



# Psychological distress and completed suicide in Japan: A comparison of the impact of moderate and severe psychological distress

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## ABSTRACT

It has already been established that severe psychological distress is a major risk factor for completed suicide. However, the impact (population attributable fraction; PAF) of moderate psychological distress on completed suicide has not been clarified. The present study investigated the association between various severities of psychological distress and completed suicide. We analyzed follow-up data covering a 7.3-year period (2006–2014) for 43,473 adults (aged  $\geq 40$  years) participating in a community-based, prospective cohort study. Psychological distress was measured using the K6 psychological distress scale at the baseline. Participants were classified into three groups according to their K6 score (low: 0–4; moderate: 5–12; severe: 13–24). Completed suicide was determined from a Japanese national database. The Cox model was used to estimate hazard ratios (HRs) for completed suicide. The PAFs of moderate and severe psychological distress for completed suicide were also estimated. The multivariate-adjusted HRs (95% confidence interval) for completed suicide were 2.37 (1.49–3.78) among participants with moderate psychological distress, and 4.16 (2.13–8.15) among those with severe psychological distress, relative to those with low psychological distress ( $P$  for trend  $< 0.001$ ). The PAF of the moderate group for completed suicide was 26.8%, whereas that of the severe group was 10.9%. Not only severe but also moderate psychological distress was significantly associated with an increased risk of completed suicide. The PAF of moderate psychological distress for completed suicide was larger than that of severe psychological distress. Public health actions for suicide prevention should focus on moderate as well as severe psychological distress.

## 1. Introduction

The suicide rate in Japan (16.8 per 100,000 person-years in 2016) is among the highest in the world (Statistics and Information Department Minister's Secretariat Ministry of Health Labour and Welfare Japan, 2017). According to data from the World Health Organization (WHO) for the period 2013–2015, the suicide rate in Japan ranked sixth in the world, being especially high among the developed countries (World Health Organization, 2017). In fact in Japan, suicide is the second to fourth leading cause of death among middle-aged adults aged 40 to 64 years (Statistics and Information Department Minister's Secretariat Ministry of Health Labour and Welfare Japan, 2017). Thus, public health action for suicide prevention is an important issue in Japan.

It has been generally acknowledged that psychological illness including clinical depression is a major risk factor for completed suicide (Walker et al., 2015). Accordingly, public health action for suicide prevention has focused on individuals with severe psychological

distress (Zalsman et al., 2016). Only one previous study has investigated the association between various severities of psychological distress and completed suicide in a general population (Bell et al., 2015). That study reported that not only severe but also moderate psychological distress was associated with an increased risk of completed suicide. Additionally, in the case of Japan, it has been reported that the prevalence of moderate psychological distress (23.1%) is approximately 7 times higher than that of severe psychological distress (3.5%) among adults aged 40 years and older (Ministry of Health, Labour and Welfare, Japan, 2017). Therefore, the population attributable fraction (PAF) of moderate psychological distress for completed suicide may be higher than that of severe psychological distress because the prevalence of the former is higher than that of the latter, even if the relative risk is lower for the former. Accordingly, the impact of moderate psychological distress on completed suicide may be larger than that of severe psychological distress. One previous systematic review has estimated the PAF of mental disorders (severe psychological

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distress) for completed suicide using data from case-control studies (Cavanagh et al., 2003). To our knowledge, however, no study has investigated the impact of various severities of psychological distress on suicide risk in the general population. Here we propose two hypotheses: 1. Not only severe but also moderate psychological distress is associated with an increased risk of completed suicide in the general population; and 2. the impact of moderate psychological distress on completed suicide is larger than that of severe psychological distress. Confirmation of these possibilities would facilitate future planning for suicide prevention.

The aim of the present population-based prospective cohort study was to investigate whether various severities of psychological distress are associated with an increased risk of completed suicide, and to compare the impact of moderate psychological distress on completed suicide with that of severe psychological distress.

## 2. Methods

### 2.1. Study cohort

The design of the Ohsaki Cohort 2006 Study has been described in detail elsewhere (Kuriyama et al., 2010). In brief, the source population for the baseline survey comprised all older citizens living in Ohsaki City, Miyagi Prefecture, northeastern Japan, on December 1, 2006, i.e. 78,101 men and women aged  $\geq 40$  years. The survey included questions about psychological distress, as well as items on history of disease, education level, smoking, alcohol drinking and time spent walking per day. The baseline survey was conducted between December 1 and December 15, 2006. A questionnaire was distributed by the heads of individual administrative districts, and then collected by mail. For this analysis, 49,603 individuals who provided valid responses formed the study cohort (response rate: 63.5%). We excluded 18 persons who had died or moved away during the period of the baseline survey and 6112 persons who had not entered responses for psychological distress. Thus, 43,473 individuals were analyzed for the purpose of this study.

During the 7.3-year period covered by the study, 1176 individuals were lost to follow-up because they moved away from the study area; thus, the follow-up rate was 97.3%.

### 2.2. Exposure measurement

The main exposure was psychological distress, as measured by the Kessler 6-item psychological distress scale (K6) (Kessler et al., 2002). The Japanese version of the K6 has been validated previously (Furukawa et al., 2008). The K6 consists of six questions about how often an individual has felt the following in the previous month: 1) nervous, 2) hopeless, 3) restless or fidgety, 4) so sad that nothing could cheer you up, 5) everything was an effort, and 6) worthless. The total K6 score ranged from 0 to 24. In previous studies, cut-off points of 5 and 13 have been commonly used to screen for moderate and severe psychological stress, respectively (Prochaska et al., 2012; Sakurai et al., 2011; Watanabe et al., 2016; Yokoyama et al., 2014). Therefore, we classified participants into three groups according to their K6 score (low: 0–4, moderate: 5–12, severe: 13–24).

### 2.3. Follow-up and case details

The end-point was completed suicide. We followed up the participants for mortality and emigration by reviewing the Residential Registry Record of Ohsaki City from 16 December 2006 to 31 March 2014. To determine the causes of death for decedents, we used the National Vital Statistics Database of Japan with permission from the Ministry of Health, Labour and Welfare, Japan. Cause of death was classified according to the International Classification of Diseases, 10th revision (ICD-10) (World Health Organization, 1992). Death due to suicide was identified as ICD-10: X60–X84.

### 2.4. Ethical issues

We considered the return of completed questionnaires to imply consent to participate in the study involving the baseline survey data and subsequent follow-up of death and emigration. The Ethics Committee of Tohoku University Graduate School of Medicine (Sendai, Japan) reviewed and approved the study protocol.

### 2.5. Statistical analysis

We counted the person-years of follow-up for each participant from 16 December 2006 until the date of death, date of emigration from the study area, or the end of the study period (31 March 2014), whichever occurred first.

First, we examined the Schoenfeld residuals to confirm that the proportional hazards assumption had not been violated, and found no important departures. We used the Cox proportional hazards model to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) of completed suicide according to each group of psychological distress, treating the low psychological distress group as the reference group. For cases where values for a confounding variable were missing, we created a separate missing category and included this in the model. To test for linear trends, we also entered the categories of psychological distress as ordinal numbers (low, moderate, or severe: 1, 2, or 3) in the corresponding Cox proportional hazards model. In these analyses, we considered the following variables as covariates in accordance with the existing literature (Bell et al., 2015): age (continuous variable), sex, medical history (cancer, stroke, or myocardial infarction), smoking status (never, ever, currently, or missing), drinking status (never, ever, currently, or missing), time spent walking per day ( $< 0.5$  h,  $0.5$ – $1$  h,  $\geq 1$  h, or missing) and education level (junior high school or less, high school, college/university or higher, or missing). We also estimated the shape of the continuous relationship between psychological distress and completed suicide using penalized splines (P-splines) in which automatic selection criteria for deciding the optimal degree of smoothing (or equivalently, the optimal degrees of freedom) with P-splines were implemented (Meira-Machado et al., 2013).

We estimated the population attributable fractions (PAFs) of moderate and severe psychological distress for completed suicide. PAF was calculated as:  $P \times (\text{multivariate HR} - 1) / \text{multivariate HR}$ , where  $P$  = proportion of cases arising from the each psychological distress group (Azimi et al., 2015; Rockhill et al., 1998).

All data were analyzed using SAS version 9.4 (SAS Institute Inc.), and P-splines were drawn by R version 3.2.1. All statistical tests were 2-sided, and differences at  $p < 0.05$  were accepted as significant.

## 3. Results

During a mean follow-up period of 6.8 years of follow-up (297,041 person-years), 84 deaths due to suicide were certified (suicide rate 28.3 per 100,000 person-years).

Baseline characteristics according to each psychological distress group are shown in Table 1. The number of participants with moderate and severe psychological distress was 14,322 (32.9%) and 2908 (6.7%), respectively. Participants with severe psychological distress were more likely to be younger, to be female, to have a history of stroke, myocardial infarction or cancer, to be current smokers, and to have a higher education level. Additionally, participants with severe psychological distress were less likely to be current drinkers and to walk  $\geq 1$  h/day.

The association between psychological distress and completed suicide is shown in Table 2. The multivariate HRs (95% CIs) for completed suicide were 2.37 (1.49–3.78) among participants with moderate psychological distress (K6 score: 5–12), and 4.16 (2.13–8.15) for those with severe psychological distress (K6 score:  $\geq 13$ ), relative to those with low psychological distress (K6 score:  $\leq 4$ ) (P-trend  $< 0.001$ ).

Fig. 1 shows the continuous association of psychological distress

**Table 1**

Baseline characteristics of the study participants according to the degree of psychological distress. (N = 43,473).

	Psychological distress (K6 score)		
	Low ( $\leq 4$ )	Moderate (5–12)	Severe ( $\geq 13$ )
No. of subjects	26,243	14,322	2908
Mean age years (SD)	62.1 (12.2)	61.2 (12.9)	61.8 (14.1)
Sex (%)			
Men	47.9	44.4	39.2
Women	52.1	55.6	60.8
Medical history (%)			
Stroke	1.9	2.6	5.3
Myocardial infarction	2.2	3.1	4.2
Cancer	5.2	5.8	7.7
Smoking status (%)			
Never	54.3	54.2	53.6
Ever	22.7	21.3	20.3
Currently	23.0	24.5	26.1
Drinking status (%)			
Never	40.9	40.9	43.2
Ever	7.6	9.6	14.7
Currently	51.5	49.5	42.1
Time spent walking (%)			
$\geq 1$ h/day	29.9	25.8	23.5
0.5–1 h/day	34.7	32.0	25.4
$\leq 0.5$ h/day	35.4	42.2	51.1
Educational levels (%) <sup>a</sup>			
$\leq 15$ years	30.5	29.8	25.0
16–18 years	51.4	51.4	50.8
$\geq 19$ years	18.1	18.8	24.2

Note: SD = standard deviation.

We used  $\chi^2$  test for variables of proportion and one-factor ANOVA for continuous variables (missing value excluded).

<sup>a</sup>Age at last school graduation.

**Table 2**

The association between psychological distress and completed suicide, the Ohsaki Cohort 2006, Japan, 2006–2014 (N = 43,473).

	Psychological distress (K6 score)			p-trend <sup>a</sup>
	Low ( $\leq 4$ )	Moderate (5–12)	Severe ( $\geq 13$ )	
Person-years	180,892	97,392	18,757	
Number of completed suicide	33	39	12	
Suicide rate/100,000 person-years	18.2	40.0	64.0	
Crude HR	1.00	2.19 (1.38–3.49)	3.49 (1.81–6.76)	< 0.001
Age-sex adjusted HR (95% CIs)	1.00	2.32 (1.46–3.70)	3.99 (2.06–7.74)	< 0.001
Multivariate HR (95% CIs) <sup>b</sup>	1.00	2.37 (1.49–3.78)	4.16 (2.13–8.15)	< 0.001

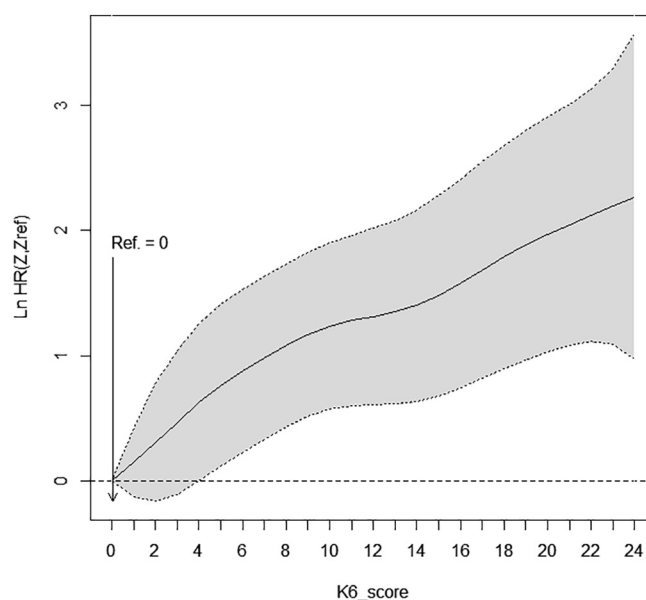
Notes: HR = Hazard ratio; CI = Confidence interval.

<sup>a</sup> Linear trend tests were calculated by treating K6 scores as categorical variables.

<sup>b</sup> Multivariate model was adjusted for age, sex, history of disease (absence or presence), smoking status (never, ever, currently, or missing), drinking status (never, ever, currently, or missing), walking time ( $< 0.5$ , 0.5–1,  $\geq 1$  h/day, or missing) and educational levels ( $\leq 15$  years, 16–18 years,  $\geq 19$  years, or missing).

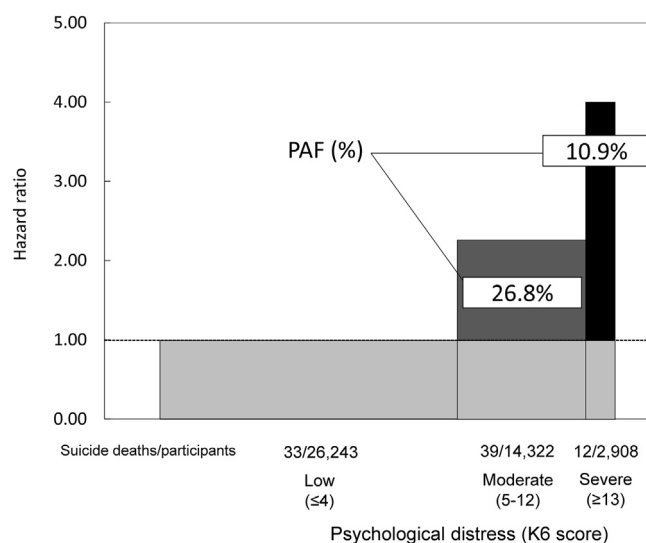
with completed suicide. We observed a dose-response relationship between psychological distress and completed suicide; the suicide risk was significantly higher for participants having a K6 score of 4–5 or more.

Fig. 2 shows the PAFs of moderate and severe psychological distress for completed suicide; the PAF of the moderate group was 26.8%, whereas that of the severe group was 10.9%.



**Fig. 1.** The continuous relationship between psychological distress and completed suicide among 43,473 adults, the Ohsaki Cohort 2006, Japan (2006–2014).

Abbreviation: HR, hazard ratio.



**Fig. 2.** Population attributable fraction (PAF) of moderate and severe psychological distress for completed suicide, the Ohsaki Cohort 2006, Japan, 2006–2014 (N = 43,473).

#### 4. Discussion

We investigated the association between various severities of psychological distress and completed suicide in a population-based prospective cohort study in Japan. We found that not only severe but also moderate psychological distress was associated with an increased risk of completed suicide. When we considered the continuous relationship between psychological distress and completed suicide using P-splines, the suicide risk was significantly higher for participants with a K6 score of 4–5 or more. The PAF for completed suicide in participants with moderate psychological distress (26.8%) was approximately 2.5 times larger than for participants with severe psychological distress (10.9%). This is the first study to have examined the impact (PAF) of moderate and severe psychological distress on completed suicide in a general population.

A previous study has reported a dose-relationship between psychological distress symptom severity, measured by the 12-item General Health Questionnaire, and suicide risk in the general population (Bell et al., 2015). That study showed that not only severe but also moderate psychological distress was associated with an increased risk of completed suicide, and that moderate or more severe psychological distress was associated with a stepwise elevation of the suicide risk. Our present findings were consistent with those results. However, the previous study did not examine the PAF of psychological distress for completed suicide.

Two national projects for suicide prevention have been conducted in Japan (Kawanishi et al., 2014; Ono et al., 2013). One project targeted individuals who had attempted suicide, and aimed to reduce repetition as a high-risk approach (Kawanishi et al., 2014). It was effective at reducing the incidence of repeated suicide attempts for up to 6 months, but not in the long term. The other project screened individuals with severe psychological distress and provided consultation services by health professionals to reduce the incident risk of attempted and completed suicide (Ono et al., 2013). It was effective at reducing the incidence of attempted suicide, but not completed suicide. These findings suggested the limitation of high-risk approach for suicide prevention. In the present study, the PAF of moderate psychological distress (26.8%) for completed suicide was higher than that of severe psychological distress (10.9%). This result suggested that a population approach for suicide prevention in the whole society in addition to high-risk approach would be necessary. For example, the Japanese government launched a new national policy from December 2015 called the Stress Check Program, which screens for workers with psychosocial stress in the workplace (Ministry of Health, Labour and Welfare, Japan, 2016; Kawakami and Tsutsumi, 2016). Kawakami and Tsutsumi have suggested that some components in addition to this program, such as improvement in the work environmental and the provision of stress management skills, might be effective for reducing psychosocial stress (Kawakami and Tsutsumi, 2016). The effect of this program in preventing psychological distress and suicide should be further researched, although the program has a limitation in that it targets only workers, and not unemployed and self-employed individuals.

The PAF estimates are calculated on the basis of not only relative risk but also prevalence. In the present study, the prevalence of severe psychological distress was 6.7% and that of moderate psychological distress was 32.9%. On the other hand, a Japanese nationally representative survey (2010) conducted at the time closest to our baseline survey found that the prevalence of severe psychological distress was 3.1% and that of moderate psychological distress was 18.6% among adults aged 40 years and older (Ministry of Health, Labour and Welfare, Japan, 2011). However, even when, using Norton's method (Norton et al., 2014), we estimated the PAFs of moderate and severe psychological distress for completed suicide using these prevalence values from the national survey (Ministry of Health, Labour and Welfare, Japan, 2011), the PAF was higher for moderate (20.3%) than for severe (8.9%) psychological distress, being not appreciably different from the values obtained in the present study (26.8% and 10.9%, respectively). In the United States, the prevalence of severe psychological distress was reported to be 3.0% and 2.9% (crude and age-adjusted, respectively) in 2006 (National Center for Health Statistics, 2016). Therefore, our primary finding, i.e. that the impact of moderate psychological distress was higher than that of severe psychological distress, would not have been limited to only the present study population (or only Japanese adults), but also possibly applicable to other populations. In order to compare the impact on completed suicide between countries, there may be a need to consider the prevalence of not only severe but also moderate psychological distress.

Our study had some methodological strengths. This was the first study to have examined the impact of moderate and severe psychological distress on completed suicide in a general population. Second, we observed a dose-response relationship between psychological distress

and completed suicide; not only severe but also moderate psychological distress was associated with an increased risk of completed suicide.

This study also had some limitations. First, we did not consider all potential confounders, such as socioeconomic status and marital status related to the association between psychological distress and suicide. Second, we investigated the association among only middle-aged to elderly people. In Japan, the degree of decline in the suicide rate among adolescents and young adults is smaller than that among middle-aged to elderly people, and suicide is the leading cause of death among adolescents and young adults (Statistics and Information Department Minister's Secretariat Ministry of Health Labour and Welfare Japan, 2017). In addition, risk factors for suicide differ between older and younger adults (Turecki and Brent, 2016). Here, we were unable to examine the association between psychological distress and completed suicide among adolescents and young adults. The PAFs of moderate and severe psychological distress among younger adults may differ from those among older adults. Third, the generalizability of our findings to the overall Japanese population aged 40 years and older may be limited. This study was based on data obtained in a single city (Ohsaki City) in Japan, where the prevalence of psychological distress was greater than that found in a Japanese nationally representative survey of adults aged 40 years and older (Ministry of Health, Labour and Welfare, Japan, 2011). Finally, 63.5% of the source population participated at the baseline. Of these subjects, 6112 did not enter any response to the questions on psychological distress (K6). The mean age of individuals among the analyzed (43,473 individuals) and excluded (6112 individuals) subjects was 62.0 and 72.8 years, respectively. The present study might have been biased toward healthier individuals. However, the suicide rates among the analyzed and excluded subjects were similar: 28.3 vs. 23.3 per 100,000 person-years.

## 5. Conclusions

This study conducted in Japan has shown that not only severe but also moderate psychological distress was associated with an increased risk of completed suicide in the general population. The PAF of moderate psychological distress for completed suicide was larger than that of severe psychological distress. These results suggest that public health actions for suicide prevention should focus on moderate as well as severe psychological distress.

## Conflict of interest

The authors declare that there are no conflicts of interest.

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## References

- Azimi, S.S., Khalili, D., Hadaegh, F., Yavari, P., Mehrabi, Y., Azizi, F., 2015. Calculating population attributable fraction for cardiovascular risk factors using different methods in a population based cohort study. *J. Res. Health Sci.* 15 (1), 22–27.
- Bell, S., Russ, T.C., Kivimaki, M., Stamatakis, E., Batty, G.D., 2015. Dose-response association between psychological distress and risk of completed suicide in the general population. *JAMA Psychiatry* 72 (12), 1254–1256.
- Cavanagh, J.T., Carson, A.J., Sharpe, M., Lawrie, S.M., 2003. Psychological autopsy studies of suicide: a systematic review. *Psychol. Med.* 33 (3), 395–405.



- Furukawa, T.A., Kawakami, N., Saitoh, M., Ono, Y., Nakane, Y., Nakamura, Y., Tachimori, H., Iwata, N., Uda, H., Nakane, H., Watanabe, M., Naganuma, Y., Hata, Y., Kobayashi, M., Miyake, Y., Takeshima, T., Kikkawa, T., 2008. The performance of the Japanese version of the K6 and K10 in the world mental health survey Japan. *Int. J. Methods Psychiatr. Res.* 17 (3), 152–158.
- Kawakami, N., Tsutsumi, A., 2016. The stress check program: a new national policy for monitoring and screening psychosocial stress in the workplace in Japan. *J. Occup. Health* 58 (1), 1–6.
- Kawanishi, C., Aruga, T., Ishizuka, N., Yonemoto, N., Otsuka, K., Kamijo, Y., Okubo, Y., Ikeshita, K., Sakai, A., Miyaoka, H., Hitomi, Y., Iwakuma, A., Kinoshita, T., Akiyoshi, J., Horikawa, N., Hirotsune, H., Eto, N., Iwata, N., Kohno, M., Iwanami, A., Mimura, M., Asada, T., Hirayasu, Y., Group, A.-J., 2014. Assertive case management versus enhanced usual care for people with mental health problems who had attempted suicide and were admitted to hospital emergency departments in Japan (ACTION-J): a multicentre, randomised controlled trial. *Lancet Psychiatry* 1 (3), 193–201.
- Kessler, R.C., Andrews, G., Colpe, L.J., Hiripi, E., Mroczek, D.K., Normand, S.L.T., Walters, E.E., Zaslavsky, A.M., 2002. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol. Med.* 32 (6), 959–976.
- Kuriyama, S., Nakaya, N., Ohmori-Matsuda, K., Shimazu, T., Kikuchi, N., Kakizaki, M., Sone, T., Sato, F., Nagai, M., Sugawara, Y., Tomata, Y., Akhter, M., Higashiguchi, M., Fukuchi, N., Takahashi, H., Hozawa, A., Tsuji, I., 2010. The Ohsaki cohort 2006 study: design of study and profile of participants at baseline. *J. Epidemiol.* 20 (3), 253–258.
- Meira-Machado, L., Cadarso-Suarez, C., Gude, F., Araujo, A., 2013. smoothHR: an R package for pointwise nonparametric estimation of hazard ratio curves of continuous predictors. *Comput. Math. Methods Med.* 2013, 745742 (11 pages).
- Ministry of Health, Labour and Welfare, 2011. National Livelihood Survey in 2010. <http://www.e-stat.go.jp/SG1/estat/NewList.do?tid=000001031016>, Accessed date: 16 March 2018.
- Ministry of Health, Labour and Welfare, 2016. Implementation Manual of the Stress Check Program based on the Industrial Safety and Health Act. <https://www.mhlw.go.jp/bunya/roudoukijun/anzenisei12/pdf/150507-1.pdf>, Accessed date: 14 August 2018.
- Ministry of Health, Labour and Welfare, 2017. National Livelihood Survey in 2016. <http://www.e-stat.go.jp/SG1/estat/NewList.do?tid=000001031016>, Accessed date: 16 March 2018.
- National Center for Health Statistics, 2016. Early Release of Selected Estimates Based on Data from the 2016 National Health Interview Survey. Center for Disease Control and Prevention. <https://www.cdc.gov/nchs/nhis/index.htm>, Accessed date: 16 March 2018.
- Norton, S., Matthews, F.E., Barnes, D.E., Yaffe, K., Brayne, C., 2014. Potential for primary prevention of Alzheimer's disease: an analysis of population-based data. *Lancet Neurol.* 13 (8), 788–794.
- Ono, Y., Sakai, A., Otsuka, K., Uda, H., Oyama, H., Ishizuka, N., Awata, S., Ishida, Y., Iwasa, H., Kamei, Y., Motohashi, Y., Nakamura, J., Nishi, N., Watanabe, N., Yotsumoto, T., Nakagawa, A., Suzuki, Y., Tajima, M., Tanaka, E., Sakai, H., Yonemoto, N., 2013. Effectiveness of a multimodal community intervention program to prevent suicide and suicide attempts: a quasi-experimental study. *PLoS One* 8 (10), e74902.
- Prochaska, J.J., Sung, H.Y., Max, W., Shi, Y., Ong, M., 2012. Validity study of the K6 scale as a measure of moderate mental distress based on mental health treatment need and utilization. *Int. J. Methods Psychiatr. Res.* 21 (2), 88–97.
- Rockhill, B., Newman, B., Weinberg, C., 1998. Use and misuse of population attributable fractions. *Am. J. Public Health* 88 (1), 15–19.
- Sakurai, K., Nishi, A., Kondo, K., Yanagida, K., Kawakami, N., 2011. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. *Psychiatry Clin. Neurosci.* 65 (5), 434–441.
- Statistics and Information Department Minister's Secretariat Ministry of Health Labour and Welfare Japan, 2017. Vital Statistics of Japan 2016. Health and Welfare Statistics Association, Tokyo. [http://www.e-stat.go.jp/SG1/estat/GL08020103.do?\\_toGL08020103&listID=000001191145&requestSender=dsearch](http://www.e-stat.go.jp/SG1/estat/GL08020103.do?_toGL08020103&listID=000001191145&requestSender=dsearch), Accessed date: 16 March 2018.
- Turecki, G., Brent, D.A., 2016. Suicide and suicidal behaviour. *Lancet* 387 (10024), 1227–1239.
- Walker, E.R., McGee, R.E., Druss, B.G., 2015. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. *JAMA Psychiatr.* 72 (4), 334–341.
- Watanabe, Z., Iwama, N., Nishigori, H., Nishigori, T., Mizuno, S., Sakurai, K., Ishikuro, M., Obara, T., Tatsuta, N., Nishijima, I., Fujiwara, I., Nakai, K., Arima, T., Takeda, T., Sugawara, J., Kuriyama, S., Metoki, H., Yaegashi, N., Japan, E., Children's Study, G., 2016. Psychological distress during pregnancy in Miyagi after the Great East Japan Earthquake: the Japan environment and children's study. *J. Affect. Disord.* 190, 341–348.
- World Health Organization, 1992. International Statistical Classification of Diseases and Related Health Problems, 10th Revision. World Health Organization, Geneva.
- World Health Organization, 2017. Suicide Rates, Age-Standardized Data by Country. <http://apps.who.int/gho/data/node.main.MHSUICIDEASDR?lang=en>, Accessed date: 16 March 2018.
- Yokoyama, Y., Otsuka, K., Kawakami, N., Kobayashi, S., Ogawa, A., Tannno, K., Onoda, T., Yaegashi, Y., Sakata, K., 2014. Mental health and related factors after the Great East Japan earthquake and tsunami. *PLoS One* 9 (7), e102497.
- Zalsman, G., Hawton, K., Wasserman, D., van Heeringen, K., Arensman, E., Sarchiapone, M., Carli, V., Hoschl, C., Barzilay, R., Balazs, J., Purebl, G., Kahn, J.P., Saiz, P.A., Lipsicas, C.B., Bobes, J., Cozman, D., Hegerl, U., Zohar, J., 2016. Suicide prevention strategies revisited: 10-year systematic review. *Lancet Psychiatry* 3 (7), 646–659.