OBSERVATIONAL STUDY

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Incidence of Major Depressive Disorder: Variation by Age and Sex in Low-Income Individuals

A Population-Based 10-Year Follow-Up Study

Chun-Te Lee, MD, PhD, Yi-Cheng Chiang, PhD, Jing-Yang Huang, MSc,
Disline M. Tantoh, MPhil, Oswald N. Nfor, DVM, MSc, Jia-Fu Lee, MD, PhD,
Cheng-Chen Chang, MD, and Yung-Po Liaw, PhD

Abstract: Major depressive disorder (MDD), the most prevalent mental disorder is a global public health issue.

The aim of this study was to assess the association between low income and major depressive disorder (MDD) by age and sex.

The National Health Insurance Research Database (NHIRD) of Taiwan was used to retrieve data. A total of 1,743,948 participants were eligible for the study. Low-income individuals were identified from 2001 and 2003 (specifically, Group Insurance Applicants, ie, category''51'' or ''52'') and followed from 2004 to 2010. MDD was identified using the *ICD-9-CM* 296.2 and 296.3 codes.

Among non-low-income individuals, the MDD incidence rates increased with age in both males and females, that is, 0.35, 0.93, 0.97, 1.40 per 10,000 person-months for males and 0.41, 1.60, 1.89, 1.95 per 10,000 person-months for females aged 0 to 17, 18 to 44, 45 to 64, and ≥65 years, respectively. Low-income females (18–44 years) and males (45–64 years) had the highest incidence of MDD, which was 3.90 and 3.04, respectively, per 10,000 person-months. Among low and non-low-income individuals, the MDD incidence rates were higher in the females than males in all age groups. Males aged 45 to 64 and 0 to 17 years had highest hazard ratios (HR) of 2.789 (95% confidence interval [CI], 1.937–4.014) and 2.446 (95% CI, 1.603–3.732), respectively. The highest HRs for females were 2.663 (95% CI, 1.878–3.775) and 2.219 (CI, 1.821–2.705) in the 0 to 17 and 18- to 44-year age groups. Low income was not found to serve as a risk factor for the development of MDD in males and females aged ≥65 years.

Among the non-low-income males and females, the incidence rates of MDD were found to increase with age. Low income was found to serve as a significant risk factor for MDD only in individuals under age 65.

From the Department of Psychiatry (C-TL); School of Medicine (C-TL); Department of Public Health and Institute of Public Health (Y-CC, J-YH, DMT, ONN, Y-PL); Department of Family and Community Medicine (Y-PL), Chung Shan Medical University Hospital, Taichung; Department of Psychiatry (J-FL), Taipei Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Taipei; School of Medicine (J-FL), Tzu Chi University, Hualien; Institute of Medicine (C-CC), Chung Shan Medical University, Taichung; and Department of Psychiatry (C-CC), Changhua Christian Hospital, Changhua, Taiwan.
Correspondence: Yung-Po Liaw, Department of Public Health and Institute of Public Health, Chung Shan Medical University; Department of Family and Community Medicine, Chung Shan Medical University Hospital, No. 110, Sec. 1 Jianguo N. Rd., Taichung City, Taiwan (e-mail: Liawyp@csmu.edu.tw).
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Abbreviations: CI = confidence interval, HR = hazard ratio, ICD-9-CM = International Classification of Disease Revision 9 Clinical Modification, LHID = Longitudinal Health Database, MDD = major depressive disorder, NHIRD = National Health Insurance Research Database.

INTRODUCTION

Depression is an important public health issue.[1] Globally, major depressive disorder (MDD) is the most prevalent mental disorder which is often long-lived, causing substantial impairment.[2–4] In 1996, the prevalence of MDD in Taiwan and Korea was 0.8% and 2.3%, respectively, whereas that in western countries ranged from 3.0% in the United States to 5.8% in New Zealand.[5] A cross-national study carried out in 10 countries across America, Europe, and Asia in 2003 estimated lifetime prevalence of MDD, which ranged from 3.0% in Japan (Asia) to 16.9% in the United States (North America).[6] Several cross-sectional studies have associated low income with MDD.[7–9] For instance, low levels of household income were associated with a number of lifetime mental disorders.[10] Furthermore, a large-scale, cross-sectional epidemiological study on MDD among urban and rural residents in Beijing found low family income and female sex, among others, as independent risk factors of MDD.[11] However, large-scale cohort studies on the relationship between low income and MDD have rarely been conducted. Therefore, this study aimed at conducting a population-based 10-year follow-up study to explore the association between low income and MDD by age and sex.

MATERIALS AND METHODS

The primary data source was the National Health Insurance Research Database (NHIRD). Participants' informations were obtained from 2001 to 2010 using the Longitudinal Health Insurance Databases (LHID 2005 and 2010), each comprising 1 million individuals. The NHIRD contains detailed healthcare data of >25 million enrollees, representing >99% of Taiwan's population. Low-income individuals (specifically, Group Insurance Applicants, ie, a category "51" or "52") were identified from 2001 and 2003.

All inpatients and outpatients with depressive disorders were identified using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. Specifically, codes 296.2 and 296.3 were used to identify MDD. Individuals diagnosed with MDD from 2001 to 2003 were excluded from the analysis. Also excluded were 20,689

TABLE 1. Demographic Characteristics of Low and Non-low-income Individuals From 2001 to 2003 (n = 1,743,948)

Variables	Non-low-income Households (n = 1,728,531)	Low-income Households (n = 15,417)	P
Sex			<0.0001
Male	854,106 (49.41%)	7247 (47.01%)	
Female	874,425 (50.59%)	8170 (52.99%)	
Age in 2003, y			<0.0001
0–17	424,651 (24.57%)	6760 (43.85%)	
18–44	790,102 (45.71%)	5068 (32.87%)	
45–64	375,091 (21.70%)	2113 (13.71%)	
≥65	138,687 (8.02%)	1476 (9.57%)	
Geographical location			<0.0001
Taipei area	632,389 (36.59%)	5209 (33.79%)	
North area	240,477 (13.91%)	1356 (8.80%)	
Central area	320,535 (18.54%)	2126 (13.79%)	
South area-1	241,995 (14.00%)	1983 (12.86%)	
South area-2	255,773 (14.80%)	3122 (20.25%)	
East area	37,362 (2.16%)	1621 (10.51%)	
Urbanization level			<0.0001
Urban	1,068,073 (61.79%)	7175 (46.54%)	
Normal	513,147 (29.69%)	4804 (31.16%)	
Rural	147,311 (8.52%)	3438 (22.30%)	
Charlson comorbidity index			<0.0001
0–1	1,422,407 (82.29%)	12,475 (80.92%)	
2–7	294,171 (17.02%)	2823 (18.31%)	
≥8	11,953 (0.69%)	119 (0.77%)	
Diagnosed MDD 2004–2010	15,988 (0.92%)	267 (1.73%)	<0.0001

MDD = major depressive disorder.

individuals whose income status changed from non-low to low from 2004 to 2010. The Institutional Review Board of Chung Shan Medical University Hospital, Taichung City, Taiwan, approved this study.

χ^2 was used to analyze nominal variables and to compare the proportion of low and non-low-income individuals. Cox proportional hazard model was used to investigate the hazard ratio (HR) of MDD in low-income individuals. Adjustments were made for age, geographic location, urbanization level, and Charlson comorbidity index. The proportional assumption of Cox regression models was tested. Statistical analyses were performed using the SAS 9.3 statistical software (SAS Institute, Cary, NC).

RESULTS

The demographic characteristics of low-income and non-low-income individuals are shown in Table 1. Eligible for the study were 15,417 low-income individuals (7247 males and 8170 females) and 1,728,531 non-low-income individuals (854,106 males and 874,425 females) from 2001 to 2003. The proportion of low-income females (52.99%) was significantly higher than their non-low-income counterparts (50.59%). However, the proportion of non-low-income males (49.41%) was significantly higher than their low-income counterparts (47.01%). Among the various age groups, the proportions of low- and high-income individuals were significantly different. The proportion of non-low-income individuals aged 18 to 44 years was significantly higher than that of other age groups. However, the proportion of low-income individuals aged 0 to 17 years (43.85%) was significantly higher when compared with other age groups. Considering the geographical location,

urbanization level, and Charlson comorbidity index, the proportion of low-income individuals differed significantly when compared with their non-low-income counterparts. From 2004 to 2008, the proportion of low-income individuals diagnosed with MDD (1.73%) was significantly higher than non-low-income individuals (0.92%).

Table 2 shows the incidence rates of MDD in the non-low-income and low-income patients categorized by age and sex. Among non-low-income individuals, the MDD incidence rates increased with age in both sexes. That is, 0.35, 0.93, 0.97, 1.40 per 10,000 person-months in males and 0.41, 1.60, 1.89, 1.95 per 10,000 person-months in females aged 0 to 17, 18 to 44, 45 to 64, and ≥65 years, respectively. Low-income males aged 45 to 64 years had the highest MDD incidence rate (3.04 per 10,000 person-months), followed by males aged 18 to 44 years (1.99 per 10,000 person-months), ≥65 years (1.59 per 10,000 person-months), and 0 to 17 years (0.86 per 10,000 person-months). Nonetheless, low-income females aged 18 to 44 years had the highest MDD incidence rate (3.90 per 10,000 person-months) followed by those aged 45 to 64 years (3.77 per 10, 000 person-months), ≥65 years (1.75 per 10,000 person-months) and 0 to 17 years (1.17 per 10,000 person-months). In both low- and non-low-income individuals, the MDD incidence rates were higher in females than males of all the age groups. Among non-low-income individuals, the female to male MDD incidence ratio (1.95) was highest among the age group 45 to 64 years. Among the low-income individuals, the incidence ratio was highest (1.96) among those who were 18 to 44 years old.

The proportional assumption of Cox regression models was tested. However, the output was not significant (P = 0.6987). This indicates that the effect of low income on MDD was constant over time; hence, the proportional

TABLE 2. Incidence Rate of MDD Among Low and Non-low-income Individuals From 2004 to 2010

	0–17 Years' Old		18–44 Years' Old		45–64 Years' Old		≥ 65 Years' Old	
	Non-low-income	Low-income	Non-low-income	Low-income	Non-low-income	Low-income	Non-low-income	Low-income
Male								
At risk person-months	18,091,120	267,742	31,524,766	155,415	15,328,007	98,586	5,673,832	75,382
Cases	628	23	2932	31	1490	30	794	12
Incidence rate* (95% CI)	0.35 (0.32–0.38)	0.86 (0.57–1.29)	0.93 (0.90–0.96)	1.99 (1.40–2.84)	0.97 (0.92–1.02)	3.04 (2.13–4.35)	1.40 (1.31–1.50)	1.59 (0.90–2.80)
Female								
At risk person-months	17,108,283	291,275	33,677,492	259,156	15,601,979	74,317	5,732,438	45,807
Cases	693	34	5382	101	2953	28	1116	8
Incidence rate* (95% CI)	0.41 (0.38–0.44)	1.17 (0.83–1.63)	1.60 (1.56–1.64)	3.90 (3.21–4.74)	1.89 (1.83–1.96)	3.77 (2.60–5.46)	1.95 (1.84–2.06)	1.75 (0.87–3.49)

CI = confidence interval, MDD = major depressive disorder.
*Per 10^4 person-months.

assumption of Cox regression models was met. Table 3 shows the HRs for MDD in low-income males and females in various age groups. Men aged 45–64 and 0–17 years were noted with the highest HRs of 2.789 (95% confidence interval [CI], 1.937–4.014) and 2.446 (95% CI, 1.603–3.732), respectively. Among females, the HR of MDD was found to decrease with age, that is, 2.663 (95% CI, 1.878–3.775), 2.219 (95% CI, 1.821–2.705), 1.902 (95% CI, 1.311–2.761), and 0.883 (95% CI, 0.440–1.771) among 0 to 17, 18 to 44, 45 to 64, and ≥65 years age groups, respectively. Low income was not found to serve as a risk factor of MDD in both males and females aged ≥65 years.

DISCUSSION AND CONCLUSIONS

This is the first large-scale longitudinal follow-up study to evaluate the association between low income and MDD by age and sex. In this study, income was significantly associated with MDD as opposed to some previous studies. A cross-sectional study of relatively smaller sample size (clinical depression n = 330) reported higher MDD prevalence in individuals with lower monthly income. However, income was not found to serve as a significant risk factor.[12] Moreover, in this study, the incidence but not prevalence rate was determined. In another cross-sectional study on major depression during the economic crisis in Greece, higher numbers of depressive symptoms were found in more financially strained than less-strained individuals.[7] Nonetheless, our study found an association between low income and MDD by sex and age.

Liu et al[11] found that female sex, age above 45 years, low family income, and poor family environment were independent risk factors of MDD. However, the study was not stratified by income. Interestingly, this study had more findings. For example, among low and non-low-income individuals, the MDD incidence rates were higher in females than males in all age groups. Furthermore, low income was not found to serve as a risk factor of MDD in both males and females aged ≥65 years. A previous study found age ≥64 years and low income among others as independent risk factors of MDD in diabetes patients.[13] The finding that older individuals (≥65 years' old) are not associated with depression is not surprising. This is because older adults have been shown to be more protective against depression,[14] as they seem to react less to stressors than younger adults.[15] Another finding of this study was that low-income females aged 18 to 44 years had the highest incidence of MDD, whereas those aged 0 to 17 years had the highest HR for MDD. However, in low-income males, the highest incidence rate and HR of MDD were found in individuals aged 45 to 64 years. A study conducted on Chinese adolescents showed that girls had more depressive symptoms than boys.[16] These results align with our findings wherein low-income females between the ages of 0 and 17 years had higher incidence rates and HR of MDD than males. Some possible explanations for these findings are girls have been found to experience higher levels of interpersonal stress than boys, and tend to show more anxiety and depression when confronted with interpersonal stress in the family and among peers.[17,18] The differences in depression between males and females escalate from early to late adolescence probably because girls are more likely to blame themselves for relationship problems and are more concerned about negative evaluations by peers than boys. Besides, once distressed, adolescent girls may even continue to create a more stressful environment.[17] A study conducted on adolescent girls associated body dissatisfaction and body mass index with depression.[19,20] Adolescence is a time of increased vulnerability

TABLE 3. MDD Hazard Ratios Among Low-income Patients

	0–17 Years' Old	**18–44 Years' Old**	**45–64 Years' Old**	**≥65 Years' Old**
Male				
HR (95% CI)	2.446 (1.603–3.732)	1.865 (1.307–2.662)	2.789 (1.937–4.014)	1.095 (0.619–1.938)
Female				
HR (95% CI)	2.663 (1.878–3.775)	2.219 (1.821–2.705)	1.902 (1.311–2.761)	0.883 (0.440–1.771)

Each model was adjusted for geographical location, urbanization level, and Charlson comorbidity index.
CI = confidence interval, HR = hazard ratio, MDD = major depressive disorder.

to depression. Females who may be aware of their low-income status at that stage are likely to be more predisposed to depression.

Some studies showed that women were roughly twice as likely as men to be classified as having major depression.[21–24] In such studies, however, subjects were not grouped by low income and age as in the present study. The female to male MDD incidence ratios among non-low-income individuals aged 0 to 17, 18 to 44, 45 to 64 and ≥65 years were, respectively, 1.17, 1.72, 1.95, and 1.39. Among low-income individuals, the female to male MDD incidence ratios were 1.36, 1.96, 1.24, and 1.10 for the age groups 0 to 17, 18 to 44, 45 to 64, and ≥65 years, respectively. These variations observed between females and males may be related to income and age.

In this study, we assessed the proportional assumption of the Cox regression models. The output was not significant ($P = 0.6987$). This is an indication that the effect of low income on MDD was constant over time; hence, the proportional assumption was met. Additionally, the KM-plots stratified by age and sex showed that the curves did not cross or intersect each other (figures not shown).

It is possible that the effects of income on MDD may vary over time. However, there were no data on the time-varying income variable; hence, the effects of varying income on MDD over time could not be determined. Individuals were simply divided into low and non-low-income groups. Those whose status changed from non-low to low income from 2004 to 2010 were excluded to minimize potential bias. That is, participants in the control group were those with stable income.

There were some major confounding factors that were not considered during analysis. The association between low income and MDD may have been confounded by environmental (including policy or social support system) and physiological problems (such as depression, anxiety disorders, schizophrenia, personality disorders, adjustment disorders, and family problems). However, these variables were not available and thus could not be adjusted for. This was our study limitation.

In conclusion, MDD incidence rates for the non-low-income men and women were found to increase with age. Furthermore, low-income females aged 18 to 44 years and males aged 45 to 64 years had the highest incidence of MDD. Finally, low income was found to serve as a significant risk factor of MDD only in individuals younger than 65 years.

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