

General Psychiatry

*Supplemental Appendix***Temporal trends and cohort variations of gender-specific major depressive disorders incidence in China: Analysis based on the age-period-cohort-interaction model**

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1. Statistical analysis of age-by-period interactions

In contrast to previous coding methods for comparison with reference groups, the APC-I model uses the ANOVA Effect Coding scheme, where the sum of effects for all classes is 0.^{1,2} Since the cohort effect is quantified as the offset of the age and period main effect, this coding scheme facilitates the calculation of A+P-1 cohort estimates based on A*P interaction terms.¹ The A*P matrix, composed of rows A and columns P, has an A+P-1 diagonal from the upper left to the lower right corner (see Supplementary Table 1-3). This process allows for obtaining the average deviation from the mean determined by the corresponding age and period main effect, i.e., the cohort effect.¹ In addition to the youngest and oldest cohorts, the cohort effect is calculated from the interaction terms of several ages and periods.

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2. Age-by-period interactions on major depressive disorder incidence

The cohort effect in the APC-I model is expressed as an interaction term between age and period. In this section, we will examine the age-period interaction of major depressive disorder (MDD) using age-period cross-tables and heatmaps.

Supplementary Tables 1, 2, and 3 present the age-period interaction terms of the APC-I model for MDD in the overall population, female population, and male population. Using the examples of the “Republic of China” generation (cohorts born in 1910, 1915, 1920, and 1925), the “War” generation (cohorts born in 1935, 1940, 1945, and 1950), the “Cultural Revolution” generation (cohorts born in 1955, 1960, 1965, 1970, and 1975), and the “Reform and Opening-up” generation (cohorts born in 1980, 1985, 1990, 1995, and 2000), the series of interaction coefficients on the diagonal correspond to the specific cohorts regarding their deviations from age and period main effects.

For instance, in Supplementary Table 1, from the fourth row, first column (age group 20-24 in the period 1990-94) to the ninth row, sixth column (age group 45-49 in the period 2015-19), it represents the deviation of the 1970 birth cohort from age and period main effects (0.28, 0.18, 0.06, -0.06, -0.10, and -0.02). This represents the variance that cannot be explained by age and period main effects and can be understood as the deviation of the 1970 birth cohort in a specific age or period compared to the age and period main effects of that cohort. Specifically, for the 1970 birth cohort at the age group 20-24 in the period 1990-94, there is a 31.8% increase in the incidence of depressive disorder ($e^{0.28} - 1$).

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Supplementary Table 3 Estimated age-by-period interaction terms on major depressive disorder (total population).

	Period											
	1990-94 (1)		1995-99		2000-04		2005-09		2010-14		2015-19	
	β	P value	β	P value	β	P value	β	P value	β	P value	β	P value
Age												
5-9	-0.13	<0.001	-0.11	<0.001	0.03	<0.001	0.12	<0.001	0.09	<0.001	0.01	0.033
10-14	-0.08	<0.001	-0.06	<0.001	0.07	<0.001	0.13	<0.001	0.02	<0.001	-0.08	<0.001
15-19	0.16	<0.001	0.10	<0.001	0.06	<0.001	0.00	0.864	-0.13	<0.001	-0.19	<0.001
20-24 (4)	0.28	<0.001	0.19	<0.001	0.06	<0.001	-0.09	<0.001	-0.20	<0.001	-0.22	<0.001
25-29	0.28	<0.001	0.18	<0.001	0.06	<0.001	-0.09	<0.001	-0.20	<0.001	-0.21	<0.001
30-34	0.24	<0.001	0.17	<0.001	0.06	<0.001	-0.08	<0.001	-0.19	<0.001	-0.20	<0.001
35-39	0.20	<0.001	0.14	<0.001	0.06	<0.001	-0.06	<0.001	-0.16	<0.001	-0.19	<0.001
40-44	0.12	<0.001	0.11	<0.001	0.03	<0.001	-0.04	<0.001	-0.10	<0.001	-0.12	<0.001
45-49 (9)	0.03	<0.001	0.05	<0.001	0.00	<0.001	-0.04	<0.001	-0.02	<0.001	-0.02	<0.001
50-54	-0.06	<0.001	-0.01	<0.001	-0.01	<0.001	-0.01	<0.001	0.03	<0.001	0.06	<0.001
55-59	-0.12	<0.001	-0.05	<0.001	-0.03	<0.001	0.01	<0.001	0.08	<0.001	0.11	<0.001
60-64	-0.15	<0.001	-0.07	<0.001	-0.05	<0.001	0.01	<0.001	0.11	<0.001	0.14	<0.001
65-69	-0.15	<0.001	-0.08	<0.001	-0.05	<0.001	0.01	<0.001	0.11	<0.001	0.15	<0.001
70-74	-0.14	<0.001	-0.09	<0.001	-0.06	<0.001	0.02	<0.001	0.11	<0.001	0.15	<0.001
75-79	-0.13	<0.001	-0.10	<0.001	-0.06	<0.001	0.02	<0.001	0.12	<0.001	0.16	<0.001
80-84	-0.13	<0.001	-0.11	<0.001	-0.06	<0.001	0.03	<0.001	0.12	<0.001	0.15	<0.001
85-89	-0.11	<0.001	-0.12	<0.001	-0.06	<0.001	0.03	<0.001	0.12	<0.001	0.14	<0.001
90-94	-0.10	<0.001	-0.12	<0.001	-0.07	<0.001	0.02	<0.001	0.12	<0.001	-0.14	<0.001

Note: age-period interaction terms of the APC-I model for major depressive disorders incidence are presented; orange represents the “Republic of China” generation, yellow represents the “War” generation, green represents the “Cultural Revolution” generation, and blue represents the “Reform and Opening Up” generation.

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Supplementary Table 4 Estimated age-by-period interaction terms on major depressive disorder (female population).

	Period												
	1990-94		1995-99		2000-04		2005-09		2010-14		2015-19		
	β	P value	β	P value	β	P value	β	P value	β	P value	β	P value	
Age	5-9	-0.16	<0.001	-0.12	<0.001	0.03	<0.001	0.13	<0.001	0.11	<0.001	0.01	0.055
	10-14	-0.10	<0.001	-0.07	<0.001	0.06	<0.001	0.14	<0.001	0.03	<0.001	-0.07	<0.001
	15-19	0.18	<0.001	0.10	<0.001	0.06	<0.001	-0.01	<0.001	-0.14	<0.001	-0.18	<0.001
	20-24	0.32	<0.001	0.20	<0.001	0.06	<0.001	-0.11	<0.001	-0.23	<0.001	-0.24	<0.001
	25-29	0.31	<0.001	0.18	<0.001	0.06	<0.001	-0.11	<0.001	-0.23	<0.001	-0.23	<0.001
	30-34	0.26	<0.001	0.16	<0.001	0.06	<0.001	-0.08	<0.001	-0.2	<0.001	-0.21	<0.001
	35-39	0.21	<0.001	0.13	<0.001	0.06	<0.001	-0.07	<0.001	-0.16	<0.001	-0.18	<0.001
	40-44	0.13	<0.001	0.10	<0.001	0.03	<0.001	-0.05	<0.001	-0.10	<0.001	-0.10	<0.001
	45-49	0.03	<0.001	0.04	<0.001	0.00	0.292	-0.04	<0.001	-0.02	<0.001	-0.01	<0.001
	50-54	-0.06	<0.001	-0.01	<0.001	-0.02	<0.001	-0.02	<0.001	0.03	<0.001	0.07	<0.001
	55-59	-0.13	<0.001	-0.04	<0.001	-0.03	<0.001	0.01	<0.001	0.08	<0.001	0.12	<0.001
	60-64	-0.16	<0.001	-0.07	<0.001	-0.05	<0.001	0.02	<0.001	0.11	<0.001	0.14	<0.001
	65-69	-0.16	<0.001	-0.08	<0.001	-0.05	<0.001	0.02	<0.001	0.12	<0.001	0.15	<0.001
	70-74	-0.16	<0.001	-0.09	<0.001	-0.06	<0.001	0.03	<0.001	0.12	<0.001	0.15	<0.001
	75-79	-0.16	<0.001	-0.10	<0.001	-0.06	<0.001	0.03	<0.001	0.13	<0.001	0.16	<0.001
	80-84	-0.15	<0.001	-0.11	<0.001	-0.06	<0.001	0.04	<0.001	0.13	<0.001	0.15	<0.001
	85-89	-0.13	<0.001	-0.11	<0.001	-0.06	<0.001	0.04	<0.001	0.12	<0.001	0.14	<0.001
	90-94	-0.11	<0.001	-0.11	<0.001	-0.05	<0.001	0.04	<0.001	0.11	<0.001	-0.12	<0.001

Note: age-period interaction terms of the APC-I model for major depressive disorders incidence are presented; orange represents the “Republic of China” generation, yellow represents the “War” generation, green represents the “Cultural Revolution” generation, and blue represents the “Reform and Opening Up” generation.

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Supplementary Table 5 Estimated age-by-period interaction terms on major depressive disorder (male population).

	Period												
	1990-94		1995-99		2000-04		2005-09		2010-14		2015-19		
	β	P value	β	P value	β	P value	β	P value	β	P value	β	P value	
Age	5-9	-0.11	<0.001	-0.12	<0.001	0.03	<0.001	0.11	<0.001	0.07	<0.001	0.02	0.005
	10-14	-0.08	<0.001	-0.06	<0.001	0.08	<0.001	0.14	<0.001	0.01	0.009	-0.08	<0.001
	15-19	0.11	<0.001	0.09	<0.001	0.07	<0.001	0.02	<0.001	-0.11	<0.001	-0.16	<0.001
	20-24	0.21	<0.001	0.17	<0.001	0.05	<0.001	-0.07	<0.001	-0.17	<0.001	-0.19	<0.001
	25-29	0.23	<0.001	0.18	<0.001	0.04	<0.001	-0.08	<0.001	-0.18	<0.001	-0.19	<0.001
	30-34	0.21	<0.001	0.17	<0.001	0.05	<0.001	-0.07	<0.001	-0.18	<0.001	-0.19	<0.001
	35-39	0.19	<0.001	0.16	<0.001	0.06	<0.001	-0.05	<0.001	-0.16	<0.001	-0.20	<0.001
	40-44	0.13	<0.001	0.13	<0.001	0.04	<0.001	-0.04	<0.001	-0.11	<0.001	-0.15	<0.001
	45-49	0.04	<0.001	0.06	<0.001	0.01	<0.001	-0.03	<0.001	-0.04	<0.001	-0.04	<0.001
	50-54	-0.04	<0.001	0.01	<0.001	-0.01	<0.001	-0.01	<0.001	0.02	<0.001	0.04	<0.001
	55-59	-0.10	<0.001	-0.03	<0.001	-0.02	<0.001	0.00	0.001	0.06	<0.001	0.09	<0.001
	60-64	-0.13	<0.001	-0.06	<0.001	-0.04	<0.001	0.01	<0.001	0.10	<0.001	0.13	<0.001
	65-69	-0.13	<0.001	-0.09	<0.001	-0.04	<0.001	0.01	<0.001	0.10	<0.001	0.14	<0.001
	70-74	-0.13	<0.001	-0.10	<0.001	-0.05	<0.001	0.02	<0.001	0.11	<0.001	0.16	<0.001
	75-79	-0.13	<0.001	-0.12	<0.001	-0.06	<0.001	0.02	<0.001	0.12	<0.001	0.17	<0.001
	80-84	-0.11	<0.001	-0.13	<0.001	-0.07	<0.001	0.02	<0.001	0.12	<0.001	0.17	<0.001
	85-89	-0.08	<0.001	-0.13	<0.001	-0.07	<0.001	0.01	0.002	0.12	<0.001	0.15	<0.001
	90-94	-0.06	<0.001	-0.13	<0.001	-0.07	<0.001	0.01	0.495	0.11	<0.001	-0.15	<0.001

Note: age-period interaction terms of the APC-I model for major depressive disorders incidence are presented; orange represents the “Republic of China” generation, yellow represents the “War” generation, green represents the “Cultural Revolution” generation, and blue represents the “Reform and Opening Up” generation.

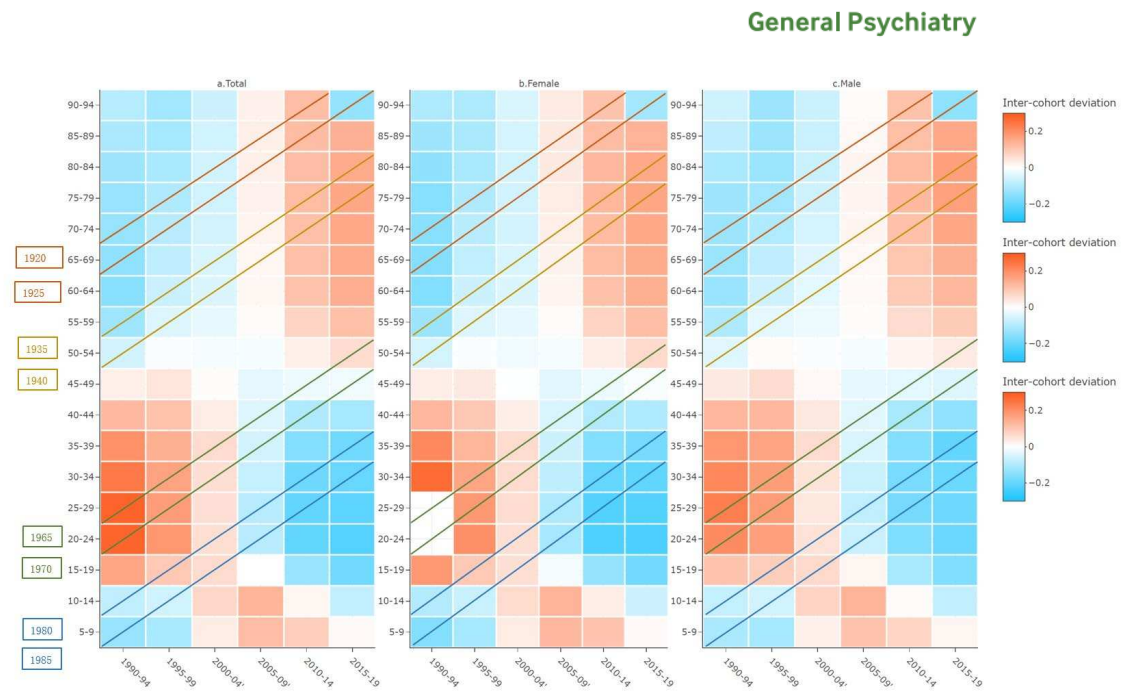
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3. Heat map of MDD categorized by age and period interaction

Supplementary Figure 2 presents a heat map of MDD categorized by age and period interaction. The diagonal of the heat map represents different birth cohorts. We have highlighted two birth cohorts for each of the “Republic of China” generation, “War” generation, “Cultural Revolution” generation, and “Reform and Opening-up” generation, namely the cohorts born in 1920 and 1925, 1935 and 1940, 1965 and 1970, and 1980 and 1985. Each cell visualizes the symbols and numerical values of the interaction terms from Supplementary Table 1, 2, and 3. Orange cells indicate depressive disorder rates higher than the expected values, while blue cells indicate rates lower than the expected values. The darker the cell color, the larger the absolute value of the depressive disorder rate, and the lighter the color, the smaller the absolute value of the depressive disorder rate.

It is evident that the cohorts born in 1920 and 1925 are in the elderly stage of life across all six observed periods. As time progresses, they transition from depressive disorder rates below the expected to slightly above the expected rates. The cohorts born in 1935 and 1940 transition from the middle age to the elderly stage of life across the six observed periods, with depressive disorder rates shifting from below the expected to above the expected rates. The cohorts born in 1965 and 1970 transition from youth to middle age across the six observed periods, with depressive disorder rates initially significantly above the expected values, transitioning to slightly above or below the expected rates. The cohorts born in 1980 and 1985 transition from childhood to adolescence across the six observed periods, with depressive disorder rates initially slightly below the expected rates, then transitioning to slightly above the expected rates, and eventually dropping far below the expected rates.

It is noteworthy that the cohort born in 1950 of the “war” cohort (at the age group 40-44 in the period 1990-94) and the cohort born in 1955 of the “Cultural Revolution” cohort (at the age group 35-40 in the period 1990-94) consistently exhibit depressive disorder rates higher than the expected values.



Supplementary Figure 2 Estimated age-by-period deviations from the mean incidence of major depressive disorder.

Note: Orange represents the “Republic of China” generation, yellow represents the “War” generation, green represents the “Cultural Revolution” generation, and blue represents the “Reform and Opening Up” generation. “Republic of China” generation: 1920 cohort and 1925 cohort; “War” generation: 1935 cohort and 1940 cohort; “Cultural Revolution” generation: 1965 cohort and 1970 cohort; “Reform and Opening Up” generation: 1980 cohort and 1985 cohort.

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4. Generational patterns and shifts of MDD incidence

It is noteworthy that understanding the intra-cohort life-course dynamics needs to be combined with inter-cohort deviations.² In the “Republican of China” generation, the incidence for all genders demonstrates a pattern of age-as-level. The estimated coefficients of the inter-cohort deviation are negative, indicating that the incidence of MDD is significantly lower than the expected value. However, the estimated coefficients of the intra-cohort slope are positive and significant, indicating that the incidence of MDD for cohorts increases with time. Age plays a balancing or turning role and the compensatory effect is achieved. In other words, although the risk of MDD in the “Republican of China” generation is significantly lower than the expected value, as the cohorts age, the internal risk of MDD for the cohorts continue to rise.

In the “War” generation, the incidence for all genders exhibits a pattern of cumulative disadvantage, with the risk of MDD significantly higher than the expected value. Additionally, as the cohorts age, the incidence of MDD for the cohorts also continue to rise and the risk of MDD accumulates over the life course.

In the “Cultural Revolution” generation, the incidence for all genders presents a pattern opposite to that of the “Republican of China” generation, namely age-as-level. Although the risk of MDD for the “Cultural Revolution” generation is significantly higher than the expected value, as the cohorts age, the internal risk of MDD for the cohorts continuously decrease.

Opposite to the pattern of the “War” generation, the incidence of the “Reform and Opening Up” generation for all genders displays a pattern of cumulative advantage, with the risk of MDD significantly lower than the expected value. Furthermore, as the cohorts age, the internal risk of MDD for the cohorts also continue to decrease.

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