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The impact of spousal bereavement on self-assessed health status: evidence from the Taiwanese elderly population

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Abstract

Bereavement is a grieved and inevitable event in our life. For an aging society, the incidence of spousal bereavement and parental bereavement is higher than the other kinds of bereavement events. This study employs the difference-in-differences (DiD) strategy and the Taiwanese panel Survey of Health and Living Status of the Elderly (SHLSE) to evaluate the impact of losing a spouse on well-being measured by self-assessed health status, depression, and life satisfaction.

The results show that spousal bereavement causes substantial depression and loss in life satisfaction. The spousal bereavement impact increases depression by 1.46 CES-D points and reduces life satisfaction by 0.71 points. The decay effect of time is not observed in this study. We also examine the demographic differences of the spousal bereavement impact and find that the gap in life satisfaction between the bereaved who received more than 9 years education and the bereaved who received 9 years or less is 1.43 points, which implies that spousal bereavement causes less impact on more educated people in terms of life satisfaction. The increase in depression for the bereaved in a larger household is smaller than that for those in a small household by 2.75 CES-D points but it is weakly significant.

The self-reported health outcomes are the intermediate outcomes between spousal bereavement and societal costs such as healthcare utilisation and death. The association between self-reported health status and mortality and health utilization has been well documented by literature. Thus, our results also provide the policy insight that giving proper interventions on the onset of bereavement may cause less societal costs afterwards.

Key words: spousal bereavement; difference-in-differences; wellbeing; depression; life satisfaction

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1. Introduction

Bereavement is a grieved and inevitable event in our life. For an aging society, the incidence of spousal bereavement and parental bereavement is higher than the other bereavement events. In Taiwan, about 31.87% of elder population aged at 65 or older suffered spousal bereavement in 2011. Among this bereaved population, the percentage of males and females was 21.83% and 78.17%, respectively[1].

Previous studies have developed the risk factor frameworks to illustrate the pathways from the occurrence of bereavement to health outcomes and explain how bereavement affects health. Most people feel intense sadness and distress (Schut and Stroebe, 2010) when bereavement occurs and then lose social contact and suffer from grief after sustaining sadness and distress. Grief is characterised by failure of adjustment to the loss, avoidant behaviors, interpersonal difficulties, and poor occupational functioning (Prigerson et al., 2009) and grieving is associated with lowered immune functions, higher rates of disability, ill health and even suicide (Prigerson et al., 2000; Stroebe et al., 2007; Hart et al., 2007; Buckley et al., 2010). Disability and ill health cause the loss of wellbeing, increases in societal costs such as medical utilisation, unemployment, and poverty, and decreases in educational attendance, labor force and productivity.

Many empirical studies have drawn attention on the association between bereavement and mortality, especially spousal bereavement (Wilson, S.E., 2002; Elwert and Christakis, 2008; Espinosa and Evans, 2008; van den Berg et al., 2011; Simeonova, 2013). According to the theories of marriage markets and health capital, the health status of a couple is correlated in their later life (Becker, 1973 and 1974; Grossman, 1972). People with similar individual characteristics, for instance, education or attractiveness, are more likely to become a couple due to assortative matching in the marriage market. After marriage, they share common life-style such as diet, smoking, exercises, and environmental risk factors for disease. Thus, the death of surviving spouse may be determined by these common observed and unobserved factors and the bereavement effect. Suicide is one of the most extreme responses to the loss of a loved one. Johnson et al. (2008) show that widowed adults with low-esteem and dependency on the deceased spouse may be associated with higher risk for depressive symptoms and suicide after spouse died. Chiang et al. (2006) and Liu (2009) point out that in Taiwan about 34.2% of the elder suicidal population is bereaved and the suicide rate of widows is higher than that of not widows. Understanding bereavement impact and providing proper supports will be able to reduce the suicide rate in the bereaved population.

Apart from mortality risk, the bereavement impact on well-being status such as happiness and psychological distress is also interest of researchers (Parkes, 1996; Hansson and Stroebe, 2003; Glaser, et al., 2006; Oswald and Powdthavee, 2008; Guldin et al., 2012). Many studies report that bereavement increases depressive symptoms (Parkes, 1996). For a few people depression reaches clinical importance, with findings of studies suggesting that 25-45% have mild levels of depressive symptoms and 10-20% show clinical levels (Hansson and Stroebe, 2004; Stroebe et al., 2007). Oswald and Powdthavee (2008) not only estimate the bereavement impact on well-being but also

[1] Annual Statistic Report 2009, Ministry of Interior. Avaliable http://sowf.moi.gov.tw/stat/year/y02-03.xls

estimate the monetary compensation of the loss of a loved one for happiness and psychological distress.

The socioeconomic and demographic differences of bereavement impact are also the concern in this study. Some studies claim the difference in the spousal bereavement impact in terms of sex and age patterns, education and ethnic origin, household size, and number of children (Schaefer et al., 1995; Martikainen and Valkonen, 1996; Smith and Zick, 1996; Stroebe et al., 2001; Manor and Eisenback, 2003; Christakis and Allison, 2006; Elwert and Christakis, 2006). Older widowers are likely to experience insufficient caloric or nutritional intakes and a deterioration of their health in the long-run due to the difficulties in cooking (Koehn, 2001; van den Berg et al., 2011). Some empirical evidence shows that widows often suffer greater poverty, which is associated with higher morbidity and mortality among older population (Benzeval and Judge, 2001; McGarry and Schoeni, 2005). Stroebe et al. (2001) conclude that conjugal bereavement results in increased morbidity and mortality for both genders but males are relatively vulnerable to the health risks than females, particularly during the period of acute grief. With respect to age, Schaefer et al. (1995) and Martikainen and Valkonen (1996) find that mortality risk is greater for younger bereaved people who have lost their spouse than for older.

This study attempts to avoid the problem of unobserved factors and control for the observed characteristics to identify the spousal bereavement impact on self-assessed health status, depression, and life satisfaction of Taiwanese elderly population and answer three questions. First, does the spousal bereavement have a significant impact on the aforementioned outcomes? Mortality is excluded from the analyses due to the data restrictions. The difference-in-differences (DiD) strategy is employed to estimate the bereavement impact on these outcomes. Before implementing DiD, the propensity score matching (PSM) approaches are used to select a comparison group from the non-bereaved and assign hypothetical bereavement dates to the non-bereaved who are matched with the bereaved to implement *ex ante* and *ex post* analyses in the DiD strategy as well as to generate a weight to the non-bereaved. A greater weight means that the characteristics of the non-bereaved are closer to the characteristics of the bereaved. Second, does the bereavement impact decay along with time? If the decay effect is observed, how long will the elder people take to recover from the loss of spouse? Third, is there any demographic and socioeconomic differences existing in spousal bereavement impact if the impact is significant?

This study is organized as follows. Section 2 introduces the longitudinal data set. Section 3 describes the analysis strategy and section 4 shows the empirical results. Finally, section 5 is the conclusion.

2. Data

The data for analyses are taken from the panel Survey of Health and Living Status of the Elderly (SHLSE). This survey was designed to measure the changes in health and living status of the elderly in Taiwan. It is a panel survey including six waves conducted in 1989, 1993, 1996, 1999, 2003, and 2007. The first survey conducted in 1989 comprises 4,049 respondents (one respondent per household) and those individuals were all aged 60 years and older. Given the age group there are large levels of attrition over time. In order to replenish the sample, a new cohort of 50-66 year-olds was added

in 1996 and another new cohort of 50-56 year-olds was added in 2003[2]. Therefore, the individuals have multiple data points over different years as long as they are alive across waves. The individuals who have existed since 1989 are defined as cohort I. The individuals added in 1996 are defined as cohort II and the individuals replenished in 2003 are defined as the cohort III.

The SHLSE comprises questions relating to demographic information, household details, health information, occupation, residence, and economic/financial wellbeing. It contains not only the current but also significant historical information with respect to marital status, bereavement, employment and retirement, and living arrangement/residence. Health information includes self-assessed general health status, a measure of depression (CES-D, Centre for Epidemiologic Studies Depression Scale), health care utilisation, and health behaviours including consumption of alcoholic beverages, smoking and aspects of diet. Questions relevant to life satisfaction are also included in the survey, however, these were absent in the 1993 wave. A section devoted to the financial wellbeing of the respondents comprises of the (main) sources of their income, their asset structure, and management of finances. However, the income is a categorical variable and the income categories are not consistent in the first wave and the other waves. Therefore, the accurate income information is scant.

The SHLSE comprised six waves (1989-2007) when this research was conducted. However, the National Health Insurance (NHI) was implemented in 1995. NHI is a compulsory health insurance and its coverage is almost 100% of population. To avoid the NHI influence, the cohort I is not used as the analytic samples. The cohort III is also excluded from the samples due to the short time span of the data. Thus, only cohort II is used for analyses. The survey of this cohort started in 1996 and it had been conducted for 4 waves until 2007. Due to the investigation of the impact of spousal bereavement, only the individuals reporting their marital status as married in 1996 are selected and the number of samples is 2,020.

3. Estimation

The method used in this study is the difference-in-differences that compares the bereaved group and the non-bereaved group before and after spousal bereavement. The bereaved individuals are defined as those individuals who suffered the loss of their spouse during 1996 and 2007 and the non-bereaved individuals, otherwise. However, the non-bereaved individuals did not have a bereavement date because spousal bereavement did not actually occur so that the pre- and post-bereavement period cannot be defined in this group. Thus, a hypothetical bereavement date needs be generated for each non-bereaved individual to implement the DiD estimation. The propensity score matching (PSM) methods are employed for this purpose. They not only assign a hypothetical bereavement date to a non-bereaved individual from his/her matched bereaved individual but also generate a weight for each individual in the samples so that the bereaved and the non-bereaved are more comparable.

[2] The sample size of the new cohort in 1996 was 2462 and the sample size of the new cohort in 2003 was 1599.

3.1 Propensity score matching (PSM)

Two matching methods, the one-to-one nearest-neighbor matching (NNPSM) and the kernel-based matching (KPSM), are used in this study for different purposes (Guo and Fraser, 2009). NNPSM is used for assigning a bereavement date for each non-bereaved individual and KPSM is used for generating a weight to each individual in both groups. The initiation of propensity score matching is to estimate the probability of becoming bereaved according to several characteristics. Here, the characteristics such as age, sex, educational year, children number, working status, household scale (median and large), living region (middle, south, and east), ethnicities (mainlander, hakka, and others), spouse's age, spouse's educational year, and spouse's working status in 1996 are used to estimate the propensity score. The equation of NNPSM is as Eq. (1):

$$(1) \quad Y_i = \alpha_0 + X_i'\alpha + e_i$$

$$Y_i = \begin{cases} 1, & SB_i = 0 \\ 0, & SB_i = 1 \end{cases}$$

where Y is a dichotomous indicator. SB_i is a bereavement indicator of individual i with value 1 meaning bereaved and 0, otherwise.[3] X is a vector of aforementioned covariates. Value 1 in the dummies of working status and spouse's working status represents working and 0, otherwise. e is a random error term. Eq. (1) is implemented by the Logistic estimation and the results are shown in Table A.1. The propensity score is a means to assign a hypothetical bereavement date to a non-bereaved individual from his/her matched bereaved individual who has the nearest propensity score. After the implementation of NNPSM, the sample size reduces to 1,827 due to the missing values in the covariates of those unmatched individuals

While the non-bereaved cohort presents a possible comparison group for the bereaved there may be reasons, other than the impact of the bereavement itself, why their longitudinal experience in terms of health status may differ from the bereaved group. Thus in order to create a more comparable non-bereaved group the non-bereaved are weighted in terms of their similarity to the bereaved cohort given their baselines characteristics.

To do this KPSM using the kernel matching method is used to generate a "closeness" weight for each non-bereaved individual in our sample (Caliendo and Kopeinig, 2008). While the bereaved are all given a weight of 1 in the subsequent analysis, those non-bereaved who more closely match the bereaved cohort in terms of their characteristics in 1996 are given a greater weight compared to those who are dissimilar to the bereaved cohort. KPSM is a one-to-many matching process in which the weight for each non-bereaved individual is calculated by a kernel function based on the predicted probability that they would have become bereaved given their initial characteristics obtained from a Probit estimation given in Eq. (2) (Greene, 2008, p. 772):[4]

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[3] We use the inverse of bereavement indicator to implement the nearest-neighbor matching in order to match the variable of bereavement date from the bereaved individuals to the non-bereaved individuals. The non-bereaved individual is regarded as the treated unit and the identification number of the matched bereaved individual is given to the non-bereaved individual. Thus, the bereavement date can be assigned to the non-bereaved individual according to the identification number.

[4] The weight (w_{ij}) is equal to $K\left[\frac{P_i - P_j}{h}\right] / \sum_{j \in \{SB=0\}} K[\frac{P_i - P_j}{h}]$, where K is a kernel function, h is the bandwidth (the bandwidth is 0.06), and P is propensity score. i is the bereaved individual and j is the non-bereaved individual.

$$(2) \quad L_i = \theta_0 + X_i'\theta + \epsilon_i$$

$$L_i = \begin{cases} 1, & SB_i = 1 \\ 0, & SB_i = 0 \end{cases}$$

where L is a dichotomous variable. The definitions of X_i and SB_i are the same as those in Eq. (1). θ is a vector of coefficients and ϵ_i is a random error term. The results of Eq. (2) are shown in Table A.2.

3.2 Sample description

Table 1 shows the sample size and the death rate in the bereaved group and the non-bereaved group. The baseline sample size is 1,827 individuals who were married and aged between 50 and 70 in 1996. 5 of 1,827 individuals died and 52 of 1,827 individuals lost their spouse during 1996 and 1999. 3 of 52 individuals who became bereaved in 1999 and 44 and 73 of 1,770 individuals who were not bereaved in 1999 died and became bereaved between 1999 and 2003, respectively. In the next period, 87 of 1,650 individuals who were not bereaved in 2003, 3 individuals in the 2003 bereaved group, and 7 individuals in the new bereaved group had died. 92 of 1,650 individuals who were not bereaved in 2003 lost their spouse during 2003 and 2007. The death rate in the non-bereaved group needs to be interpreted with caution because it might be overestimated. For instance, 44 individuals who were in the non-bereaved group died during 1999 and 2003. However, the marital status of these individuals at death was absent so that we cannot certainly know whether their marital status at death was consistent with that in 1999 when the survey was conducted. Due to this data restriction, we restrict our estimation samples to the individuals surviving during the analytic period (1996 – 2007). The sample size reduces to 1,658.

Table 2 shows that the sample sizes of the bereaved group and the non-bereaved group are 203 and 1,456 respectively. The upper part of the table is the baseline statistics and the bottom part of the table is the statistics of the variables may change over time. The third column of Table 2 presents the weighted statistics of the non-bereaved group.

Table 1. Sample size and death rate of the bereaved and non-bereaved groups (*N*=1,827 in 1996)

Group	1999	2003	2007
	Age: 53-73	Age: 57-75	Age: 61-79
Non-bereaved group	1,770	1,650 (44)	1,474 (87)
Bereaved group	52	47 (3)	43 (3)
New bereaved group in 2003	-	73	62 (7)
New bereaved group in 2007			92
Death rate of the non-bereaved group	-	2.49%	5.9%
Death rate of the bereaved group	-	5.77%	6.38%
Death rate of 2003 new bereaved group	-	-	9.59%

Note: The number in the parentheses represents the death number

Minnan is the major ethnic group and the following ethnic groups are Hakka, Mainlander, and others. The Minnan samples in the bereaved group and the non-bereaved group are 81.28% and 73.08%, respectively. After weighting, the percentage of Minnan in the non-bereaved group rises up to 82.65%. The initial income here was the sum of the annual income of the individual and his/her spouse in 1996. 66.5% of the

bereaved samples reports their initial income income is less than NT$600,000 (approximate to US$20,000) whereas it is only 59.96% in the non-bereaved group. After weighing, the percentage increases to 63.56%. 15.27% of the bereaved suffered the loss of children before 1996, which is higher than that of the non-bereaved. As for sex, males are less than females in the bereaved group whereas it is reverse in the non-bereaved group. The percentage of males in the bereaved group is 24.14% but 56.8% in the non-bereaved group. The weighted percentage of males is similar to that in the bereaved group. The bereaved group, on average, received less education than the non-bereaved group. The average educational years for each group are 3.33 and 5.94 years, respectively, and 3.62 years after weighting.

Table 2. Sample characteristics

Variable	**Spousal bereavement group**[1]	**Non-spousal bereavement group**	**Weighted Non-spousal bereavement group**
	***N*=1,659, *T*=1 (1996)**		
Baseline characteristics	**Sample size (%)**	**Sample size (%)**	**Sample size (%)**
Ethnicity			
Minnan (baseline: 1996)	165 (81.28%)	1,064 (73.08%)	145.889 (82.65%)
Hakka (baseline: 1996)	28 (13.79%)	282 (19.37%)	22.865 (12.95%)
Mainlander (baseline: 1996)	6 (2.96%)	96 (6.59%)	4.524 (2.56%)
Others (baseline: 1996)	4 (1.97%)	14 (0.96%)	3.228 (1.83%)
Initial income[2] **(1,000 NTD/per year)**			
I. <100	50 (24.63%)	128 (8.79%)	24.689 (13.99%)
II. 100 ~ <300	55 (27.09%)	370 (25.41%)	51.89 (29.4%)
III. 300 ~ <600	30 (14.78%)	375 (25.76%)	35.599 (20.17%)
IV. 600 ~ <1,000	8 (3.94%)	175 (12.02%)	10.665 (6.04%)
V. 1,000 ~ <2,000	4 (1.97%)	106 (7.28%)	6.441 (3.65%)
VI. >=2,000	0 (0%)	8 (0.55%)	0.580 (0.53%)
Sex			
Male	49 (24.14%)	827 (56.8%)	45.189 (25.6%)
Female	154 (75.86%)	629 (43.2%)	131.317 (74.4%)
Child death before 1996	31 (15.27%)	167 (11.47%)	25.022 (14.18%)
	Mean (std.)	**Mean (std.)**	**Mean (std.)**
Educational year (baseline: 1996)	3.325 (3.78)	5.935 (4.555)	3.621 (3.979)
Sample Size	203	1,456	176.506
	***N*=1,659, *T*=4 (1996, 1999, 2003, and 2007)**		
	Mean (std.)	**Mean (std.)**	**Mean (std.)**
SAH	0.306 (0.461)	0.433 (0.496)	0.361 (0.481)
CES-D	7.879 (4.279)	6.933 (3.802)	7.575 (4.173)
LS	5.318 (1.835)	5.74 (1.751)	5.688 (1.79)
Age	64.488 (5.701)	62.467 (6.079)	64.266 (6.004)
Children number	4.083 (1.547)	3.789 (1.351)	4.092 (1.364)
Bereavement duration (month)	63.126 (39.429)	57.763 (39.067)	64.776 (38.253)
Household scale			
Small (<5)	0.515 (0.5)	0.515 (0.5)	0.496 (0.5)
Median (5-10)	0.456 (0.498)	0.458 (0.498)	0.479 (0.5)
Large (>10)	0.029 (0.168)	0.027 (0.161)	0.024 (0.155)
Region			
North	0.207 (0.405)	0.271 (0.445)	0.188 (0.391)
Middle	0.318 (0.466)	0.333 (0.471)	0.368 (0.483)
South	0.456 (0.498)	0.37 (0.483)	0.427 (0.495)

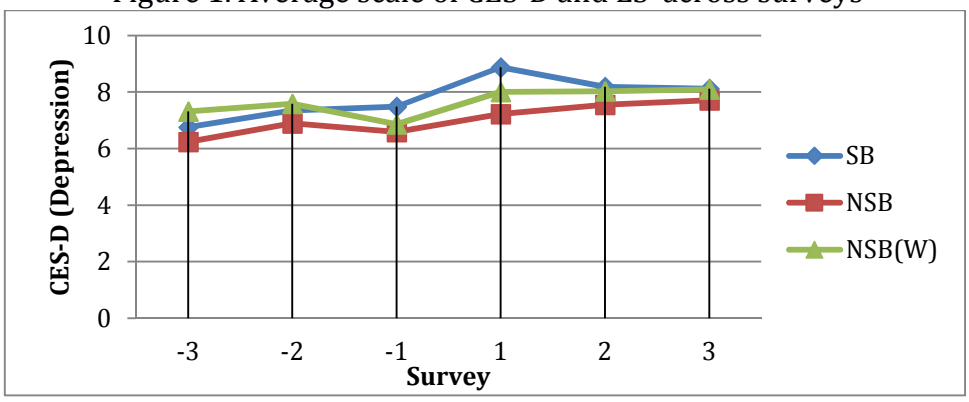
East	0.019 (0.136)	0.026 (0.159)	0.017 (0.131)
Religion			
No religion	0.05 (0.217)	0.068 (0.252)	0.049 (0.216)
Western religion	0.05 (0.217)	0.023 (0.151)	0.019 (0.137)
Eastern religion	0.901 (0.299)	0.908 (0.289)	0.932 (0.252)
Sample size	812	5,824	706.025

1. Individuals are classified in this group if they suffered spousal bereavement in the 4 waves (1996-2007)
2. In 1996, the average currency rate of 1 US$ to NT$ was 27.448 and the average currency rate of 1 GBP to NT$ was 45.788.

With respect to the health status and life satisfaction, the self-assessed health (SAH) is a dichotomous variable and the measures of depression (CES-D) and life satisfaction (LS) are continuous variables. The individuals responding "very good" and "good" to the question that how do you think about your current health status are given 1 and 0 if they responded "fair", "bad", and "worse". The full scales of CES-D and LS are 30 points and 10 points respectively and the higher scales the more depression and life satisfaction. The non-bereaved group reports better self-assessed health, less depression, and higher life satisfaction than the bereaved group. The percentage of reporting good health for the bereaved and the non-bereaved group are 30.6% and 43.3% respectively. The average scales of CES-D and LS are 7.88 and 5.32 respectively for the bereaved group as well as 6.93 and 5.74 respectively for the non-bereaved group. The weighed percentage and scales of the non-bereaved group are closer to those of the bereaved group.

The average age of the bereaved is 64.49 years old that is older than the average age of the non-bereaved by 2 years. The weighted average age is 64.27 much closer to the average age of the bereaved group. The average children number of individuals whether living in the same household or not in both groups approximates to 4. The average maximal post-bereavement duration is 63.13 months. The variable of post-bereavement duration indicates the ordinal number of months from the month of losing spouse to the end of analytical period. The value starts from 1 meaning one month after the loss of spouse. The average maximal hypothetical post-bereavement duration is 57.77 months but the average weighted duration is 64.78 months. The household size is similar in both groups. More than 90% samples live in small or median households. As for the living regions, the majority of individuals in both groups live in the south and the follows are the middle, the south, and the east of Taiwan. More than 90% of individuals have the belief of eastern religion.

Figure 1. Average scale of CES-D and LS across surveys



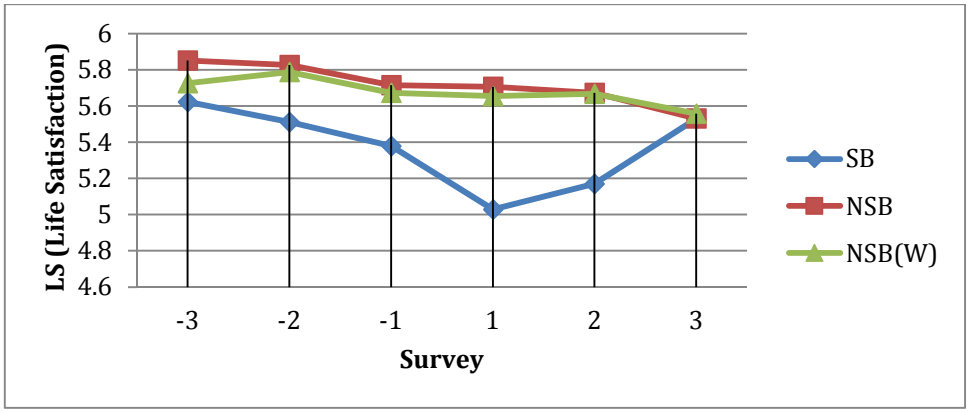


Figure 1 presents the pattern of average scales of depression and life satisfaction for the bereaved group, the non-bereaved group, and the weighted non-bereaved group. The positive numbers on horizontal axis mean the ordinal number of surveys conducted after the bereavement date or the hypothetical bereavement date. Similarly, the negative numbers denote the ordinal number of surveys conducted before the bereavement date or the hypothetical bereavement date. Each time interval is about 4 years and the bereavement occurs in the interval between -1 and 1.

The upper figure shows that the bereaved group, on average, has more than the non-bereaved group. The gap broadens gradually after the second survey prior to spousal bereavement and it achieves the biggest in the first survey after bereavement. The gap narrows down in the second and third survey after bereavement. Similarly, the same pattern is observed in the bottom figure. Both figures all show that the gap achieves the biggest in the first survey after bereavement and the lines of the weighted non-bereaved group (NSB(W)) lie between the lines of the bereaved group (SB) and the non-bereaved group (NSB) in most surveys whether before or after spouse bereavement.

3.3 Difference-in-differences (DiD)

The DiD strategy identifies the spousal bereavement impact by comparing the bereaved with the non-bereaved pre- and post-spousal bereavement (Donald and Lang, 2007). The framework is shown as Eq. (3):

$$(3) \quad \Delta^{SB} = \left(H_{SB\ Group}^{After\ SB} - H_{SB\ Group}^{Before\ SB}\right) - \left(H_{NSB\ Group}^{After\ SB} - H_{NSB\ Group}^{Before\ SB}\right)$$

where *SB* and *NSB* represent the bereaved and the non-bereaved respectively. The first pair of parentheses on the right hand side eliminates the time constant factors in the bereaved group. In addition, the second pair of parentheses attempts to control for the time-variant factors not related to bereavement by using the longitudinal experience of the non-bereaved group. This relies on the longitudinal experience of the non-bereaved group providing a reasonable counterfactual of the expected longitudinal experience of the bereaved group has they not become bereaved. Because bereavement is non-random the propensity score weighting approach is needed to place greater importance on the longitudinal experience of those non-bereaved that had similar initial characteristics as the bereaved and thus create a "comparable" non-bereaved group. Thus, the time-variant factors not related to bereavement can be controlled for by subtracting the second pair of parentheses from the first pair of parentheses to leave only the spousal bereavement impact (Δ^{SB}). The estimation equation is shown as Eq. (4):

$$(4)\quad H_{it} = \beta_0 + \beta_1 SB_{it} + \beta_2 Post_{it} + \beta_3 SB_{it} \cdot Post_{it} + \beta_4 D_{it} + \beta_5 SB_{it} \cdot D_{it} + X'_{it}\beta + \varepsilon_{it}$$

where H_{it} indicates the self-assessed health, depression, and life satisfaction for individual i at time t. *SB* and *Post* are the indicators representing spousal bereavement and post-bereavement period. The individuals are given 1 in *SB* if they suffered the loss of spouse between 1996 and 2007 and 0, otherwise. Similarly, the value 1 in the *Post* denotes the time after the (hypothetical) bereavement date and 0, otherwise. D_{it} denotes the number of months starting from one month after bereavement until time t for individual i and takes value 0 before bereavement. X_{it} is a covariate vector comprising age, age square divided by one hundred, educational year, number of individual's children, and dummies for sex, initial income (100 ~ <300, 300 ~ <600, 600 ~ <1,000, 1,000 ~ <2,000, 2,000 ~ < 5,000, and >= 5,000), ethnicities (Mainlander, Hakka, and other), living regions (north, middle, and south), household sizes (median and large), religion belief, and experience of child bereavement before 1996. The dummies for sex, religion belief, and experience of child bereavement before 1996 take value one for male, having religion belief, and suffering the loss of children before 1996 respectively and 0, otherwise. β_0 is a scalar. β_1, β_2, β_3, β_4, and β_5 are the coefficients for their corresponding variable. β_3 presents the spousal bereavement impact. It is the interest of this study. β_5 presents the decay effect of spousal bereavement impact. It reveals the changes of outcome variables impacted by spousal bereavement in post bereavement period. β is a vector of coefficients representing the relationship between controlling factors (X) and H. ε is a random error term.

With the dichotomous outcome variable, self-assessed health status, the estimations of pooling Probit and population-averaged, are implemented. As for the continuous outcomes, depression and life satisfaction, the estimations of pooling OLS, population-averaged, and fixed-effects are implemented. The restriction in fixed-effects model is that the time-invariant variables are dropped from the estimation. Thus, the two-stage approach is used to surmount this restriction.

4. Result

4.1 Bereavement impact

Table 3, Table 4, and Table 5 show the results of depression, life satisfaction, and self-assessed health status respectively. Table 3 shows spousal bereavement has a significant impact on depression at 10% level in the pooled OLS estimate whereas this impact becomes significant at 5% level in the population-averaged. The bereavement impact raises the depression scale in a range between 1.31 and 1.46 points. The decay effect of the bereavement impact is not significant in both estimations.

In the pooled OLS estimation, only the covariate of male is significant at 1% level and the covariates of initial annual income category III, large household size, and ethnic group of Hakka are significant at 10% level. Males report less depression than females by 1.03 points. People whose initial annual income is between NT$300,000 and NT$600,000 report less depression than those whose initial annual income is less than NT$100,000 by 0.72 points. People living in a large household also report less depression than those living in a small household by 0.96 points and Hakka ethnic group reports more depression than the group of others by 1.6 points, holding other

covariates constant. The population-averaged estimation has consistent result but the coefficients are slightly bigger than those in the pooled OLS estimation apart from ethnic group of Hakka.

The coefficients of spousal bereavement impact on life satisfaction in Table 4 are all significant at 5% level and they varies in an interval between -0.714 point and -0.712 points, which means that spousal bereavement reduces the scale of life satisfaction form 0.712 to 0.714 points. The decay effect of spousal bereavement impact is not significant in both estimations, which implies that the loss of life satisfaction does not restore with time going by.

In the pooled OLS estimation, the covariates of male, educational year, and initial annual income category V are significant at 1% level and the covariates of initial annual income categories III and IV and child bereavement before 1996 are significant at 5% level. The covariates such as annual income category II is only significant at 10% level. Males report lower life satisfaction than females by 0.37 points. Education has a positive association with life satisfaction. Life satisfaction increases 0.07 points when educational year increases one year. People in the initial annual income categories of NT$100,000~NT$300,000, NT$300,000~NT$600,000, NT$600,000~NT$1,000,000, and NT$1,000,000~NT$2,000,000 report higher life satisfaction than those in the reference category by 0.308, 0.456, 0.458, and 0.889 points, respectively. People who suffered the experience of losing children before this study period report lower life satisfaction than those who did not by 0.35 points. The result shown in the population-averaged estimation is similar to that in the pooled OLS estimation. The coefficients of initial annual income categories II, IV, and V are slightly bigger and the coefficients of initial annul income III and child bereavement before 1996 are slightly smaller.

Table 3. Bootstrapping Depression (CES-D) Weighted Regressions

	Pooled OLS	Population-averaged
	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
SB (Spousal bereavement)	-0.105 (0.355)	-0.139 (0.354)
Post (Post bereavement)	-0.038 (0.577)	-0.070 (0.570)
SB*Post	1.312* (0.751)	1.456** (0.735)
Decay of bereavement impact		
Post bereavement duration (unit: 6 months)	-0.022 (0.052)	-0.026 (0.052)
Post bereavement duration*SB	-0.078 (0.067)	-0.085 (0.063)
Personal & Household Characteristics		
Age	-0.051 (0.365)	-0.029 (0.356)
Squ. Age/100	0.066 (0.285)	0.050 (0.277)
Male	-1.031*** (0.319)	-1.035*** (0.319)
Educational year	-0.053 (0.046)	-0.050 (0.046)
Initial income (1,000 NTD/ per year) (ref: 100 <)		
II. 100 ~ <300	-0.371 (0.385)	-0.350 (0.382)
III. 300 ~ <600	-0.722* (0.428)	-0.733* (0.427)
IV. 600 ~ <1,000	-0.470 (0.537)	-0.487 (0.536)
V. 1,000 ~ <2,000	-0.432 (0.686)	-0.436 (0.681)
VI. >=2,000	0.779 (0.728)	0.778 (0.727)
Children number	0.187 (0.114)	0.184 (0.114)
Household size (ref: small (5<))		
Median (5-10 people)	-0.193 (0.276)	-0.153 (0.277)
Large (more than 10 people)	-0.956* (0.540)	-0.798 (0.562)
Region (ref: East)		
Middle	0.287 (0.762)	0.425 (0.812)
South	-0.180 (0.745)	-0.043 (0.788)

North	-0.185 (0.752)	-0.071 (0.798)
Ethnicity (ref: Others)		
Mainlander	0.917 (0.864)	0.874 (0.871)
Hakka	1.600* (0.831)	1.532* (0.83)
Minna	0.558 (0.769)	0.499 (0.768)
Religion belief	0.008 (0.547)	0.010 (0.056)
Child bereavement before 1996	0.149 (0.383)	0.118 (0.384)
Year dummy	Yes	Yes
N(clusters by personal ID)	1,283	1,283

* p<0.1, ** p<0.05, *** p<0.01. The bootstrapping process replicates samples 200 times.

Table 4. Bootstrapping Life Satisfaction (LS) Weighted Regressions

	Pooled OLS	Population-averaged
	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
SB (Spousal bereavement)	-0.142 (0.136)	-0.145 (0.134)
Post (Post bereavement)	0.028 (0.241)	0.002 (0.236)
SB*Post	-0.712** (0.329)	-0.714** (0.321)
Decay of bereavement impact		
Post bereavement duration (unit: 6 months)	-0.016 (0.022)	-0.015 (0.022)
Post bereavement duration*SB	0.039 (0.030)	0.043 (0.029)
Personal & Household Characteristics		
Age	-0.130 (0.168)	-0.116 (0.172)
Squ. Age/100	0.117 (0.133)	0.106 (0.136)
Male	-0.374*** (0.139)	-0.374*** (0.140)
Educational year	0.069*** (0.017)	0.069*** (0.017)
Initial income (1,000 NTD/ per year) (ref. 100 <)		
II. 100 ~ <300	0.308* (0.184)	0.313* (0.185)
III. 300 ~ <600	0.456** (0.184)	0.452** (0.187)
IV. 600 ~ <1,000	0.458** (0.233)	0.461** (0.234)
V. 1,000 ~ <2,000	0.889*** (0.252)	0.895*** (0.252)
VI. >=2,000	-1.126 (0.830)	-1.081 (0.817)
Children number	-0.013 (0.049)	-0.005 (0.050)
Household size (ref: small (5<))		
Median (5-10 people)	0.055 (0.112)	0.037 (0.110)
Large (more than 10 people)	0.453 (0.350)	0.374 (0.345)
Region (ref: East)		
Middle	0.229 (0.468)	0.315 (0.514)
South	0.273 (0.450)	0.352 (0.496)
North	0.297 (0.458)	0.377 (0.505)
Ethnicity (ref: Others)		
Mainlander	0.022 (0.572)	0.041 (0.586)
Hakka	0.235 (0.447)	0.242 (0.464)
Minnan	0.016 (0.400)	0.025 (0.416)
Religion belief	-0.169 (0.269)	-0.181 (0.263)
Child bereavement before 1996	-0.352** (0.171)	-0.350** (0.173)
Year dummy	Yes	Yes
N(clusters by personal ID)	1,281	1,281

* p<0.1, ** p<0.05, *** p<0.01. The bootstrapping process replicates samples 100 times.

Table 5 shows the result of spousal bereavement impact on self-assessed health status. Spousal bereavement does not cause a significant impact on self-assessed health status and the decay effect is not significant in both estimations. In the pooled Probit

estimation, male is significant at 1% level and the covariates such as educational year and initial annual income categories II, III, IV, and V (except for the top two categories) are significant at 5% level. Males have high probability of reporting good health than females. People in the income categories ranging from NT$100,000 to NT$1,000,000 have higher life satisfaction than those in the category of less than NT$100,000. The result presented in population-averaged estimation is similar to that in the pooled Probit estimation.

Table 5. Bootstrapping Self-Assessed Health (SAH) Weighted Regressions

	Pooled Probit	Population-averaged
	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
SB (Spousal bereavement)	-0.012 (0.109)	-0.019 (0.109)
Post (Post bereavement)	-0.125 (0.157)	-0.146 (0.156)
SB*Post	-0.160 (0.204)	-0.167 (0.201)
Decay of bereavement impact		
Post bereavement duration (unit: 6 months)	0.0001 (0.015)	-0.0003 (0.019)
Post bereavement duration*SB	0.009 (0.020)	0.011 (0.091)
Personal & Household Characteristics		
Age	0.016 (0.118)	0.029 (0.117)
Squ. Age/100	-0.031 (0.093)	-0.041 (0.091)
Male	0.315*** (0.095)	0.309*** (0.094)
Educational year	0.031** (0.013)	0.032** (0.013)
Initial income (1,000 NTD/ per year) (ref. 100 <)		
II. 100 ~ <300	0.294** (0.136)	0.292** (0.136)
III. 300 ~ <600	0.374** (0.157)	0.379** (0.157)
IV. 600 ~ <1,000	0.505** (0.300)	0.515** (0.232)
V. 1,000 ~ <2,000	0.470** (0.212)	0.476** (0.217)
VI. >=2,000	-0.574 (0.537)	-0.582 (0.533)
Children number	-0.021 (0.033)	-0.023 (0.032)
Household size (ref: small (5<))		
Median (5-10 people)	0.075 (0.089)	0.106 (0.085)
Large (more than 10 people)	-0.037 (0.222)	-0.032 (0.194)
Region (ref: East)		
Middle	0.045 (0.312)	0.070 (0.305)
South	-0.055 (0.293)	-0.026 (0.288)
North	0.093 (0.308)	0.110 (0.303)
Ethnicity (ref: Others)		
Mainlander	0.212 (0.502)	0.225 (0.515)
Hakka	0.311 (0.491)	0.315 (0.502)
Minnan	0.210 (0.564)	0.222 (0.477)
Religion belief	0.059 (0.188)	0.068 (0.191)
Child bereavement before 1996	0.089 (0.131)	0.108 (0.139)
Year dummy	Yes	Yes
N(clusters by personal ID)	1,290	1,290

* p<0.1, ** p<0.05, *** p<0.01. The bootstrapping process replicates samples 100 times.

4.2 Demographic differences in spousal bereavement impact

We examine the differences of the impact of spousal bereavement regarding sex, age, household scale, education, and experience of losing children before 1996. The results are shown in Table 6. The bereaved group and the non-bereaved group are split into two subgroups according to above variables respectively. The indicators of age (AI), household scale (HS), and education (EI) are assigned to 1 respectively if individual is 60 years old or older, individual's household size is greater than 4 people, and individual's educational year is greater than 9 years (more than compulsory education) and 0, otherwise. The result shows spousal bereavement does not have identical impacts on depression and life satisfaction respectively. The impacts vary across education groups and household sizes. The bereaved receiving education more than 9 years have 1.433 points higher life satisfaction comparing with the bereaved whose educational year are less than 9 years. The bereaved living in a median or large household have less depression than the bereaved living in a small household by 2.75 points. However, the spousal bereavement does not show significant different impacts on depression, life satisfaction, and self-assessed health in terms of sex, age, and the experience of losing children before 1996.

Table 6. Differences in Bereavement Effect (Bootstrapping Weighted Regression)

Panel Estimation	Fixed-Effects		Probit
	CES-D	LS	SAH
Sex (1: Male)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
Sex*SB*Post	0.623 (1.241)	0.492 (0.665)	-0.389 (0.442)
Age (1: Age >= 60)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
AI*SB*Post	-1.827 (2.485)	0.406 (0.974)	-0.146 (1.177)
Household Size (1: Household member > 4)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
HS*SB*Post	-2.750* (1.428)	-0.486 (0.612)	0.156 (0.418)
Education (1: Educational year > 9)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
EI*SB*Post	-0.585 (2.199)	1.433** (0.719)	-0.792 (43.480)
Child Bereavement (1: Experienced child bereavement before 1996)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)	Coef. (Bootstrap S.E.)
CB*SB*Post	0.840 (1.881)	-0.593 (0.929)	-0.765 (0.703)

Notes: 1. The covariates are controlled in the estimation but not shown in the table. 2. * p<0.1, ** p<0.05, ***p<0.01.

5. Conclusion

This study assesses the impact of spousal bereavement on self-assessed health status, depression, and life satisfaction at older ages. We employ the difference-in-differences in which the bereaved group is compared with the non-bereaved group to identify the spousal bereavement impact. The nearest-neighbor propensity score matching and kernel propensity score matching are used to generate a hypothetical bereavement date which is required in DiD and a weight to the non-bereaved. After weighting, the non-bereaved group is more comparable with the bereaved group. By estimating well-being equations, in a way that averages across the individuals in our sample, the study draws three conclusions.

First, spousal bereavement causes substantial depression and loss in life satisfaction. The spousal bereavement impact increases depression by 1.46 CES-D points and reduces life satisfaction by 0.71. Losing a loved one causes the survival spouse stressed and unhappy. Second, the decay effect of time to spousal bereavement is not observed in this study. Thus we are unable to predict the length of recovering in objective welling from losing spouse confidently. Third, with our data, spousal bereavement causes different magnitudes of impact on the bereaved people with different characteristics such as household size and education. People losing a spouse and living in a bigger household have less depression than those living in a small household. Education also helps relieving spousal bereavement impact. The bereaved receiving more education have higher life satisfaction than those only receiving compulsory education. Education is one of the proxies reflecting socio-economic status. Higher education in general implies higher socioeconomic status, higher income, and more social network and support. Once those people with higher education level encounter spousal bereavement, they may have more societal resources to assist them to cope with deep sorrow. The impact of spousal bereavement does not vary across sex, age, and previous experience of losing children.

Bereavement may cause not only the loss in wellbeing but also other societal costs such as mortality, utilization of healthcare, loss in labour force and education, and so on. Mental health is a mediator between spousal bereavement and those societal costs. This study employs an identification strategy and contributes to the current literature with the conclusion that spousal bereavement causes the impact not only on mental health but also on happiness. Proper interventions are needed to help those elderly bereaved population to prevent the onset of future societal costs. Our study samples are restricted to those who survive in whole analytic period only. Thus, the impact of spouse bereavement may be underestimated. Taking the individuals who died in the analytic period into analyses and considering whether the impact of bereavement depends on the cause of death and other possible determinants would also be beneficial as it would allow interventions to be targeted on those who are likely to need the greatest support.

Appendix

Table A1. Nearest-Neighbour Propensity Score Matching (Logistic Regression)

Bereavement indicator (1: non-bereaved; 0: bereaved)	Coef.	Bootstrap St. Err.
Male	0.978***	0.347
Age	-0.032	0.031
Age of spouse	-0.085***	0.228
Education year	0.042	0.036
Education year of spouse	0.049	0.03
Work status (0: not work; 1: work)	-0.156	0.237
Work status of spouse (0: not work; 1: work)	-0.384*	0.228
Number of children	0.074	0.082
Household size (ref: small (5<))		
Median (5-10 people)	-0.082	0.232
Large (more than 10 people)	-0.104	0.548
Region (ref: East)		
Middle	0.701	4.334
South	-0.965	4.315
North	-0.369	4.305
Ethnicity (ref: Others)		
Mainlander	0.163	6.405
Hakka	0.432	6.383
Minnan	0.048	6.378
Sample size	1,669	

* p<0.10, ** p<0.05, *** p<0.01

Table A2. Kernel Propensity Score Matching (Probit Regression)

Bereavement indicator (1: bereaved; 0: non-bereaved)	Coef.	Bootstrap St. Err.
Male	-0.55***	0.178
Age	0.021	0.016
Age of spouse	0.042***	0.014
Education year	-0.024	0.019
Education year of spouse	-0.026	0.016
Work status (0: not work; 1: work)	0.1	0.123
Work status of spouse (0: not work; 1: work)	0.212*	0.122
Number of children	-0.047	0.045
Household size (ref: small (5<))		
Median (5-10 people)	0.039	0.125
Large (more than 10 people)	0.011	0.297
Region (ref: East)		
Middle	0.435	1.36
South	0.576	1.35
North	0.254	1.345
Ethnicity (ref: Others)		
Mainlander	-0.253	2.025
Hakka	-0.143	2.046
Minnan	-0.056	2.02
Sample size	1,652	

* p<0.10, ** p<0.05, *** p<0.01

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