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ABSTRACT

Mental health problems among the elderly have attracted increasing attention. The most serious mental health problems may result in suicide, and lack of family companionship is often speculated to be a major cause. In this paper, we use high-frequency suicide rate data and utilize a novel temporal variation in the lunisolar calendar to provide evidence on the protective effects of the Chinese Lunar New Year (when the elderly people receive unusually high level of family companionship) on elderly suicide. We find that elderly suicide rate decreases by 8.7% during the Chinese Lunar New Year. In addition, the protective effects are stronger in counties where the typical level of daily family companionship for the elderly is lower. By contrast, we do not find similar protective effects for young and middle-age cohorts. We consider a variety of alternative mechanisms, and conclude that family companionship is an important channel for the protective effects of the Chinese Lunar New Year. Our study calls for greater attention to the mental health status and suicide problem of the elderly, especially with the rapid population aging and increasing prevalence of the "empty-nest" elderly in developing countries.

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1 Introduction

The prevalence of mental health problems and suicide among the elderly has attracted increasing attention. Approximately 15% of adults age 60 and above suffer from mental disorders, and 6.6% of disability among this group is attributed to mental and neurological disorders (WHO 2017).[1] In the extreme form, these mental disorder problems lead to suicide. The suicide rate is highest among people age 70 years old and above (WHO 2014), and suicide and mental disorder are highly correlated among the elderly (Wærn et al. 2002).[2] Severe mental disorder and suicide have large economic costs. For example, Shepard et al. (2016) find that the total cost for all suicides and suicide attempts in the United States in 2013 is around $93.5 billion. The concern about mental health problems and suicide among the elderly is becoming increasingly important as the population is aging rapidly (Bloom and Luca 2016). Between 2010 and 2050, the proportion of the world's population over 65 will nearly double, from 8% to 16% (WHO 2011).[3] Therefore, understanding the causes of mental health problems and suicide among the elderly, as well as providing effective policy assistance, is urgent and crucial.[4]

The concern about the mental health among the elderly is especially serious in developing countries. Between 2010 and 2050, the elderly population in developing countries is projected to increase by more than 250%, compared with a 71% increase in developed countries (WHO 2011). As a prominent example, China is experiencing rapid population aging, and the share of elderly in the total population is expected to increase from 12.6% in 2020 to 27.9% in 2050.[5] At the same time, China's national elderly suicide rates are four to five times higher than the general Chinese population and more than twice the global average (Li et al. 2009, Chen and Fang 2018). With rapid urbanization and increased internal migration, the proportion of the "empty-nest" elderly who are left-behind also increases dramatically, from 50% in 2010

[1] https://www.who.int/news-room/fact-sheets/detail/mental-health-of-older-adults.
[2] https://www.who.int/mediacentre/news/releases/2014/suicide-prevention-report/en/.
[3] https://www.who.int/ageing/publications/global_health/en/.
[4] There is no absolute cutoff for the start age of the elderly people. Throughout the paper, we refer to the elderly people as individuals age 65 or above.
[5] https://baijiahao.baidu.com/s?id=1679779779278495724&wfr=spider&for=pc (in Chinese).

to nearly 90% in 2030.[6] Therefore, the mental disorder and suicide problems for the elderly are extremely challenging in China.

Among numerous potential reasons for elderly mental disorder and suicide, lack of family companionship is hypothesized to be a crucial one. Many news articles suggest the importance of family companionship for the mental health of the empty-nest elderly in China.[7] However, scientific research is lacking to establish a convincing relationship between family companionship and elderly suicide. Previous studies have mostly provided correlational evidence (Antman 2010, Chen and Short 2008, Zurlo et al. 2014) or suggested the relationship between family companionship and the mental health of the elderly (Chen and Fang 2018).[8] In addition, those studies often hypothesize similar effects of family companionship for mental disorder and for suicide (Chen and Fang 2018).

In this study, we provide more direct evidence on the relationship between family companionship and elderly suicide, using the Chinese Lunar New Year (hereinafter referred to as "CLNY") as a social experiment. The CLNY is one of the most important holidays in China, with family reunion as the most central customs. Approximately 3 billion trips are being made each year during the "Spring Festival travel rush" around the CLNY to reunite with families.[9] During the CLNY, the elderly people, on average, receive a considerably higher level of family companionship than normal weeks in the year. Our paper proceeds in two steps. First, we estimate a causal effect of the CLNY on the elderly suicide rate. Second, we provide suggestive evidence that increased family companionship during the CLNY is the main channel for the reduction in elderly suicide rate.

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[6] http://www.15lu.com/shijie/6158.html (in Chinese).
[7] For some examples, see https://opinion.huanqiu.com/article/9CaKrnJREXR, http://www.yidianzixun.com/article/0PVg0gE4, and http://news.sohu.com/20100714/n273498420.shtml (in Chinese).
[8] Chen and Fang (2018) use the family planning policy in China and find that the family planning policy leads to fewer children and worse mental health of the elderly, suggesting the importance of reduced family companionship for the elderly due to the family planning policy. Antman (2010) finds that a child's migration to the US is associated with a greater chance that his elderly parent in Mexico will be in poor physical and mental health, also suggesting the importance of family companionship on the mental health of the elderly. Chen and Short (2008) find that living alone is associated with lower subjective wellbeing of the elderly, whereas co-residence with immediate family is associated with positive subjective wellbeing of the elderly in China. Zurlo et al. (2014) find that family, community, and public support are significantly and negatively associated with depressive symptoms of the Chinese elderly.
[9] https://baike.baidu.com/item/%E6%98%A5%E8%BF%90/329360#15 (in Chinese).

We use a uniquely grand new dataset from the Chinese Center for Disease Control and Prevention (CCDC), which contains county-week suicide rate data by gender and age cohorts from 2013 to 2017. To distinguish CLNY effect from a calendar week effect, we utilize a novel exogenous variation in the timing of the CLNY because of the traditional Chinese lunisolar calendar. For example, during 1991–2020, the CLNY fell 11 times in January and 19 times in February, fell 4 times in the 3rd week, 6 times in the 4th week, 8 times in the 5th week, 7 times in the 6th week, and 5 times in the 7th week of the year. Our identification strategy is to compare the elderly suicide rates in otherwise similar weeks whose treatment status differs because of the Chinese lunisolar calendar conditional on other flexibly temporal controls.

We find that the elderly suicide rate decreases by 8.7% (or 0.52 cases per 1 million people) during the CLNY, when the elderly people receive unusually high level of family companionship. We refer to this as the *protective effect* of the CLNY. The effects are pronounced and are of similar magnitude for men and women. By contrast, we do not find similar protective effects of CLNY for young and middle-age cohorts, indicating that income shocks or underreporting are unlikely to drive all of our results.

We utilize the geographical variations in the average daily family companionship that the elderly typically receives throughout the year to provide suggestive evidence on the mechanisms underlying the protective effect of the CLNY. We construct proxy measures of average daily family companionship for the elderly based on the living arrangements with their children using two data sources, namely, individual-level data from the 2010 Census, and 2011 China Health and Retirement Longitudinal Study (CHARLS) survey data. We find that the protective effects of the CLNY for the elderly are stronger in counties with a lower level of average daily family companionship, where the elderly people are expected to receive a more dramatic increase in family companionship during the CLNY. A one standard deviation increase in the average daily family companionship for the elderly people in typical weeks of the year reduces the protective effects of the CLNY by 5%–7%. We also show that the alternative mechanisms, including short-term population flows, symbolic effects of holidays, and self-discipline of the elderly, cannot fully explain our results.

Next, we investigate the dynamic effects of the CLNY on elderly suicides by directly estimating the treatment effects of weeks before and after the CLNY. We find that the protective effects start to emerge two weeks prior to the CLNY weeks, and some weak evidence shows that female elderly suicide rate may increase in the subsequent 1 to 2 weeks after the CLNY week. However, the average of the treatment effects within the two-month window is -5.7% and statistically significant. These results suggest that the protective effects are not fully offset by the temporal displacement and separation anxiety effects, and the extra family companionship during the CLNY generally reduces elderly suicides, rather than simply postponing them.

Finally, we use CHARLS data to examine whether children are aware of the importance of the companionship, and how they respond to the deterioration of their elderly parents' mental health. We find that children may be aware of the mental health deterioration of their elderly parents and respond by increasing wealth transfers to their parents. However, they are less likely to adjust their living arrangements and provide more daily companionship. Overall, our results indicate that public policies calling for the attention on family companionship for the elderly parents are urgently needed.

The contributions of this study are two-fold. First, we contribute to the literature on family companionship and the mental health of the elderly, and to the broad literature on the causes of mental disorder and suicide (Case and Deaton 2015, Zou 2017, Carleton 2017, Burke et al. 2018, Pierce and Schott, 2020). We suggest the relationship between family companionship and elderly mental health from a novel perspective, and extend the previous literature by directly examining the effects on suicide. Second, we contribute to the literature on the holiday effects on suicide (Jessen and Jensen 1999, Nishi et al. 2000, Beauchamp et al. 2014). We improve the identification by utilizing a novel timing variation of lunisolar calendar holidays across different years to control for confounding temporal trends and provide convincing causal estimates.

The remainder of this paper is organized as follows. In Section 2 we briefly introduce the background of the Chinese Lunar New Year. In Section 3 we describe the data and the empirical strategy and present our main results and discusses alternative explanations in Section 4. Finally, in Section 5 we conclude.

2 Background

The Chinese Lunar New Year (the Spring Festival) is the Chinese festival that celebrates the beginning of a new year on the traditional Chinese lunisolar calendar. It is one of the most important holidays in China (also in neighboring countries such as Korea and Vietnam). It is also celebrated worldwide in regions and countries with significant overseas Chinese population, including Singapore, Indonesia, and Malaysia, as well as many in North America and Europe.[10] In China, the CLNY is a statutory holiday that starts from the day before the New Year's Day (Lunar New Year's Eve) and lasts for seven consecutive days. The exact timing of the CLNY varies across different years because of the variation generated by the Chinese lunisolar calendar.

The CLNY is associated with many rituals and customs. The most important one is family reunion, similar to Thanksgiving in the United States. The evening preceding the Chinese New Year's Day is frequently regarded as an occasion for Chinese families to gather for the annual reunion dinner. Around 3 billion trips are being made each year during the Spring Festival travel rush around the CLNY to reunite with families. Other rituals include house cleaning, paper-cutting, and lighting firecrackers, all having the meaning of welcoming good luck.

3 Data and Empirical Strategy

3.1 Data

The main dataset used in this study is county–week suicide rate data by gender and age cohorts from the CCDC. The sample covers 597 counties (if in rural area) or districts (if in urban area) (6-digit administrative code) under the Disease Surveillance Point (DSP) system from 2013 to 2017.[11] The system collects death

[10] https://en.wikipedia.org/wiki/Chinese_New_Year.
[11] The administrative division from high to low in China is follows: provinces/municipalities (2-digit administrative code), prefectures (4-digit administrative code), counties/districts (6-digit administrative code).

records from the surveillance locations and is representative at provincial and national levels. Under the DSP system, deaths that occurred in hospitals and at homes are reported, and the causes of death are determined according to a standard protocol by trained staff located in local hospitals or CCDC branches. The DSP system covers more than 324 million people in China, accounting for 24.3% of the country's population. Figure 1 shows the geographical distribution of the counties/districts under the DSP system, which illustrates the representativeness of our sample.

[Figure 1 About Here]

We also use two additional datasets to construct the proxy measures of average daily family companionship for the elderly. The first data source is the microdata of the 2010 Chinese Population Census. The dataset contains 4,400,367 individual observations, which are randomly drawn from the total population in 2010. The dataset contains information on the number of people registered in the household, which we refer to as household size, and we use the average household size of the elderly people at the prefecture level (4-digit administrative code) as a proxy for the average level of daily family companionship that the elderly people receive.[12]

The second data source is the CHARLS survey data, which contains detailed information on the living arrangements of children of the elderly. CHARLS aims to collect a high-quality nationally representative sample of Chinese residents age 45 and older. The baseline national wave of CHARLS was fielded in 2011 and includes about 10,000 households and 17,500 individuals in 150 counties/districts.[13] We construct two measures on daily family companionship. The first is the proportion of children living in the household. For example, if a household has four children, and two of them live with the elderly parents, we define the proportion for the household as 50%. We then take the average for all households in the prefecture. The second is the proportion of the elderly people with at least one child living in the same household; that is, we define a dummy variable that equals 1 if at least one child lives in the household, and then take the

[12] We do not average at the county level because there are only a few individual observations in the county.
[13] The CHARLS data can be accessed at http://charls.pku.edu.cn/index/en.html.

average for all households in the prefecture.[14] Note that these variables are measured at prefecture level (4-digit administrative code) because only prefecture codes are publicly available for the CHARLS data, and then matched with the counties or districts (6-digit administrative code) under that prefecture in our sample. On average, each prefecture is linked with less than 2 counties in our sample. The underlying assumption is that prefecture-level measures are good proxies for the characteristics of counties and districts within the prefecture. These measures may contain classical measurement error, and our estimates may be biased toward 0. Therefore, our estimates may serve as a lower bound for the true effects. More detailed discussions are in Section 4.

Another assumption is that the elderly people receive more family companionship if they have children living in the same household. Moreover, the variations in these proxy measures are cross sectional and only capture the geographical variation in the average daily family companionship for the elderly, potentially due to differences in labor markets, migration tendency, and social security service across different regions.

3.2 Empirical Strategy

We consider the fact that the timing of the CLNY varies across different years to estimate the causal effects of the CLNY on suicide. The main specification is as follows:

$$Y_{ctmw} = \alpha + \beta CLNY_{tmw} + \mu_c + \eta_t + \delta_m + \rho_w + \varepsilon_{ctmw},$$

where Y_{ctmw} is the outcome variable of county c in year t, month m, and week w. Each observation is a county–week combination. $CLNY_{tmw}$ is a binary variable that equals 1 if the week of observation is during the CLNY. The observation is at the week level that starts on Sunday and ends on Saturday, and the statutory holidays of the CLNY last for seven days, which usually do not perfectly coincide with a Sunday–Saturday

[14] We use baseline survey (2011) of CHARLS to construct the measures because they are closely comparable to measures constructed from the microdata of the 2010 Population Census, and the baseline survey is most comprehensive and representative.

week. Thus, we define the week as in the CLNY if at least part of the week contains the statutory holidays. Figures A1–A3 provide an illustration. As shown in Figure A1, the CLNY in 2013 was on February 10, and February 9–15 were statutory holidays. Therefore, the two weeks in red in the calendar (February 3–9 and 10–16) are defined as in the CLNY. Figure A2 illustrates the case for 2016, when the statutory holidays perfectly coincide with a Sunday–Saturday week (February 7–13), and it is thus the only week defined as in the CLNY in 2016. The year 2016 is the only year in the sample that shows perfect coincidence and has only one week defined as in the CLNY, whereas the other years all have two weeks defined to be in the CLNY. To ensure that our results are not contaminated by week lengths, we conduct a robustness check by excluding 2016, and our results are robust. Similarly, Figure A3 illustrates the case for 2017, when the CLNY was in January, and two weeks (January 22–28 and January 29–February 4) are defined as in the CLNY. It illustrates the temporal variation of the CLNY within our sample period, that is, the CLNY may happen in different weeks and months across different years.

The main outcome of interest is suicide rate. We specify the inverse hyperbolic sine of suicide cases per 1 million people as the dependent variable. The inverse hyperbolic sine function, $IHS(x) = log(x + \sqrt{1 + x^2})$, is approximate to log function that the marginal effects can be interpreted as percentage changes for small changes, but the function is well-defined at 0. This measure is commonly used in the literature (Barreca et al. 2017, Card and Della Vigna 2017). We prefer the inverse hyperbolic sine model because suicide is a rare event, and around 82% of the county-week observations have zeros in elderly suicide rate.[15] Nevertheless, our results are robust if we use raw suicide rate.[16]

We include year fixed effects η_t, month fixed effects δ_m, and week-of-month fixed effects ρ_w to control for the possible time trends and seasonality of suicide.[17] We also control for county fixed effects μ_c to

[15] Throughout the rest of the paper, we use the inverse hyperbolic sine of suicide rate as the dependent variable unless explicitly specified.
[16] An alternative approach to model suicide events is to use nonlinear count models such as Poisson regression. However, as discussed in Carleton (2017), modeling the data generating process as Poisson imposes the restriction that the mean and variance of the suicide rates are identical, which is not the case in our sample, as shown in Table 1. Therefore, we do not report results of nonlinear count models, but our results are still robust when using Poisson regression.
[17] A strong temporal pattern and seasonality is observed in suicide rate, as shown in Figures 2 and 3.

control for time-invariant differences across counties. The regression is weighed by county population, and the standard errors are clustered at the county level.

Our identification strategy is that the timing of the CLNY is based on the traditional Chinese lunisolar calendar, which varies across different years and allows us to address the potential confoundedness of temporal trends by flexibly controlling for temporal fixed effects. Table A1 presents the distribution of the timing of the CLNY in the past 30 years (1991–2020). The CLNY fell 11 times in January and 19 times in February. The timing ranges from the 3rd week to the 7th week of the year, and the distribution is more or less random. The temporal variation allows us to compare otherwise similar weeks whose treatment status differs because of the Chinese lunisolar calendar. The assumption is that the potential temporal trends in suicide are absorbed by temporal fixed effects based on the solar calendar.

One may be concerned that the temporal trends are based on the Chinese lunisolar calendar rather than the solar calendar. We cannot test this hypothesis because our suicide data are based on the solar calendar. However, Martin et al. (1992) find little evidence on the relationship between lunar cycles and suicide attempts and completions. In addition, most individual and social activities are arranged based on the solar calendar in China; thus, arguably, most time trends are absorbed by time fixed effects based on the solar calendar. By contrast, most previous studies examining the holiday effects on suicide (Nishi et al. 2000, Beauchamp et al. 2014) are unable to control for temporal trends as most solar calendar holidays appear on the same days (or the same week) every year. Therefore, their results may be confounded by temporal trends, such as seasonality.

4 Results

We start by presenting a set of descriptive evidence of the overall pattern of the suicide rate in China. Figure 2 depicts the temporal trends in national-level suicide rate.[18] Panel A shows the temporal trends in total suicide rate. The overall weekly suicide rate is around 1–1.5 cases per 1 million people. The suicide rate peaks in spring and summer and falls in autumn and winter, exhibiting strong seasonality. The strong temporal trends in suicide rate further illustrate the advantage of our research design to eliminate the confounding temporal trends. Panel B shows the temporal trends in suicide rate by gender. The suicide rate of female and male follows similar temporal trends. Men, on average, have higher suicide rate than women. Figure 3 shows the temporal trends in suicide rate by age cohort. The elderly (age 65+) have considerably higher suicide rate than middle-age adults (age 20–64) and children and teenagers (age 0–19). The weekly suicide rate of the elderly reaches 4–6 per 1 million people, which is 4 to 5 times higher than the general population. Table 1 shows the summary statistics of weekly suicide rate by gender and age cohorts. The average suicide rate for the elderly is 4.44 cases per 1 million population per week in our sample, with a standard deviation of 13.29.

[Figures 2 and 3 About Here]

[Table 1 About Here]

4.1 Correlational Evidence

We first present a set of correlational evidence to illustrate the relationship between family companionship and elderly suicide. If family companionship is effective in preventing elderly suicide, we should observe a lower level of elderly suicide in counties where the elderly receives a higher level of average daily family companionship. We construct proxy measures of average daily family companionship that the elderly people receive in different counties from two data sources. The first data source is the microdata of the

[18] The weekly suicide rate is aggregated at the national level by computing the weighted average of county-level suicide rates, with county-level population as weights.

2010 Chinese Population Census, which contains information on the number of people registered in the household.[19] Our main measure on average daily family companionship is the average household size of the elderly people. Our alternative measure is a dummy variable which takes value of 1 if the elderly people live in households with at least three other people. We then average the two measures at prefecture level to match with suicide data.

We also use a separate data source, CHARLS, which collects detailed information on the living arrangements of the children of the elderly. We calculate the proportion of children that live in the household, averaged at the prefecture level. We also define an alternative measure as the proportion of the elderly people with at least one child living in the same household at the prefecture level. Note that these variables are measured at prefecture level (4-digit administrative code), and then matched with the counties/districts (6-digit administrative code) that belong to the prefecture in our sample, assuming that prefecture-level measures are good proxies for the characteristics of counties and districts within the prefecture. On average, each prefecture is linked with less than 2 counties/districts in our sample.

These four different proxy measures from two data sources are highly correlated and are expected to capture the average daily family companionship that the elderly receive in different counties. The underlying assumption is that the elderly people receive more family companionship if they have children living in the same household. Note that the variations in these measures are cross sectional only, and capture the geographical variation in the average daily family companionship for the elderly, potentially due to differences in labor markets, migration tendency, and social security service across different counties.

We regress the elderly suicide rate on these average daily family companionship measures, controlling for temporal fixed effects including year fixed effects, month fixed effects, and week-of-month fixed effects. Note that we cannot control of county fixed effects in these regressions because the main variables only have county-level variations. Table 2 presents the results. We exclude observations of all counties/districts

[19] When constructing the proxy measures, observations with household size larger than or equal to 10 are dropped (less than 1% of total observations).

of direct-controlled municipalities (including Beijing, Shanghai, Tianjin, and Chongqing), as the administrative level of these counties/districts are higher than the normal counties/districts of prefectures and are thus not comparable.[20] We control for a set of socioeconomic characteristics of these counties in the baseline (Columns (1), (3), (5) and (7)).[21] We also include a set of labor market and demographic characteristics of the elderly people as additional controls to assess the robustness of the results (Columns (2), (4), (6) and (8)).[22] All these control variables and measures of average daily family companionship are standardized to have a mean of 0 and standard deviation of 1 to facilitate interpretation.[23] In addition, a dummy indicator for being an urban district rather than a rural county is included in all columns.

[Table 2 About Here]

The results in Table 2 provide consistent evidence that elderly suicide rate is negatively associated with the average daily family companionship. The coefficients are negative and statistically significant in most specifications. Estimates suggest that a one standard deviation increase in the average daily family companionship is associated with around 10% decrease in elderly suicide rate. The results are robust to different proxy measures of average daily family companionship. In addition, we find that the elderly suicide rate is smaller in urban districts than in rural counties and decreases with regional economic development (GDP per capita), healthcare access (number of hospital per capita), and educational attainment of the elderly people. These results are correlational and may not be interpreted as causal relationships. However, the correlational evidence still suggests that family companionship may have

[20] The administrative levels in China include (from high to low) province–prefecture–county/district. However, the counties/districts of direct-controlled municipalities (including Beijing, Shanghai, Tianjin, and Chongqing) are at the prefecture administrative level and are thus not directly comparable with other counties/districts under prefectures.
[21] These socioeconomic characteristics include regional GDP per capita, average rural income, and number of hospitals per capita of the prefecture in 2012, retrieved from the *China Statistical Yearbook for Regional Economy*.
[22] These additional control variables include the rate of employment of the city, the proportion of immigrants among the elderly, and the average years of schooling of the elderly, calculated from the microdata of the 2010 Chinese Population Census.
[23] Note that all these variables are measured at the prefecture level. Ideally, we would like to directly use county-level characteristics, but county-level data for all Chinese counties are unavailable. Therefore, we use prefecture-level characteristics instead and assume that it is a good proxy for the characteristics of counties and districts within the prefecture. In fact, when excluding all direct-controlled municipalities, there are 565 counties in 315 prefectures; thus, on average, each prefecture is linked with less than 2 counties in our sample. These characteristics may contain classical measurement error, and our estimates may be biased toward 0. Therefore, our estimates may serve as a lower bound for the true effects.

important protective effects on elderly suicide, even after controlling for socioeconomic and demographic characteristics.

4.2 Main Results

In this section, we illustrate the protective effects of the CLNY on elderly suicide. Table 3 presents the main results. Columns (1) and (2) show the results with total elderly (65+) suicide rate as the dependent variable. In the preferred specification (Column (1)), we use the inverse hyperbolic sine of suicide rate as the dependent variable. We also provide results using the level of suicide rate (per 1 million people) as the dependent variable in Column (2). These results suggest that the elderly suicide rate decreases by 8.7% (or by 0.52 cases per 1 million people) during the CLNY. Columns (3) to (6) further show the results separately by gender. During the CLNY, the suicide rate of the female elderly decreases by 6.3% (or 0.44 cases per 1 million people), and the suicide rate of the male elderly decreases by 6.7% (or 0.61 cases per 1 million people), which are statistically significant.[24]

[Table 3 About Here]

The effects are sizable compared with previous studies on causes of suicide. Zou (2017) shows that wind farm installation in the United States leads to a 2% increase in suicide rate in the following years. Carleton (2017) shows that for days above 20 °C in India, a 1 °C increase in a single day's temperature during the growing season increases annual suicides by 0.008 per 100,000 people, which translates to increase in suicide rate by 3.5% for a standard deviation increase in temperature. Burke et al. (2018) show that suicide rate increases by 0.7% in the United States and by 2.1% in Mexico for a 1 °C increase in monthly average

[24] Note that the effect on total elderly suicide rate is out of the convex combination of the effect on female and male elderly suicide rate, because of the inverse hyperbolic sine transformation. The results in the level form still have the property that the effect on total elderly suicide rate is in the convex combination of the effect on female elderly suicide rate and the effect on male elderly suicide rate, and the results are qualitatively similar.

temperature. Our estimates are of similar magnitude or even more pronounced compared with previous studies.

[Table 4 About Here]

In Table 4, we further examine the effects of the CLNY on suicide rate by gender and age cohort, no longer restricted to the elderly (65+) group. Columns (1)–(3) present the results for age cohorts 0–19, 20–64, and 65+, respectively; and Columns (4)–(6) further divide the 20–64 group into three subgroups (i.e., 20–34, 35–49, and 50–64, respectively). Panel A presents the results for total suicide rate, and Panels B and C present the results for female and male, respectively. We find no evidence to suggest that the suicide rate decreases for teenagers or middle-age people during the CLNY. The estimates are all small in magnitude and statistically insignificant.

[Table 5 About Here]

To assess the robustness of the results, Table 5 presents the estimation results of a few variants of the baseline specification reported in Table 3. Panels A–C present the results for total, female, and male elderly suicide rate, respectively. We report the baseline estimates in Column (1) as a comparison. First, we test the robustness of our treatment definition. In Column (2), instead of defining treatment status as a dummy variable in our baseline, we define the treatment as the proportion of days in the week that are during statutory holidays for the CLNY. The proportion variable changing from 0 to 1 indicates changing from the case that no day in the week is during statutory holidays to the case that all seven days in the week are during statutory holidays. The results are qualitatively similar, suggesting that the elderly suicide rate decreases by 9.8% if the whole week is during the statutory holidays of the CLNY.

Second, we test the robustness of temporal fixed effects. One may be concerned that month fixed effects and week-of-the-month fixed effects cannot sufficiently capture the temporal trends in suicide rate, as the first week of the month may have different effects in different months. Therefore, in Column (3), we consider a more conservative specification and replace week-of-the-month fixed effects with week-of-the-

year fixed effects, which fully captures the temporal trends across weeks in a year. The results are generally smaller and less precisely estimated, because the residual variation is smaller in the more saturated model.[25] However, we still find a 5.7% decrease in total elderly suicide rate during the CLNY, and it is statistically significant at the 5% level.

Third, we test the robustness of weighing the regression. Our baseline weighs the regression by county-level population. In Column (4), we do not weigh the regression. We expect to find similar results because the variation in treatment does not change at the county level; thus, weighing should matter less as we already control for county fixed effects. The results are consistent with our expectation.

Fourth, we test the robustness of clustering of standard errors. Our baseline model clusters standard errors at the county level, which controls for autocorrelation within each county. In Column (5), we cluster the standard errors at the province level to control for both auto and spatial correlation within each province, and we obtain similar results because the treatment does not vary across geographical units. In Column (6), we use two-way clustering at the county and week levels to control for autocorrelation within each county and spatial correlation within each week. Our results are generally robust.

Lastly, we test the robustness of sample construction. In Column (7), we exclude observations of year 2016, because this is the only year that the statutory holidays perfectly coincide with a Sunday–Saturday week, such that only one week in the year is defined to be during the CLNY. The results are highly similar. In Column (8), we exclude observations of all counties/districts of direct-controlled municipalities, because the administrative level of these counties/districts are higher than the normal counties/districts of prefectures. We lose approximately 5% of observations, but the results are similar. Finally, as shown in Table A1, the CLNY mostly happen during January and February, and one may be concerned that weeks in other months are incomparable. Thus, we restrict the sample to only weeks in January to February in Column (9), and the results are similar.

[25] Thus, we do not choose this model as the baseline model.

4.3 Heterogenous Effects and Mechanisms

As family reunion is the most important custom of the CLNY, increase in family companionship and emotional support from family members is the largest change for the elderly people during the CLNY. To reunite with families, around 3 billion trips are being made each year during the Spring Festival travel rush around the CLNY. Survey evidence suggests that 80% of people go back home to reunite with their families, and 70% agree that family reunion during the CLNY is a traditional custom and they keep celebrating with families every year.[26] Therefore, we can hypothesize that family companionship is one important channel for the protective effects of the CLNY on elderly suicide documented in Tables 3 and 5. However, many other contemporaneous changes also occur during the CLNY, which makes it difficult to precisely pinpoint the family companionship as the only driver for the protective effects of the CLNY for the reduction in the elderly suicides. Indeed, our intention is not to argue that family companionship is the only channel for the protective effects of CLNY on the elderly. In this section, we examine heterogeneous effects across geographical regions and provide *suggestive* evidence that at least the family companionship mechanism is one of the key channels. The other competing mechanisms may also be operating, but they alone cannot explain the set of facts we documented in this paper.

The key fact we consider is that change in family companionship during the CLNY is not homogeneous for all the elderly people. For the elderly who do not live with children in the same household and receive low level of daily family companionship, the change in family companionship during the CLNY is considerably more dramatic. Therefore, in counties where the elderly people receive a lower level of daily family companionship, on average, the aggregate protective effects should be larger.[27]

[26] http://finance.sina.com.cn/consume/xiaofei/2018-02-13/doc-ifyrpeie1483601.shtml (in Chinese).
[27] Ideally, we would like to investigate whether the protective effects of CLNY are different for individuals living in households with different sizes, but no such individual-level data are available in the Chinese context. Therefore, we can only investigate the relationship at the aggregate (i.e. county) level.

[Table 6 About Here]

We examine the hypothesis in Tables 6 and 7. We regress elderly suicide rate on the interaction term of the CLNY dummy and proxy measures of average daily family companionship, and we hypothesize that the coefficient of the interaction term should be positive (i.e., the protective effect of the CLNY is less pronounced in counties with more daily family companionship). In this part of the analysis, again, we exclude observations of all counties/districts of direct-controlled municipalities. In Columns (1) to (4) of Table 6, we use the average household size as the proxy measure. In Columns (5) to (8), we measure daily family companionship using the proportion of the elderly people living in household with at least three other people. In all regressions, we include the proxy measure itself, the interaction, the CLNY dummy, a dummy variable for whether the unit is rural county or urban district, and the interaction between the CLNY dummy and the urban-rural dummy.[28] We also control for the year, month, and week-of-month fixed effects.

We start with omitting county fixed effects and economic controls in Column (1). We find that the interaction term is indeed positive and statistically significant, which agrees with our hypothesis. In Column (2), we control for the county fixed effects, and thus the cross-sectional measure of average daily family companionship is omitted. The results are highly stable. In Columns (3) and (4), we further include interaction terms of the CLNY dummy and other county characteristics, including regional GDP per capita, average rural income, number of hospitals per capita, employment rate, the proportion of immigrants among the elderly, and the average years of schooling of the elderly, to allow for heterogeneous effects. The results on the interaction term of the CLNY dummy and proxy measures of average daily family companionship are robust to the inclusion of these additional interaction controls. More importantly, the estimates on the other additional interactions controlling themselves are insignificant, thereby suggesting that heterogeneity in daily family companionship plays a dominant role.

[28] Our results are robust if we drop the urban dummy and the urban-CLNY interaction.

In Columns (5) to (8), we repeat the same analysis but use the proportion of the elderly people living in household with at least three other people as the proxy measure. The results are robust to this alternative measure. Overall, the results in Table 6 suggest that a one standard deviation increase in the proxy measure of the average daily family companionship for the elderly reduces the protective effects of the CLNY by 5%–7%.

[Table 7 About Here]

One may be concerned that the household size constructed from the census data is not a good measure on daily family companionship. Here, we repeat the analysis using a more direct measure, which is the proportion of children living in the household, from CHARLS. Note that CHARLS only covers around 100 prefectures; thus, the sample size is reduced by more than a half. In Column (1) of Table 7, we first repeat the main regression using the subsample. We find a significant yet considerably larger effect than the full-sample estimate. In Columns (2) to (5), we repeat the same analysis as in Table 6, and we find significantly positive estimates on the interaction terms between the CLNY dummy and the proxy measure. Through Columns (6) to (9), we use a dummy variable on whether having children living in the household as the proxy measure and find similar effects. These results suggest that a one standard deviation increase in the measure of the average daily family companionship for the elderly people reduces the protective effects of the CLNY by 6%–9% in this subsample. We also repeat these analyses by gender and report them in Tables A2–A5. The results are qualitatively similar, and the effects are more pronounced for elderly men.

Although there may exist alternative explanations for the protective effects of the CLNY, the alternative explanations should be able to explain several important aspects of our main finding as follows:

(1) The suicide rate of the elderly is reduced during the CLNY.

(2) No change is observed in the suicide rate of other age groups.

(3) The protective effects decline as the average daily family companionship for the elderly increases.

Now, we discuss several competing explanations as follows.

Short-run population flows and Spring Festival travel rush

One potential explanation for the reduction of the elderly suicide rate during the CLNY is short-term travels. Billions of individuals in China travel during the CLNY season to reunite with their families.[29] The reduction of suicide rate may simply reflect that individuals travel out of counties and will not be recorded as committing suicide in the county. However, this hypothesis is unlikely to explain the results for several reasons. First, the protective effects are only for the elderly group, which is the least likely group to participate in the Spring Festival travel rush. Children of the elderly are more likely to travel to visit the elderly, instead of the other way around. Second, as shown in Tables 6 and 7, the protective effects do not change with the proportion of the elderly immigrants (as a proxy for the intensity of potential outflows during the Spring Festival travel rush). Therefore, short-term population flows are unlikely to explain the results.

Changes in income during the CLNY

Another competing explanation is that the income of the elderly may change during the seven-day statutory holiday. However, most of the elderly group has already retired and is unlikely to face income shocks or other labor market shocks during the CLNY.[30] In addition, we find no effects for the middle-age group who is more likely to face labor market shocks. Therefore, labor market shocks cannot explain the results. Another potential source of income shock is the custom of giving "red-envelope money" and gift giving during the CLNY.[31] The elderly people may give out red-envelope money to their children and their grandchildren or may also receive red-envelope money from their children who have jobs, and the net wealth change due to the exchange of red-envelope money may depend on local customs. Nevertheless, despite the possibility that the elderly may receive positive income shocks from red-envelope money and

[29] http://www.gov.cn/xinwen/2015-03/16/content_2835003.htm (in Chinese).
[30] The retirement age in China is 60 for men, and is either 55 or 50 for women depending on her occupations.
[31] A red envelope (also known as *hongbao*) is a monetary gift usually given during the CLNY, which has the symbol of good luck. See https://en.wikipedia.org/wiki/Red_envelope for more introduction on the custom of red envelope.

gifts during the CLNY, this does not invalidate the mechanism of family companionship. That is, red-envelope money and gifts are often from family members, usually given in person, and may be perceived as a particular form of family companionship. It is worthwhile to point out that generally the potential income shocks from red-envelope money and gifts should be independent of the level of daily family companionship received by the elderly, thus the red-envelope money and gift alone cannot explain the results of heterogeneous effects by itself.

Changes in healthcare institution access during the CLNY

Another explanation is that access to healthcare institutions may change during the seven-day statutory holiday. However, even during the seven-day statutory holidays, many public hospitals remain open and provide emergency services. Moreover, even if such effects are observed, they should lead to more, not less, attempted suicides resulting in deaths. Thus, it should only bias the results downward. In addition, we do not find evidence that the protective effects depend on healthcare institution access, measured by number of hospitals per capita (Tables 6 and 7).

Underreporting of suicide during the CLNY

Another concern is that suicide cases may be underreported during the CLNY, potentially due to lack of officials to record the suicide deaths during statutory holidays. However, if the reduction of suicide rate is due to underreporting, we should observe similar effects for all age cohorts, which is not the case.

Symbolic effects of holidays

Another potential explanation of the protective effects is that holidays may represent a good symbol that improves mental health. However, it cannot explain why the protective effects depend on daily family companionship. In addition, we directly examine this hypothesis by investigating the effects of other Chinese lunisolar calendar holidays, including Dragon Boat Festival and Mid-Autumn Festival, on elderly suicide rate. Note that the timing of these lunisolar calendar holidays also varies across different years, which enables us to control for temporal trends. The specifications are similar to our baseline specification

for the CLNY. Different from the CLNY, Dragon Boat Festival and Mid-Autumn Festival are only a one-day holiday, and the day off is sometimes adjusted.[32] Young and middle-age people are considerably less likely to return home to visit their parents during these statutory holidays.

[Figures 4 and 5 About Here]

Figures 4 and 5 show the effects of Dragon Boat Festival and Mid-Autumn Festival on suicide rate by gender and age cohort. Little evidence supports the protective effects of Dragon Boat Festival and Mid-Autumn Festival on elderly suicide, thus casting doubt on the symbolic effects as a mechanism.

Here, we further discuss why strong protective effects exist for the CLNY, but not for the Dragon Boat Festival and Mid-Autumn Festival. The potential explanation is still the family companionship story. Family reunion is the core value of the CLNY. To reunite with families, around 3 billion trips are being made each year during the Spring Festival travel rush around the CLNY. Survey evidence suggests that 80% of people go back home to reunite with their families, and 70% agree that family reunion during the CLNY is a traditional custom and they keep practicing celebrating with families every year (see Footnote 26). The seven-day statutory holiday enables most people to travel and reunite with families.

By contrast, although other traditional Chinese lunisolar calendar holidays, such as Dragon Boat Festival and Mid-Autumn Festival, also have symbols of family reunion, the statutory holidays last for only three days, which impedes many people from going back home. For example, survey evidence suggests that 58% of people cannot go back home and visit their parents during the Mid-Autumn Festival.[33] In addition, survey evidence suggests that 53% of young and middle-age people living outside of hometown are only able to

[32] For example, if the day of the holiday is next to a weekend, then that day will usually be specified as the day off. If the day of the holiday is far from weekends, then it may be adjusted that people work on the holiday and have a three-day long weekend. As our data are at the week level, we specify the week that has the actual additional day off as the treatment week for Dragon Boat Festival and the Mid-Autumn Festival.

[33] https://news.qq.com/a/20110912/000360.htm (in Chinese).

pay visitation to their parents for 3–10 days a year, which also suggests that people are less able to reunite with their families in holidays other than the CLNY.[34]

Self-discipline of the elderly to avoid suicide during happy events

Another alternative explanation is that the elderly people may have self-discipline to avoid committing suicide during happy events, which may create additional sadness for their family. However, as previously discussed, no similar evidence shows the protective effects for other Chinese lunisolar calendar holidays. In addition, this mechanism cannot explain why the protective effects differ across different levels of daily family companionship. If self-discipline is driving the results, then the effects should be similar regardless of whether children are living in the households.

Social companionship during the CLNY

Another potential confounding mechanism is the increased social companionship during the CLNY. Some local communities may visit the elderly people in poverty or living alone, and help them prepare for the CLNY, and the additional social companionship may also contribute to the reduction of elderly suicide rate.[35] We cannot acquire measures of social companionship and cannot directly test the hypothesis. However, the increased social companionship only covers a small proportion of elderly people, whereas the increased family companionship covers most of the elderly people during the CLNY. In addition, this explanation alone cannot explain the heterogeneous effects results. Even if the protective effects come through additional social companionship during the CLNY, it still suggests the importance of companionship and highlights the concern of aging population and increasing proportion of the empty-nest elderly.

[34] https://cj.sina.com.cn/articles/view/1704103183/65928d0f020017mno (in Chinese).
[35] See https://baijiahao.baidu.com/s?id=1623729898423645282&wfr=spider&for=pc (in Chinese) and https://www.sohu.com/a/222845573_100014930 (in Chinese) for examples of news reports on social companionship activities.

To conclude, most contemporaneous changes during the CLNY and alternative mechanisms cannot fully explain our results. Therefore, the results suggest family companionship as a crucial mechanism of the protective effects of the CLNY on elderly suicide.

4.4 Dynamic Effects

In this section, we explore the dynamic effects of the CLNY. There could be several reasons for why there are changes in elderly suicide rate in the weeks before and after the CLNY. First, there may exist an *anticipation effect*, that is, anticipating the family companionship in the upcoming CLNY weeks may improve the mental health of the elderly people. Previous studies (Rutledge et al. 2014) have found that expectations for happy events can contribute to individuals' happiness before they even occur.[36] Similar effects may exist for the anticipation of family companionship, and in that case, we expect to observe a decrease in elderly suicide rate before the CLNY. Second, there may exist a *temporal displacement* of suicide, that is, the elderly may simply postpone their suicides to later weeks. In that case, we expect to observe an increase in elderly suicide rate after the CLNY. Testing temporal displacement is important in the sense that if all the protective effects are driven by temporal displacement, the social benefit of these protective effects will be considerably smaller. Third, there may exist *separation anxiety* (Wijeratne and Manicavasagar 2003) for the elderly people after the CLNY, and separating with children after the CLNY may worsen the mental health of the elderly people. In that case, we also expect to observe an increase in elderly suicide rate after the CLNY. Finally, there may exist a *long-lasting effect* of companionship, that is, the companionship during the CLNY may improve the mental health of the elderly people even after the holiday. In that case, we expect a decrease in elderly suicide rate after the CLNY.

Therefore, the direction of dynamic effects is ex-ante unclear. We investigate the dynamic effects by directly estimating the treatment effects of weeks before and after the CLNY. We exclude year 2016

[36] https://psychcentral.com/blog/expecting-to-be-happy-makes-you-happier/.

throughout this analysis, such that two weeks will be defined as in the CLNY for every year in the sample.[37] Then, we define dummy variables indicating 1 to 4 weeks prior to the first week defined as in the CLNY and dummy variables indicating 1 to 4 weeks after the last week defined as in the CLNY, and we include all of them into the regression.[38]

[Figure 6 About Here]

Figure 6 shows the results. We find that the protective effects of the CLNY start to exhibit 2 weeks prior to the CLNY weeks, and there is some evidence that elderly suicide rate increases in the following 1 to 2 weeks after the CLNY weeks, especially for female. By contrast, we do not find evidence that suicide rate of the male elderly increases after the CLNY.

These results strongly support the *anticipation effect*, and some evidence supports *temporal displacement* and *separation anxiety*, especially for female. Note that we cannot separately identify these mechanisms. However, we are able to estimate the average of the treatment effects of the CLNY weeks and other weeks within the two-month window to examine the overall effects.[39] The average effect is a 5.7% decline (p-value of 0.025) in elderly suicide rate, and a 6.0% decline (p-value of 0.022) in suicide rate of the male elderly. However, we cannot reject the null hypothesis that the overall effect is 0 for the female elderly (average effect of −0.9%, p-value of 0.675). Therefore, even with the existence of *temporal displacement* and *separation anxiety*, the protective effects are not fully offset, especially for male, and the CLNY is effective at preventing elderly suicide. In addition, gender difference in dynamic effects suggests that the male elderly may be more sensitive to family companionship than the female elderly, which is consistent with the findings in previous studies (Stokes and Levin 1986) that the loneliness of men is more sensitive to social network density than women.

[37] Year 2016 is excluded because it is the only year in our sample that only one week is defined to be during the CNLY, and the results are hard to interpret when year 2016 is included as the weeks before and after the CNLY weeks are not comparable in year 2016 and in other years. Nevertheless, the results are overall very similar when year 2016 is included in the analysis.
[38] There are in general no effects for weeks beyond the scope of this two-month time window.
[39] The average of effects is defined as $1/10 * (\beta_{-4} + \beta_{-3} + \beta_{-2} + \beta_{-1} + 2 * \beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4)$, because two weeks will take the value of 1 for the CLNY dummy.

4.5 Children's Response

If family companionship is crucial to the mental health of the elderly, are children aware of the importance of family companionship, and do they respond to the mental health deterioration of their elderly parents? In this section, we use CHARLS data (2011, 2013, and 2015) to construct a panel data of the elderly and provide evidence on children's response to the elderly's mental health deterioration.

We estimate the following model:

$$\Delta Y_{i,t} = \alpha + \beta \Delta Depress_{i,t-1} + \gamma X_{i,t} + \varepsilon_{i,t},$$

where the dependent variable is the change in children's behavior, including changes in living arrangements and wealth transfers. The independent variable is the change in depression of the elderly i.[40] To avoid reverse causality and simultaneity bias, we estimate the effect of lagged change of depression of the elderly (in period $t-1$) on the change in children's response in period t. Specifically, we estimate the effect of the change of depression of the elderly during 2011–2013 on the change in children's behavior during 2013–2015. Age fixed effects (age at the baseline survey in 2011), prefecture fixed effects, and the gender of the elderly respondent are included as controls. The regressions are weighed by sample weights. Standard errors are clustered at the prefecture level. Note that the coefficient of interest β still needs to be interpreted with caution. That is, we cannot exclude the possibility that confounders correlated with change in depression of the elderly and change in children's later behavior still exist, such that the effects may not be interpreted as causal relationships.

[Table 8 About Here]

[40] CHARLS survey contains 10 questions about the severity of depression symptoms based on CES-D scale. The severity is rated from 0 to 3. There are 8 questions about negative behavior and 2 questions about positive behavior, and the severity is reversely ordered for the 2 questions about positive behavior. The depression index is defined as the mean of the severity points for the 10 questions. Results are similar using an alternative measure based on factor analysis.

The results are presented in Table 8. In the odd columns, we present the baseline estimates. In the even columns, we also control for the change in self-reported health, the change in instrumental limitations in activities of daily living (IADL), the change in activities of daily living (ADL), and the change in marital status.[41] These additional covariates control for the changes in physical health, disabilities, daily living limitations, and marital status in the same period that may confound the effects of changes in mental health. Some additional baseline controls, including non-agricultural hukou status, years of schooling, and marital status at the baseline survey (year 2011), are also included in the even columns.

In Columns (1) and (2), we present the effects of the elderly's mental health deterioration on the change in whether at least one child lives in the household. No evidence shows that children respond to the elderly's mental health deterioration by living with their elderly parents, as the estimates are insignificant and negative. In Columns (3) and (4), we instead define the dependent variable as the change in whether at least one child lives in the same county as the elderly parents and, again, find small and statistically insignificant estimates. The results are robust to the inclusion of baseline controls and covariates on the changes in physical health daily living limitations and are highly similar if we alternatively define the dependent variables as the changes in the proportion of children living in the household/same county. Therefore, we find no evidence that children respond to the elderly's mental health deterioration by adjusting their living arrangements.

By contrast, we find some evidence that children increase intergenerational wealth transfers to their elderly parents. Columns (5) and (6) present the effects on the change in net wealth transfer from the children to the elderly parents. Column (5) suggests that if the change in the depression index of the elderly increases by 1 unit, then children will increase the total net wealth transfer by CNY 1,365 (0.08 standard deviation).[42]

[41] These change variables are all measured at the same period (2011–2013) as the change of depression. Self-reported health ranges from 1 (poor) to 5 (excellent). IADL measures people's difficulty in doing the following daily activities: doing household chores, preparing meals, shopping for groceries, making phone calls, and taking medications. ADL measures people's difficulty in doing the following daily activities: dressing, bathing and showing, self-feeding, getting into or out of bed, toilet hygiene, and controlling urination and defecation. The respondent is defined to have limitations if reporting "have difficulty and need help" or "cannot do it," following Chen and Fang (2018).

[42] Note that the net wealth transfer can be both positive and negative, so we use the level of net wealth transfer as the dependent variable and are unable to use the log transformation.

When including additional baseline controls and covariates on the changes in physical health and daily living limitations, the point estimate loses precision but still remains economically pronounced. Note that changes in daily living limitations also lead to an increase in total net wealth transfer from children at similar magnitude, as shown in Column (6). These results suggest that children may be aware of the deterioration of the mental health of their elder parents and respond by increasing wealth transfer to their parents.

To conclude, the results in Table 8 indicate that children in China may be aware of the mental health status of their elderly parents; however, they seem not to be responding by adjusting living arrangements and providing more daily companionship to their parents. By contrast, they may respond by increasing wealth transfers to their elderly parents. However, as also discussed in Chen and Fang (2018), monetary transfers may not be as helpful for the mental health of the elderly as for physical health and living limitations.

Several potential explanations can describe why children are not responding by adjusting living arrangements and providing more daily companionship to their parents. First, they may not correctly perceive the influence of daily family companionship on the mental health of the elderly and underestimate the benefits of adjusting living arrangements. Second, they may be aware of the benefits, but are constrained to adjust living arrangements by other concerns, such as their career and the schooling of their children. This explanation is especially plausible for people working in a different city. Third, the family planning policy in China has reduced the number of children per household and thus reduced the likelihood that the elderly have children who are able to adjust their living arrangements (Chen and Fang 2018). In conclusion, policy interventions are needed to remove the barriers to children's response.

5 Conclusion

In this study, we document a novel finding that elderly suicide rate decreases by 8.7% during the CLNY, when the elderly people receive unusually high level of family companionship. In addition, the protective

effects for the elderly are stronger in counties where the level of the average daily family companionship for the elderly is lower. We do not find any evidence of similar protective effects for young and middle-age cohorts. These results suggest that family companionship is an important mechanism for the protective effects of the CLNY, indicating the importance of family companionship on the mental health of the elderly.

The finding in this study is especially policy-relevant in China, given the rapidly growing population of empty-nest elderly and other countries with similar demographic structures. In fact, the revision of the *Law of the People's Republic of China on Protection of the Rights and Interests of the Elderly* has been passed in 2012, which legally requires that family members should care for the mental need of the elderly, and family members who do not live with the elderly should regularly contact and visit the elderly.[43] However, the enforcement of the law has not been highly effective because the legal responsibilities are not clearly specified, and the pressure on career and daily life also impedes the children of the elderly people from providing more daily companionship to their elderly parents.[44] Therefore, public policies calling for attention on the importance of the family companionship for the elderly parents, or facilitating alternative types of companionship for the elderly, such as charitable visit and community care, may also be effective in preventing elderly suicide.

There are at least two limitations in our study. First, due to data constraints, we can only use proxy measures of daily family companionship at the aggregated level, and thus preventing us from exploringwhat types of the elderly people are most at risk and how individual characteristics interact with the protective effects of the CLNY. Second, although we are confident on the causal effect of the CLNY on elderly suicide rate because of the exogenous variation in the lunisolar calendar, we are less confident on the underlying mechanisms for the protective effects since the geographic variation in daily family companionship may be confounded with other factors related to elderly mental health. We leave these questions for future research.

[43] http://www.gov.cn/flfg/2012-12/28/content_2305570.htm (in Chinese).
[44] http://opinion.people.com.cn/n1/2017/0118/c1003-29031862.html and http://www.xinhuanet.com/2017-06/19/c_1121165931.htm (in Chinese).

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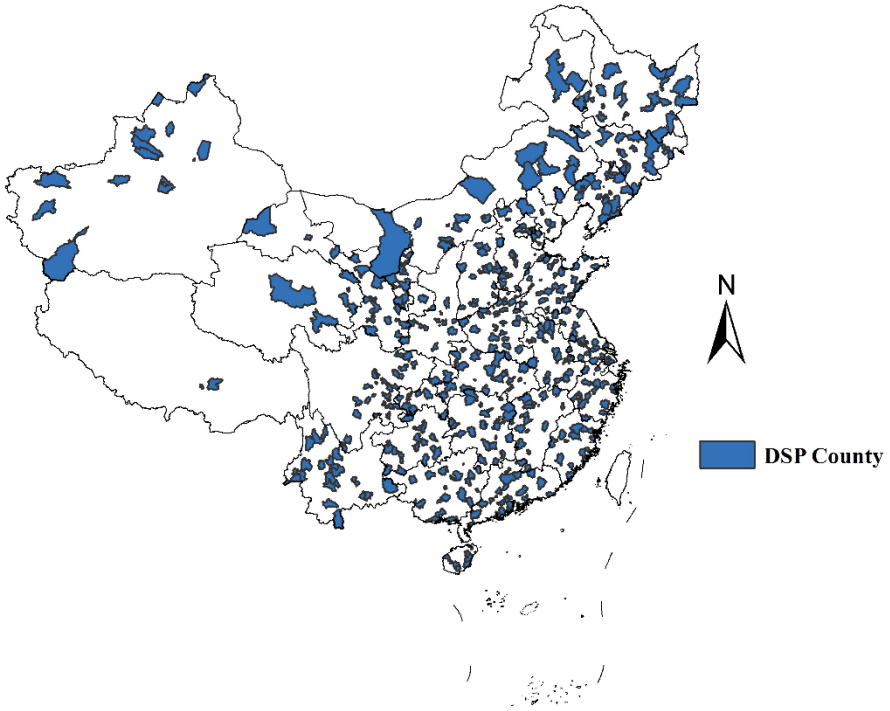
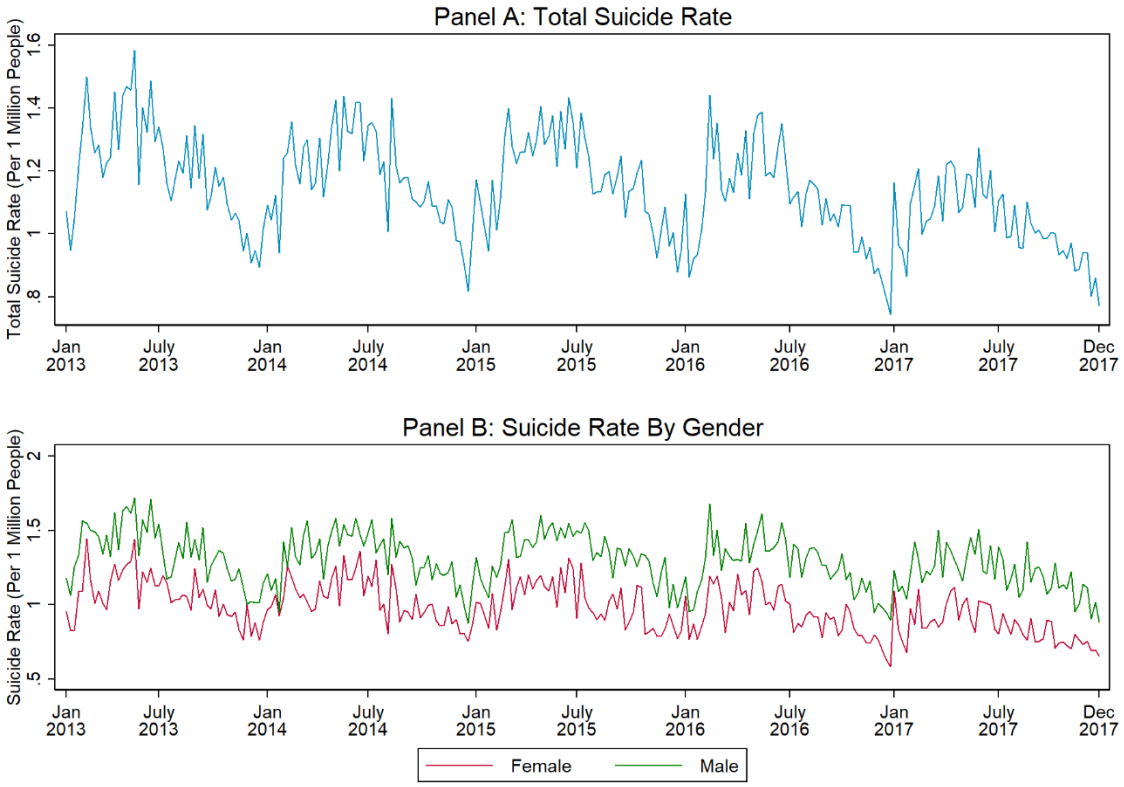
Figures and Tables

Figure 1: Geographical Distribution of Counties under the DSP System



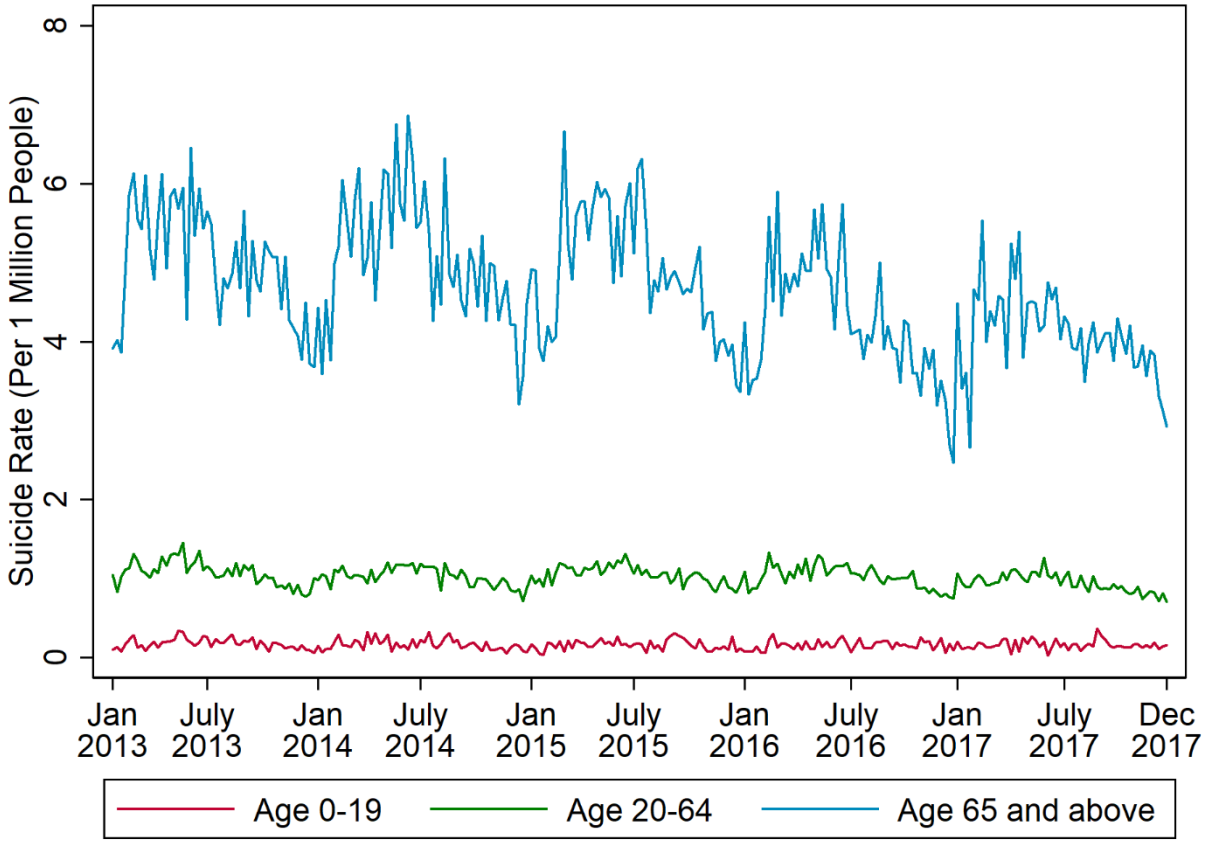
Notes: This figure plots the geographical distribution of counties under the DSP system in the sample.

Figure 2: Temporal Trends in National Suicide Rate



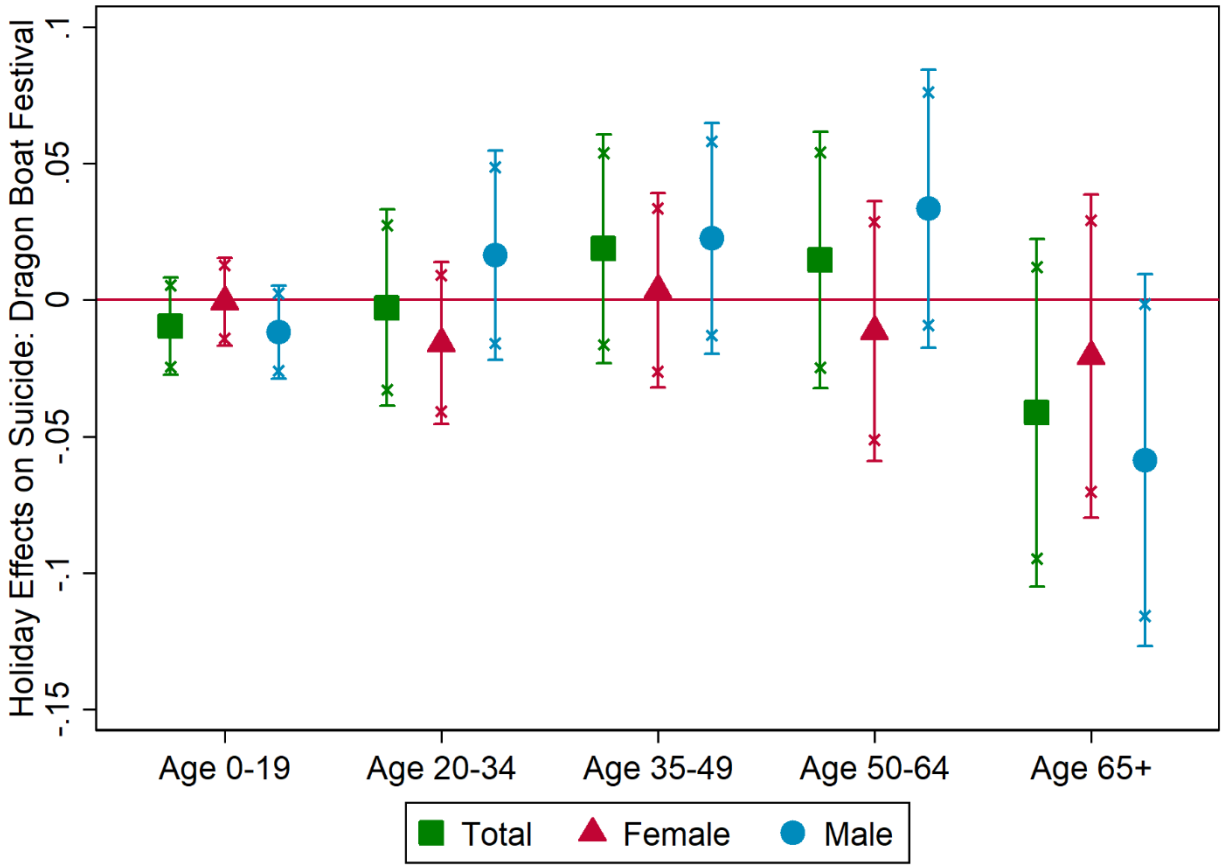
Notes: This figure plots the temporal trends in weekly national-level suicide rate. Panel A plots the total suicide rate. Panel B plots the suicide rate by gender. The weekly suicide rate is aggregated at national level by computing the weighted average of county-level suicide rates, with county population as weights.

Figure 3: Temporal Trends in National Suicide Rate by Age Cohort



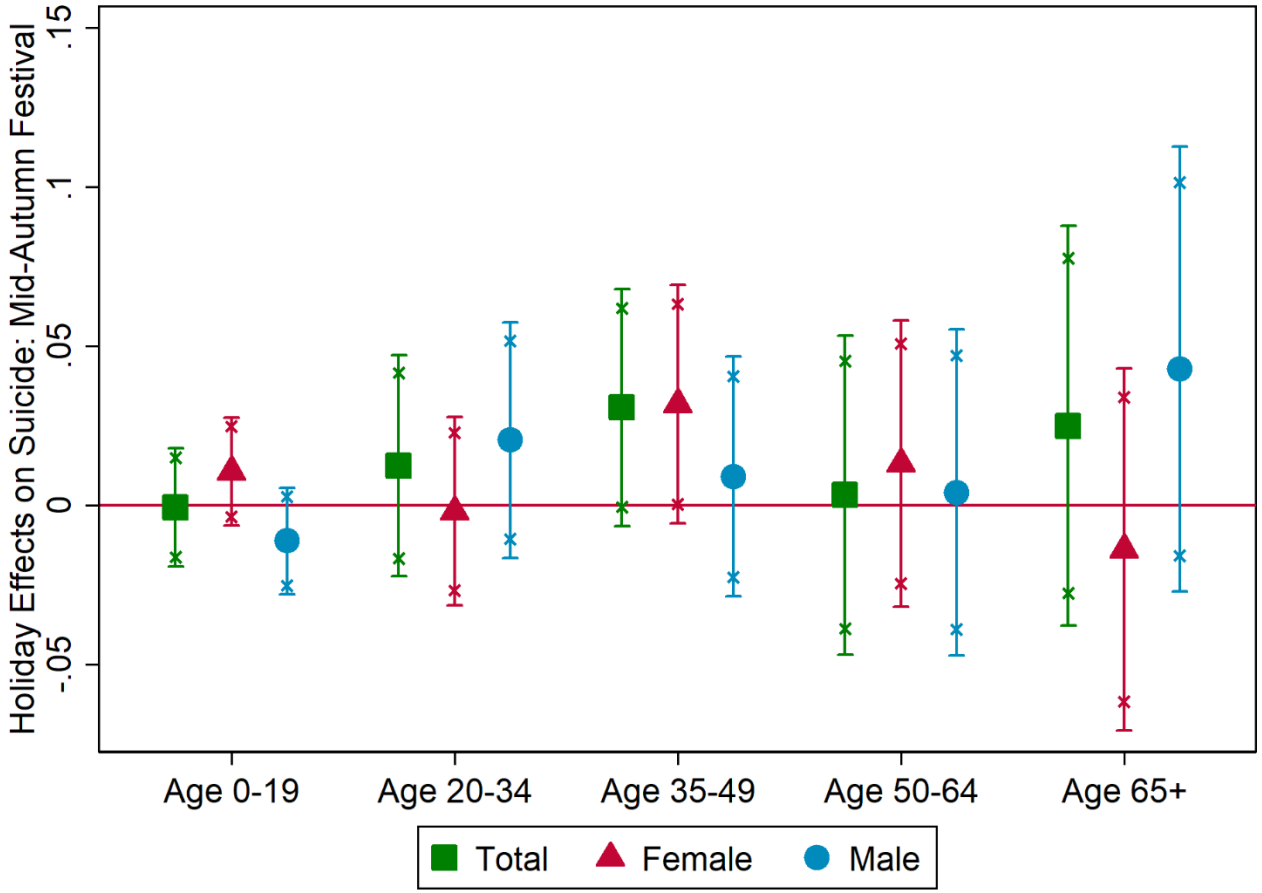
Notes: This figure plots the temporal trends in weekly national-level suicide rate by age cohort. The weekly suicide rate is aggregated at national level by computing the weighted average of county-level suicide rates, with county population as weights.

Figure 4: Effects of Dragon Boat Festival on Suicide Rate: by Gender and Age Cohort



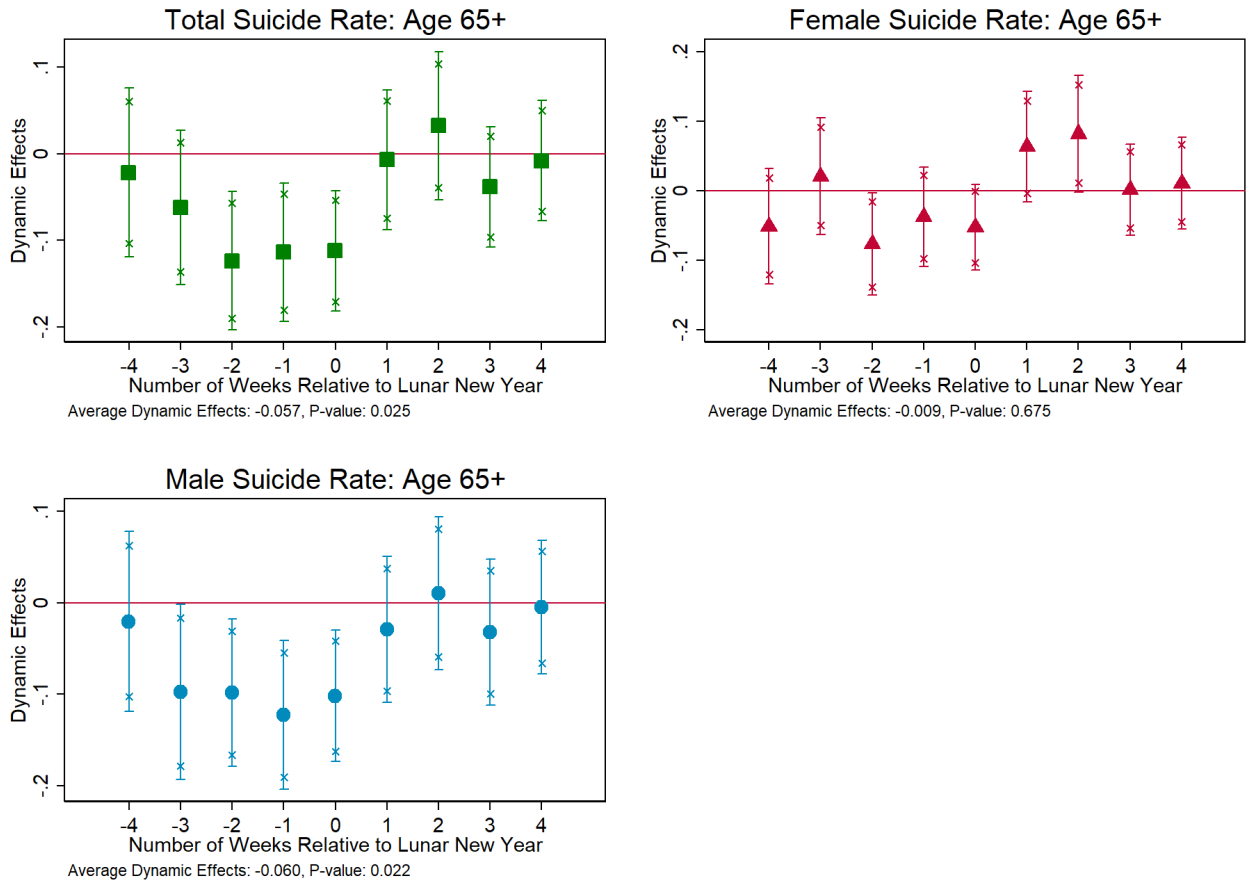
Notes: This figure plots the effects of Dragon Boat Festival on suicide rate by gender and age cohort. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. County fixed effects, year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level. "x" markers represent bounds of 90% confidence interval. "-" markers represent bounds of 95% confidence interval.

Figure 5: Effects of Mid-Autumn Festival on Suicide Rate: by Gender and Age Cohort



Notes: This figure plots the effects of Mid-Autumn Festival on suicide rate by gender and age cohort. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. County fixed effects, year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level. "x" markers represent bounds of 90% confidence interval. "-" markers represent bounds of 95% confidence interval.

Figure 6: Dynamic Effects of Chinese Lunar New Year on Suicide Rate



Notes: This figure plots the effects of weeks before and after Chinese lunar new year on elderly suicide. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. County fixed effects, year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level. "x" markers represent bounds of 90% confidence interval. "-" markers represent bounds of 95% confidence interval. The average dynamic effect is the average of the treatment effects of Chinese lunar new year weeks and weeks within the two-month window. The p-value is the test p-value for whether the average dynamic effect is statistically different from 0.

Table 1: Summary Statistics for Weekly Suicide Rate

	Mean	S.D.	Min	Max
Panel A Total Suicide Rate				
All age cohorts	1.158	2.198	0	95.815
Age 0-19	0.179	1.752	0	87.441
Age 20-64	1.074	2.524	0	143.057
Age 65+	4.437	13.291	0	571.646
Panel B Female Suicide Rate				
All age cohorts	0.967	2.721	0	196.321
Age 0-19	0.154	2.351	0	164.907
Age 20-64	0.864	3.159	0	290.731
Age 65+	3.674	15.785	0	1101.466
Panel C Male Suicide Rate				
All age cohorts	1.341	3.144	0	95.320
Age 0-19	0.200	2.558	0	163.583
Age 20-64	1.278	3.739	0	143.441
Age 65+	5.260	19.974	0	998.942

Notes: Number of observations=151,253. The suicide rate is measured by number of cases per 1 million people.

Table 2: Correlational Evidence on the Effects of Daily Family Companionship on Elderly Suicide

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Total Suicide Rate, Age 65+							
Average Household Size, Age 65+	-0.0883**	-0.1144***						
	(0.0395)	(0.0437)						
% Household Size >=4, Age 65+			-0.0615	-0.0789*				
			(0.0395)	(0.0443)				
Average Proportion of Children Living in the Household, Age 65+					-0.1435***	-0.1166***		
					(0.0417)	(0.0412)		
% Having Children Living in the Household, Age 65+							-0.0904*	-0.0797
							(0.0542)	(0.0527)
Urban District	-0.2919***	-0.2613***	-0.2963***	-0.2628***	-0.2915**	-0.2954**	-0.2910**	-0.2953**
	(0.0779)	(0.0767)	(0.0778)	(0.0766)	(0.1279)	(0.1273)	(0.1288)	(0.1275)
GDP Per Capita	-0.0962**	-0.0149	-0.0847*	0.0007	-0.2199	0.1020	-0.2427*	0.0981
	(0.0479)	(0.0535)	(0.0476)	(0.0539)	(0.1349)	(0.1504)	(0.1369)	(0.1522)
Average Rural Income	0.0055	0.0230	0.0083	0.0295	0.1258	-0.0585	0.1372	-0.0568
	(0.0429)	(0.0522)	(0.0421)	(0.0524)	(0.1076)	(0.1155)	(0.1085)	(0.1166)
Number of Hospital Per Capita	-0.2039***	-0.0939**	-0.2013***	-0.0913**	-0.2704***	-0.1388**	-0.2655***	-0.1298*
	(0.0415)	(0.0391)	(0.0414)	(0.0394)	(0.0664)	(0.0651)	(0.0682)	(0.0667)
Employment Rate		0.1061**		0.0997**		0.0115		-0.0016
		(0.0474)		(0.0484)		(0.0677)		(0.0665)
Proportion of Immigrants, Age 65+		-0.0149		-0.0312		0.0447		0.0503
		(0.0379)		(0.0383)		(0.0888)		(0.0872)
Average Years of Schooling, Age 65+		-0.1907***		-0.1883***		-0.3291***		-0.3546***
		(0.0545)		(0.0546)		(0.0941)		(0.0921)
Observations	122,960	122,960	122,960	122,960	57,878	54,219	57,878	54,219
R-squared	0.035	0.053	0.034	0.051	0.056	0.078	0.051	0.075
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	No	No	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. Year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table 3: Effects of Chinese Lunar New Year on Elderly Suicide Rate

	(1)	(2)	(3)	(4)	(5)	(6)
	Suicide Rate: Total, Age 65+		Suicide Rate: Female, Age 65+		Suicide Rate: Male, Age 65+	
VARIABLES	Inverse Hyperbolic Sine	Level	Inverse Hyperbolic Sine	Level	Inverse Hyperbolic Sine	Level
CLNY	-0.0867***	-0.5212***	-0.0632***	-0.4374**	-0.0666***	-0.6117***
	(0.0221)	(0.1509)	(0.0216)	(0.2029)	(0.0238)	(0.2323)
Observations	151,253	151,253	151,253	151,253	151,253	151,253
R-squared	0.258	0.294	0.199	0.194	0.204	0.170
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people in columns (1), (3) and (5), and is the level of suicide cases per 1 million people in columns (2), (4) and (6). County fixed effects, year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table 4: Effects of Chinese Lunar New Year on Suicide Rate: By Gender and Age Cohort

VARIABLES	(1) Suicide Rate Age 0-19	(2) Suicide Rate Age 20-64	(3) Suicide Rate Age 65+	(4) Suicide Rate Age 20-34	(5) Suicide Rate Age 35-49	(6) Suicide Rate Age 50-64
Panel A Total Suicide Rate						
CLNY	-0.0079	-0.0148	-0.0867***	-0.0095	-0.0101	-0.0087
	(0.0070)	(0.0141)	(0.0221)	(0.0137)	(0.0157)	(0.0180)
Observations	151,253	151,253	151,253	151,253	151,253	151,253
R-squared	0.012	0.150	0.258	0.034	0.065	0.129
Panel B Female Suicide Rate						
CLNY	-0.0042	-0.0228	-0.0632***	-0.0115	0.0023	-0.0265
	(0.0072)	(0.0148)	(0.0216)	(0.0120)	(0.0141)	(0.0170)
Observations	151,253	151,253	151,253	151,253	151,253	151,253
R-squared	0.008	0.095	0.199	0.019	0.036	0.087
Panel C Male Suicide Rate						
CLNY	-0.0049	0.0037	-0.0666***	-0.0017	-0.0166	0.0171
	(0.0065)	(0.0168)	(0.0238)	(0.0145)	(0.0153)	(0.0204)
Observations	151,253	151,253	151,253	151,253	151,253	151,253
R-squared	0.010	0.103	0.204	0.023	0.045	0.086
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. County fixed effects, year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table 5: Robustness Checks

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent Variables: Suicide Rate								
Panel A Total Suicide Rate, Age 65+									
CLNY	-0.0867***		-0.0568**	-0.0784***	-0.0867***	-0.0867***	-0.0680***	-0.0970***	-0.0970***
	(0.0221)		(0.0251)	(0.0192)	(0.0278)	(0.0302)	(0.0242)	(0.0228)	(0.0246)
Proportion of Weekdays During CLNY		-0.0977***							
		(0.0356)							
Panel B Female Suicide Rate, Age 65+									
CLNY	-0.0632***		-0.0362	-0.0570***	-0.0632***	-0.0632**	-0.0589**	-0.0690***	-0.0723***
	(0.0216)		(0.0242)	(0.0165)	(0.0213)	(0.0283)	(0.0230)	(0.0228)	(0.0230)
Proportion of Weekdays During CLNY		-0.0562*							
		(0.0335)							
Panel C Male Suicide Rate, Age 65+									
CLNY	-0.0666***		-0.0494*	-0.0599***	-0.0666**	-0.0666***	-0.0501*	-0.0743***	-0.0781***
	(0.0238)		(0.0257)	(0.0195)	(0.0271)	(0.0241)	(0.0259)	(0.0248)	(0.0262)
Proportion of Weekdays During CLNY		-0.0822**							
		(0.0386)							
Cluster	County	County	County	County	Province	County-Week Two-way	County	County	County
Population Weight	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	Full	Exclude 2016	Exclude Municipalities	Jan-Feb
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Year FE	No	No	Yes	No	No	No	No	No	No
Observations	151,253	151,253	151,253	151,253	151,253	151,253	121,063	143,361	23,438

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. County fixed effects, year fixed effects, month fixed effects and week-of-month fixed effects are included as controls in all columns except for column (3). In column (3), week-of-month fixed effects are replaced by week-of-year fixed effects. The regression is weighted by county population in all columns except for column (4). Standard errors are clustered at county level in all columns except for columns (5)-(6). In column (5), standard errors are clustered at province level. In column (6), standard errors are two-way clustered by county and week. Full sample is used in columns (1)-(6). Year 2016 is excluded from the sample in column (7). All direct-controlled municipalities are excluded from the sample in column (8). All months other than January and February are excluded from the sample in column (9).

Table 6: Heterogeneous Effects by Daily Family Companionship, Census Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Total Suicide Rate, Age 65+							
	Proxy Measure for Daily Family Companionship:				Proxy Measure for Daily Family Companionship:			
VARIABLES	Average Household Size, Age 65+				% Household Size >=4, Age 65+			
CLNY	-0.0875***	-0.0879***	-0.0874***	-0.0932***	-0.0879***	-0.0883***	-0.0879***	-0.0930***
	(0.0298)	(0.0298)	(0.0311)	(0.0307)	(0.0298)	(0.0298)	(0.0312)	(0.0308)
CLNY*Average Household Size, Age 65+	0.0529**	0.0527**	0.0581**	0.0709**				
	(0.0220)	(0.0220)	(0.0249)	(0.0276)				
Average Household Size, Age 65+	-0.0156							
	(0.0456)							
CLNY*% Household Size >=4, Age 65+					0.0507**	0.0503**	0.0510**	0.0635**
					(0.0223)	(0.0223)	(0.0240)	(0.0266)
% Household Size >=4, Age 65+					-0.0001			
					(0.0501)			
CLNY*Urban District	-0.0513	-0.0501	-0.0679	-0.0543	-0.0523	-0.0511	-0.0656	-0.0528
	(0.0455)	(0.0456)	(0.0457)	(0.0460)	(0.0455)	(0.0456)	(0.0457)	(0.0461)
CLNY*GDP Per Capita			-0.0068	0.0087			-0.0105	0.0044
			(0.0391)	(0.0377)			(0.0392)	(0.0380)
CLNY*Average Rural Income			0.0172	0.0328			0.0144	0.0294
			(0.0332)	(0.0315)			(0.0332)	(0.0316)
CLNY*Number of Hospital Per Capita			-0.0021	0.0097			-0.0035	0.0082
			(0.0219)	(0.0238)			(0.0218)	(0.0238)
CLNY*Employment Rate				-0.0258				-0.0275
				(0.0311)				(0.0316)
CLNY*Proportion of Immigrants, Age 65+				-0.0460				-0.0415
				(0.0300)				(0.0295)
CLNY*Average Years of Schooling, Age 65+				-0.0351				-0.0390
				(0.0271)				(0.0273)
Observations	126,561	126,561	122,960	122,960	126,561	126,561	122,960	122,960
R-squared	0.017	0.266	0.244	0.244	0.017	0.266	0.244	0.244
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. Year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table 7: Heterogeneous Effects by Daily Family Companionship, CHARLS Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total Suicide Rate, Age 65+								
		Proxy Measure for Daily Family Companionship:				Proxy Measure for Daily Family Companionship:			
VARIABLES		Average Proportion of Children Living in the Household, Age 65+				% Having Children Living in the Household, Age 65+			
CLNY	-0.1486***	-0.1485***	-0.1490***	-0.1808***	-0.1918***	-0.1495***	-0.1501***	-0.1809***	-0.1949***
	(0.0358)	(0.0447)	(0.0448)	(0.0442)	(0.0458)	(0.0446)	(0.0447)	(0.0440)	(0.0454)
CLNY*Average Proportion of Children Living in the Household, Age 65+		0.0597*	0.0601*	0.0719**	0.0739**				
		(0.0328)	(0.0328)	(0.0319)	(0.0334)				
Average Proportion of Children Living in the Household, Age 65+		-0.1340***							
		(0.0431)							
CLNY*% Having Children Living in the Household, Age 65+						0.0742*	0.0745*	0.0853**	0.0936**
						(0.0394)	(0.0394)	(0.0381)	(0.0394)
% Having Children Living in the Household, Age 65+						-0.0694			
						(0.0519)			
CLNY*Urban District		-0.0060	-0.0044	-0.0027	0.0011	0.0007	0.0024	0.0010	0.0048
		(0.0705)	(0.0706)	(0.0674)	(0.0704)	(0.0701)	(0.0702)	(0.0675)	(0.0701)
CLNY*GDP Per Capita				-0.1929**	-0.1961*			-0.1846**	-0.2031*
				(0.0831)	(0.1069)			(0.0823)	(0.1060)
CLNY*Average Rural Income				0.1637**	0.1801**			0.1615**	0.1845**
				(0.0699)	(0.0798)			(0.0692)	(0.0788)
CLNY*Number of Hospital Per Capita				0.0101	0.0137			0.0117	0.0149
				(0.0347)	(0.0381)			(0.0344)	(0.0374)
CLNY*Employment Rate					-0.0033				0.0101
					(0.0492)				(0.0477)
CLNY*Proportion of Immigrants, Age 65+					-0.0339				-0.0219
					(0.0765)				(0.0776)
CLNY*Average Years of Schooling, Age 65+					0.0001				0.0122
					(0.0513)				(0.0500)
Observations	58,394	58,394	58,394	57,878	54,219	58,394	58,394	57,878	54,219
R-squared	0.267	0.027	0.267	0.270	0.271	0.022	0.267	0.270	0.271
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

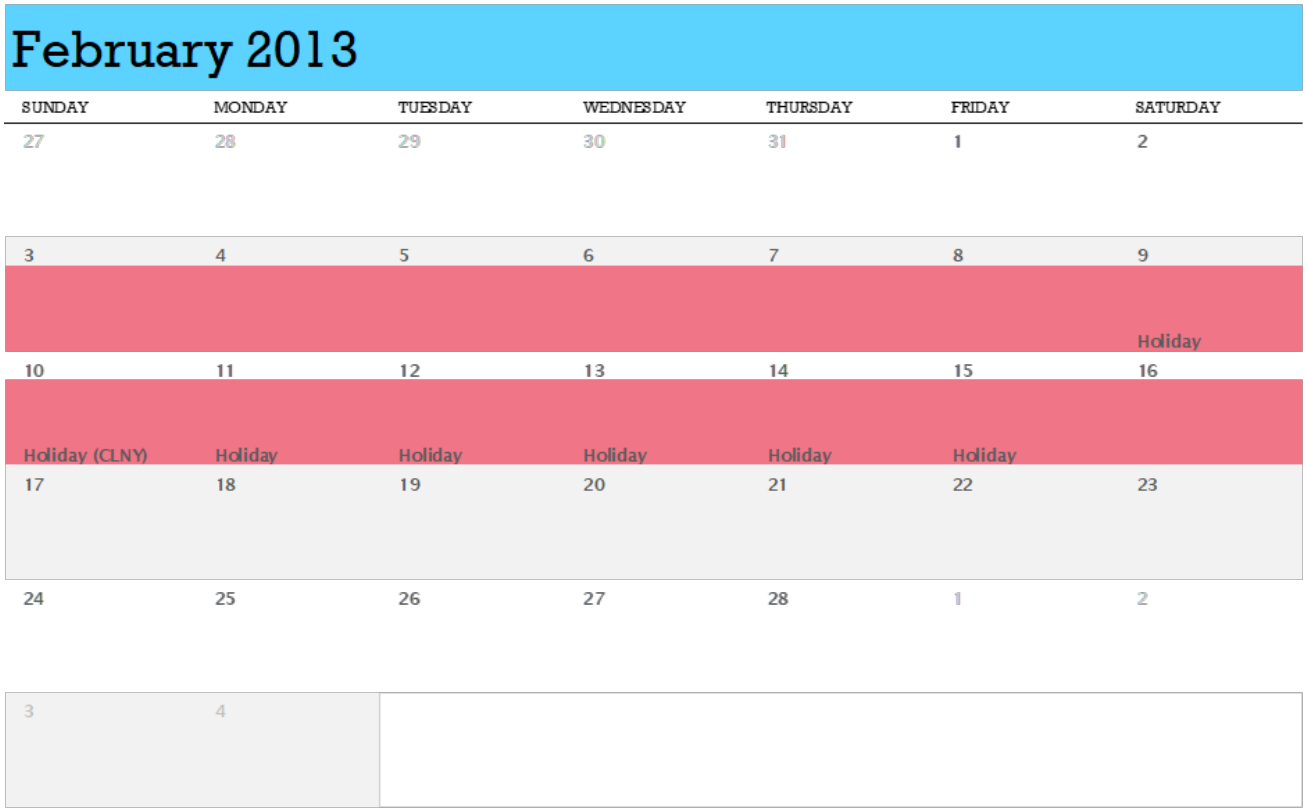
Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. County fixed effects, year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table 8: Children's Response to Mental Health Deterioration of Elderly Parents

VARIABLES	(1) Δ Having Children Living in the Household	(2) Δ Having Children Living in the Household	(3) Δ Having Children Living in the Same County	(4) Δ Having Children Living in the Same County	(5) Δ Total Net Transfer from Children	(6) Δ Total Net Transfer from Children
Δ Depression Index	-0.0268	-0.0225	0.0088	0.0068	1,365**	1,044
	(0.0224)	(0.0230)	(0.0107)	(0.0106)	(665)	(680)
Δ Self-reported Health		0.0257**		0.0016		-477
		(0.0127)		(0.0041)		(312)
Δ IADL		-0.0092		-0.0057		1,362**
		(0.0362)		(0.0153)		(633)
Δ ADL		0.0371		0.0158		2,186
		(0.0524)		(0.0172)		(1,439)
Observations	1,272	1,268	1,272	1,268	1,272	1,268
R-squared	0.151	0.157	0.133	0.139	0.117	0.130
Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Baseline Control	No	Yes	No	Yes	No	Yes

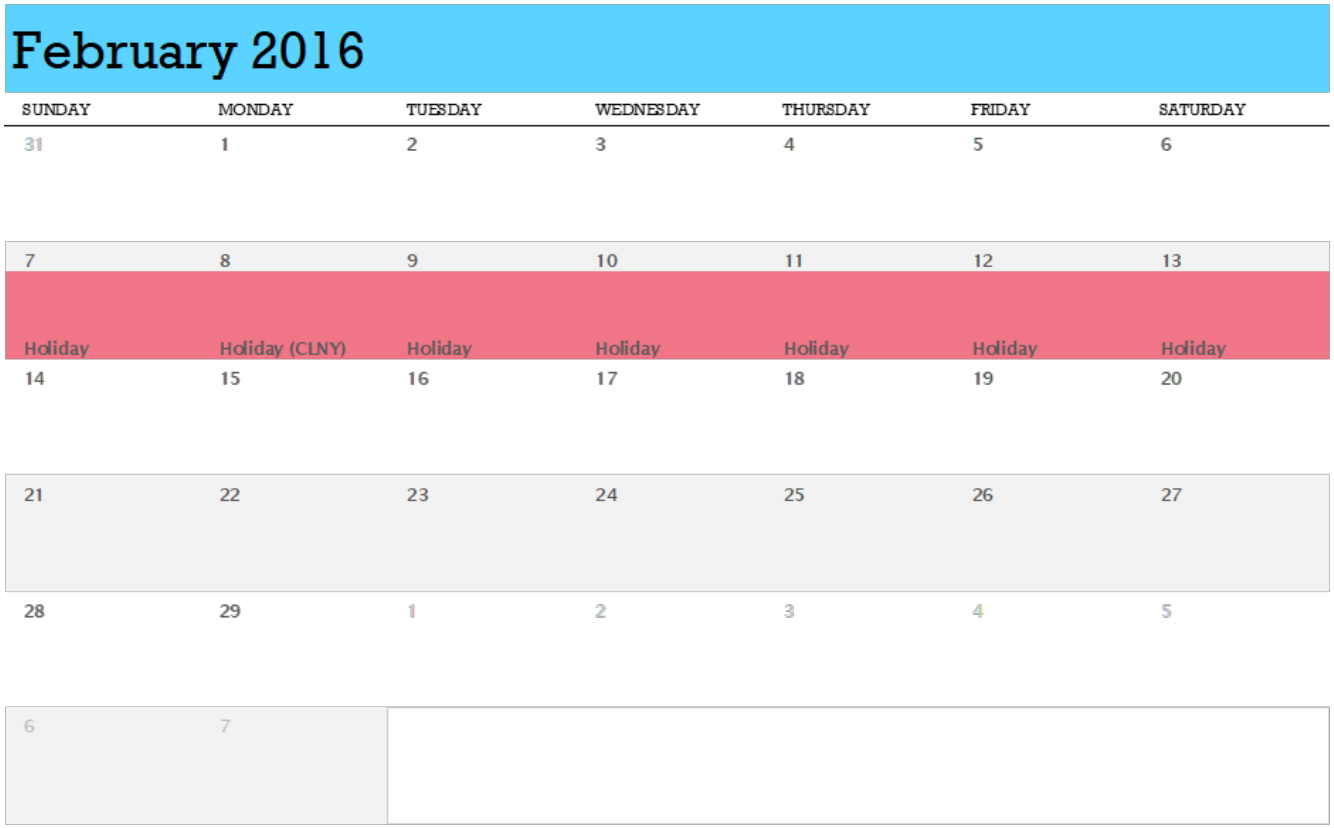
Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at prefecture level. The regressions are weighted by sample weights. Age fixed effects (age at baseline survey in 2011), prefecture fixed effects and the gender of the elderly respondent are always included as controls. The dependent variables are the change in children's behavior during 2013-2015. The independent variable is the change in depression index of the elderly respondent during 2011-2013. The depression index is constructed from 10 questions about the severity of depression symptoms based on CES-D scale. In the even columns, the change in self-reported health, the change in instrumental limitations in activities of daily living (IADL), the change in activities of daily living (ADL), and the change in marital status (all during 2011-2013), as well as non-agricultural hukou status, years of schooling and marital status at the baseline survey (year 2011), are all included as additional covariates. Self-reported health ranges from 1 (poor) to 5 (excellent). IADL measures people's difficulty in doing the following daily activities: doing household chores, preparing meals, shopping for groceries, making phone calls, and taking medications. ADL measures people's difficulty in doing the following daily activities: dressing, bathing and showing, self-feeding, getting into or out of bed, toilet hygiene, controlling urination and defecation.

Figure A1: Definition of Chinese Lunar New Year Variable, February 2013



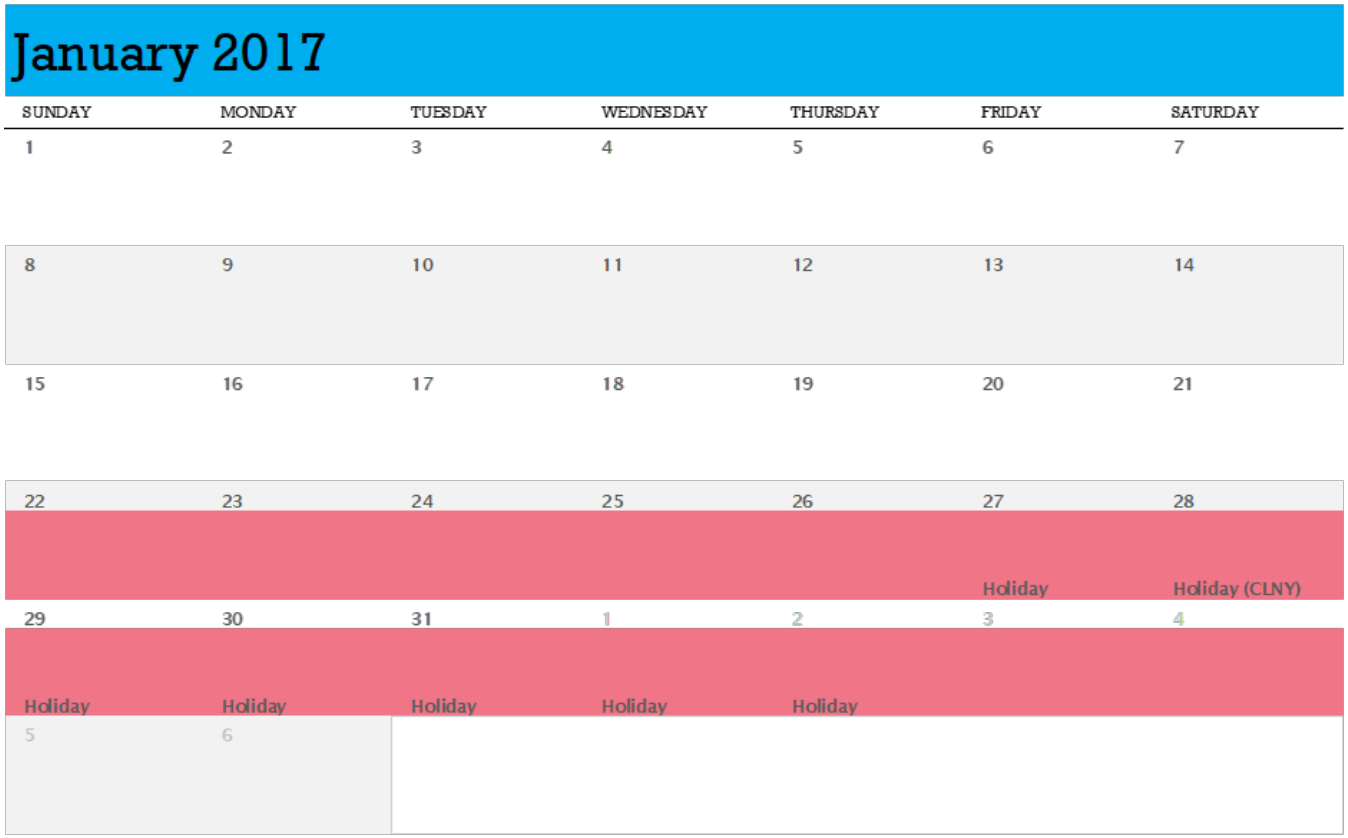
Notes: This figure depicts the calendar in February 2013. The CLNY is on Feb 10th, and the statutory holidays are during Feb 9th-15th. We define the CLNY treatment as 1 from Feb 3rd to 16th.

Figure A2: Definition of Chinese Lunar New Year Variable, February 2016



Notes: This figure depicts the calendar in February 2016. The CLNY is on Feb 8th, and the statutory holidays are during Feb 7th-13th. We define the CLNY treatment as 1 from Feb 7th to 13th.

Figure A3: Definition of Chinese Lunar New Year Variable, January 2017



Notes: This figure depicts the calendar in January 2017. The CLNY is on Jan 28th, and the statutory holidays are during Jan 27th-Feb 2nd. We define the CLNY from Jan 22nd to Feb 4th.

Table A1: Distribution of the Chinese Lunar New Year, 1991-2020

Panel A By Month	
Chinese Lunar New Year in	Frequency
January	11
February	19
Panel B By Week	
Chinese Lunar New Year in	Frequency
Week 3	4
Week 4	6
Week 5	8
Week 6	7
Week 7	5

Notes: This table presents the distribution of the Chinese Lunar New Year during 1991-2020. The weeks are counted from Sunday to Saturday.

Table A2: Heterogeneous Effects by Daily Family Companionship, Census Measures, Female

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Female Suicide Rate, Age 65+							
	Proxy Measure for Daily Family Companionship: Average Household Size, Age 65+				Proxy Measure for Daily Family Companionship: % Household Size >=4, Age 65+			
VARIABLES								
CLNY	-0.0640**	-0.0642**	-0.0614**	-0.0634**	-0.0643**	-0.0645**	-0.0613**	-0.0633**
	(0.0297)	(0.0297)	(0.0301)	(0.0302)	(0.0297)	(0.0297)	(0.0301)	(0.0302)
CLNY*Average Household Size, Age 65+	0.0323*	0.0321*	0.0235	0.0334				
	(0.0194)	(0.0194)	(0.0211)	(0.0236)				
Average Household Size, Age 65+	0.0086							
	(0.0394)							
CLNY*% Household Size >=4, Age 65+					0.0357*	0.0354*	0.0270	0.0372
					(0.0203)	(0.0203)	(0.0212)	(0.0238)
% Household Size >=4, Age 65+					0.0218			
					(0.0445)			
CLNY*Urban District	-0.0351	-0.0345	-0.0406	-0.0352	-0.0352	-0.0346	-0.0401	-0.0343
	(0.0433)	(0.0433)	(0.0424)	(0.0433)	(0.0432)	(0.0433)	(0.0424)	(0.0432)
CLNY*GDP Per Capita			-0.0076	-0.0063			-0.0068	-0.0057
			(0.0326)	(0.0328)			(0.0328)	(0.0331)
CLNY*Average Rural Income			-0.0120	-0.0051			-0.0137	-0.0064
			(0.0294)	(0.0289)			(0.0297)	(0.0290)
CLNY*Number of Hospital Per Capita			-0.0075	-0.0115			-0.0079	-0.0121
			(0.0202)	(0.0207)			(0.0201)	(0.0208)
CLNY*Employment Rate				-0.0233				-0.0269
				(0.0263)				(0.0271)
CLNY*Proportion of Immigrants, Age 65+				-0.0271				-0.0278
				(0.0242)				(0.0238)
CLNY*Average Years of Schooling, Age 65+				0.0008				-0.0022
				(0.0256)				(0.0259)
Observations	126,561	126,561	122,960	122,960	126,561	126,561	122,960	122,960
R-squared	0.010	0.208	0.172	0.172	0.010	0.208	0.172	0.172
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. Year fixed effects, month fixed effects, and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table A3: Heterogeneous Effects by Daily Family Companionship, Census Measures, Male

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male Suicide Rate, Age 65+							
	Proxy Measure for Daily Family Companionship:				Proxy Measure for Daily Family Companionship:			
VARIABLES	Average Household Size, Age 65+				% Household Size >=4, Age 65+			
CLNY	-0.0767**	-0.0771**	-0.0805**	-0.0843***	-0.0770**	-0.0773**	-0.0810**	-0.0840***
	(0.0323)	(0.0323)	(0.0329)	(0.0321)	(0.0323)	(0.0323)	(0.0330)	(0.0322)
CLNY*Average Household Size, Age 65+	0.0430*	0.0428*	0.0533**	0.0619**				
	(0.0222)	(0.0223)	(0.0241)	(0.0261)				
Average Household Size, Age 65+	-0.0177							
	(0.0413)							
CLNY*% Household Size >=4, Age 65+					0.0374*	0.0371	0.0420*	0.0508**
					(0.0225)	(0.0226)	(0.0237)	(0.0258)
% Household Size >=4, Age 65+					-0.0074			
					(0.0460)			
CLNY*Urban District	-0.0042	-0.0031	-0.0168	-0.0066	-0.0054	-0.0044	-0.0144	-0.0055
	(0.0463)	(0.0464)	(0.0493)	(0.0494)	(0.0463)	(0.0464)	(0.0492)	(0.0495)
CLNY*GDP Per Capita			-0.0203	-0.0032			-0.0254	-0.0087
			(0.0349)	(0.0331)			(0.0348)	(0.0330)
CLNY*Average Rural Income			0.0413	0.0576*			0.0391	0.0544*
			(0.0308)	(0.0311)			(0.0308)	(0.0311)
CLNY*Number of Hospital Per Capita			0.0097	0.0274			0.0082	0.0260
			(0.0255)	(0.0271)			(0.0254)	(0.0270)
CLNY*Employment Rate				-0.0249				-0.0246
				(0.0298)				(0.0304)
CLNY*Proportion of Immigrants, Age 65+				-0.0273				-0.0216
				(0.0296)				(0.0292)
CLNY*Average Years of Schooling, Age 65+				-0.0576**				-0.0602**
				(0.0273)				(0.0274)
Observations	126,561	126,561	122,960	122,960	126,561	126,561	122,960	122,960
R-squared	0.014	0.212	0.188	0.188	0.014	0.212	0.188	0.188
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. Year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table A4: Heterogeneous Effects by Daily Family Companionship, CHARLS Measures, Female

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Female Suicide Rate, Age 65+								
		Proxy Measure for Daily Family Companionship: Average Proportion of Children Living in the Household, Age 65+				Proxy Measure for Daily Family Companionship: % Having Children Living in the Household, Age 65+			
VARIABLES									
CLNY	-0.0865**	-0.0878*	-0.0879*	-0.0935**	-0.1007*	-0.0894*	-0.0896*	-0.0948**	-0.1030**
	(0.0391)	(0.0488)	(0.0488)	(0.0472)	(0.0520)	(0.0483)	(0.0483)	(0.0469)	(0.0511)
CLNY*Average Proportion of Children Living in the Household, Age 65+		0.0165	0.0166	0.0281	0.0319				
		(0.0330)	(0.0330)	(0.0324)	(0.0347)				
Average Proportion of Children Living in the Household, Age 65+		-0.0883***							
		(0.0320)							
CLNY*% Having Children Living in the Household, Age 65+						0.0444	0.0445	0.0553	0.0656
						(0.0461)	(0.0461)	(0.0449)	(0.0474)
% Having Children Living in the Household, Age 65+						-0.0412			
						(0.0394)			
CLNY*Urban District		0.0019	0.0023	-0.0148	0.0033	0.0068	0.0074	-0.0112	0.0071
		(0.0694)	(0.0695)	(0.0677)	(0.0710)	(0.0689)	(0.0690)	(0.0678)	(0.0709)
CLNY*GDP Per Capita				-0.0549	-0.0776			-0.0534	-0.0862
				(0.0743)	(0.0877)			(0.0734)	(0.0870)
CLNY*Average Rural Income				0.0297	0.0332			0.0307	0.0382
				(0.0628)	(0.0679)			(0.0617)	(0.0667)
CLNY*Number of Hospital Per Capita				0.0044	-0.0080			0.0073	-0.0035
				(0.0315)	(0.0325)			(0.0310)	(0.0325)
CLNY*Employment Rate					0.0048				0.0136
					(0.0484)				(0.0457)
CLNY*Proportion of Immigrants, Age 65+					-0.0003				0.0140
					(0.0590)				(0.0622)
CLNY*Average Years of Schooling, Age 65+					0.0316				0.0345
					(0.0635)				(0.0609)
Observations	58,394	58,394	58,394	57,878	54,219	58,394	58,394	57,878	54,219
R-squared	0.176	0.015	0.176	0.178	0.178	0.011	0.176	0.178	0.178
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. Year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.

Table A5: Heterogeneous Effects by Daily Family Companionship, CHARLS Measures, Male

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Male Suicide Rate, Age 65+								
		Proxy Measure for Daily Family Companionship: Average Proportion of Children Living in the Household, Age 65+				Proxy Measure for Daily Family Companionship: % Having Children Living in the Household, Age 65+			
VARIABLES									
CLNY	-0.1347***	-0.1500***	-0.1506***	-0.1941***	-0.2046***	-0.1487***	-0.1494***	-0.1920***	-0.2054***
	(0.0362)	(0.0454)	(0.0454)	(0.0454)	(0.0472)	(0.0456)	(0.0456)	(0.0455)	(0.0472)
CLNY*Average Proportion of Children Living in the Household, Age 65+		0.0499*	0.0503*	0.0592**	0.0591**				
		(0.0291)	(0.0291)	(0.0284)	(0.0289)				
Average Proportion of Children Living in the Household, Age 65+		-0.1120***							
		(0.0386)							
CLNY*% Having Children Living in the Household, Age 65+						0.0250	0.0252	0.0317	0.0325
						(0.0334)	(0.0334)	(0.0331)	(0.0339)
% Having Children Living in the Household, Age 65+						-0.0605			
						(0.0459)			
CLNY*Urban District		0.0367	0.0384	0.0669	0.0532	0.0373	0.0391	0.0662	0.0525
		(0.0673)	(0.0673)	(0.0700)	(0.0721)	(0.0681)	(0.0681)	(0.0709)	(0.0729)
CLNY*GDP Per Capita				-0.2717***	-0.2924***			-0.2618***	-0.2888***
				(0.0863)	(0.1056)			(0.0869)	(0.1070)
CLNY*Average Rural Income				0.2319***	0.2705***			0.2267***	0.2686***
				(0.0734)	(0.0818)			(0.0740)	(0.0825)
CLNY*Number of Hospital Per Capita				0.0284	0.0400			0.0258	0.0343
				(0.0376)	(0.0383)			(0.0380)	(0.0389)
CLNY*Employment Rate					-0.0150				-0.0093
					(0.0425)				(0.0420)
CLNY*Proportion of Immigrants, Age 65+					-0.0134				-0.0190
					(0.0746)				(0.0760)
CLNY*Average Years of Schooling, Age 65+					-0.0233				-0.0097
					(0.0504)				(0.0508)
Observations	58,394	58,394	58,394	57,878	54,219	58,394	58,394	57,878	54,219
R-squared	0.208	0.020	0.208	0.209	0.210	0.017	0.208	0.209	0.210
Population Weight	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-of-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the inverse hyperbolic sine of suicide cases per 1 million people. Year fixed effects, month fixed effects and week-of-month fixed effects are included as controls. The regression is weighted by county population. Standard errors are clustered at county level.