Cigarette and Alcohol Expenditures and Body Weight Outcomes among Rural Households

Abstract

Although the health effects of cigarette and alcohol (CA) consumption have been extensively documented, little is known about how CA expenditures influence body weight outcomes, particularly among rural populations. This study addresses this gap by investigating the impact of CA, cigarette, and alcohol expenditures on body weight outcomes, including underweight, normal weight, overweight, and obesity, which are categorized using body mass index. We employ a two-stage residual inclusion approach, combining Tobit and multinomial logit models, to account for the endogeneity of CA expenditure variables and estimate data from 1,487 rural households in China. The results reveal that higher CA expenditure is significantly associated with a decreased likelihood of being underweight or maintaining a normal weight while increasing the probability of obesity. Similarly, both cigarette and alcohol expenditures are found to reduce the probability of being underweight and elevate the likelihood of obesity. Notably, these effects are gender-specific: for male household heads, increased spending on CA products significantly lowers the risk of being underweight and raises the risk of obesity. In contrast, these expenditures exhibit no statistically significant association with the body weight outcomes of female household heads. These findings underscore the need for integrated health and fiscal policies in rural areas that address not only the addictive and economic burden of cigarette and alcohol use but also their implications for nutritional health.

Keywords: Cigarette expenditure; Alcohol expenditure; Body weight; Obesity; Rural households

JEL Codes: I12; L66

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1. Introduction

Body weight plays a critical role in shaping long-term human development, as it directly affects people's physical health (Chen et al., 2023), quality of life (Hecker et al., 2022), and broader socioeconomic outcomes (Okunogbe et al., 2021). Research indicates that the economic losses associated with obesity in 2019 were equivalent to nearly 2% of GDP in eight countries—Australia, Brazil, India, Mexico, Saudi Arabia, South Africa, Spain, and Thailand (Okunogbe et al., 2021). In 2021, an estimated 1 billion adult men and 1.1 billion adult women worldwide were overweight or obese (GBD, 2025), highlighting the severity of this public health challenge. The economic burden of obesity encompasses substantial direct medical expenditures and indirect costs resulting from factors such as reduced labor productivity, which is often higher than the direct costs (Ling et al., 2023).

Although rural areas have historically suffered from undernutrition, overweight and obesity have become increasingly prevalent in these communities (Ferreira et al., 2021). For example, in India, the growth of obesity in rural areas has become the main driving force behind the rise in the national obesity rate (Chaudhary & Sharma, 2023). In rural areas of Cameroon, the rates of overweight and obesity among adults have reached 31.1% and 18.9%, respectively (Simo et al., 2021). Weight changes among rural adults also show apparent differences in sociodemographic characteristics: women are often more affected by the obesity epidemic than men (Koliaki et al., 2023).

Several studies have demonstrated that expenditures on cigarettes and alcohol often lead to a 'crowding-out' effect on other consumer spending (Jolex & Kaluwa, 2022; Jumrani & Birthal, 2017; Kshatri et al., 2022; Sánchez & Gómez, 2024; Vladisavljevic et al., 2024). With a limited household budget, spending on tobacco and alcohol may crowd out spending on essential goods such as food, healthcare, and other necessities (Jumrani & Birthal, 2017). A survey of rural India found that households' spending on tobacco and alcohol significantly

reduced their spending on food, healthcare, and education (Kshatri et al., 2022). Similarly, excessive alcohol consumption was found to crowd out essential spending on food, housing, and education among low-income rural households in Malawi, Africa (Jolex & Kaluwa, 2022). Accordingly, expenditures on cigarettes and alcohol can displace household spending on food, resulting in inadequate nutritional intake. This nutritional deficiency, in turn, can adversely affect body weight outcomes, particularly among low-income households with limited budgets and the margin for reallocating expenditures.

In addition to its economic crowding-out effect, smoking and excessive alcohol consumption have been shown to exert direct deleterious impacts on human health (He et al., 2019; Huang et al., 2023; Joshy et al., 2025; Kotlyarov, 2023; Minami et al., 2021; Selvamani et al., 2024). Long-term smoking impairs pulmonary function and substantially increases the risk of chronic respiratory diseases, such as chronic obstructive pulmonary disease, while also being associated with elevated risks for cardiovascular and metabolic disorders (Kotlyarov, 2023). Excessive alcohol consumption is also closely related to many chronic diseases and cardiovascular risks. It is one of the important reasons for the high incidence of non-communicable diseases in developing countries (He et al., 2019).

The number of deaths caused by alcohol worldwide exceeds 3 million each year (Huang et al., 2023). Smoking is one of the main causes of fatal diseases worldwide, accounting for about one-quarter of cancer deaths (Joshy et al., 2025). The risk of cancer is multiplied if heavy smoking and alcohol abuse coexist (Minami et al., 2021). These health hazards are particularly prominent among middle-aged and elderly rural workers. Due to relatively scarce medical resources and heavy workloads, long-term smoking and drinking habits are more likely to cause a premature decline in lung function, exacerbation of cardiovascular disease, and even malnutrition, such as being underweight in middle-aged and elderly rural people (Selvamani et al., 2024). This will seriously reduce their health and working ability and increase the burden

on public health.

Existing literature has focused on the relationship between CA expenditure and body weight among urban residents, specific groups and at the national level (Chiolero et al., 2008; Grunberg, 1990; Koppes et al., 2005; FRENCH et al., 2008; Winsløw et al., 2015). For example, Winsløw et al. (2015) found that high smoking rates among current smokers in Copenhagen, Denmark, were found to causally contribute to lower body weight, suggesting that smoking itself is a direct factor in weight loss. In addition to urban populations, it is crucial to investigate the relationship between CA expenditure and body weight among rural residents, who may exhibit distinct consumption patterns and health outcomes. Understanding this linkage can help policymakers design more targeted health and nutrition interventions that address substance use and its broader socioeconomic implications. However, to date, no studies have directly examined the relationship between CA expenditure and body weight among rural populations in developing countries.

This study aims to examine the nexus between CA expenditure and body weight outcomes. We strive to make three contributions to the literature. First, we look into how the total CA expenditure, cigarette expenditure, and alcohol expenditure affect rural residents' body weight outcomes. Second, we further investigate how these effects vary by the gender of the household heads. Understanding gendered effects allows for more targeted public health interventions. Third, we employ a two-stage residual inclusion approach that combines the Tobit model with the multinomial logit (MNL) model to address the endogeneity of CA expenditure variables when estimating the impact of CA expenditures on body weight outcomes. The MNL model allows for multiple distributions of key explanatory and dependent variables (Best et al., 2023). We estimate cross-sectional data from rural residents in China's Yunnan, Hubei, and Jiangsu provinces.

Given the alarming rise in obesity-related health issues and their substantial economic

burden, China presents a compelling case study examining the relationship between CA expenditure and body weight, particularly in the context of rapidly shifting consumption patterns and public health challenges. In China, the number of obese adults aged 18-69 years was estimated to be 85 million in 2018, triple the 2004 figure (Wang et al., 2021). Not only are adults plagued by obesity, but also children, with the prevalence of overweight and obesity among school-age children in China rising from 5.3% in 1985 to 20.5% in 2014 (Dong et al., 2019). The global prevalence of overweight and obesity rose from 37% in 2014 to 42% in 2024, marking a 13.5% increase (see Figure 1). During the same period, the proportion of the population classified as overweight or obese in China increased by 24.2%, rising from 33% to 41%.

[Insert Figure 1 here]

China is not only experiencing a rapid rise in obesity rates but is also a major consumer of tobacco and alcohol products. According to data from Statista Market Insights, China ranked fifth in cigarette consumption. In 2023, per capita cigarette expenditure in China reached USD 217 (see Figure 2). In comparison, the top two countries—Germany and France—reported significantly higher per capita spending at USD 406 and USD 343, respectively. Similarly, China also ranked fifth in alcohol consumption, with an annual per capita expenditure of USD 148. This figure is considerably lower than that of the United States (USD 532), the United Kingdom (USD 454), France (USD 414), and Germany (USD 334).

[Inseter Figure 2 here]

[Insert Figure 3 here]

The rest of the paper is structured as follows. Section 2 presents a literature review. Section 3 introduces the conceptual framework and econometric models. Section 4 presents data, variables, and descriptive statistics. Section 5 presents and discusses the empirical results. Section 6 summarises and discusses the policy implications.

2. Literature review

In many developing countries and economically vulnerable regions, CA expenditures are associated with various economic outcomes for households, including enhanced social interactions, altered poverty levels, and the displacement of other consumption expenditures. (Naseri & Faghih, 2024; Williams et al., 2024; Wu et al., 2021). For example, Wu et al. (2021) explored the crowding-out effect of tobacco and alcohol consumption on other spending in six low- and middle-income countries, including Ethiopia, India, Indonesia, Jordan, Kenya, and Nigeria. They found that increased spending on tobacco and alcohol was significantly associated with reduced household expenditures on essential items such as food, healthcare, and education. Naseri & Faghih (2024) found that in Iran, tobacco use and alcohol consumption have increasingly been integrated into leisure and social activities, thereby contributing to a rise in discretionary expenditures. Williams et al. (2024) discovered that people in the Central African Republic are addicted to tobacco and alcohol, leading to extreme poverty.

CA expenditures affect rural residents' economic well-being and overall health outcomes. These health outcomes include a higher incidence of chronic diseases, elevated mortality rates, and adverse health effects on family members resulting from passive smoking (Guerra et al., 2024; Lodhia, 2024; Batu et al., 2022). Batu et al. (2022) found that smoking and alcohol consumption are among the important risk factors for many chronic diseases (e.g., diabetes, respiratory diseases, and cancer) in the Congo. Lodhia (2024) discovered that the mortality rates among young people in East Africa have increased due to colorectal cancer caused by the risky lifestyle factors of smoking and drinking. Guerra et al. (2024) investigated sleep disturbances in Mexico, finding that passive smoking contributes to sleep problems among non-smoking family members, which, in turn, are associated with various physical health issues.

The study of body weight is crucial since the issue of overweight is a global concern that also has a significant impact on the daily lives of rural residents, directly affecting their quality

of life and, in the long term, may also affect the health and psychological well-being of rural residents (Adeloye et al., 2021; Marcus et al., 2022; Mehrabi et al., 2021; Stephenson et al., 2021). Stephenson et al. (2021) found that obesity significantly reduced people's health-related quality of life in Yorkshire. Adeloye et al. (2021) showed that obesity significantly increased the prevalence of multiple cardiovascular metabolic diseases in Nigeria. Mehrabi et al. (2021) illustrated that obese people in West Asia may experience higher levels of stress. A study by Marcus et al. (2022) identified that obesity leads to a range of childhood illnesses in ten countries in the European Union, with long-term effects on health and quality of life in adulthood.

On the consumption side, abnormal body weight may lead to more healthcare spending (Errico et al., 2022; Malkin et al., 2022). Errico et al. (2022) found that in 2020, obesity in Italy resulted in total economic losses of €13.34 billion, including €7.89 billion in direct medical costs and €5.45 billion in indirect productivity losses, with absenteeism and presenteeism contributing almost equally to indirect costs. Malkin et al. (2022) reported that in Saudi Arabia, six major non-communicable diseases linked to overweight and obesity—such as stroke, asthma, and colon cancer—resulted in direct costs totaling US$3.8 billion, equivalent to 4.3% of the country’s total health expenditure in 2019.

Despite the rich findings in the literature, no previous studies have explored the association between CA expenditure and body weight outcomes among rural households. Thus, this study employs rigorous econometric models to investigate the relationship between CA expenditure and body weight empirically.

3. Econometric models

3.1. Model selection

Assuming that rural residents' CA expenditure is exogenously determined, the actual impact of CA expenditure on rural residents' body weights can be estimated using a Tobit model. However,

rural residents self-decided whether to consume CA, depending on their economic status and intrinsic characteristics (e.g., emotional intelligence, personal values, and motivation). This introduces the potential endogeneity of CA expenditure in econometric estimates. Therefore, using the Tobit model cannot produce unbiased estimates of the impact of CA expenditure on rural residents' body weight because the Tobit model assumes that all explanatory variables are exogenous. A more rigorous empirical strategy is, therefore, required.

Because our endogenous variable is left-censored in nature, as not all rural households have consumed alcohol or cigarettes, and the dependent variable is category, we can employ either a two-stage predictor substitution (2SPS) approach (Ma et al., 2022) or a two-stage residual inclusion (2SRI) approach (Rahman et al., 2023) that combines the Tobit model with the MNL model to estimate the impact of CA expenditure on the body weight of rural residents. As Terza (2017) and Zhang & Lewsey (2024) argued, the 2SRI model can provide more consistent estimates of structural parameters and average partial/marginal effects than the 2SPS model; therefore, we employ the former for our empirical analysis.

3.2. Two-stage residual inclusion approach

In our study context, the first stage of the 2SRI model uses the Tobit model to estimate the impact of control variables and an instrumental variable (IV) on rural residents' CA expenditure. It is specified as follows:

$$CA_i^{E*} = \alpha X_i + \beta IV_i + \varepsilon_i, with\ CA_i^{E*} = \begin{cases} CA_i^E, if\ CA_i^{E*} > 0 \\ 0, if\ CA_i^{E*} = 0 \end{cases} \quad (1)$$

where CA_i^{E*} denotes the latent variable for total CA expenditure ($E = 1$), cigarette expenditure ($E = 2$), or alcohol expenditure ($E = 3$), corresponding to the rural resident indexed by i, which can be observed by the left-censored variable CA_i^E. X_i refers to a vector of control variables such as age, health status, education, and household size. IV_i refers to an instrumental variable (IV), which is discussed in detail in the next section. α and β are the parameters that

need to be estimated. ε_i is an error term.

To account for the endogeneity issue of CA expenditure variables, we predict the residual term after estimating Equation (1) and then include the predicted residual term in the body weight equation as an extra regressor for the second stage estimation of the 2SRI model. In practice, we can predict the residuals from the first stage of the 2SRI model using the following two equations:

When CA_i>0:

$$\hat{R}_i = CA_i^E - (\hat{\alpha}X_i + \hat{\beta}'IV_i) \tag{3}$$

When CA_i =0:

$$\hat{R}_i = -\sigma \frac{\phi(\frac{\hat{\alpha}X_i + \hat{\beta}'IV_i}{\sigma})}{\Phi(\frac{\hat{\alpha}X_i + \hat{\beta}'IV_i}{\sigma})} \tag{4}$$

where ϕ refers to the probability density function of the standard normal distribution; Φ refers to the Cumulative Distribution Function of the standard normal distribution.

The second stage of the 2SRI model estimates the impact of CA expenditure (CA_i^E) and control variables (X_i) on body weight outcomes, and the residual term ($\hat{R}_i$) predicted from stage one is included as an extra regressor to account for the endogeneity issues of the CA expenditure variables. In our analysis, body weight outcomes were categorized into four categories (1=underweight, 2=normal weight, 3=overweight, and 4=obesity) as categorical discrete variables according to the different body weight levels of the respondents. Accordingly, the second stage of our study should be estimated using the MNL model, which captures the effect of CA expenditure on body weight in different categories, which can be specified as follows:

$$\Pr(B_i = j|CA_i^E, \hat{R}_i, X_i) = \frac{\exp(\rho_j + \varrho_j CA_i^E + \lambda_j \hat{R}_i + \gamma_j^{\mathrm{T}} X_i)}{\sum_{m=1}^{4} \exp(\rho_m + \varrho_m CA_i^E + \lambda_m \hat{R}_i + \gamma_m^{\mathrm{T}} X_i)} \ (j = 1, 2, 3, 4) \tag{4}$$

where B_i is the probability that a rural resident i falls into the body weight category j, with $j = 1$ for underweight, $j = 2$ for normal weight, $j = 3$ for overweight, and $j = 4$ for obesity. CA_i^E

represents an observed variable for CA, cigarette, or alcohol expenditure. X_i refers to a vector of control variables. ρ_j refers to category j of the intercept term. ϱ_j refers to the CA_i^E's coefficient for category j. λ_j refers to the category j coefficient of the residual term $\hat{R}_i$. γ_j refers to the category j vector of coefficients of the control variable X_i. By estimating Equation (4), we can obtain the direct effects of CA expenditure on the body weight of rural residents.

3.2.3. IV selection and its validity tests

Care should be taken to fully identify the IV included in Equation (1) to account for the endogeneity issue of the CA expenditure variables. IV identification is always tricky in empirical analyses because the variable must be related to the endogenous variable, not the outcome variables. In this study, we used the male ratio, a variable representing the ratio of males to total household members, as the IV. Previous studies have confirmed that this IV is valid for two reasons (Chen et al., 2022; Dong et al., 2021). Firstly, cigarettes and alcohol are primarily consumed by males (Zhang et al., 2022). Thus, when the proportion of males in a household is higher, the household's CA expenditure is likely also higher. At the same time, the proportion of males in a household does not directly affect the body weight of the household heads. Therefore, the selected IV is recognized as eligible to address the endogeneity issues of CA expenditure.

We use a falsification test to test and confirm the validity of the IV. The results are presented in Table A1 in the Appendix. As can be seen, our IV is significantly correlated with the key explanatory variables (i.e., CA expenditure, cigarette expenditure, and alcohol expenditure) but not with the body weight outcomes. Therefore, the selected IV is suitable for solving the endogeneity and intensity of CA expenditure.

4. Data, variables, and descriptive statistics

4.1. Data

The data analyzed in this study came from a survey of rural households conducted in eastern, central, and western China. In practice, data were collected in five steps using a multi-stage sampling method. First, we selected Jiangsu, Hubei, and Yunnan provinces from eastern, central, and western China. Second, two prefecture-level cities in each province were randomly selected for the second step. Third, two towns from each selected county were randomly chosen. Fourth, two villages from each selected town were randomly selected. Finally, 15-25 households in each sampled village were randomly selected for interviews, resulting in a sample of 1,577 rural households. After cleaning the data by removing samples with missing data on key variables, we obtained a sample of 1,487 households.

The survey was conducted between November 2023 and January 2024. The information collected referred to the year 2023. A team of researchers and postgraduate students from a local university who can speak Mandarin and local dialects sponsored and conducted the survey. The survey collected rich information to reflect rural residents' demographic, financial, and living characteristics. The survey also gathered rich information capturing rural residents' height, weight, and CA consumption patterns, which suits our research objectives well.

4.2. Key variable measurements

4.2.1. Cigarette and alcohol expenditure

We use three variables to measure CA expenditure at the household level: CA expenditure, cigarette expenditure, and alcohol expenditure. Specifically, CA expenditure is the total amount spent on cigarettes and alcohol within a household during the reference week. Cigarette expenditure specifically denotes the amount spent on cigarettes, while alcohol expenditure represents the amount spent on alcohol within the same reference period. These three variables are measured at the per capita level.

This study focuses on household-level expenditures rather than individual spending on cigarettes and alcohol for three reasons. First, household members often influence each other's

consumption habits, particularly for goods like cigarettes and alcohol, which are frequently shared or consumed in social settings (Fauci et al., 2021; Xolnazarova, 2022). Examining expenditure at the household level captures this interdependence and provides a more accurate picture of overall consumption dynamics. Second, the decision to purchase cigarettes or alcohol is rarely isolated to an individual; rather, it affects and is influenced by other household members. For example, if one household member reduces consumption due to health concerns, financial constraints, or policy interventions (e.g., taxation), it may impact the spending habits of others in the household. Analyzing expenditures at the household level helps account for these spillover effects. Third, household expenditures are typically pooled, and decisions on discretionary spending, such as alcohol and cigarettes, are made in the context of the overall household budget. Examining household-level expenditure allows a better understanding of allocating resources among essential and non-essential goods.

4.2.2. Body weight outcomes

The body weight outcomes are measured into four categories: underweight, normal weight, overweight, and obesity. During the survey, we collected the household heads' height and weight and used them to calculate their body mass index (BMI) as follows:

$$BMI = werght(kg) \div [height\ (m)]^2 \quad (5)$$

Following Kim et al. (2021), we categorise household heads' BIM into four levels: 1=underweight (BMI<18.5), 2=normal weight (18.5≤BMI≤23.9), 3=overweight (23.9<BMI≤27.9), and 4=obesity (BMI>27.9).

We focus on household heads' body weight outcomes for two reasons. First, household heads typically dominate household decision-making, particularly regarding consumption and resource allocation. Their dietary choices, lifestyle habits, and financial decisions directly influence the overall food expenditure, alcohol and cigarette consumption, and access to healthcare within the household (Jayasinghe & Smith, 2021). As such, their BMI serves as a

representative indicator of household-level health and nutrition trends. Second, given that household heads generally have the most control over household spending, their habits and preferences often set the tone for the family's overall consumption behavior. Previous studies have found that the spending patterns of household heads on food, alcohol, and tobacco significantly shape the dietary and lifestyle choices of other family members, making their BMI a more relevant indicator of household-wide health status (Rezaei et al., 2024). Third, obesity among household heads can have broader implications beyond individual health. Research indicates that obesity is associated with higher healthcare costs, reduced labor productivity, and increased household financial burdens (Qin et al., 2022). Since household heads are typically the primary earners, their health status can directly impact household income stability and overall economic well-being.

4.3. Descriptive statistics

Table 1 presents the definitions and summary statistics for the selected variables. The dependent variable is the body weight outcome, which is categorised into four categories based on the BMI index that ranges from 1 to 4. The mean of the body weight outcome is 2.66, suggesting that, on average, the weight of household heads in our sample is between normal and overweight. The per capita CA expenditure was 16.03 yuan per week among the core independent variables. The average cigarette spending and alcohol spending were 11.73 and 4.30 yuan per week, respectively. The average age of the household heads was 57.91 years. About 68% of sampled rural residents were male. The mean household size was five persons, and about 66% had air conditioners. The households cultivated 9.57 mu of land (1 mu=1/15 hectare). About 18% of the respondents had received dietary training, and 43% of the rural households had experienced natural disasters or soil fertility degradation in the past year. Regarding regional distribution, 34%, 31%, and 35% of respondents were from Jiangsu, Hubei, and Yunnan provinces.

[Insert Table 1 here]

Table 2 reports the mean differences in body weight outcomes and CA, cigarette, and alcohol expenditures among rural residents across the surveyed provinces. The results show that household heads in Jiangsu province have the highest level of body weight, with an average score of 2.80 (out of 4). Rural residents in Yunnan province have the lowest body weight outcome, with a mean of 2.56. Table 2 also shows that Yunnan's CA and cigarette expenditures are the highest among the three provinces, which are 18.86 yuan and 15.86 yuan in the reference week. Alcohol expenditure in Jiangsu province is the highest, with a mean of 7.19 yuan in the reference week. The findings in Table 2 highlight that it is essential to include provincial dummies in the model to control for region-based characteristics (e.g., cultures, social-economic conditions, and government regulations) that affect CA expenditure and body weight outcomes.

[Insert Table 2 here]

Figure 4 presents the distribution of male and female household heads across different bodyweight categories. Among male household heads, the largest proportion (48%) falls within the normal weight range, followed by 35% who are overweight. Meanwhile, 14% are classified as obese, and only 3% are underweight. For female household heads, the proportions of those with normal weight and those who are overweight are quite similar, at 39% and 38%, respectively. Approximately 22% of female household heads are classified as obese, while just 1% are underweight in the sample. Figure 5 displays the average expenditures on CA, cigarettes, and alcohol for male- and female-headed households. Overall, male-headed households spend more on all three categories than their female counterparts.

[Insert Figure 4 here]

[Insert Figure 5 here]

5. Empirical results and discussion

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5.1. Determinants of CA expenditure

Column 2 of Table 3 presents the results of the analysis of the determinants of CA expenditure, which is estimated by Equation (1) using the Tobit model. The results show that the coefficient of the gender variable is positive and statistically significant, suggesting that rural households headed by males spend more on CA than those headed by females. In many societies, smoking and drinking are more socially acceptable for men than for women. Traditional gender roles often associate these behaviours with masculinity, social bonding, and status (Zubair et al., 2022). Men are more likely to engage in social drinking and smoking as part of bonding activities, such as networking, workplace gatherings, or leisure activities with friends (Dasgupta, 2022). Alsulami et al. (2023) observed that women tend to consume fewer cigarettes and less alcohol, which may be attributed to higher health consciousness or differing social norms surrounding substance use. The health condition variable is positive and statistically significant, indicating that rural households with healthy household heads spend more on CA. Healthy household heads may have higher disposable income due to fewer medical expenses and greater work productivity, allowing them to spend more on cigarettes and alcohol (Khanna et al., 2022).

The coefficient of the household size variable is negative and statistically significant, indicating that households with larger household sizes spend less on CA. The finding is consistent with the finding of Coibion & Weber (2020), showing that larger households likely have higher overall expenses, such as food, education, and healthcare, constraining discretionary spending on cigarettes and alcohol. The coefficient of the asset ownership variable is positive and statistically significant, indicating that rural households owning air conditioners tend to spend more on CA. In rural areas, air conditioner ownership can be considered a symbol of household wealth. Thus, households owning air conditioners are more likely to be richer, enabling greater discretionary spending on cigarettes and alcohol (Ogada et al., 2020). The coefficient of the farm size variable is positive and statistically significant, indicating that

households cultivating larger farm sizes spend more on CA. Households with larger farm sizes tend to earn more, enabling more lavish discretionary spending on cigarettes and alcohol. Carnazza et al. (2021) found that larger farms are usually accompanied by higher incomes, which leads to greater consumption of cigarettes and alcohol. Besides, farming is physically demanding, and some rural residents may use CA products for stress relief or social consumption in rural communities.

The coefficient of the risk preference variable is positive and statistically significant, indicating that rural households with household heads who are more willing to take risks spend more on CA. Household heads with a higher risk preference may be more inclined toward behaviors associated with immediate gratification, such as smoking and drinking, despite potential long-term health consequences. Their willingness to take risks may also make them less concerned about the financial and health-related downsides of CA consumption (Fryt et al., 2022).

Regarding the regional variables, our results indicate that, relative to rural households in Yunnan province (reference group), those in Jiangsu and Hubei provinces spend less on CA. Compared to Yunnan, which has a strong tobacco industry and cultural acceptance of smoking, Jiangsu and Hubei may have stricter regulations, higher health awareness, or different social norms that discourage CA expenditure. Finally, our results show that the IV has a positive and statistically significant effect on CA expenditures, proving its utility.

5.2. Determinants of body weight outcomes

The impacts of CA expenditure and control variables on household heads' body weight outcomes are presented in the last four columns of Table 3. The results are estimated by the MNL model using Equation (4). The significance of residual terms presented in the underweight and obesity specifications suggests the existence of endogeneity issues of the CA expenditure variable. It verifies the importance of addressing it using the 2SRI approach. Because the

coefficients of the variables, estimated by the MNL model, are not straightforward in interpretation, we calculate and present the results of the marginal effects estimate in Table 3 for a better understanding. The results of the MNL's coefficient estimates are presented in Table A2 in the Appendix for reference.

5.2.1. Impact of CA expenditure

Table 3 shows that CA expenditure is negatively and statistically significantly associated with the probability of being underweight and of normal weight. Specifically, a one-unit increase in CA expenditure reduces the likelihood of household heads being underweight by 0.2% and of being of normal weight by 0.7%. This suggests that higher spending on CA may lead to lifestyle and dietary changes that shift individuals away from healthier weight categories. One possible explanation is that alcohol is calorie-dense and often consumed in conjunction with high-fat, high-sugar foods, leading to increased caloric intake. Although cigarette use may suppress appetite in some cases, this effect is unlikely to fully offset the weight gain associated with alcohol consumption, particularly in contexts where alcohol use is more prevalent (Prokopidis & Witard, 2022; Robinson et al., 2023). Moreover, higher CA expenditure may correlate with disordered body metabolism and behaviors such as late-night eating, irregular meal patterns, and poor dietary quality, further diminishing the chances of maintaining a normal or underweight status.

[Insert Table 3 here]

In contrast, the marginal effect of CA expenditure on obesity is positive and statistically significant. A one-unit increase in CA spending is associated with a 0.7% increase in the probability of obese household heads. This finding aligns with broader evidence that CA consumption is linked to sedentary lifestyles and reduced physical activity. Physical activity levels are dropping significantly in rural areas where traditional agricultural labor is declining due to mechanisation and urbanisation. For example, a study by Wang et al. (2022) found that

over half of rural residents in eastern China sit for more than four hours a day, and nearly 70% fail to meet recommended physical activity levels. In such a lifestyle context, the excess calories from alcohol—and the broader behaviors associated with CA consumption — are more likely to contribute to weight gain.

5.2.2. Impacts of control variables

Some control variables also provide fascinating insights into the different body weight outcomes: underweight, normal weight, overweight, and obesity. For example, the marginal effects of the age variable are positive and significant in the normal weight specification and negative and significant in the obesity specification. The findings suggest that a one-year increase in the household heads' age would increase the likelihood of being normal weight by 0.4% and decrease the probability of obesity by 0.3%. These findings imply that age is associated with healthier body weight outcomes, possibly due to accumulated life experience, changing health priorities, or reduced engagement in risky health behaviors over time. As household heads grow older, they tend to have greater health awareness, more stable lifestyles, and increased medical attention that often comes with age (Izquierdo et al., 2021).

The marginal effects of the gender variable are positive and significant in the underweight and normal weight specifications but negative and significant in the obesity specification. The findings suggest that male household heads are 3.6~11.1% more likely to be underweight and normal weight but are 9.7% less likely to be obese. These findings suggest that gender plays a significant role in shaping body weight distribution, likely through a combination of physiological, behavioral, and socio-economic factors (Cooper et al., 2021). In many rural areas, male household heads often engage in more physically demanding labor, which can contribute to lower body weight. Besides, cultural norms and dietary patterns may lead to different consumption habits between men and women, influencing body weight outcomes. In rural China, obese women tend to have a higher family status as obesity is regarded as the symbol of

fertility (Mo et al., 2014). The lower likelihood of obesity among male household heads could also be linked to differences in metabolism, body composition, or a lower tendency to consume calorie-dense foods compared to women in the same context.

Our results also reveal significant regional differences in body weight outcomes. Compared to rural household heads in Yunnan, those in Jiangsu are 5.6% less likely to be underweight, 29% less likely to have a normal weight, 18.9% more likely to be overweight, and 15.7% more likely to be obese. Similarly, households in Hubei are 6.1% less likely to be underweight, 16.9% less likely to have a normal weight, and 15% more likely to be obese than their counterparts in Yunnan. These findings highlight notable regional disparities in nutrition and health outcomes, suggesting that rural households in more economically developed provinces like Jiangsu and Hubei face a greater risk of overweight and obesity. This may be driven by lifestyle changes, dietary transitions, and reduced physical labor associated with higher income levels. The results underscore the need for region-specific health and nutrition interventions that address both undernutrition in poorer regions and rising obesity in more affluent rural areas.

5.3. Impacts of cigarette expenditure and alcohol expenditure

To provide a more intuitive understanding, we also estimate how cigarette expenditure and alcohol expenditure determine household heads' body weight outcomes. The results are presented in Table 4. For brevity, we only present the marginal effects of cigarette expenditure and alcohol expenditure on body weight outcomes. Table A3 in the Appendix presents the estimation results for the cigarette and alcohol expenditure equations. Additionally, Table A4 reports the multinomial logit (MNL) coefficient estimates for the impact of cigarette expenditure on body weight outcomes, while Table A5 provides the corresponding estimates for alcohol expenditure.

5.3.1 Impacts of cigarette expenditure

The upper part of Table 4 shows that cigarette expenditure is significantly associated with changes in body weight categories. Specifically, the marginal effects indicate that a one-unit increase in cigarette expenditure reduces the likelihood of household heads being underweight by 0.3% while increasing the likelihood of obesity by 0.8%. These findings suggest a complex relationship between smoking and body weight. On one hand, nicotine suppresses appetite and induces metabolic compensation decline, which can lower food intake and slightly elevate energy expenditure. This may explain why smokers are less likely to be severely underweight compared to non-smokers (Driva et al., 2022). On the other hand, long-term smokers are more prone to adopting unhealthy lifestyles, including the consumption of calorie-dense processed foods (Alribdi et al., 2024). They may experience reduced physical activity due to impaired lung function (Dahlawi et al., 2024). Moreover, smoking is often accompanied by alcohol consumption, compounding caloric intake, and gradually shifting individuals from underweight to obese categories.

[Insert Table 4 here]

5.3.2 Impacts of alcohol expenditure

Similarly, alcohol expenditure also exhibits significant effects on body weight outcomes. A one-unit increase in alcohol expenditure reduces the probability of being underweight by 0.8% and increases the probability of being obese by 3.3%. The impact of alcohol on body weight is more direct and substantial compared to cigarettes. Alcohol is rich in calories and contributes significantly to total energy intake, especially when consumed frequently. Unlike nicotine, which may reduce appetite, alcohol tends to increase appetite and promote the intake of unhealthy, high-fat foods (Fong et al., 2021). Additionally, alcohol inhibits fat oxidation and promotes fat storage, particularly in the liver and abdominal area, thereby accelerating weight gain (Dukewich et al., 2025). Excessive alcohol use is also associated with reduced physical

activity and metabolic imbalances, further contributing to the risk of obesity.

5.3.3 Comparative impact and underlying mechanisms

Table 4 shows that the impact of alcohol expenditure on underweight and obesity outcomes is larger than the impact of cigarette expenditure, which is rooted in their physiological and behavioural differences. While cigarettes may influence weight through appetite suppression and minor metabolic effects, alcohol directly adds to energy intake without offsetting increases in energy expenditure. This makes alcohol a stronger driver of weight gain. Moreover, alcohol consumption disrupts fat metabolism, leading to greater fat retention and a higher risk of obesity. Social and cultural factors also play a critical role. In rural regions, cigarette and alcohol consumption is often shaped by peer influence, social norms, and a desire to maintain relationships or social capital (Denlinger-Apte et al., 2021; Zhang et al., 2022). These behaviors are particularly pronounced among male-headed households, where the prevalence of smoking and drinking tends to be higher (Iqbal et al., 2019). This pattern of habitual consumption — fueled by addiction, stress relief, and cultural imitation — reinforces unhealthy behaviors and elevates the risk of obesity.

5.4. Disaggregated analyses by gender

Table 5 reveals significant gender disparities in how CA expenditures affect body weight. Among male household heads, increases in CA, cigarette, and alcohol expenditures reduce the likelihood of being underweight by 0.3%, 0.5%, and 0.9%, respectively, while increasing the probability of being obese by 0.6%, 0.8%, and 2.5%. In contrast, none of these expenditure variables significantly affects the body weight outcomes of female household heads, even at the 10% significance level.

[Insert Table 5 here]

The findings in Table 5 reflect higher overall expenditure of CA among male household

heads, often driven by social, cultural, or occupational factors. Elevated CA expenditure among men is associated with reduced physical activity and increased caloric intake, both from alcohol itself and the consumption of unhealthy, high-calorie foods that often accompany drinking and smoking behaviors (Egbuna et al., 2021). While nicotine may initially suppress appetite and increase metabolism, the long-term lifestyle patterns associated with smoking, such as poor diet, reduced exercise tolerance, and habitual co-consumption of alcohol, tend to counteract these effects and promote gradual weight gain (Krupa et al., 2024). Alcohol, in particular, contributes directly to energy intake and impairs fat metabolism, which explains its stronger effect on obesity among male household heads.

The absence of significant effects among female household heads likely reflects lower levels of CA consumption, particularly in rural areas where cultural norms discourage these behaviors (Ikoona et al., 2023). Even among women who do consume alcohol or smoke, biological differences—such as lower alcohol tolerance, slower metabolism, and greater fat storage efficiency—may influence how their bodies process these substances. These differences can lead to weight gain, but the overall lower consumption levels limit the statistical significance of these effects. Furthermore, social pressures and health awareness may lead women to adopt compensatory behaviors, such as dietary restraint or increased physical activity, which can mitigate the potential weight-related consequences of CA consumption (Merino et al., 2024).

6. Conclusions, policy implications, and limitations

6.1. Conclusions

Analyzing the impact of CA expenditure is essential for understanding how rural households' economic behaviors influence their overall well-being. While extensive research has explored the health risks associated with smoking and alcohol consumption, little attention has been given to their effects on body weight outcomes, particularly in rural areas. Given rural China's

unique socioeconomic conditions and lifestyle factors, where agricultural labor, dietary habits, and health awareness vary significantly, assessing how CA expenditures shape body weight is critical but is currently overlooked in the literature. This study aims to bridge this research gap by systematically analyzing the relationship between CA expenditures and body weight among rural households in China. This study employs a two-stage residual inclusion (2SRI) approach to address potential endogeneity in the CA expenditure variables and estimate survey data from 1,487 rural households collected in 2023 across Jiangsu, Hubei, and Yunnan.

The findings show that a one-unit increase in CA expenditure reduces the likelihood of household heads being underweight by 0.2% and of being of normal weight by 0.7%. In contrast, a one-unit increase in CA spending is associated with a 0.7% increase in the probability of obese household heads. Besides, cigarette expenditure is significantly related to changes in body weight categories. Specifically, a one-unit increase in cigarette expenditure reduces the likelihood of household heads being underweight by 0.3% while increasing the likelihood of obesity by 0.8%. Similarly, alcohol expenditure also exhibits significant effects on body weight. A one-unit increase in alcohol expenditure reduces the probability of being underweight by 0.8% and increases the likelihood of being obese by 3.3%. In addition, our estimates reveal that the impact of alcohol expenditure on obesity and underweight outcomes is larger than the impact of cigarette expenditure.

Significant gender disparities exist in how CA expenditures affect body weight. Among male household heads, increases in CA, cigarette, and alcohol expenditures reduce the likelihood of being underweight by 0.3%, 0.5%, and 0.9%, respectively, while increasing the probability of being obese by 0.6%, 0.8%, and 2.5%. In contrast, none of these expenditure variables significantly affects the body weight outcomes of female household heads, even at the 10% significance level.

6.2. Policy Implications

The findings from this study show that an increase in CA expenditure would reduce the probability of being underweight and normal weight and increase the probability of being overweight among rural households. This finding suggests that activities and initiatives aimed at raising awareness of the harmful effects of tobacco and alcohol consumption may help rural residents maintain a normal weight and reduce obesity rates. Therefore, the government should carry out targeted health knowledge campaigns. Use plain language and media to publicise the harmful effects of smoking and alcohol abuse on the body, especially weight and metabolic health, in rural areas. For example, it can be emphasized that long-term alcohol abuse can lead to high-calorie intake, obesity, and liver damage; smoking not only damages cardiopulmonary function but can also lead to appetite disorders and malnutrition, thus affecting healthy weight. These measures can help rural residents understand the harm of smoking and drinking and, to a certain extent, reduce the obesity rate.

Male household heads tend to have higher cigarette and alcohol consumption. This finding suggests that the government should leverage the leading role of women in family health management. Policies should be formulated to support women's voices in family consumption and health decision-making, such as through women's health programs, family nutrition monitoring, and healthy consumption guidance, to help women take the lead in the rational allocation of family budgets and health resources. These measures can ensure that families receive more scientific health management and reduce the hidden health risks caused by poor consumption behaviours. Last but not least, our results suggest that rural residents in Jiangsu and Hubei provinces are at a high risk of being overweight and obese. In contrast, those in Yunnan province consume more cigarettes and alcohol. This underscores the need for policymakers to develop region-specific strategies aimed at curbing CA consumption and promoting healthy weight management among rural residents.

6.3 Limitations

Although this study provides significant and interesting insights regarding the nexus between CA expenditure and body weight outcomes among rural households, it is subject to two limitations. First, different types of cigarettes and alcohol may have varied impacts on body weight outcomes among rural households. However, this cannot be identified in the present study due to the absence of detailed data on rural households' consumption of different types of cigarettes and alcohol. Second, our analyses rely on cross-sectional data collected from three provinces in China, which do not allow us to investigate the dynamic effects of CA expenditure on body weight outcomes. Nevertheless, we believe these are interesting areas to be explored for future studies when the required data becomes available.

References

Adeloye, D., Ige-Elegbede, J. O., Ezejimofor, M., Owolabi, E. O., Ezeigwe, N., Omoyele, C., Mpazanje, R. G., Dewan, M. T., Agogo, E., Gadanya, M. A., Alemu, W., Harhay, M. O., Auta, A., & Adebiyi, A. O. (2021). Estimating the prevalence of overweight and obesity in Nigeria in 2020: a systematic review and meta-analysis. *Annals of Medicine*, *53*(1), 495–507. https://doi.org/10.1080/07853890.2021.1897665

Alribdi, F. F., Almutairi, S., Jo, M., & Teixeira-lemos, E. (2024). *Dietary Patterns among Smokers and Non-Smokers : Findings*. 2017–2018.

Alsulami, S., Baig, M., Ahmad, T., Althagafi, N., Hazzazi, E., Alsayed, R., Alghamdi, M., & Almohammadi, T. (2023). Obesity prevalence, physical activity, and dietary practices among adults in Saudi Arabia. *Frontiers in Public Health*, *11*(1). https://doi.org/10.3389/fpubh.2023.1124051

Amezcua-Guerra, L. M., Pazarán-Romero, G., Gutiérrez-Esparza, G. O., Fonseca-Camarillo, G., Martínez-García, M., Groves-Miralrío, L. E., & Brianza-Padilla, M. (2024). Gender assessment of sleep disorders in an adult urban population of Mexico City. *Salud Publica de Mexico*, *66*(6), 824–830. https://doi.org/10.21149/15654

Best, R., Marrone, M., & Linnenluecke, M. (2023). Meta-analysis of the role of equity dimensions in household solar panel adoption. *Ecological Economics*, *206*(January), 107754. https://doi.org/10.1016/j.ecolecon.2023.107754

Carnazza, G., Liberati, P., Resce, G., & Molinaro, S. (2021). Smoking and income distribution: Inequalities in new and old products. *Health Policy*, *125*(2), 261–268. https://doi.org/10.1016/j.healthpol.2020.11.012

Chaudhary, M., & Sharma, P. (2023). Abdominal obesity in India: analysis of the National Family Health Survey-5 (2019–2021) data. *The Lancet Regional Health - Southeast Asia*, *14*, 100208. https://doi.org/10.1016/j.lansea.2023.100208

Chen, N., Fong, D. Y. T., & Wong, J. Y. H. (2023). Health and Economic Outcomes Associated with Musculoskeletal Disorders Attributable to High Body Mass Index in 192 Countries and Territories in 2019. *JAMA Network Open*, *6*(1), E2250674. https://doi.org/10.1001/jamanetworkopen.2022.50674

Chen, Z., Huang, X., & Zhang, L. (2022). Local gender imbalance and corporate risk-taking. *Journal of Economic Behavior and Organization*, *198*, 650–672. https://doi.org/10.1016/j.jebo.2022.05.001

Chiolero, A., Faeh, D., Paccaud, F., & Cornuz, J. (2008). Consequences of smoking for body weight, body fat distribution, and insulin resistance. *American Journal of Clinical Nutrition*, *87*(4), 801–809. https://doi.org/10.1093/ajcn/87.4.801

Coibion, O., & Weber, M. (2020). *HOW DID U.S. CONSUMERS USE THEIR STIMULUS PAYMENTS?*

Cooper, A. J., Gupta, S. R., Moustafa, A. F., & Chao, A. M. (2021). Sex/Gender Differences in Obesity Prevalence, Comorbidities, and Treatment. *Current Obesity Reports*, *10*(4), 458–466. https://doi.org/10.1007/s13679-021-00453-x

D'Errico, M., Pavlova, M., & Spandonaro, F. (2022). The economic burden of obesity in Italy: a cost-of-illness study. *European Journal of Health Economics*, *23*(2), 177–192. https://doi.org/10.1007/s10198-021-01358-1

Dahlawi, M., Aldabbagh, M., Alzubaidy, B. A., Dahlawi, S., Alotaibi, R. N., Alsharif, W. K., Alosaimi, S. B., & Hassan-Hussein, A. (2024). Association Between Smoking Habits and Body Weight Among General Population in Saudi Arabia. *Cureus*, *16*(1), 1–11. https://doi.org/10.7759/cureus.51485

Dasgupta, M. (2022). *CONSTRUCTION OF MASCULINITY : A SOCIOLOGICAL STUDY OF HIGH SCHOOL BOYS IN NORTH KOLKATA A Synopsis Submitted for the Degree of DOCTOR OF PHILOSPHY IN SOCIOLOGY BY*.

Denlinger-Apte, R. L., White, C. M., Donny, E. C., Hatsukami, D. K., Benowitz, N. L., Carpenter, M. J., & Smith, T. T. (2021). "I actually finally feel like the cigarettes aren't controlling me." – Interviews with participants smoking very low nicotine content cigarettes during a residential study. *Drug and Alcohol Dependence*, *219*(November 2020), 108465. https://doi.org/10.1016/j.drugalcdep.2020.108465

Dong, Y., Jan, C., Ma, Y., Dong, B., Zou, Z., Yang, Y., Xu, R., Song, Y., Ma, J., Sawyer, S. M., & Patton, G. C. (2019). Economic development and the nutritional status of Chinese school-aged children and adolescents from 1995 to 2014: an analysis of five successive national surveys. *The Lancet Diabetes and Endocrinology*, *7*(4), 288–299. https://doi.org/10.1016/S2213-8587(19)30075-0

Dong, Z., Alhaj-Yaseen, Y., Jiao, Y., & Zhong, Y. (2021). Surplus men and scarce women: The impact of mating competition on the desire for sons in China*. *Pacific Economic Review*, *26*(3), 339–371. https://doi.org/10.1111/1468-0106.12349

Driva, S., Korkontzelou, A., Tonstad, S., Tentolouris, N., & Katsaounou, P. (2022). The Effect of Smoking Cessation on Body Weight and Other Metabolic Parameters with Focus on People with Type 2 Diabetes Mellitus. *International Journal of Environmental Research and Public Health*, *19*(20), 4–5. https://doi.org/10.3390/ijerph192013222

Dukewich, M., Yuan, L., & Terrault, N. A. (2025). At the Crossroads of Health and Disease: Consequences of Fat in the Liver. *Annual Review of Physiology*, *87*(1), 325–352. https://doi.org/10.1146/annurev-physiol-022724-105515

Egbuna, C., Hassan, S., & Compounds, N. B. (2021). Dietary Phytochemicals. In *Dietary Phytochemicals*. https://doi.org/10.1007/978-3-030-72999-8

Ferreira, A. P. de S., Szwarcwald, C. L., Damacena, G. N., & de Souza Júnior, P. R. B. (2021). Increasing trends in obesity prevalence from 2013 to 2019 and associated factors in Brazil. *Revista Brasileira de Epidemiologia*, *24*. https://doi.org/10.1590/1980-549720210009.SUPL.2

Fong, M., Scott, S., Albani, V., Adamson, A., & Kaner, E. (2021). 'Joining the Dots': Individual, sociocultural and environmental links between alcohol consumption, dietary intake and body weight—A narrative review. *Nutrients*, *13*(9). https://doi.org/10.3390/nu13092927

Fryt, J., Szczygieł, M., & Duell, N. (2022). Positive and negative risk-taking: Age patterns and relations to domain-specific risk-taking. *Advances in Life Course Research*, *54*(February). https://doi.org/10.1016/j.alcr.2022.100515

GBD. (2025). Global, regional, and national prevalence of child and adolescent overweight and obesity, 1990-2021, with forecasts to 2050: a forecasting study for the Global Burden of Disease Study 2021. *Lancet (London, England)*, *405*(10481), 785–812. https://doi.org/10.1016/S0140-6736(25)00397-6

GlobalData. (2022). *Chinese spirits market reache*.

Grunberg, N. E. (1990). The Inverse Relationship between Tobacco Use and Body Weight. *Research Advances in Alcohol and Drug Problems*, 273–315. https://doi.org/10.1007/978-1-4899-1669-3_9

He, Z., Bishwajit, G., & Yaya, S. (2019). Prevalence of alcohol and tobacco use among men and women in Namibia. *International Journal of Environmental Research and Public Health*, *16*(1). https://doi.org/10.3390/ijerph16010059

Hecker, J., Freijer, K., Hiligsmann, M., & Evers, S. M. A. A. (2022). Burden of disease study of overweight and obesity; the societal impact in terms of cost-of-illness and health-related quality of life. *BMC Public Health*, *22*(1), 1–13. https://doi.org/10.1186/s12889-021-12449-2

Huang, D. Q., Mathurin, P., Cortez-Pinto, H., & Loomba, R. (2023). Global epidemiology of alcohol-associated cirrhosis and HCC: trends, projections and risk factors. *Nature Reviews Gastroenterology and Hepatology*, *20*(1), 37–49. https://doi.org/10.1038/s41575-022-00688-6

Ikoona, E. N., Toure, M. A., Njenga, A., Namulemo, L., Kaluya, R., Kamara, K., Oyat, F. W. D., Aloyo, J., Matovu, J. B., & Kitara, D. L. (2023). Double burden of malnutrition among women in reproductive age (15–49 years) in Sierra Leone: a secondary data analysis of the demographic health survey 2019 (SLDHS-2019). *BMC Nutrition*, *9*(1), 1–23. https://doi.org/10.1186/s40795-023-00795-w

Iqbal, Z., Yar Khan, M., Awan, T., & Javed, A. (2019). *Kashmir Economic Review*. *28*(2), 26–42.

Izquierdo, M., Merchant, R. A., Morley, J. E., Anker, S. D., Aprahamian, I., Arai, H., Aubertin-Leheudre, M., Bernabei, R., Cadore, E. L., Cesari, M., Chen, L. K., de Souto Barreto, P., Duque, G., Ferrucci, L., Fielding, R. A., García-Hermoso, A., Gutiérrez-Robledo, L. M., Harridge, S. D. R., Kirk, B., … Singh, M. F. (2021). International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. *Journal of Nutrition, Health and Aging*, *25*(7), 824–853. https://doi.org/10.1007/s12603-021-1665-8

Jayasinghe, M., & Smith, C. (2021). Poverty Implications of Household Headship and Food Consumption Economies of Scales: A Case Study from Sri Lanka. *Social Indicators Research*, *155*(1), 157–185. https://doi.org/10.1007/s11205-020-02560-z

Jolex, A., & Kaluwa, B. (2022). Crowding Out Effects of Alcohol Consumption Expenditure on Household Resource Allocation in Malawi. *PLoS ONE*, *17*(2 February), 1–12. https://doi.org/10.1371/journal.pone.0263330

Joshy, G., Soga, K., Thurber, K. A., Egger, S., Weber, M. F., Sarich, P., Welsh, J., Korda, R. J., Yazidjoglou, A., Nguyen, M. T. H., Paige, E., Gourley, M., Canfell, K., & Banks, E. (2025). Relationship of tobacco smoking to cause-specific mortality: contemporary estimates from Australia. *BMC Medicine*, *23*(1). https://doi.org/10.1186/s12916-025-03883-9

Jumrani, J., & Birthal, P. S. (2017). Does consumption of tobacco and alcohol affect household food security? Evidence from rural India. *Food Security*, *9*(2), 255–279. https://doi.org/10.1007/s12571-017-0660-8

Khanna, K., Lu, J., & Warrier, J. (2022). *The Impact of Socioeconomic Factors on Health Disparities*. http://arxiv.org/abs/2212.04285

Kim, T. S., Roslin, M., Wang, J. J., Kane, J., Hirsch, J. S., & Kim, E. J. (2021). BMI as a Risk Factor for Clinical Outcomes in Patients Hospitalized with COVID-19 in New York. *Obesity*, *29*(2), 279–284. https://doi.org/10.1002/oby.23076

Koliaki, C., Dalamaga, M., & Liatis, S. (2023). Update on the Obesity Epidemic: After the Sudden Rise, Is the Upward Trajectory Beginning to Flatten? *Current Obesity Reports*, *12*(4), 514–527. https://doi.org/10.1007/s13679-023-00527-y

Koppes, L. L. J., Twisk, J. W. R., Van Mechelen, W., Snel, J., & Kemper, H. C. G. (2005). Cross-sectional and longitudinal relationships between alcohol consumption and lipids, blood pressure and body weight indices. *Journal of Studies on Alcohol*, *66*(6), 713–721. https://doi.org/10.15288/jsa.2005.66.713

Kotlyarov, S. (2023). The Role of Smoking in the Mechanisms of Development of Chronic Obstructive Pulmonary Disease and Atherosclerosis. *International Journal of Molecular Sciences*, *24*(10). https://doi.org/10.3390/ijms24108725

Krupa, H., Gearhardt, A. N., Lewandowski, A., & Avena, N. M. (2024). *Food Addiction*. 1–19.

Kshatri, J. S., Satpathy, P., Sharma, S., Bhoi, T., Mishra, S. P., & Sahoo, S. S. (2022). Health research in the state of Odisha, India: A decadal bibliometric analysis (2011-2020).

Journal of Family Medicine and Primary Care, *6*(2), 169–170. https://doi.org/10.4103/jfmpc.jfmpc

La Fauci, V. L., Mondello, S., Squeri, R., Alessi, V., Genovese, C., Laudani, N., & Cattaruzza, M. S. (2021). Family, lifestyles and new and old type of smoking in young adults: insights from an italian multiple-center study. *Annali Di Igiene Medicina Preventiva e Di Comunita*, *33*(2), 131–140. https://doi.org/10.7416/ai.2021.2419

Ling, J., Chen, S., Zahry, N. R., & Kao, T. S. A. (2023). Economic burden of childhood overweight and obesity: A systematic review and meta-analysis. *Obesity Reviews*, *24*(2), 1–13. https://doi.org/10.1111/obr.13535

Lodhia, J. (2024). *Case Report Advanced Mucinous Colorectal Carcinoma in a Teenager : A Case Report of a Changing Age Paradigm*. *29*(3), 9–15. https://doi.org/10.4314/ecajs.v29i3.3

Ma, G., Meyer, C. L., Jackson-Morris, A., Chang, S., Narayan, A., Zhang, M., Wu, D., Wang, Y., Yang, Z., Wang, H., Zhao, L., & Nugent, R. (2024). The return on investment for the prevention and treatment of childhood and adolescent overweight and obesity in China: a modelling study. *The Lancet Regional Health - Western Pacific*, *43*, 100977. https://doi.org/10.1016/j.lanwpc.2023.100977

Ma, W., Zheng, H., Zhu, Y., & Qi, J. (2022). Effects of cooperative membership on financial performance of banana farmers in China: A heterogeneous analysis. *Annals of Public and Cooperative Economics*, *93*(1), 5–27. https://doi.org/10.1111/apce.12326

Macías Sánchez, A., & García Gómez, A. (2024). Crowding out and impoverishing effect of tobacco in Mexico. *Tobacco Control*, *33*, S68–S74. https://doi.org/10.1136/tc-2022-057791

Malkin, J. D., Baid, D., Alsukait, R. F., Alghaith, T., Alluhidan, M., Alabdulkarim, H., Altowaijri, A., Almalki, Z. S., Herbst, C. H., Finkelstein, E. A., El-Saharty, S., & Alazemi, N. (2022). The economic burden of overweight and obesity in Saudi Arabia. *PLoS ONE*, *17*(3 March 2022), 1–8. https://doi.org/10.1371/journal.pone.0264993

Marcus, C., Danielsson, P., & Hagman, E. (2022). Pediatric obesity—Long-term consequences and effect of weight loss. *Journal of Internal Medicine*, *292*(6), 870–891. https://doi.org/10.1111/joim.13547

Mehrabi, F., Amiri, P., Cheraghi, L., Kheradmand, A., Hosseinpanah, F., & Azizi, F. (2021). Emotional states of different obesity phenotypes: a sex-specific study in a west-Asian population. *BMC Psychiatry*, *21*(1), 1–10. https://doi.org/10.1186/s12888-021-03131-3

Merino, M., Tornero-Aguilera, J. F., Rubio-Zarapuz, A., Villanueva-Tobaldo, C. V., Martín-Rodríguez, A., & Clemente-Suárez, V. J. (2024). Body Perceptions and Psychological Well-Being: A Review of the Impact of Social Media and Physical Measurements on Self-Esteem and Mental Health with a Focus on Body Image Satisfaction and Its Relationship with Cultural and Gender Factors. *Healthcare (Switzerland)*, *12*(14). https://doi.org/10.3390/healthcare12141396

MICHAEL T. FRENCH, E. C. N., FANG, H., & MACLEAN, J. C. (2008). *ALCOHOL CONSUMPTION AND BODY WEIGHT*. *1131*(2007), 1127–1131. https://doi.org/10.1002/hec

Minami, T., Inoue, M., Sawada, N., Yamaji, T., Iwasaki, M., & Tsugane, S. (2021). Alcohol consumption, tobacco smoking, and subsequent risk of renal cell carcinoma: The JPHC study. *Cancer Science*, *112*(12), 5068–5077. https://doi.org/10.1111/cas.15129

Mo, J. J. Y., Cheung, K. W. K., Gledhill, L. J., Pollet, T. V., Boothroyd, L. G., & Tovée, M. J. (2014). Perceptions of Female Body Size and Shape in China, Hong Kong, and the United Kingdom. *Cross-Cultural Research*, *48*(1), 78–103. https://doi.org/10.1177/1069397113510272

Mwene-Batu, P., Bisimwa, G., Donnen, P., Bisimwa, J., Tshongo, C., Dramaix, M., Hermans, M. P., & Briend, A. (2022). Risk of Chronic Disease after an Episode of Marasmus, Kwashiorkor or Mixed–Type Severe Acute Malnutrition in the Democratic Republic of Congo: The Lwiro Follow-Up Study. *Nutrients*, *14*(12). https://doi.org/10.3390/nu14122465

Naseri, S., & Faghih, S. (2024). *Review Paper Investigating the Relationship Between Cultural, Social, Political, and Economic Factors With Hookah Smoking in Iran Adolescents*. *3*(1), 1–8.

Ogada, M. J., Rao, E. J. O., Radeny, M., Recha, J. W., & Solomon, D. (2020). Climate-smart agriculture, household income and asset accumulation among smallholder farmers in the Nyando basin of Kenya. *World Development Perspectives*, *18*(June 2019), 100203. https://doi.org/10.1016/j.wdp.2020.100203

Okunogbe, A., Nugent, R., Spencer, G., Ralston, J., & Wilding, J. (2021). Economic impacts of overweight and obesity: Current and future estimates for eight countries. *BMJ Global Health*, *6*(10). https://doi.org/10.1136/bmjgh-2021-006351

Prokopidis, K., & Witard, O. C. (2022). Understanding the role of smoking and chronic excess alcohol consumption on reduced caloric intake and the development of sarcopenia. *Nutrition Research Reviews*, *35*(2), 197–206. https://doi.org/10.1017/S0954422421000135

Qin, G., Qin, Y., & Liu, B. (2022). Association between BMI and health-related physical fitness: A cross-sectional study in Chinese high school students. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.1047501

Rahman, M. S., Toiba, H., Nugroho, T. W., Hartono, R., Shaleh, M. I., Sugiono, S., & Saeri, M. (2023). Does internet use make farmers happier? Evidence from Indonesia. *Cogent Social Sciences*, *9*(2). https://doi.org/10.1080/23311886.2023.2243716

Rezaei, M., Ghadamgahi, F., Jayedi, A., Arzhang, P., Yekaninejad, M. S., & Azadbakht, L. (2024). The association between food insecurity and obesity, a body shape index and body roundness index among US adults. *Scientific Reports*, *14*(1), 23631. https://doi.org/10.1038/s41598-024-74108-x

Robinson, E., Boyland, E., Evans, R., Finlay, A., Halsall, L., Humphreys, G., Langfield, T., McFarland-Lesser, I., Patel, Z., & Jones, A. (2023). Energy labelling of alcoholic drinks: An important or inconsequential obesity policy? *Obesity Science and Practice*, *9*(2), 75–86. https://doi.org/10.1002/osp4.638

Selvamani, Y., Pradhan, J., & Fong, J. H. (2024). Tobacco Use, Food Insecurity, and Low BMI in India's Older Population. *Nutrients* , *16*(21), 1–14. https://doi.org/10.3390/nu16213649

Simo, L. P., Agbor, V. N., Temgoua, F. Z., Fozeu, L. C. F., Bonghaseh, D. T., Mbonda, A. G. N., Yurika, R., Dotse-Gborgbortsi, W., & Mbanya, D. (2021). Prevalence and factors associated with overweight and obesity in selected health areas in a rural health district in Cameroon: a cross-sectional analysis. *BMC Public Health*, *21*(1), 1–12. https://doi.org/10.1186/s12889-021-10403-w

Stephenson, J., Smith, C. M., Kearns, B., Haywood, A., & Bissell, P. (2021). The association between obesity and quality of life: a retrospective analysis of a large-scale population-based cohort study. *BMC Public Health*, *21*(1), 1–9. https://doi.org/10.1186/s12889-021-12009-8

Sun, X., Yan, A. F., Shi, Z., Zhao, B., Yan, N., Li, K., Gao, L., Xue, H., Peng, W., Cheskin, L. J., & Wang, Y. (2022). Health consequences of obesity and projected future obesity health burden in China. *Obesity*, *30*(9), 1724–1751. https://doi.org/10.1002/oby.23472

Terza, J. V. (2017). Two-stage residual inclusion estimation: A practitioners guide to stata implementation. *Stata Journal*, *17*(4), 916–938. https://doi.org/10.1177/1536867X1801700409

Vladisavljevic, M., Zubović, J., Jovanovic, O., & Aukic, M. (2024). Crowding-out effect of tobacco consumption in Serbia. *Tobacco Control*, *33*, S88–S94. https://doi.org/10.1136/tc-2022-057727

Wang, J., Wang, Y., Korivi, M., Chen, X., & Zhu, R. (2022). Status of Sedentary Time and Physical Activity of Rural Residents: A Cross-Sectional Population-Based Study in Eastern China. *Frontiers in Public Health*, *10*(April), 1–11. https://doi.org/10.3389/fpubh.2022.838226

Wang, L., Zhou, B., Zhao, Z., Yang, L., Zhang, M., Jiang, Y., Li, Y., Zhou, M., Wang, L., Huang, Z., Zhang, X., Zhao, L., Yu, D., Li, C., Ezzati, M., Chen, Z., Wu, J., Ding, G., & Li, X. (2021). Body-mass index and obesity in urban and rural China: findings from consecutive nationally representative surveys during 2004–18. *The Lancet*, *398*(10294), 53–63. https://doi.org/10.1016/S0140-6736(21)00798-4

Williams, H., Makunyane, L., Molobe, I., Freeman, R., & Ogbonnaya, I. (2024). *Substance Use among Adolescents in Sub-Saharan Africa : A Narrative Review of Epidemiological Data*. *12*.

Winsløw, U. C., Rode, L., & Nordestgaard, B. G. (2015). High tobacco consumption lowers body weight: A Mendelian randomization study of the Copenhagen General Population Study. *International Journal of Epidemiology*, *44*(2), 540–550. https://doi.org/10.1093/ije/dyu276

Wu, D. C., Shannon, G., Reynales-Shigematsu, L. M., Saenz de Miera, B., Llorente, B., & Jha, P. (2021). Implications of household tobacco and alcohol use on child health and women's welfare in six low and middle-income countries: An analysis from a gender perspective. *Social Science and Medicine*, *281*(May), 114102. https://doi.org/10.1016/j.socscimed.2021.114102

Xolnazarova, M. (2022). *Factors and socio-psychological causes of behavior deviation in minors*. *20*(20), 1781–1785. https://doi.org/10.48047/NQ.2022.20.20.NQ109185

Zhang, L., Huang, L., Weiger, C., Jiao, C., Li, Y., & Wu, D. (2022). Prevalence, correlates, and behavioral outcomes of alcohol gifting in China. *BMC Public Health*, *22*(1), 1–10. https://doi.org/10.1186/s12889-022-13946-8

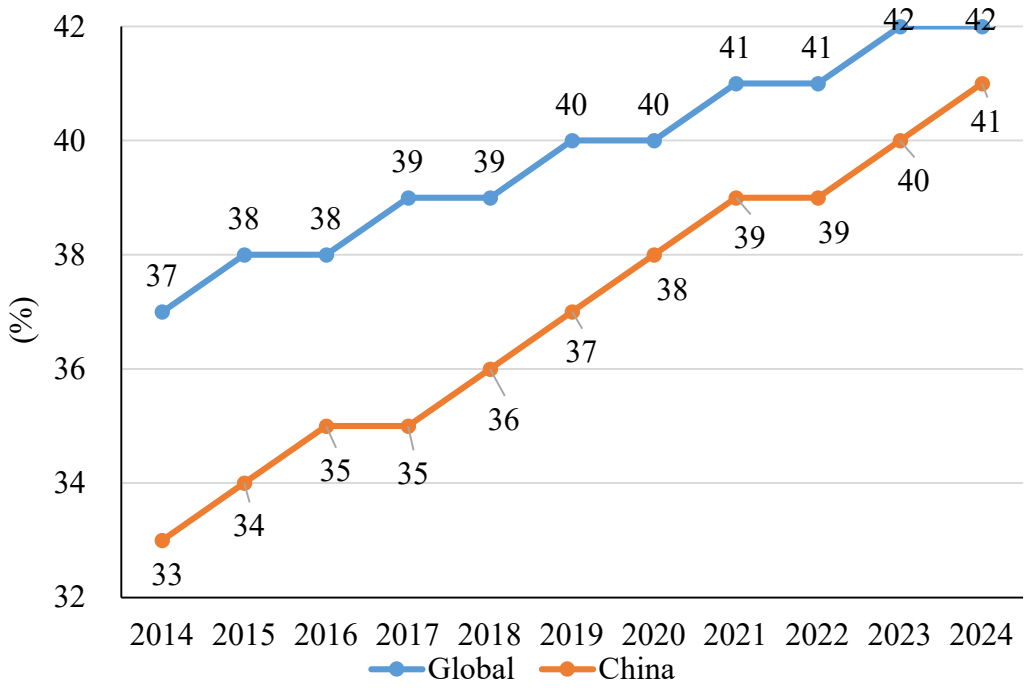
Zhang, L., & Lewsey, J. (2024). Comparing the performance of two-stage residual inclusion methods when using physician's prescribing preference as an instrumental variable: unmeasured confounding and noncollapsibility. *Journal of Comparative Effectiveness Research*, *13*(5). https://doi.org/10.57264/cer-2023-0085

Zhang, M., Yang, L., Wang, L., Jiang, Y., Huang, Z., Zhao, Z., Zhang, X., Li, Y., Liu, S., Li, C., Wang, L., Wu, J., Li, X., Chen, Z., & Zhou, M. (2022). Trends in smoking prevalence in urban and rural China, 2007 to 2018: Findings from 5 consecutive nationally representative crosssectional surveys. *PLoS Medicine*, *19*(8), 1–21. https://doi.org/10.1371/journal.pmed.1004064

Zhao, S. (2022). A Study on China's Tobacco Taxation and Its Influencing Factor on Economic Growth. *Frontiers in Psychology*, *13*(February), 1–13. https://doi.org/10.3389/fpsyg.2022.832040

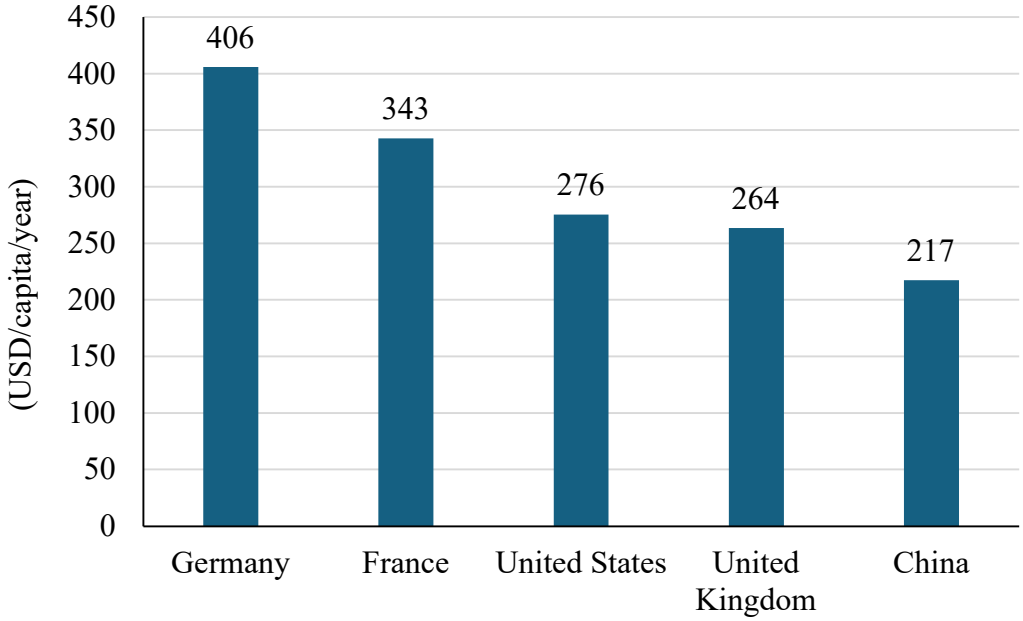
Zubair, F., Husnain, M. I. ul, Zhao, T., Ahmad, H., & Khanam, R. (2022). A gender-specific assessment of tobacco use risk factors: evidence from the latest Pakistan demographic and health survey. *BMC Public Health*, *22*(1), 1–11. https://doi.org/10.1186/s12889-022-13574-2

Figures

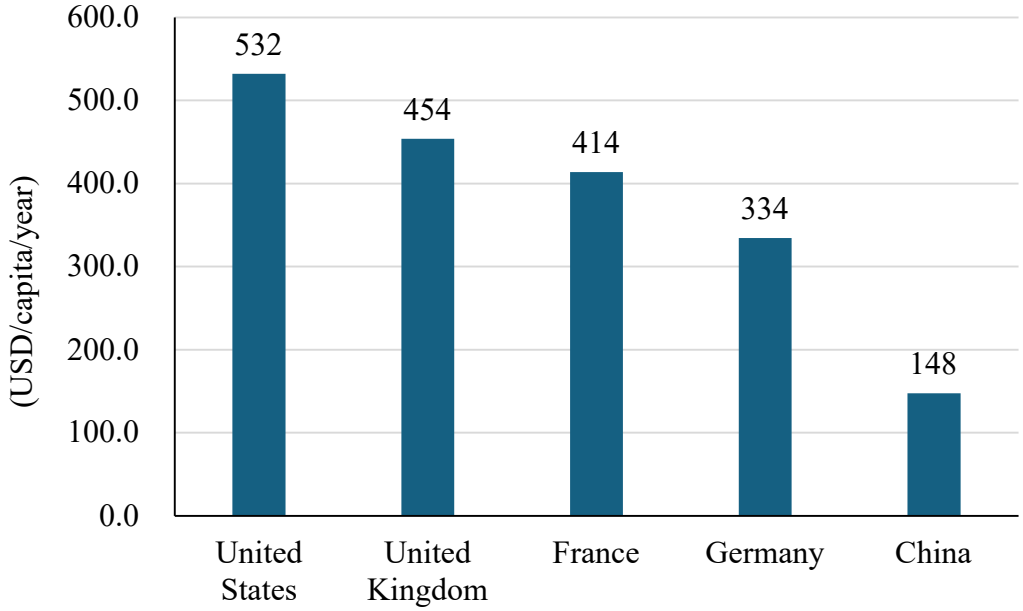


Source: Statista; WHO

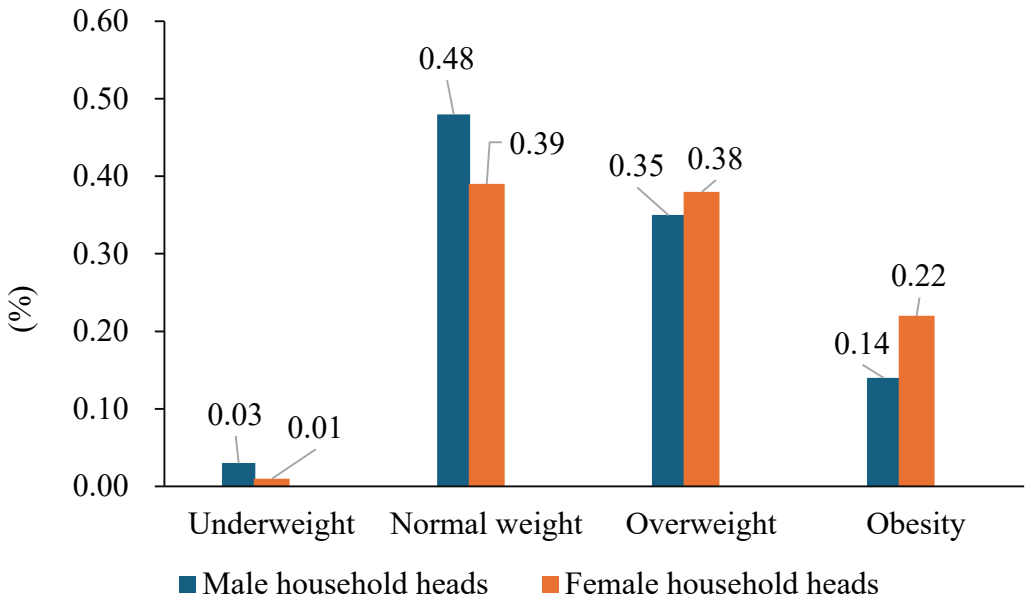
Figure 1: Ratios of people who are overweight and obese globally and in China



Source: Statista Market Insights (2024)
Figure 2: Top 5 countries in spending on cigarettes in 2023

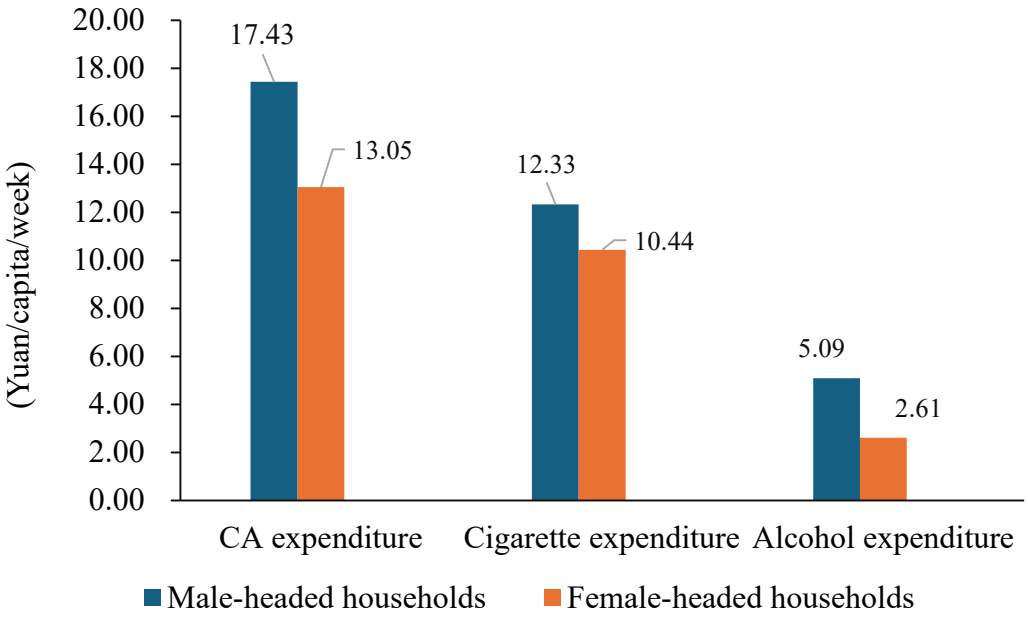


Source: Statista Market Insights (2024)
Figure 3: Top 5 countries in spending on alcohol in 2023 (USD/capita)



Note: Means are shown above bars; Standard deviations are in parentheses

Figure 4: Sample distributions under different body weight categories between male and female household heads



Note: Means are shown above bars; Standard deviations are in parentheses

Figure 5: Means in CA, cigarette, and alcohol expenditures between male- and female-headed households

Tables

Table 1 Variable definitions and descriptive statistics

Variables	Definitions	Mean	S.D.
Dependent variable			
Body weight outcome	Body weight outcomes of respondent: 1=underweight (BMI＜18.5), 2=normal weight (18.5≤BMI≤23.9), 3=overweight (23.9＜BMI≤27.9), and 4=obesity (BMI>27.9)	2.66	0.78
Key independent variables			
CA expenditure	Total household cigarette and alcohol (CA) expenditure (yuan/capita/week) [a]	16.03	21.67
Cigarette expenditure	Total household cigarette expenditure (yuan/capita/week)	11.73	15.28
Alcohol expenditure	Total household alcohol expenditure (yuan/capita/week)	4.30	13.56
Control variables			
Age	Age of the household head (HH) (years)	57.91	11.90
Gender	1 if HH is male, 0 otherwise	0.68	0.47
Education	Educational level of the HH: 1=No formal education (illiterate), 2=Primary school, 3=Junior middle school, and 4=High school or above	2.59	0.92
Health condition	Self-reported health condition of HH: 1=very poor, 2=poor, 3=fair, 4=good, and 5=very good	3.60	1.05
Household size	Number of people residing in a household (persons)	5.10	2.08
Old member ratio	The ratio of the number of residents over 65 to the number of household members	0.18	0.25
Asset ownership	1 if a household owns an air conditioner, 0 otherwise	0.66	0.47
Farm size	Total farmland area of a household (mu)[b]	9.57	15.04
Risk preference	Degree of a HH's preference for risk: 1=extremely risk-averse to 10=extremely risk-prefer	3.90	2.92
Dietary training	1 if a household receives dietary training, 0 otherwise	0.18	0.39
Natural disaster	1 if a household experienced natural disaster and or soil fertility degradation in the previous year, 0 otherwise	0.43	0.50
Jiangsu	1 if the household is in Jiangsu province, 0 otherwise	0.34	0.47
Hubei	1 if the household is in Hubei province, 0 otherwise	0.31	0.46
Yunnan	1 if the household is in Yunnan province, 0 otherwise	0.35	0.48
Male ratio (IV)	The ratio of males to total household members	0.33	0.13
Sample size		1,487	

Note: S.D. refers to standard deviation. [a] Yuan is a Chinese currency. [b] 1 mu=1/15 hectare.

Table 2 Mean values of dependent and key independent variables across the surveyed provinces

Variables	Jiangsu	Hubei	Yunnan
Dependent variable			
Body weight outcome	2.80 (0.73)	2.62 (0.76)	2.56 (0.83)
Key independent variables			
CA expenditure	17.22 (26.33)	11.57 (19.55)	18.86 (17.55)
Cigarette expenditure	10.03 (15.42)	8.92 (14.22)	15.86 (15.22)
Alcohol expenditure	7.19 (19.89)	2.66 (11.75)	3.00 (5.61)

Note: Standard deviations are in parenthesis. CA, cigarette, and alcohol expenditures are measured at yuan/capita/week.

Table 3 Determinants of CA expenditure and its impact on body weight outcomes: 2SRI approach

Variables	CA expenditure (Stage 1: Tobit model)	Stage 2: Marginal effects estimated by the MNL model			
		Underweight	Normal weight	Overweight	Obesity
CA expenditure		-0.002 (0.001)***	-0.007 (0.003)**	0.002 (0.003)	0.007 (0.002)***
Age	0.077 (0.095)	0.001 (0.001)	0.004 (0.002)**	-0.002 (0.002)	-0.003 (0.001)***
Gender	7.763 (2.461)***	0.036 (0.010)***	0.111 (0.049)**	-0.051 (0.040)	-0.097 (0.028)***
Education	0.154 (0.657)	-0.005 (0.005)	0.007 (0.019)	0.008 (0.017)	-0.010 (0.015)
Health condition	2.398 (1.243)*	0.003 (0.004)	0.006 (0.012)	0.022 (0.012)*	-0.031 (0.007)***
Household size	-1.408 (0.608)**	-0.007 (0.004)*	-0.017 (0.008)**	0.013 (0.011)	0.012 (0.004)***
Old member ratio	-2.146 (4.305)	-0.023 (0.034)	0.041 (0.057)	-0.001 (0.060)	-0.016 (0.045)
Asset ownership	7.323 (2.722)***	0.014 (0.011)	0.049 (0.022)**	0.039 (0.032)	-0.102 (0.035)***
Farm size (ln)	0.744 (0.238)***	0.002 (0.002)	-0.005 (0.006)	0.004 (0.004)	-0.001 (0.005)
Risk preference	0.765 (0.183)***	0.004 (0.001)***	0.001 (0.006)	-0.007 (0.005)*	0.002 (0.003)
Dietary training	3.610 (3.121)	0.008 (0.005)	-0.007 (0.040)	0.006 (0.036)	-0.007 (0.034)
Natural disaster	1.917 (2.117)	-0.009 (0.009)	-0.017 (0.029)	0.020 (0.025)	0.005 (0.021)
Jiangsu	-9.969 (3.928)**	-0.056 (0.023)**	-0.290 (0.047)***	0.189 (0.044)***	0.157 (0.054)***
Hubei	-17.515 (1.949)***	-0.061 (0.023)***	-0.169 (0.030)***	0.079 (0.050)	0.150 (0.042)***
Residual (predicted)		0.002 (0.001)**	0.006 (0.004)	-0.001 (0.004)	-0.007 (0.002)***
Male ratio (IV)	34.066 (7.473)***				
Constant	-13.882 (10.784)				
Log-likelihood	-5,099.999				
Sample size	1,487	1,487	1,487	1,487	1,487

Note: City-level clustered standard errors are in parenthesis. CA expenditure is measured at yuan/capita/week. The reference region is Yunnan province. ***<0.01, **<0.05, and *<0.10.

Table 4 Impacts of cigarette expenditure and alcohol expenditure on body weight outcomes of rural residents: 2SRI approach

	Cigarette/alcohol expenditure	Stage 2: Marginal effects estimated by the MNL model			
Variables	(Stage 2: Tobit model)	Underweight	Normal weight	Overweight	Obesity
Cigarette					
Cigarette expenditure		-0.003 (0.001)**	-0.008 (0.006)	0.003 (0.005)	0.008 (0.003)***
Control variables	Yes	Yes	Yes	Yes	Yes
Residual (predicted)		0.003 (0.001)**	0.007 (0.006)	-0.003 (0.006)	-0.008 (0.003)**
Male ratio (IV)	27.161 (6.514)***				
Constant	-7.988 (6.975)				
Sample size	1,487	1,487	1,487	1,487	1,487
Alcohol					
Alcohol expenditure		-0.008 (0.004)**	-0.023 (0.015)	-0.002 (0.017)	0.033 (0.009)***
Control variables	Yes	Yes	Yes	Yes	Yes
Residual (predicted)		0.008 (0.004)**	0.021 (0.015)	0.002 (0.017)	-0.032 (0.009)***
Male ratio (IV)	13.653 (6.428)**				
Constant	-29.887 (7.705)***				
Sample size	1,487	1,487	1,487	1,487	1,487

Note: City-level clustered standard errors are in parenthesis. Cigarette and alcohol expenditures are measured at yuan/capita/week. ***<0.01 and **<0.05.

 Wenguang Zhang omly use in NZARES

Table 5 Disaggregated analyses by gender: Marginal effects of the MNL model estimates

Key independent variables	Underweight	Normal weight	Overweight	Obesity
Impacts on male household heads				
CA expenditure	-0.003 (0.001)***	-0.006 (0.004)	0.003 (0.004)	0.006 (0.002)***
Cigarette expenditure	-0.005 (0.001)***	-0.009 (0.006)	0.006 (0.005)	0.008 (0.003)***
Alcohol expenditure	-0.009 (0.003)***	-0.020 (0.019)	0.004 (0.015)	0.025 (0.012)**
Impacts on female household heads				
CA expenditure	0.000 (0.003)	-0.010 (0.010)	-0.000 (0.011)	0.011 (0.006)*
Cigarette expenditure	0.001 (0.004)	-0.014 (0.015)	0.001 (0.015)	0.012 (0.007)
Alcohol expenditure	0.004 (0.011)	-0.041 (0.040)	-0.001 (0.044)	0.038 (0.024)

Note: City-level clustered standard errors are in parentheses. CA, cigarette, and alcohol expenditures are measured in yuan/capita/week. ***<0.01, **<0.05, and *<0.10.

 Wenguang Zhang omly use in NZARES

Appendix

Table A1 Falsification test

Variables	$\chi^2(3)$	*p*-value
Body weight outcomes	5.56	0.135
CA expenditure	28.66***	0.000
Cigarette expenditure	24.90***	0.000
Alcohol expenditure	4.51**	0.034

Note: CA, cigarette, and alcohol expenditures are measured at yuan/capita/week. ***<0.01 and **<0.05.

Table A2 The impacts of CA expenditure on body weight outcomes: Coefficient estimates of the MNL model

Variables	Normal weight	Overweight	Obesity
CA expenditure	0.077 (0.023)***	0.100 (0.033)***	0.138 (0.032)***
Age	-0.046 (0.031)	-0.062 (0.037)*	-0.074 (0.033)**
Gender	-1.138 (0.295)***	-1.570 (0.240)***	-2.019 (0.347)***
Education	0.206 (0.197)	0.216 (0.168)	0.132 (0.137)
Health condition	-0.110 (0.133)	-0.063 (0.122)	-0.315 (0.150)**
Household size	0.242 (0.137)*	0.325 (0.166)**	0.360 (0.140)**
Old member ratio	0.942 (1.142)	0.851 (1.336)	0.754 (1.396)
Asset ownership	-0.436 (0.374)	-0.452 (0.359)	-1.191 (0.407)***
Farm size (ln)	-0.087 (0.078)	-0.062 (0.077)	-0.080 (0.085)
Risk preference	-0.134 (0.024)***	-0.160 (0.020)***	-0.124 (0.032)***
Dietary training	-0.317 (0.222)	-0.285 (0.211)	-0.345 (0.235)
Natural disaster	0.291 (0.415)	0.395 (0.316)	0.370 (0.357)
Jiangsu	1.528 (0.636)**	2.799 (0.700)***	3.223 (0.769)***
Hubei	1.964 (0.558)***	2.629 (0.635)***	3.328 (0.572)***
Residual (predicted)	-0.073 (0.021)***	-0.093 (0.036)***	-0.129 (0.032)***
Constant	3.582 (2.060)*	2.958 (2.370)	3.540 (2.148)*
Log-likelihood		-1,592.530	
Sample size	1,487	1,487	1,487

Note: City-level clustered standard errors are in parenthesis. CA expenditure is measured at yuan/capita/week. The reference region is Yunnan province. ***<0.01, **<0.05, and *<0.10.

Table A3 Determinants of rural household cigarette and alcohol expenditures: Tobit model estimates

Variables	Cigarette expenditure	Alcohol expenditure
Age	0.069 (0.073)	0.019 (0.080)
Gender	4.792 (1.897)**	5.955 (1.798)***
Education	-0.548 (0.564)	0.825 (0.997)
Health condition	1.197 (0.670)*	2.642 (0.767)***
Household size	-0.809 (0.406)**	-0.608 (0.402)
Old member ratio	-2.857 (4.028)	1.240 (3.345)
Asset ownership	5.395 (2.351)**	4.598 (3.184)
Farm size (ln)	0.360 (0.349)	0.757 (0.330)**
Risk preference	0.558 (0.083)***	0.341 (0.260)
Dietary training	3.161 (2.355)	0.763 (1.964)
Natural disaster	1.675 (2.117)	1.005 (1.714)
Jiangsu	-15.037 (2.761)***	-1.697 (3.521)
Hubei	-15.891 (2.115)***	-14.269 (3.539)***
Male ratio (IV)	27.161 (6.514)***	13.653 (6.428)**
Constant	-7.988 (6.975)	-29.887 (7.705)***
Log-likelihood	-4,201.857	-3,100.306
Sample size	1,487	1,487

Note: City-level clustered standard errors are in parenthesis. Cigarette and alcohol expenditures are measured at yuan/capita/week. The reference region is Yunnan province. ***<0.01, **<0.05, and *<0.10.

Table A4 The impacts of cigarette expenditure on body weight outcome: Coefficient estimates of the MNL model

Variables	Normal weight	Overweight	Obesity
Cigarette expenditure	0.109 (0.035)***	0.138 (0.054)**	0.177 (0.049)***
Age	-0.047 (0.031)	-0.063 (0.037)*	-0.076 (0.033)**
Gender	-1.074 (0.307)***	-1.478 (0.244)***	-1.844 (0.369)***
Education	0.251 (0.209)	0.272 (0.181)	0.202 (0.152)
Health condition	-0.068 (0.127)	-0.008 (0.117)	-0.231 (0.143)
Household size	0.226 (0.132)*	0.300 (0.159)*	0.313 (0.136)**
Old member ratio	1.045 (1.140)	0.976 (1.335)	0.911 (1.389)
Asset ownership	-0.433 (0.370)	-0.437 (0.350)	-1.126 (0.395)***
Farm size (ln)	-0.071 (0.077)	-0.042 (0.073)	-0.050 (0.082)
Risk preference	-0.133 (0.027)***	-0.158 (0.021)***	-0.115 (0.034)***
Dietary training	-0.352 (0.227)	-0.322 (0.216)	-0.363 (0.259)
Natural disaster	0.277 (0.414)	0.380 (0.313)	0.365 (0.356)
Jiangsu	2.021 (0.600)***	3.409 (0.678)***	3.940 (0.746)***
Hubei	2.150 (0.557)***	2.845 (0.651)***	3.498 (0.575)***
Residual (predicted)	-0.104 (0.032)***	-0.131 (0.054)**	-0.172 (0.049)***
Constant	3.219 (2.135)	2.516 (2.556)	3.117 (2.305)
Log-likelihood		-1,594.315	
Sample size	1,487	1,487	1,487

Note: City-level clustered standard errors are in parenthesis. Cigarette expenditure is measured at yuan/capita/week. The reference region is Yunnan province. ***<0.01, **<0.05, and *<0.10.

Table A5 The impacts of alcohol expenditure on body weight outcome: Coefficient estimates of the MNL model

Variables	Normal weight	Overweight	Obesity
Alcohol expenditure	0.268 (0.122)**	0.324 (0.159)**	0.534 (0.146)***
Age	-0.044 (0.030)	-0.059 (0.036)*	-0.071 (0.032)**
Gender	-1.265 (0.362)***	-1.687 (0.394)***	-2.344 (0.385)***
Education	0.129 (0.175)	0.125 (0.160)	-0.015 (0.118)
Health condition	-0.239 (0.170)	-0.207 (0.161)	-0.576 (0.192)***
Household size	0.211 (0.135)	0.280 (0.167)*	0.325 (0.141)**
Old member ratio	0.681 (1.139)	0.538 (1.304)	0.262 (1.382)
Asset ownership	-0.505 (0.343)	-0.502 (0.354)	-1.366 (0.359)***
Farm size (ln)	-0.116 (0.081)	-0.094 (0.092)	-0.148 (0.093)
Risk preference	-0.126 (0.028)***	-0.147 (0.029)***	-0.116 (0.034)***
Dietary training	-0.206 (0.240)	-0.140 (0.222)	-0.166 (0.217)
Natural disaster	0.290 (0.425)	0.401 (0.328)	0.359 (0.365)
Jiangsu	1.159 (0.647)*	2.294 (0.715)***	2.528 (0.752)***
Hubei	2.318 (0.624)***	2.961 (0.802)***	4.097 (0.596)***
Residual (predicted)	-0.264 (0.127)**	-0.313 (0.165)*	-0.518 (0.147)***
Constant	4.241 (2.034)**	3.839 (2.254)*	4.603 (2.035)**
Log-likelihood		-1590.590	
Sample size	1,487	1,487	1,487

Note: City-level clustered standard errors are in parenthesis. Alcohol expenditure is measured at yuan/capita/week. The reference region is Yunnan province. ***<0.01, **<0.05, and *<0.10.