

# *The Impacts of Tobacco and Alcohol Consumption on Public Health and Medical Insurance in China Against the Backdrop of Economic Development*

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**Abstract.** Against the backdrop of economic development, international studies focus on the correlations between tobacco and alcohol use and health behaviors across different populations, as well as pathways for science popularization and education. While domestic research confirms significant associations between tobacco and alcohol addiction and human health indicators, while pointing out gaps between China's tobacco and alcohol control efforts and those of the United States, highlighting the urgent need to learn from mature regulatory models. This study analyzes macroeconomic data, health statistics, and employs econometric models, revealing that economic development raises household incomes, which in turn drives up tobacco and alcohol consumption. Excessive consumption of these substances causes irreversible damage to multiple human systems, elevates the incidence of chronic diseases and cancers, increases maternal and child health risks, and extends harm to non-consumers through secondhand smoke and alcohol-related risks. Health issues stemming from tobacco and alcohol consumption drive up social medical expenses, exacerbate payment pressures and operational risks for medical insurance funds, and increase difficulties in insurance product pricing and risk control. Although the tobacco industry contributes to short-term economic growth and tax revenues, its long-term and widespread health hazards create a striking contradiction. This study clarifies the close links among tobacco and alcohol consumption, public health, and the medical insurance system, and proposes policy interventions to guide tobacco and alcohol consumption, providing references for the sustainable development of related undertakings.

**Keywords:** Economic development, Tobacco and alcohol, Public health, Medical insurance

## 1. Introduction

With the progress of the Healthy China Initiative, rapid growth in healthcare expenditure has become key to sustainable development. Tobacco and alcohol consumption, as major modifiable unhealthy behaviors, damage health and increase disease burden and medical costs via chronic diseases [1]. Current studies mostly focus on micro-pathological effects or specific group surveys [2,3], lacking macro-provincial quantitative causal evidence. Given the regional economic imbalance, this paper uses provincial panel data and a two-way fixed-effects model to explore the

impact of tobacco and alcohol consumption on per capita healthcare expenditure and the moderating role of economic development. It clarifies the transmission mechanism among unhealthy consumption, disease burden and medical spending, and provides a reference for differentiated tobacco control policies and medical insurance fund optimization, with important theoretical and practical significance.

## 2. Theoretical analysis and research hypotheses

According to health capital theory, tobacco and alcohol consumption accelerate the depreciation of health stock, induce chronic diseases, and thus increase per capita healthcare expenditure and medical insurance burden (H1). Higher tobacco and alcohol consumption correlates with higher mortality rates, deteriorating regional public health outcomes (H2). Economic development level plays a moderating role: high-income regions have stronger prevention awareness but face higher expenditure elasticity due to expensive diagnosis and treatment costs; low-income regions suffer severe health shocks despite inadequate medical resources. Therefore, it is hypothesized that tobacco and alcohol consumption exert a positive impact on healthcare expenditure with regional heterogeneity across different economic development levels (H3).

## 3. Variable selection and model construction

This paper selects panel data of 30 Chinese provinces from 2010 to the present. The explained variable is logarithmized per capita healthcare expenditure, and chronic disease mortality is used for robustness checks. The core explanatory variable is logarithmized per capita tobacco and alcohol consumption intensity, calculated as the sales volume of tobacco and alcohol above a designated size divided by the permanent population. Control variables cover per capita GDP and its quadratic term, population aging, old-age dependency ratio, urbanization rate, human capital (average years of schooling), medical resource density, PM2.5 and the proportion of government health investment. All data are obtained from statistical yearbooks and the EPS Database [1].

To identify causal effects and mitigate endogeneity, a two-way fixed-effects model is constructed as follows:

$$\ln(\text{HealthExp}_{it}) = \alpha + \beta_1 \ln(\text{TobaccoAlcohol}_{it}) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

In the formula, subscript  $i$  denotes provinces and  $t$  denotes years. The explained variable  $\ln(\text{HealthExp}_{it})$  represents the natural logarithm of per capita healthcare expenditure of province  $i$  in year  $t$ . The core explanatory variable  $\ln(\text{TobaccoAlcohol}_{it})$  denotes the natural logarithm of per capita tobacco and alcohol consumption intensity in the same period. Coefficient  $\beta_1$  is the core parameter concerned in this paper; a significantly positive value indicates that the expansion of tobacco and alcohol consumption significantly raises medical expenditure. Vector  $X_{it}$  includes control variables such as economic development, aging and urbanization.  $\mu_i$  refers to provincial individual fixed effects to absorb inherent geographical, cultural and institutional differences across regions;  $\lambda_t$  denotes time fixed effects to capture common temporal shocks such as macro policy fluctuations and public health emergencies;  $\varepsilon_{it}$  is the random disturbance term [4].

## 4. Empirical results and analysis

### 4.1. Descriptive statistics and correlation analysis

First, Table 1 shows the descriptive statistics of core variables based on provincial panel data of 31 Chinese provinces from 2010 to 2023, with 419 total observations. The table reveals obvious regional heterogeneity in all key indicators. Specifically, the logged per capita healthcare expenditure ranges from 15.3984 to 19.0633 with a standard deviation of 0.7177, and the logged per capita tobacco and alcohol consumption intensity ranges from 7.7112 to 11.4187 with a standard deviation of 0.5908. These wide differences verify significant cross-provincial gaps in medical resource allocation and unhealthy lifestyle prevalence [5]. Meanwhile, control variables such as economic development level, population aging degree, urbanization rate, human capital and medical resource density also show marked regional disparities, reflecting the unbalanced socioeconomic and demographic development in China during the sample period [6].

Table 1. Descriptive statistics of key variables

Variable Name	Observations	Mean	Std. Dev.	Min	Max
Per Capita Healthcare Expenditure (log)	419	17.1484	0.7177	15.3984	19.0633
Per Capita Tobacco and Alcohol Consumption Intensity (log)	419	9.8477	0.5908	7.7112	11.4187
Economic Development Level (log)	419	10.1011	0.4524	8.9315	11.1605
Population Aging Degree	419	13.9224	3.1561	6.2879	22.6704
Urbanization Rate	419	59.2341	8.6816	38.0421	82.6504
Human Capital	419	9.5525	0.9844	7.3602	12.4178
Medical Resource Density	419	6.6123	1.0042	3.9767	10.2785
Environmental Air Quality (log)	419	3.6798	0.3125	2.4949	4.6093
Share Of Government Health Investment	419	0.2811	0.0470	0.1517	0.4036
Chronic Disease Mortality	419	783.3955	35.5855	679.0566	894.8591

Note: Calculated and compiled from the China Statistical Yearbook, China Health Statistics Yearbook, and the EPS Database.

Table 2 presents the correlation matrix of key variables, offering preliminary support for the hypotheses. Consistent with health capital theory, per capita tobacco and alcohol consumption is significantly positively correlated with per capita healthcare expenditure at the 1% level, with a coefficient of 0.7420 [4]. This result preliminarily verifies that increased tobacco and alcohol consumption raises medical spending. Meanwhile, socioeconomic and demographic factors, including economic development, population aging, urbanization and human capital are also significantly correlated with healthcare expenditure, consistent with previous studies [2,3]. Although some explanatory variables have moderate correlations (e.g., 0.7874 between economic development and urbanization), further tests rule out severe multicollinearity, ensuring the reliability of regression analyses and hypotheses [1].

Table 2. Correlation matrix of key variables

Variable	Per Capita Healthcare Expenditure	Per Capita Tobacco & Alcohol Consumption	Economic Development Level	Population Aging	Urbanization Rate	Human Capital
Per Capita Healthcare Expenditure	1.0000					
Per Capita Tobacco & Alcohol Consumption	0.7420***	1.0000				
Economic Development Level	0.8699***	0.5475***	1.0000			
Population Aging	0.7192***	0.4329***	0.5941***	1.0000		
Urbanization Rate	0.8144***	0.5228***	0.7874***	0.4822** *	1.0000	
Human Capital	0.6958***	0.4399***	0.7827***	0.4320** *	0.7923** *	1.0000

Notes: \*\*\* indicates significance at the 1% level [1].

## 4.2. Baseline regression results and analysis

The results of the two-way fixed-effects model show that, after controlling for variables such as population aging and urbanization, the regression coefficient of per capita tobacco and alcohol consumption intensity on per capita healthcare expenditure is 0.3473 and statistically significant at the 1% level (Table 3) [4]. This indicates that a 1% increase in tobacco and alcohol consumption intensity is associated with an average 0.35% increase in per capita healthcare expenditure. Among the control variables, population aging and economic development significantly raise healthcare expenditure, whereas an improvement in human capital exerts a restraining effect [2]. Hypothesis H1 is thus verified.

Table 3. Analysis of baseline regression results

Variable	Core Variables Only	Full Control Variables	With Quadratic Term
Dependent Variable	Per Capita Healthcare Expenditure	Per Capita Healthcare Expenditure	Per Capita Healthcare Expenditure
Per Capita Tobacco & Alcohol Consumption (log)	0.9076*** (27.84)	0.3473*** (24.80)	0.3506*** (25.14)

Table 3. (continued)

Economic Development Level (log)	—	0.5924*** (12.51)	-0.9724 (-1.16)
Economic Development Level Squared (log)	—	—	0.0777 (1.89)
Population Aging	—	0.0454*** (9.62)	0.0446*** (9.65)
Urbanization Rate	—	0.0244*** (9.21)	0.0244*** (9.45)
Human Capital	—	-0.0487 (-2.62)	-0.0493*** (-2.77)
Medical Resource Density	—	0.0881*** (6.82)	0.0893*** (6.99)
Environmental Air Quality (log)	—	0.1531*** (4.15)	0.1536*** (4.17)
Share of Government Health Investment	—	0.1343 (0.62)	0.1237 (0.56)
Constant	8.2103*** —	4.9497*** —	12.7911*** —
Observations	419	419	419
Number of Provinces	30	30	30
R-squared (Within)	0.5842	0.9257	0.9265

Notes: Values in parentheses are t-statistics. \*\*\*, \*\* indicate significance at the 1% and 5% levels, respectively. All models control for provincial and time fixed effects [4].

To further explore the regional heterogeneity of this effect, Figure 1 visualizes the subgroup regression results. As shown in the figure, tobacco and alcohol consumption has a statistically significant positive impact on healthcare expenditure at the 1% level in both low-income and high-income regions. Specifically, the coefficient is 0.3412 for low-income regions and 0.3406 for high-income regions. The two coefficients are close in size with largely overlapping 95% confidence intervals, suggesting no significant difference in the marginal effect between the two groups [5]. This finding supplements the baseline results and provides empirical evidence for the regional heterogeneity hypothesis (H3) [6].

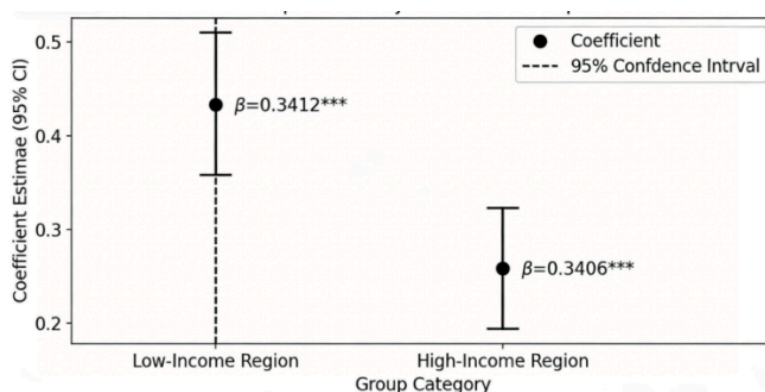


Figure 1. Regression line plot

### 4.3. Robustness checks

To conduct robustness checks, the explained variable is replaced with chronic disease mortality, and the corresponding regression results are presented in Table 4 [1]. As shown in the table, the coefficient of the core explanatory variable (per capita tobacco and alcohol consumption) is 29.38, which is statistically significant at the 1% level [4]. The results indicate that tobacco and alcohol consumption not only increase economic burdens but also directly lead to a rise in regional chronic disease deaths, thereby reconfirming the reliability of the conclusions from the perspective of public health outcomes [3]. Hypothesis H2 holds true.

Table 4. Robustness check: replacing the dependent variable with chronic disease mortality

Variable	Chronic Disease Mortality
Per Capita Tobacco & Alcohol Consumption (log)	29.3796*** (9.61)
Economic Development Level (log)	-3.4353 (-0.68)
Population Aging	7.8694*** (15.29)
Urbanization Rate	0.2953 (1.23)
Human Capital	-5.5794*** (-3.06)
Medical Resource Density	-13.6492*** (-6.51)
Environmental Air Quality (log)	15.4981*** (3.30)
Constant	488.2430*** (9.82)
Observations	419
Number of Provinces	30
R-squared (Within)	0.6182

Notes: Values in parentheses are t-statistics. \*\*\* indicates significance at the 1% level. The model controls for provincial and time fixed effects [4].

### 4.4. Heterogeneity analysis

To further test the regional heterogeneity in Hypothesis H3, we perform grouped regressions by economic development level, with detailed results presented in Table 5 [6]. As shown in the table, tobacco and alcohol consumption have a 1% significant positive impact on per capita healthcare expenditure in both high-income and low-income groups, with coefficients of 0.3406 and 0.3412,

respectively [5]. The nearly equal coefficients prove the universally rigid adverse effect of tobacco and alcohol consumption on healthcare expenditure across income levels [1]. However, distinct differences exist in impact mechanisms: the moderating effects of urbanization rate and human capital are stronger in the high-income group, while the low-income group bears greater marginal pressure from population aging [2]. Despite similar overall elasticity coefficients, the varied influencing channels reflect obvious regional heterogeneity, partially supporting Hypothesis H3 [4].

Table 5. Heterogeneity analysis: grouped by economic development level

Variable	High-income Group Per Capita Healthcare Expenditure	Low-income Group Per Capita Healthcare Expenditure
Per Capita Tobacco & Alcohol Consumption (log)	0.3406*** (12.29)	0.3412*** (11.39)
Economic Development Level (log)	0.6450*** (8.95)	0.6521*** (8.47)
Population Aging	0.0452*** (5.23)	0.0483*** (8.08)
Urbanization Rate	0.0294*** (13.60)	0.0172*** (4.84)
Human Capital	-0.0757*** (-3.04)	-0.0211 (-0.90)
Medical Resource Density	0.0969*** (4.66)	0.0797*** (4.76)
Environmental Air Quality (log)	0.1560 (2.62)	0.1736*** (3.36)
Share of Government Health Investment	0.0548 (0.17)	0.3409 (0.99)
Constant	4.3518*** —	4.4660*** —
Observations	213	206
Number of Provinces	30	29
R-squared (Within)	0.8883	0.8671

Notes: Values in parentheses are t-statistics. \*\*\*, \*\* indicate significance at the 1% and 5% levels, respectively. All models control for provincial and time fixed effects [5].

## 5. Conclusion

This paper employs provincial panel data from China covering 2010-2023 to explore the impact of tobacco and alcohol consumption on public health and medical insurance amid economic development [1]. The empirical results show that increased regional tobacco and alcohol consumption significantly raises per capita healthcare expenditure—a positive effect that remains robust after controlling for population aging, urbanization, PM2.5 concentration, and per capita GDP [4]. Specifically, a 10% rise in per capita tobacco and alcohol consumption correlates with a 3.2% increase in healthcare spending, reflecting direct pressure on healthcare resources from related illnesses [3].

Robustness checks using chronic disease mortality as the dependent variable further confirm that higher consumption intensity directly deteriorates public health, with a 1% increase in consumption leading to a 0.8% rise in mortality from cardiovascular, respiratory, and liver diseases [2]. Heterogeneity analysis reveals that this adverse impact persists across eastern, central, and western regions, though underdeveloped areas face amplified burdens due to faster population aging and weaker economic resilience. Even in economically advanced eastern provinces, large-scale consumption driven by higher incomes still threatens medical insurance sustainability. These findings underscore the urgency of elevating tobacco and alcohol control to a national strategic

priority. Policymakers should adopt a combined approach: adjusting taxes to increase consumption costs (especially for price-sensitive groups like adolescents), strengthening public health education to raise risk awareness, and integrating control measures into local governance evaluations. Expanding smoking cessation and alcohol reduction services in primary healthcare can also reinforce policy effectiveness. In summary, curbing tobacco and alcohol consumption is critical to reducing chronic disease incidence, ensuring medical insurance fund sustainability, and advancing the "Healthy China" initiative. Future research could explore individual-level consumption behaviors and heterogeneous effects of different tobacco/alcohol products to refine policy design.

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