. The corresponding estimates in Qin *et al.* (2002) were even lower, at 3.38 and 2.03. The heightened risk found in our study might be partially explained by our study's inadequate adjustment for potential confounder such as familial psychiatric disorders. A wide CI associated with the OR estimates noted in our study also limits the interpretation of the different ORs between previous studies and ours.

Table 2. Odds ratios of adolescent completed suicide in relation to prior history of parental death

	Controls	Cases	OR (95% CI)					
			Unadjusted		Model 1 ^a		Model 2 ^b	
Death of parent(s)								
No	14036	432	1.00		1.00		1.00	
Yes	964	68	2.29	(1.76–2.98)	2.29	(1.75–3.00)	2.20	(1.68–2.89)
Father died only	704	48	2.22	(1.63–3.01)	2.20	(1.61–3.01)	2.11	(1.54–2.89)
Mother died only	232	17	2.38	(1.44–3.93)	2.47	(1.49–4.09)	2.41	(1.45–4.01)
Both parents died	28	3	3.48	(1.05–11.50)	2.95	(0.88–9.95)	2.76	(0.82–9.36)
Paternal death ^c								
No	14268	449	1.00		1.00		1.00	
Yes	732	51						
Suicide cause	31	6	6.15	(2.55–14.82)	5.78	(2.23–13.48)	5.38	(2.17–13.33)
Other causes	701	45	2.04	(1.49–2.80)	1.96	(1.42–2.71)	1.88	(1.35–2.60)
Maternal death ^d								
No	14740	480	1.00		1.00		1.00	
Yes	260	20						
Suicide cause	14	3	6.58	(1.89–22.98)	6.63	(1.82–24.19)	6.59	(1.82–23.91)
Other causes	246	17	2.12	(1.29–3.50)	1.99	(1.20–3.31)	1.94	(1.16–3.24)

OR, Odds ratio; CI, confidence interval.

^a Adjusted for study subject's sex, parental ages at the time of delivery, place of birth, and receiver.

^b Adjusted for the selected variables included in model 1 plus familial socio-economic factors including urbanization of residence at birth, parental educational level and age difference of parents.

^c Additional adjustment for maternal death in both models 1 and 2.

^d Additional adjustment for paternal death in both models 1 and 2.

Bold values indicate statistical significance.

Table 3. Odds ratios of male adolescent completed suicide in relation to prior history of parental death

	OR (95% CI)						
	Unadjusted		Model 1 ^a		Model 2 ^b		
Paternal death ^c							
No (case/control=275/8758)		1.00		1.00		1.00	
Yes (case/control=32/452)							
Suicide (case/control=5/18)		8.85	(3.26–24.00)	8.76	(3.18–24.14)	8.23	(2.96–22.90)
Other causes (case/control=27/434)		1.98	(1.32–2.98)	1.88	(1.25–2.85)	1.76	(1.16–2.67)
Maternal death ^d							
No (case/control=293/9,062)		1.00		1.00		1.00	
Yes (case/control=14/148)							
Suicide (case/control=1/7)		4.42	(0.54–36.03)	3.42	(0.39–29.88)	3.50	(0.41–30.13)
Other causes (case/control=13/141)		2.85	(1.60–5.09)	2.69	(1.49–4.88)	2.62	(1.44–4.76)

OR, Odds ratio; CI, confidence interval.

^a Adjusted for study subject's sex, parental ages at the time of delivery, place of birth, place of birth, and receiver.

^b Adjusted for the selected variables included in model 1 plus familial socio-economic factors including urbanization of residence at birth, parental educational level and age difference of parents.

^c Additional adjustment for maternal death in both models 1 and 2.

^d Additional adjustment for paternal death in both models 1 and 2.

Bold values indicate statistical significance.

Table 4. Odds ratios of female adolescent completed suicide in relation to prior history of parental death

	OR (95% CI)					
	Unadjusted		Model 1 ^a		Model 2 ^b	
Paternal death^c						
No (case/control=174/5,510)	1.00		1.00		1.00	
Yes (case/control=19/280)						
Suicide (case/control=1/13)	2.44	(0.32–18.73)	2.14	(0.27–17.10)	2.42	(0.30–19.57)
Other causes (case/control=18/267)	2.14	(1.30–3.52)	2.07	(1.23–3.48)	2.07	(1.22–3.51)
Maternal death^d						
No (case/control=187/5,678)	1.00		1.00		1.00	
Yes (case/control=6/112)						
Suicide (case/control=2/7)	8.68	(1.79–42.04)	11.01	(2.19–55.35)	9.71	(1.89–49.94)
Other causes (case/control=4/105)	1.16	(0.42–3.17)	1.07	(0.38–2.97)	1.05	(0.38–2.93)

OR, Odds ratio; CI, confidence interval.

^a Adjusted for study subject's sex, parental ages at the time of delivery, place of birth, place of birth, and receiver.

^b Adjusted for the selected variables included in model 1 plus familial socio-economic factors including urbanization of residence at birth, parental educational level and age difference of parents.

^c Additional adjustment for maternal death in both models 1 and 2.

^d Additional adjustment for paternal death in both models 1 and 2.

Bold values indicate statistical significance.

Our study suggests gender-specific risk associations between offspring completed suicide and history of parental deaths by suicide. Risk of completed suicide for female adolescents was significantly associated with maternal suicide but not with paternal suicide. The opposite was true for male adolescents. In particular, after taking gender of offspring into consideration, the risk magnitude between parental and offspring suicides of the same sex increased considerably. On the contrary, the links between parent and children of the opposite-sex were reduced and were no longer significant.

Buist *et al.* (2004) found that, in general, same-sex attachments were greater than opposite-sex attachments, and that the level of attachment in both male and female adolescents to their same-sex parent was similar during adolescence. Thus, a compromised relationship with same-sex parent might be more destructive than that with the opposite-sex parent. Israelashvili *et al.* (2006) suggested that suicidal female adolescents were lacking mothers as a positive role model to learn from her ways of coping. According to the social learning theory, imitative learning is augmented when the model is closely identified by the observer. A few studies have implied that family transmission of suicide may be a result of imitation (Lieb *et al.* 2005; Mittendorfer-Rutz *et al.* 2008; Burke *et al.* 2010). As the same-sex parent is usually the figure a child closely identifies with, the parent's ways of coping, including self-harming behavior, will be more readily imitated by their children. Thus, the association

between parental and offspring suicides was only observed for same-sex dyads and not for opposite-sex dyads. Our findings support the hypothesis that attachment to the same-sex parent is of particular importance with regard to young suicide whereas that to the opposite-sex parent is not.

The notion that familial transmission of suicide might be the result of imitation has been supported by some studies (Brent & Mann, 2005; Lieb *et al.* 2005; Mittendorfer-Rutz *et al.* 2008; Burke *et al.* 2010) but not others (e.g. Insel & Gould, 2008). By indicating a significant risk link between parent-child dyads of the same sex, our study tends to demonstrate that suicide modeling might occur with the same-sex parent, with whom youth more closely identify. The same-sex parent could be an important source of identification for children and adolescents to develop a sense of self. The sameness between them means they bond each to the other. When young children are bereaved by parental suicide, the misfortune will be more readily incorporated into their personality and identity (Hung & Rabin, 2009; Ratnarajah & Schofield, 2011). Thus, there might be a strong tendency for children and adolescents to model same-sex parents' ways of problem solving, including suicide, when they encounter hardships in life. Nevertheless, more research is needed to determine whether these findings are reproduced with samples from other countries and with other types of suicidal behavior, such as suicidal attempts.

There are several methodological strengths in our study. First, we used nationwide population-based

registry data, ensuring the representativeness of the study subjects. The linkage between birth and death registries also effectively reduces the likelihood of sample attribution, providing reassurance of limited selection bias. Moreover, we used a nested case-control design, which further provides reassurance for a limited likelihood of selection bias. Second, the study sample consisted of 500 cases of suicidal cases and 1500 controls, making it possible to perform detailed sex stratifications. Third, most of the previous research probed for suicidal ideations and attempts. Our research reported that the impact of parental death on adolescents could be as deleterious as suicide completion. Such information has public health implications as suicidal death in adolescents can result in a significant loss of years of potential life and economic loss.

Several limitations of this study should be mentioned. First, we were unable to control for psychiatric histories of participants and their parents. Statham *et al.* (1998) argued that the risk of persistent suicidal thoughts and attempts is determined by a complex interplay of psychiatric history, neuroticism, traumatic life experiences, genetic vulnerability specific for suicidal behavior and sociocultural risk or protective factors. In addition, the study by Sørensen *et al.* (2009) showed that parental history of suicide is a risk factor for suicide in offspring, but primarily in offspring without psychiatric hospitalization. Past research suggests that familial psychiatric history is associated with family socio-economic factors, and the risk of familial psychiatric history is associated with increased poverty in families (Agerbo *et al.* 2002). Because our research controlled for family socio-economic factors, partial control for the potential influences of psychiatric history was achieved. Inadequate adjustment for potential confounding by study subject's psychiatric disorder might result in overestimation of the relationship between offspring completed suicide and parent's suicide by death. Second, our study noted a lack of significant association of completed suicide in female offspring with paternal death by suicide, along with a lack of significant association of completed suicide in male offspring with maternal death by suicide; these may be caused by the very limited sample size in our gender-specific analyses. In fact, there was only one male suicide case whose mother also died by suicide, and there was only one female suicide case whose father died by suicide. Third, because the study findings were based entirely on birth and death registry data, we do not know whether the parents were together with the children at the time of suicide; it might be that, if the father was not in the child's life at that time, his suicide might have had less impact. Additionally, some adolescents might have witnessed the suicide personally,

some might just have been told about it, and some might never have been told that their parents died by suicide. A lack of detailed information on the scene of suicide makes it very difficult to assess the intensity of exposure of parental suicide on their offspring. Another limitation is that findings of risk links between parent-child dyads are only true for completed suicide.

Conclusions

This study extends our knowledge of the familial transmission of suicide by exploring associations of adolescent completed suicide with paternal and maternal death by suicide separately in an Asian country. Risk of completed suicide in adolescents was positively associated with parental death, especially death by suicide. One of the potential novel contributions of our study is that our data indicate that familial transmission of suicide completion occurs only for same-sex parent-child dyads, suggesting that same-sex identification and modeling, along with same-sex parental bonding, might play a crucial role in explaining the associations between parental suicide and adolescent completed suicide. However, firm conclusions about these relationships are limited because of the small sample size in the stratified analyses. Future studies with larger sample sizes would help to elucidate whether the familial transmission of completed suicide for same-sex parent-child dyads truly exists. If it does indeed exist, more attention needs to be paid to identification and modeling issues in designing suicide prevention and treatment plans for adolescents. In particular, children or adolescents who have lost their same-sex parent to suicide need to receive particular attention because they are likely to show a heightened risk of suicide modeling.

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Declaration of Interest

None.

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