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Emptying villages, overflowing glasses: Out-migration and drinking patterns in Rural China

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ABSTRACT

Background: Rural-urban migration is a significant phenomenon in China, resulting in family separation and the emergence of left-behind populations in rural communities. Previous research suggests that migration can influence health behaviors through various pathways. However, limited empirical studies have examined the effects of migration on the drinking behavior of adults left behind. Moreover, the impact of migration at the household and community levels remains unclear.

Methods: This study analyzes the relationship between migration and drinking behavior in rural China with data from the China Health and Nutrition Survey (CHNS 1997–2015) (N = 20,264). Multilevel mixed-effects models are employed to test how household and community levels migration status affects rural residents' weekly alcohol intake.

Results: Weekly alcohol intake would increase by 7.51 g (SE = 2.976, $p = 0.012$) for men and 0.98 g (SE = 0.419, $p = 0.019$) for women in families whose members have moved out, while the influence of household migration was no longer significant after controlling for community-level effects. One percentage change in community migration rates would increase men's alcohol intake by 0.6319 g (SE = 26.494, $p = 0.017$) and women's by 0.0823 g (SE = 2.394, $p = 0.001$).

Conclusions: Our study emphasizes the importance of considering migration at different levels of analysis. The findings indicate that out-migration is associated with increased alcohol consumption among left-behind adults in rural China. Intervention policies should also consider the unique neighborhood relations in rural China, potentially leveraging social ties within rural communities to spread health awareness and reduce alcohol consumption.

1. Introduction

The increasing prevalence of alcohol consumption in China poses significant health risks, particularly in rural areas (Im et al., 2019). Compared with people living in urban areas, rural residents tend to intake a greater amount of standard drinks per week and start to use alcohol at a younger age (Liao et al., 2017). Clinical studies further reveal an alarming rise in alcohol abuse and dependence among rural males (Lee et al., 2020). This health risk is amplified by a preference for home-brewed spirits with high ethanol content, leading to frequent acute intoxication (Millwood et al., 2013a; Zhou et al., 2011, 2006). Limited healthcare access, lower income, and education levels further heighten rural residents' vulnerability to these health threats (Li and Zhang, 2020; Song et al., 2018). While empirical studies have identified excessive alcohol consumption in rural China, the underlying causes remain largely unexplored. Existing researchers primarily attribute this problem to socio-demographic factors and lower socioeconomic conditions (Cai et al., 2017; Im et al., 2020; Li et al., 2011; Zhou et al., 2011).

In this paper, we consider the unique structural characteristics of rural communities and propose a novel migration perspective to explain the alcohol prevalence in rural China. Over recent decades, economic development and the loosening of household registration policy have led to large-scale out-migration from rural areas. However, research on the impact of rural migration on the health behaviors of those left behind is scant, particularly regarding the spillover effects of out-migration on non-household members' drinking behavior.

Using longitudinal data from China spanning 1997 to 2015, this study addresses these gaps. In the following sections, we first discuss and

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develop hypotheses on how household-level out-migration may affect the drinking behavior of the family members left behind in rural villages. Next, we argue that community-level out-migration may impact the drinking behavior of villagers, above and beyond the effects of household-level migration. We then outline the data, methods, and findings, concluding with a discussion of the implications for public health and rural governance. Our findings highlight the health consequences of rural depopulation, underscoring the urgent need for targeted policies addressing alcohol-related risks and strengthening community resilience.

1.1. Household migration and drinking behavior

Rural-to-urban migration, constituting the majority of population movement in China, has seen a significant surge, reaching its peak at 63.3 % in 2010 (UNFPA, 2019). This phenomenon has resulted in a substantial left-behind population in rural communities (Fan and Li, 2020; Xu et al., 2022a). Past research suggests that the out-migration of family members may influence the health behavior of those left behind through several pathways. First, out-migration may reduce social control in the household, and therefore, those left behind are more likely to adopt risky behavior (Gao et al., 2010). Second, it alters the labor arrangements within the family (Tong et al., 2019; Ye et al., 2016), causing increased stress levels and potential substance use for psychological comfort. Third, migrant remittances increase household disposable income, enabling the purchase of non-essential goods like alcohol (Jiang et al., 2015; Liu et al., 2021; Mas'udah, 2020). Finally, researchers have proposed the concept of social remittances, which refers to the process whereby migrant workers bring new values, ideologies, knowledge, or lifestyles to their home communities (Levitt, 1998). The social remittances related to health and wellbeing may change the practices of those still residing in rural communities (Lindstrom and Muñoz-Franco, 2005; Yang and Fahad, 2022).

Empirical studies on rural migration have primarily focused on the health behavior of children left behind, revealing higher stress levels and unhealthy habits like smoking and drinking (Gao et al., 2010; He et al., 2021; Jiang et al., 2015). The same mechanisms are likely applicable to the adult population, but research in this area remains scarce. As mentioned above, household-level out-migration may contribute to increased alcohol consumption by generating stress, reducing social control, and enhancing disposable income. Drawing on these insights, we propose the following hypothesis:

H1. *The presence of migrant relatives in a rural household will increase an individual's alcohol consumption.*

1.2. Community-level migration and drinking behavior

We further argue that community-level out-migration also may affect the drinking behavior of community members, above the effects observed at the household level. Research discussing alcohol use points out that it is not only small-scale interpersonal relationships such as family or peer groups that are influential but also the physical and social environment in which individuals are embedded that plays a vital role (Bryden et al., 2012; Gruenewald et al., 2014). An increasing number of empirical studies have stressed the protective effect of community social cohesion on alcohol use. On the one hand, members living in more cohesive communities often trust and support each other, and these individuals have better mental health and are less likely to use addictive substances for psychological comfort (Bertossi Urzua et al., 2019; Pei et al., 2020). On the other hand, more cohesive communities tend to discourage the deviant behavior of their members, thereby reducing the prevalence of harmful drinking (Kuipers et al., 2012; Ma and Smith, 2017).

Compared to urban areas, rural Chinese communities have a higher level of social cohesion. The past and present agricultural production allowed the preservation of closer social ties and traditional norms in rural China (Talhelm and English, 2020). However, the effective functioning of those informal institutions depends on stable residential relations (Luo et al., 2020), while the frequent movement of inhabitants has severely undermined the foundation for social solidarity in rural China. Researchers indicate that rural flight has permanently impacted the social structure of Chinese rural communities, altering intergenerational, neighborhood, and intimate relationships (Elrick, 2008; Liu, 2017). The erosion of social cohesion also shapes drinking patterns. For example, when residents left behind have difficulty adapting to communities that are no longer cohesive, they may resort to alcohol to counteract and alleviate feelings of powerlessness. Meanwhile, the breakdown of rural social control systems—previously maintained by acquaintanceship and face-saving norms—has diminished moral condemnation and informal sanctions against alcohol abuse.

It is crucial to differentiate the effects of migration on drinking behaviors at the household and community levels, as these dynamics operate through distinct mechanisms. At the household level, remittances from migrant workers increase disposable income, potentially loosening budgetary constraints and enabling higher alcohol consumption for left-behind family members. In contrast, in the community context, migrant remittances imply an expansion of income inequality in rural communities and raise the stress level generated by social comparisons (Akay et al., 2016; Ha et al., 2016; Shen et al., 2010). This divergence underscores the need to conceptualize rural communities not merely as scaled-up versions of households but as distinct social contexts with unique dynamics influencing drinking behaviors.

Building on these insights, we propose the following hypotheses regarding the impact of community-level migration on alcohol consumption:

H2. *The higher the migration rate of a rural community, the greater the amount of alcohol consumed by members.*

2. Data and method

2.1. Data source

We utilize the China Health and Nutrition Survey (CHNS, hereafter) dataset, which is widely employed in health research. CHNS covers fifteen provinces and municipalities in China. It employs a stratified probability sampling strategy and follows a three-level structure: community, household, and individual. This multilevel structure allows researchers to analyze both individual characteristics and the institutional context. As an ongoing longitudinal survey spanning ten waves since 1989, CHNS provides a rich source of data (Zhang et al., 2019). For this study, we focus on the seven survey waves conducted between 1997 and 2015, as household migration data became available only from 1997. To align with the study's objective of examining rural drinking behaviors, we retained only rural samples, resulting in a dataset comprising 20,264 unique individuals and 78,871 person-wave observations.

2.2. Measures

Weekly alcohol consumption amount. The dependent variable in this study is weekly alcohol consumption, measured in grams. CHNS collected detailed information on respondents' alcohol beverage consumption types and weekly drinking amounts. We converted people's alcohol intake according to recommendations in the Chinese Dietary Guidelines (Chinese Nutrition Society, 2016). One bottle of beer contains 20 g of alcohol, one Liang of grape wine is 5 g, and one Liang of liquor is 15 g. Those who do not have drinking histories or drink no more than once a month are coded into 0 g. Since some individuals reported more than one type of beverage consumed per week during the survey, we retained only the one with the highest alcoholicity among the three beverages as the measurement. The dependent variable for this paper is a continuous one.

Household Migration. We constructed a household migration variable to measure whether there are out-migrating members within the family. For this variable, if any member under the same household identifier is no longer living in the home for purposes such as employment, schooling, or military services, all observations sharing the same household ID will be coded as 1; otherwise, 0.

Community Migration Rate. We designed a continuous variable for the migration rate at the community level. The indicator was constructed by calculating the proportion of observations under the same community ID who no longer live at home due to work, schooling, and military service. Quantitative studies have used community-level migration rates as predictors of health-related outcomes. For example, migration rates within Mexican communities affect neonatal weight and obesity among residents (Hamilton and Choi, 2015; Riosmena et al., 2012), and Chinese researchers have noted that the hollowing rate of rural communities affects residents' wellbeing (Chen et al., 2019).

Covariates. We controlled for a range of demographic, socioeconomic, and contextual variables. Demographic controls included age (continuous) and squared age to capture nonlinear effects, as well as marital status, with married individuals coded as 1 and others (single, divorced, or widowed) as 0. Socioeconomic variables included household income per capita, adjusted for inflation to 2015 currency values to ensure cross-year comparability, and years in education. Regions (coastal, northeast, and midwest) were also considered due to potential geographical differences in Chinese drinking culture. Additionally, we included survey wave fixed effects to control for temporal variations, ensuring that changes in drinking patterns and migration effects over time were accurately captured.

Finally, to address the potential confounding effects of community environments on both migration decisions and drinking behaviors, we included the CHNS-validated urbanization index as a community-level covariate (Zhang et al., 2014a). This index comprises 12 components representing physical, social, cultural, and economic environments, such as population density, economic activity, market types, transportation infrastructure, sanitation, communication and media access, housing quality, education, diversity, health infrastructure, and social services. The urbanization index captures modernization factors and heterogeneity within communities, influencing both migration and health-related behaviors (Jones-Smith and Popkin, 2010).

2.3. Analytic strategy

Multilevel mixed-effect models have been adopted to estimate the effects of migration on weekly alcohol consumption among rural residents, incorporating both individual and individual-within-community level factors. At the individual level, drinking patterns have been proven to be connected to gene or psychological dispositions, with different individuals having different susceptibilities to the environment (Carvalho et al., 2019; Young et al., 2006). At the community level, drinking, as a collective activity, is perceived differently by rural members within distinct communities. The intra-class correlation also indicates that such a random effect constitutes 34.8 percent of the total residual variance.

Below formula denotes the multilevel model, where Alcohol_{ijt} is alcohol consumption of individual i in community j at time t. The fixed-effects component includes an intercept β_0, coefficients for the migration factor $\beta_1$and β_2. $\sum_{k=1}^{k} \alpha_k Z_{ijk}$ represent k time-constant individual-level control variables and their coefficients (e.g. education); $\sum_{l=1}^{l} \gamma_l X_{ijtl}$ represent l time-varying individual-level control variables and their coefficients (e.g. income); $\sum_{m=1}^{m} \varphi_m S_{jm}$ are m time-invariant community-level control variables (e.g. region); $\sum_{p=1}^{p} \delta_p W_{jtp}$ are p time-varying community-level control variables (e.g. urbanization index). The random-effects structure captures unobserved heterogeneity at two levels: community-level random interceptu_j, reflecting differences across communities, and individual-level random intercept v_{ij}, accounting for variability among individuals within communities. Both random effects are assumed to follow normal distributions with mean zero and variances σ_u^2 and σ_v^2, respectively. The residual error ϵ_{ij} captures unexplained individual-level variation and follows a normal distribution with variance σ_ϵ^2.

$$\text{Alcohol}_{ijt} = \beta_0 + \beta_1(\textit{migrating relatives})_{ijt} + \beta_2(\textit{community migration rate})_{jt} + \sum_{k=1}^{k} \alpha_k Z_{ijk} + \sum_{l=1}^{l} \gamma_l X_{ijtl} + \sum_{m=1}^{m} \varphi_m S_{jm} + \sum_{p=1}^{p} \delta_p W_{jtp} + u_j + v_{ij} + \epsilon_{ijt}$$

Given the significant gender differences in drinking patterns, our analysis is stratified by gender. Prior studies consistently indicate that women consume alcohol less frequently and in smaller quantities than men (Liao et al., 2017; Oncini and Guetto, 2018). In rural China, this disparity is further exacerbated by structural gender inequities, with men typically controlling household resources and decision-making power (Li and Tsang, 2003; Zhang and Sun, 2024). Alcohol, as a non-essential commodity, is more often purchased and consumed by men (Wang, 2014). Moreover, gender influences key socioeconomic factors such as education, income, and migration likelihood (Dong et al., 2008; Wang et al., 2020), all of which are associated with drinking behavior in rural contexts.

Two types of sensitivity analyses were conducted to ensure our findings' robustness. First, we replaced the dependent variable with consumption grams of liquor, the most common type of alcohol consumed by rural Chinese residents (Ding et al., 2021; Newman et al., 2017). Second, we designed a dichotomous indicator of harmful alcohol use based on The Chinese Dietary Guidelines, which define harmful consumption as exceeding 25 g of alcohol per day for men and 15 g for women (Chinese Nutrition Society, 2016). We then performed multilevel mixed-effects logistic regression to model the effects of rural migration on harmful drinking. Both sensitivity analyses yielded consistent results with the original models (details in Appendix).

3. Results

3.1. Descriptive analysis

Table 1 presents the descriptive statistics of weekly alcohol consumption (in grams) by survey wave and gender. Gender disparities in drinking amounts align with previous empirical findings, with rural males reporting significantly higher alcohol intake than females in all survey years. On average, men consumed 81.79 g more alcohol per week than women. The substantial standard deviations in the male group (largest SD=195.27, smallest SD=145.33) indicate wide variations in drinking habits, encompassing non-drinkers and heavy consumers. Meanwhile, alcohol consumption among rural women remained consistently low. When converted to daily consumption, these averages remain within the recommended daily limits of 25 g for men and 15 g for women (Chinese Nutrition Society, 2016).

The explanatory variables of interest are household and community-level migration. Community migration rate, a continuous variable, averaged 16 % across sampled communities, reflecting individuals leaving for educational, occupational, or military purposes. The migration rate in Chinese rural communities has shown an increasing trend since 1997, peaking at approximately 20 % in 2006 and declining yearly since 2009. The decrement may be associated with the global economic recession in 2008. Household migration, represented as a dichotomous variable, shows that approximately 40 % of rural households reported having at least one migrant member, mirroring trends in community migration.

Descriptive statistics for other control variables can be found in Table 1.

3.2. Drinking patterns at the household level

The effect of rural migration status on alcohol consumption was

Table 1
Descriptive statistics of study variables.

	1997		2000		2004		2006		2009		2011		2015		Total
	Male N = 4194	Female N = 4298	Male N = 4656	Female N = 4754	Male N = 4721	Female N = 4749	Male N = 5587	Female N = 6201	Male N = 5649	Female N = 6426	Male N = 6410	Female N = 7240	Male 6444	Female 7542	78,871
Weekly consumed alcohol in gram															
Mean	81.84	3.53	107.09	5.26	97.74	4.33	100.89	4.36	78.40	3.48	77.12	2.97	62.25	2.26	42.68
(SD)	(158.58)	(26.42)	(190.15)	(37.52)	(183.92)	(32.84)	(195.27)	(28.27)	(154.17)	(27.02)	(145.33)	(21.28)	(167.59)	(28.59)	(126.87)
Constructed age															
Mean	39.29	39.79	40.15	40.86	41.20	42.05	41.04	41.12	42.71	42.46	43.87	43.68	45.63	45.32	42.38
(SD)	(16.49)	(17.19)	(16.45)	(17.14)	(17.15)	(17.62)	(16.98)	(16.96)	(16.95)	(16.81)	(16.87)	(16.77)	(16.95)	(16.66)	(17.02)
Log transformed household income per capita (inflated into 2015)															
Mean	8.04	8.03	8.17	8.16	8.36	8.33	8.41	8.38	8.86	8.82	9.00	8.98	9.28	9.24	8.64
(SD)	(0.84)	(0.84)	(0.98)	(0.98)	(0.98)	(0.99)	(1.08)	(1.08)	(1.07)	(1.09)	(1.09)	(1.09)	(1.24)	(1.23)	(1.15)
Education in years															
Mean	7.31	5.37	7.86	6.11	7.92	5.90	7.90	5.88	7.90	6.03	8.21	6.41	9.46	7.88	7.16
(SD)	(3.45)	(4.12)	(3.34)	(4.14)	(3.31)	(4.04)	(3.72)	(4.31)	(3.56)	(4.21)	(3.68)	(4.41)	(3.22)	(4.31)	(4.04)
Urbanization Index															
Mean	46.44	46.85	52.08	52.60	53.98	54.43	55.73	56.13	60.11	60.18	61.66	61.53	66.33	66.41	57.77
(SD)	(16.54)	(16.71)	(16.59)	(16.76)	(17.42)	(17.77)	(17.41)	(17.51)	(16.97)	(16.86)	(17.65)	(17.56)	(16.73)	(16.56)	(18.10)
Constructed community migration rate															
Mean	8 %	8 %	11 %	11 %	19 %	19 %	20 %	19 %	17 %	17 %	18 %	18 %	15 %	15 %	16 %
(SD)	(0.06)	(0.06)	(0.07)	(0.07)	(0.11)	(0.11)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.09)	(0.08)	(0.10)
Marital status															
No	1130	1054	1200	1098	513	556	434	540	474	563	466	621	940	895	10,484
(%)	(30.2 %)	(28.7 %)	(29.1 %)	(27.4 %)	(16.6 %)	(16.8 %)	(14.2 %)	(16.0 %)	(14.9 %)	(16.3 %)	(12.9 %)	(15.4 %)	(19.0 %)	(18.3 %)	(20.0 %)
Yes	2616	2621	2925	2916	2582	2757	2613	2829	2705	2885	3134	3417	3996	4007	42,003
(%)	(69.8 %)	(71.3 %)	(70.9 %)	(72.6 %)	(83.4 %)	(83.2 %)	(85.8 %)	(84.0 %)	(85.1 %)	(83.7 %)	(87.1 %)	(84.6 %)	(81.0 %)	(81.7 %)	(80.0 %)
Region															
Coastal	981	1045	987	1050	964	997	1184	1344	1117	1277	1614	1760	1642	1867	17,829
(%)	(23.4 %)	(24.3 %)	(21.2 %)	(22.1 %)	(20.4 %)	(21.0 %)	(21.2 %)	(21.7 %)	(19.8 %)	(19.9 %)	(25.2 %)	(24.3 %)	(25.5 %)	(24.8 %)	(22.6 %)
Northeast	380	370	892	920	902	901	962	1014	1006	1081	1010	1109	995	1088	12,630
(%)	(9.1 %)	(8.6 %)	(19.2 %)	(19.4 %)	(19.1 %)	(19.0 %)	(17.2 %)	(16.4 %)	(17.8 %)	(16.8 %)	(15.8 %)	(15.3 %)	(15.4 %)	(14.4 %)	(16.0 %)
Midwest	2833	2883	2777	2784	2855	2851	3441	3843	3526	4068	3786	4371	3807	4587	48,412
(%)	(67.5 %)	(67.1 %)	(59.6 %)	(58.6 %)	(60.5 %)	(60.0 %)	(61.6 %)	(62.0 %)	(62.4 %)	(63.3 %)	(59.1 %)	(60.4 %)	(59.1 %)	(60.8 %)	(61.4 %)
Are there migrants within the household															
No	3184	3278	3197	3270	2505	2577	2708	3091	2941	3409	3348	3834	3653	4290	45,285
(%)	(75.9 %)	(76.3 %)	(68.7 %)	(68.8 %)	(53.1 %)	(54.3 %)	(48.5 %)	(49.8 %)	(52.1 %)	(53.1 %)	(52.2 %)	(53.0 %)	(56.7 %)	(56.9 %)	(57.4 %)
Yes	1010	1020	1459	1484	2216	2172	2879	3110	2708	3017	3062	3406	2791	3251	33,585
(%)	(24.1 %)	(23.7 %)	(31.3 %)	(31.2 %)	(46.9 %)	(45.7 %)	(51.5 %)	(50.2 %)	(47.9 %)	(46.9 %)	(47.8 %)	(47.0 %)	(43.3 %)	(43.1 %)	(42.6 %)

tested using multilevel models, which incorporated random effects for individuals and communities. Likelihood-ratio tests indicated that the multilevel model significantly improved model fit compared to a single-level model.

Model 1A and 1B contain only control variables without accounting for the effects of out-migration in rural China. Household migration status was added in Models 2A and 2B. As shown in Table 2, having migrant family members will significantly affect alcohol consumption for both gender groups. After adjusting for the nested-level error structure, compared to those intact rural households, weekly alcohol intake would increase by 7.51 g (SE=2.976, $p = 0.012$) for men and 0.98 g (SE=0.419, $p = 0.019$) for women in families whose members have moved out. Although these increases were statistically significant, the increments were minor and did not exceed the recommended daily alcohol limits. To conclude, hypothesis 1 was supported.

3.3. Dinking pattern at the community level

Community migration rates were incorporated into Models 3A and 3B to examine the broader effects of rural migration, controlling for household migration status. Likelihood-ratio tests confirmed that these models outperformed both single-level models and Models 2A and 2B, with a further reduction in AIC.

As shown in the table, hypothesis 2 was supported as the impact of community migration rates is significant in both genders. One percentage change in migration rates would increase men's alcohol intake by 0.6319 g (SE=26.494, $p = 0.017$). It could be inferred that rural exodus raises the problem of drinking and associated health risks in Chinese villages. It is also worth noting that the effect of family-level migration status is no longer significant after including community migration rates. Similarly, for women, the impact of household migration status became insignificant when community migration rates were included. A 1 % increase in community migration rate corresponded to a significant rise of 0.0823 g (SE=2.394, $p = 0.001$) in weekly alcohol consumption.

Overall, the findings highlight that community-level migration effects outweigh household-level migration influences. Rural exodus appears to foster social conditions that amplify alcohol consumption, necessitating a distinction between household and community-level migration effects. These results underscore the importance of exploring the broader social consequences of rural migration in China beyond the household context, supporting Hypothesis 2.

4. Discussion

Alcohol consumption in rural China poses significant health risks, particularly in areas with inadequate healthcare infrastructure. Identifying risk factors for drinking in rural communities is essential for developing effective intervention policies. This study finds that out-

Table 2
Multilevel mixed-effect model for migration and weekly alcohol consumption.

	Model 1A Male	**Model 1B** Female	**Model 2A** Male	**Model 2B** Female	**Model 3A** Male	**Model 3B** Female
Age	9.06***	0.26***	8.91***	0.24***	8.83***	0.23**
	(0.646)	(0.073)	(0.638)	(0.072)	(0.641)	(0.072)
Squared age	−0.09***	−0.00*	−0.08***	−0.00	−0.08***	−0.00
	(0.006)	(0.001)	(0.006)	(0.001)	(0.006)	(0.001)
Wave	−2.75***	−0.24***	−2.86***	−0.26***	−3.18***	−0.30***
	(0.332)	(0.044)	(0.344)	(0.045)	(0.362)	(0.045)
Household income per capita[a]	3.48**	0.43*	3.78**	0.48**	3.90***	0.50**
	(1.181)	(0.178)	(1.188)	(0.181)	(1.178)	(0.181)
Education in years	−0.44	−0.02	−0.49	−0.03	−0.47	−0.02
	(0.486)	(0.074)	(0.485)	(0.074)	(0.483)	(0.074)
Urbanization index	0.05	0.02	0.06	0.02	0.12	0.03*
	(0.140)	(0.013)	(0.141)	(0.013)	(0.143)	(0.012)
Region[b]						
Northeast	−4.11	−0.38	−4.01	−0.35	−4.22	−0.33
	(7.615)	(0.862)	(7.545)	(0.855)	(7.378)	(0.843)
Midwest	−0.80	−0.06	−1.84	−0.18	−5.43	−0.58
	(6.975)	(0.745)	(6.899)	(0.736)	(6.938)	(0.752)
Marital status[c]						
Yes	6.93	0.30	7.55	0.39	7.63	0.36
	(4.210)	(0.673)	(4.237)	(0.683)	(4.243)	(0.681)
Migrant family member[d]						
Yes			7.51*	0.98*	4.88	0.56
			(2.976)	(0.419)	(2.841)	(0.403)
Community migration rate					63.19*	8.23***
					(26.494)	(2.394)
Constant	5358.26***	477.34***	5570.31***	513.16***	6203.41***	594.03***
	(654.054)	(86.915)	(677.476)	(89.237)	(714.739)	(89.502)
Random-Effects Parameters						
Community-Level						
Intercept	896.86***	5.40***	884.56***	5.27***	845.63***	4.76***
	(76.506)	(0.693)	(76.081)	(0.680)	(74.805)	(0.641)
Individual-Level						
Intercept	6967.22***	145.12***	6965.75***	145.14***	6966.28***	145.00***
	(308.561)	(19.126)	(308.791)	(19.141)	(308.505)	(19.098)
Residual	20,391.27***	673.22***	20,383.62***	673.08***	20,372.87***	673.04***
	(658.254)	(46.458)	(657.412)	(46.433)	(657.151)	(46.423)
Log Likelihood	−139,637.6	−111,211.8	−139,633.0	−111,209.0	−139,625.6	−111,204.0
AIC	279,301.2	222,449.6	279,294.0	222,445.9	279,281.2	222,437.9
Number of Observations	21,504	23,394	21,504	23,394	21,504	23,394
Number of Communities	177	177	177	177	177	177

Notes.
Standard errors are in parentheses. ***$p < 0.001$,**$P < 0.01$,*$p < 0.05$.
[a:] Log-transformed Household income per capita; [b:] The reference group is Coastal; [c & d:] The reference group is No.

migration in rural China is significantly associated with higher alcohol consumption among the left-behind population, with men showing a more substantial increase in alcohol intake compared to women. Rural residents with migrant relatives consume more alcohol than those without, but the household-level influence becomes insignificant after controlling for community-level migration status. Additionally, the higher the migration rate within Chinese villages, the greater the alcohol consumption among the left-behind men and women.

This study contributes to the rural population health research by introducing a migration framework, shifting away from the traditional "fundamental causes" approach. Our findings suggest that migration-related factors, rather than socioeconomic indicators like income and education, have a more significant impact on drinking behaviors among the left-behind population. It aligns with the ongoing debate in Chinese empirical research regarding the inconsistent relationship between drinking patterns and socioeconomic status (Gu and Ming, 2020; Millwood et al., 2013b). In rural areas, education and income are often intertwined with migration possibilities (Chiang et al., 2012; Du et al., 2005), leading to complex and unstable predictions about health behaviors.

In fact, the key distinction between rural and urban health analyses lies not only in the systematic socioeconomic differences between these populations but also in the degree of social cohesion and interpersonal connections (Yip et al., 2007). The migration perspective captures this divergence and highlights how others' life choices can influence individuals' behavioral outcomes through social control, resource constraints, or socio-psychological pathways (Chen et al., 2022). Our findings support existing research on migration and health, which shows that rural-to-urban migration often leads to social isolation and increased substance use (Lin et al., 2005). However, unlike prior studies, we emphasize that migration also leads to the erosion of social ties in left-behind households, adversely affecting the health of those who remain behind. This study extends the current understanding of the health impacts of migration in rural settings.

More importantly, our research enriches the understanding of how community migration rates shape villagers' drinking behaviors, moving beyond the predominantly intra-family focus of prior studies. While household and community migration share similar economic and institutional drivers, they differ fundamentally. Household migration is often motivated by maximizing family benefits, with remittances from one migrant member reducing the incentive for others to migrate (Liang and Chunyu, 2013). Migration decisions are also influenced by intersecting factors such as gender, marital status, and the family's social standing within the community (Chiang et al., 2012; Giles and Mu, 2018; Xu et al., 2022b). In contrast, community migration is shaped by the development of established migration networks and local migration culture, which can amplify the outflow propensity across the village (Liang and Chunyu, 2013). As more people leave, it alters the social fabric of the community, potentially changing social dynamics and contributing to broader shifts in rural society (Elrick, 2008; Liu, 2017).

Rural transitions accompanying mass migration processes, such as increasing relative deprivation, introduction of new ideologies and lifestyles, and degradation of social cohesion, can influence the lifestyles and coping strategies of left-behind community members (Ye, 2018). While we have yet to determine which specific mechanism dominates, our statistical results suggest that rural decline has coincided with increased alcohol consumption. These findings also imply that promoting an alcohol-free lifestyle in rural China may face unprecedented challenges, as rural residents' drinking problems are not only public health issues but also social consequences of rural hollowing due to rapid urbanization. Addressing this issue calls for interdisciplinary collaborative efforts. Intervention policies should also consider the unique neighborhood relations in rural China, potentially leveraging social ties within rural communities to spread health awareness and reduce alcohol consumption (Davis and O'Neill, 2022).

In addition to its contributions to migration and health literature, this study offers important insights into rural women's drinking behavior. While much of the existing research has focused on male drinking patterns, this study finds that rural women are also impacted by migration-induced changes in their social environment. Moreover, given our finding that rural men in communities with high migration rates are more prone to excessive drinking, issues related to the potential exposure of women to crime and domestic violence also require attention (Tang et al., 2013; Zhang et al., 2009). In rural communities where residents follow more traditional gender norms, left-behind women are at greater risk of becoming victims of alcohol-related violence. Greater attention and care are needed to address the hardships faced by rural women due to alcohol consumption.

This study has some limitations. First, data constraints prevented a comprehensive assessment of the strength of social ties among migrant and left-behind family members, as well as the potential effects of long-distance communication on health behaviors. Second, there may be unquantified confounding factors, such as the prevailing migration culture within villages and institutional environments, which could also influence drinking patterns. Lastly, while we discussed potential causal pathways for migration's effects on drinking patterns at the household and community levels, the specific mechanisms remain unclear. Further research with more comprehensive data is needed to make causal inferences and distinguish specific causes of elevated alcohol consumption among rural residents.

5. Conclusion

This study highlights the significant impact of rural out-migration on alcohol consumption among left-behind populations in China. Migration at both the household and community levels is linked to increased alcohol consumption, with gender differences influencing the magnitude of this effect. The findings suggest that migration-induced changes in social networks and community cohesion play a crucial role in shaping drinking behaviors. Policies aimed at reducing alcohol consumption in rural China must be multifaceted, incorporating social support networks and addressing the broader consequences of rural depopulation.

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CRediT authorship contribution statement

Yaxin LAN: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. **Lei JIN:** Funding acquisition, Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmh.2025.100311.

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