


# Cancer diagnosis and care among rural-to-urban migrants in China

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## ABSTRACT

**Introduction** Cancer is a leading cause of death in China. Rural-to-urban migrants are a group of over 260 million people in China sometimes termed the ‘floating’ population. This study assessed the prevalence of cancer diagnosis and access to needed healthcare by residence and migration status in China.

**Methods** We used data from the China Health and Retirement Longitudinal Survey, a nationally representative population-based random sample of adults age 45 years and older and their spouses in China. We used multivariable logistic regressions to compare outcomes among rural-to-urban migrants, local urban residents and local rural residents after adjusting for province of residence, socioeconomic status and demographic characteristics.

**Results** The sample included 7335 urban residents, 9286 rural residents and 3255 rural-to-urban migrants. Prevalence of cancer diagnosis was 9.9 per 1000 population among rural-to-urban migrants (95% CI 6.5 to 15.1 per 1000 population). Rural-to-urban migrants had higher tobacco use (OR=2.01; 95% CI 1.59 to 2.56,  $p<0.001$ ), lower use of a health check-up (OR=0.57; 95% CI 0.48 to 0.67,  $p<0.001$ ) and lower prevalence of diagnosed cancer (OR=0.41; 95% CI 0.18 to 0.95,  $p=0.037$ ) than urban residents. Among participants with diagnosed cancer, residence and migration status were not predictive of foregoing needed healthcare, but were predictive of diagnosis with a screen-detectable tumour (ie, breast, colon, prostate or cervical cancer) (OR=0.17; 95% CI 0.05 to 0.63,  $p=0.007$  for rural residents; OR=0.34; 95% CI 0.09 to 1.22,  $p=0.098$  for rural-to-urban migrants, compared with urban residents).

**Conclusion** Rapid and large migration is still a driving force transitioning China. Due to some remaining dual policy settings in favour of local residents, rural migrants tend to use lower primary care and preventive health check-ups in general, and diagnosis of screen-detectable tumours in particular, leading to potentially higher risk of missing early diagnosis of cancers. Closing gaps in diagnosis of screen-detectable tumours could increase treatment and improve cancer outcomes.

## INTRODUCTION

Cancer is the second leading cause of death worldwide behind cardiovascular diseases, and China accounts for an estimated 22% of new cancer cases and about 27% of cancer deaths worldwide.<sup>1–3</sup> The 2.8 million deaths

## Key questions

### What is already known?

- Cancer is a leading cause of death in China, and China accounts for about 27% of cancer deaths worldwide.
- There are over 260 million people in China who lack local registration status (*hukou*), sometimes termed a ‘floating’ population, whose cancer outcomes are not reported in cancer registry data.

### What are the new findings?

- In nationally representative survey data, prevalence of diagnosed cancer was 9.9 per 1000 population among middle-aged and older adults who were rural-to-urban migrants.
- Among people with diagnosed cancer, the proportion of screen-detectable tumours (ie, tumours of the breast, colon, prostate or cervix) was lower for rural residents and possibly lower for rural-to-urban migrants compared with urban residents.

### What do the new findings imply?

- There is a sizeable population of rural-to-urban migrants in China diagnosed with cancer.
- Strategies to improve cancer outcomes should emphasise closing gaps in diagnosis of screen-detectable tumours, particularly among people with rural *hukou*.

in China in 2016 imply that, on average, five people die of cancer every minute in China.<sup>1</sup> Improving cancer outcomes in China is therefore important to improving health globally.

Accurate statistics on population-level cancer prevalence are crucial to developing optimal cancer control policy.<sup>4–5</sup> Yet, some patient populations at risk of poor health outcomes are difficult to track in administrative datasets due to their mobility, marginalisation or other factors.<sup>6–7</sup> When important populations are not well tracked in administrative data, survey-based data are frequently required to provide much-needed estimates of the burden of disease.<sup>8–9</sup>

In China, there are a large and relatively vulnerable group of internal migrants (sometimes called the *liudong renkou* or ‘floating’ population) whose outcomes are not well

tracked in cancer registry data.<sup>10–12</sup> The floating population is a group of over 260 million people who have migrated internally in China, typically from rural to urban areas of China, giving them a different legal status from local residents under the *hukou* (household registration) system.<sup>13</sup> Existing cancer registries in China lack information about migration status and inadequately sample the migrant population.<sup>10–12</sup>

During their years of migration, rural-to-urban migrants do not have equal access to local healthcare compared with local urban residents.<sup>14</sup> Rural health insurance providers are remote from the destination cities and unlikely to reimburse for medical services from urban facilities.<sup>15</sup> While many migrants working in the formal sector are covered by urban employee medical insurance funded via payroll taxes,<sup>16 17</sup> patients requiring major medical procedures often must pay in full up-front and then pursue reimbursement, leading to temporary financial distress.<sup>18 19</sup> A new policy called *yibao yidi jiesuan* aims to smooth the reimbursement across health insurance schemes, and shift the burden of reimbursement paperwork and financial risk from patient to hospital. Nonetheless, this policy faces challenges in providing meaningful and comprehensive coverage for rural-to-urban migrants due to preregistration requirements that can lead to delay in access for new migrants, as well as non-participation by some hospitals and lack of coverage for outpatient care.<sup>20</sup> Ultimately, data from Beijing and elsewhere in China show that migrants are less likely to seek medical care when they experience discomfort, illness, or injury than non-migrant locals.<sup>21 22</sup>

There is reason to believe that cancer burden may be substantial among rural-to-urban migrants in China. Cancer incidence and death rates vary greatly by geography in China.<sup>1 23 24</sup> Residents of rural areas in China have significantly higher incidence and mortality from cancer than do urban residents, after adjusting for age differences.<sup>1</sup> Obesity, physical inactivity and exposure to environmental pollution also contribute to the burden of cancer in China, and each of these factors could plausibly vary with duration of rural or urban residency.<sup>25</sup> Migration from rural to urban areas in China has been associated with the onset of smoking, a key cancer risk factor.<sup>26 27</sup>

Little is known about the prevalence of cancer among rural-to-urban migrants, a group facing challenges in accessing healthcare compared with local residents.<sup>25</sup> Data on prevalence of cancer diagnosis and access to needed care in the migrant population are crucial to informing design appropriate policies to meet this public health challenge. In addition, little is known about the effect of location of residence on cancer diagnosis and care. To address this gap, our study traces the distribution of cancer risk factors, access to care and prevalence of diagnosed cancer by migration status and location of residence in China.

## METHODS

We conducted a cross-sectional analysis of self-reported data from the 2015 China Health and Retirement Longitudinal Study (CHARLS), a population-based random sample survey which is nationally representative of people in China aged 45 years and older living in households. Survey respondents were selected by sequential county, neighbourhood and household-level sampling using a sampling frame stratified by region, by urban district or rural county and by Gross Domestic Product (GDP) per capita. Within sampled households, a main respondent was selected from all adults aged 45 years and older living in residence; in addition to the main respondent, the spouse of the main respondent was also interviewed.<sup>28</sup>

All respondents with information on relevant variables for each analysis were included. No other inclusion criteria were imposed.

We identified each respondent's migration status according to definitions based on the *hukou* or household registration system in China. Under this system, Chinese residents are categorised into urban (non-agricultural) and rural (agricultural) residents of a particular province.

The main predictor variables of interest were current residence and migration status. Rural-to-urban migrants were respondents with a rural *hukou* who lived in an urban area. Other participants were classified as urban or rural residents. Rural and urban locations were classified using National Bureau of Statistics definitions.

The outcomes of interest in the full sample relate to cancer diagnosis. Because cancer is often asymptomatic and undiagnosed, we not only measured prevalence of diagnosed cancer but also measured outcomes related to underlying cancer risk and cancer screening. Our outcomes of interest included prior or current tobacco use; receiving a physical exam to assess health during the last year, the closest available proxy measure for access to cancer screening; and prior diagnosis of cancer by a doctor.

We also conducted analyses related to tumour location and healthcare access among respondents who reported a diagnosis of cancer. Our first outcome of interest was whether the diagnosed cancer was a cancer detectable by screening; tumours of the breast, colon, prostate and cervix were classified as detectable by screening. Additional outcomes of interest included whether respondents with a cancer diagnosis had skipped needed healthcare due to cost, and whether the respondent had received chemotherapy, surgery and radiation therapy, therapies which can be costly and have specific relevance to cancer.

To compare these outcomes among rural-to-urban migrants as compared with local urban or rural residents, we used multivariable logistic regressions. Covariates included age, gender, marital status, education (less than middle school education vs middle school education and higher), reported total current financial assets (quintiles in the sample) as a measure of socioeconomic status, and current province of residence. Current financial assets were measured by totaling cash, deposits, bonds, stocks,

mutual funds reported as owned by the respondent. Covariates with multiple categories were modelled using multiple indicator variables. SEs were clustered by household, to reflect the fact that spouse of the main respondent in each household was also interviewed, and sample weights were incorporated to account for the complex sample scheme of the CHARLS survey.

To assess heterogeneity in outcomes by region and respondent characteristics, we stratified the data. Specifically, we estimated models with the data stratified by region (east, central, vs north and west); gender (male vs female); occupation (agricultural work vs non-agricultural work); and by age (45–55, 55–65, 65+ years). The east region included Shanghai, Beijing, Tianjin, Shandong, Guangdong, Jiangsu, Hebei, Zhejiang and Fujian; the central region included Anhui, Shanxi, Jiangxi, Henan, Hubei and Hunan; and the north and west region included Xinjiang, Yunnan, Inner Mongolia, Sichuan, Guangxi, Gansu, Guizhou, Chongqing, Shaanxi, Jilin, Liaoning, Heilongjiang and Qinghai. Tibet was not included in the CHARLS survey.

In a robustness check, we included people with missing migration status in the model. These models included an additional binary variable to indicate people with missing migration status.

Finally, we conducted a power analysis to assess the minimum detectable difference in cancer prevalence between migrants and local residents. The Stata function *power* was used to estimate the power based on the calculated prevalence of cancer, the number of individuals and households in each location and migration group, and intracluster correlation within households. Assuming that inclusion of covariates in the models can increase power, this represents a conservative lower bound for the power of our study to detect effects across groups.

We used two-sided p values and conducted the analysis using Stata. The University of Southern California Institutional Review Board approved the analysis.

### Patient and public involvement

We report no patient or public involvement in the design or implementation of the study.

## RESULTS

**Table 1** provides descriptive statistics. The sample included 7335 urban residents, 9286 rural residents and 3255 rural-to-urban migrants. Prevalence of cancer diagnosis was 9.9 per 1000 population among rural-to-urban migrants (95% CI 6.5 to 15.1 per 1000 population), compared with 16.0 per 1000 population among non-migrants (95% CI 11.0 to 23.4 per 1000 population). Based on the intracluster correlation of 0.026 for data within the same household and number of individuals and households in each migration group, our power analysis suggested 74% power to detect differences in diagnosed cancer prevalence of this size between migrants and non-migrants before adjustment for covariates.

The first panel of **table 2** compares cancer diagnosis and related risk factors for all rural-to-urban migrants, rural residents and urban residents after adjusting for province of residence, socioeconomic status and demographic characteristics. Rural-to-urban migrants were more likely to have used tobacco (OR=2.01; 95% CI 1.59 to 2.56,  $p<0.001$ ), less likely to have a physical exam or health check-up (OR=0.57; 95% CI 0.48 to 0.67,  $p<0.001$ ) and less likely to have been diagnosed with cancer (OR=0.41; 95% CI 0.18 to 0.95,  $p=0.037$ ) compared with local urban residents. The models also compared rural residents and urban residents. This comparison

**Table 1** Descriptive statistics for the sample

	Proportion (95% CI)*			Differences between groups: p value†
	Urban residents (n=7335)	Rural residents (n=9286)	Rural-to-urban migrants (n=3255)	
Women	50.6 (47.90 to 53.2)	53.3 (52.2 to 54.40)	53.40 (50.7 to 56.0)	<0.001
Age, years (mean (95% CI))	60.7 (60.0 to 61.40)	61.5 (61.3 to 61.8)	60.5 (60.0 to 61.0)	0.004
Married	85.9 (84.1 to 87.5)	83.90 (83 to 84.80)	86 (84.30 to 87.5)	0.044
Past or present tobacco use	39.7 (37.2 to 42.2)	44.0 (42.90 to 45.1)	45.3 (42.7 to 48.0)	<0.001
Physical exam in last year	54.6 (51.90 to 57.3)	33.7 (32.7 to 34.8)	41.2 (38.6 to 43.8)	<0.001
In last month, ill but skipped needed healthcare due to cost	8.2 (6.9 to 9.7)	9.6 (9.0 to 10.3)	9.8 (8.3 to 11.5)	0.329
Have at least a middle school education	91.0 (89.4 to 92.4)	79.1 (78.2 to 80)	79.7 (77.7 to 81.6)	<0.001
Diagnosed with cancer (prevalence per 1000 people (95% CI))	23.1 (13.1 to 40.5)	9.9 (8.1 to 12.2)	9.9 (6.5 to 15.1)	0.019

\* All analyses incorporate sample weights.

† Differences between groups are tested using an F-test, which assesses the joint significance of regression coefficients indicating rural residence or rural-to-urban migrant status, with urban residence as the absorbed category.

**Table 2** Cancer diagnosis and access to care among rural-to-urban migrants, compared with local residents**A. Full sample**

	Adjusted OR (95% CI)		
	Model 1	Model 2	Model 3
	Past or current tobacco use	Physical exam during last year	Diagnosed with cancer
<b>Location and migration status</b>			
Urban residents	Reference group	Reference group	Reference group
Rural-to-urban migrants	2.014*** (1.585 to 2.558)	0.565*** (0.476 to 0.671)	0.414** (0.181 to 0.948)
Rural residents	1.659*** (1.418 to 1.940)	0.442*** (0.389 to 0.502)	0.435*** (0.274 to 0.693)
<b>Demographic factors</b>			
Female	0.0181*** (0.0160 to 0.0206)	1.191*** (1.074 to 1.321)	1.29 (0.631 to 2.635)
Age	1.005 (0.989 to 1.021)	1.031*** (1.021 to 1.041)	1.01 (0.981 to 1.040)
Married	0.739** (0.579 to 0.942)	1.263*** (1.075 to 1.485)	1.128 (0.670 to 1.899)
Have a least a middle school education	0.921 (0.790 to 1.074)	1.188*** (1.044 to 1.351)	0.87 (0.584 to 1.296)
<b>Socioeconomic status</b>			
Quantile 1	Reference group	Reference group	Reference group
Quantile 2	1.228* (0.969 to 1.556)	0.991 (0.834 to 1.178)	0.922 (0.519 to 1.640)
Quantile 3	1.068 (0.819 to 1.393)	1.047 (0.847 to 1.294)	2.024 (0.598 to 6.850)
Quantile 4	1.02 (0.822 to 1.266)	1.207** (1.004 to 1.450)	1.085 (0.600 to 1.962)
Quantile 5	0.904 (0.709 to 1.152)	1.626*** (1.333 to 1.984)	1.356 (0.758 to 2.424)
N	16 636	16 314	16 644

**B. Only people previously diagnosed with cancer**

	Adjusted OR (95% CI)		
	Model 1	Model 2	Model 3
	Screening amenable cancer	Skip needed care due to cost	Received chemotherapy, surgery and/or radiation therapy
<b>Location and migration status</b>			
Urban residents	Reference group	Reference group	Reference group
Rural-to-urban migrants	0.339* (0.0944 to 1.220)	1.13 (0.184 to 6.936)	1.104 (0.337 to 3.614)
Rural residents	0.172*** (0.0470 to 0.628)	0.781 (0.179 to 3.400)	1.847 (0.752 to 4.540)
<b>Demographic factors</b>			
Female	38.90*** (7.977 to 189.7)	0.784 (0.163 to 3.773)	0.473* (0.208 to 1.075)
Age	1.100** (1.012 to 1.196)	1.049 (0.951 to 1.157)	0.916*** (0.869 to 0.966)
Married	6.363** (1.071 to 37.79)	26.48** (1.421 to 493.7)	0.775 (0.251 to 2.389)
Have a least a middle school education	4.988** (1.032 to 24.11)	7.282 (0.356 to 149.1)	0.63 (0.248 to 1.602)
<b>Assets</b>			
Quantile 1	Reference group	Reference group	Reference group
Quantile 2	0.739 (0.154 to 3.542)	1.182 (0.141 to 9.913)	0.91 (0.279 to 2.962)
Quantile 3	0.225* (0.0474 to 1.065)	0.762 (0.0881 to 6.594)	0.849 (0.249 to 2.897)
Quantile 4	1.855 (0.295 to 11.67)	0.0696** (0.00606 to 0.800)	1.712 (0.546 to 5.373)
Quantile 5	0.665 (0.165 to 2.685)	1.325 (0.236 to 7.438)	1.214 (0.397 to 3.708)
N	180	150	192

\*P<0.1; \*\*P<0.05; \*\*\*P<0.01. Models included a constant term and indicators for province of residence, which are not shown in the table. SEs were clustered by household, and survey weights were used to account for the complex sampling scheme of CHARLS. CHARLS, China Health and Retirement Longitudinal Study.



showed that rural residents were also more likely to have used tobacco (OR=1.66; 95% CI 1.42 to 1.94,  $p<0.001$ ), less likely to have a physical exam or health check-up (OR=0.44; 95% CI 0.39 to 0.50,  $p<0.001$ ) and less likely to have been diagnosed with cancer (OR=0.44; 95% CI 0.27 to 0.69,  $p<0.001$ ) than urban residents.

The second panel of table 2 compares tumour location and access to healthcare between rural-to-urban migrants, rural residents and urban residents who had been diagnosed with cancer, after adjustment for covariates. Compared with the tumours of urban residents diagnosed with cancer, tumours of rural residents were less likely to be screen-detectable tumours (ie, tumours of the breast, colon, prostate or cervix) (OR=0.17; 95% CI 0.05 to 0.63,  $p=0.007$ ); a similar pattern may also hold for

rural-to-urban migrants (OR=0.34; 95% CI 0.09 to 1.22,  $p=0.098$ ). We found no significant differences between rural-to-urban migrants, rural residents or urban residents diagnosed with cancer in skipping needed health-care due to cost, or in use of advanced cancer treatments such as chemotherapy, radiation or surgery.

Table 3 presents the patterns in cancer diagnosis and related risk factors by region and respondent characteristics. Rural-to-urban migrants showed significantly higher tobacco use and significantly lower use of a recent physical exam than local residents across all region, gender, occupation and age groups. In contrast, the relationship between migrant status and prevalence of diagnosed cancer showed more heterogeneity in statistical significance across region, gender, occupation and age groups.

**Table 3** Cancer diagnosis and related factors among rural-to-urban migrants, compared with local residents

	Adjusted OR for rural-to-urban migrants (95% CI)		
	Model 1	Model 2	Model 3
	Past or current tobacco use	Physical exam during last year	Diagnosed with cancer
Full sample	2.014*** (1.585 to 2.558)	0.565*** (0.476 to 0.671)	0.414** (0.181 to 0.948)
N	16636	16314	16644
By region			
East	2.735*** (1.796 to 4.166)	0.589*** (0.426 to 0.815)	0.279** (0.102 to 0.759)
N	5369	5268	5371
Central	1.411** (1.026 to 1.942)	0.644*** (0.511 to 0.812)	0.859 (0.327 to 2.256)
N	4691	4598	4694
North and west	1.588*** (1.196 to 2.108)	0.494*** (0.401 to 0.609)	0.547 (0.240 to 1.247)
N	6576	6448	6579
By gender			
Male	1.976*** (1.421 to 2.747)	0.573*** (0.448 to 0.732)	0.159*** (0.0503 to 0.505)
N	7913	7791	7318
Female	2.142*** (1.591 to 2.885)	0.564*** (0.440 to 0.722)	0.830 (0.439 to 1.571)
N	8723	8523	8727
By occupation			
Agricultural work	1.435** (1.013 to 2.033)	0.733** (0.540 to 0.996)	0.835 (0.277 to 2.511)
N	7630	7481	6865
Non-agricultural work	2.062*** (1.319 to 3.223)	0.633*** (0.463 to 0.866)	0.118*** (0.0286 to 0.490)
N	4653	4597	3324
By age			
45–55 years old	2.271*** (1.481 to 3.482)	0.612*** (0.469 to 0.799)	0.177*** (0.0572 to 0.548)
N	5769	5687	5528
55–65 years old	1.518*** (1.141 to 2.018)	0.499*** (0.373 to 0.669)	0.599 (0.242 to 1.486)
N	5782	5691	5259
65+ years old	1.763*** (1.221 to 2.546)	0.526*** (0.374 to 0.739)	0.863 (0.374 to 1.992)
N	5085	4936	4185

\* $P<0.1$ ; \*\* $P<0.05$ ; \*\*\* $P<0.01$ . This table lists the adjusted OR for rural-to-urban migrants (95% CIs are in parentheses) from multiple logistic regression models where the sample is stratified by region, gender, occupation and age. Rows indicate the sample used in the model, and columns indicate the outcome tested in the model. N denotes the total number of people included in the model. Models included a constant term and indicators for province of residence, which are not shown in the table. SEs were clustered by household, and survey weights were used to account for the complex sampling scheme of CHARLS. CHARLS, China Health and Retirement Longitudinal Study.

Although all estimated ORs were  $<1$ , consistent with lower prevalence of diagnosed cancer among migrants than local residents, the ORs were only statistically significant at the 5% level for migrants who lived in the east region of China (ie, Shanghai, Beijing, Tianjin, Shandong, Guangdong, Jiangsu, Hebei, Zhejiang or Fujian), who were male, who were engaged in non-agricultural work and who were 45–55 years old. Due to the small sample size of the group diagnosed with cancer, we were unable to stratify the analyses of respondents diagnosed with cancer by additional characteristics.

Finally, in a robustness check, we replicated our main regression models but with the inclusion of people whose migration status was missing. The ORs associated with rural-to-urban migration were nearly identical to those in the main analysis. See online supplementary appendix table 1.

## DISCUSSION

There are over 260 million migrants within China; this population faces unique challenges in healthcare access and are not tracked in cancer registry data.<sup>11 15 21</sup> A lack of accurate statistics about the health of migrant populations is a crucial concern in global health, given that what is not measured is often not prioritised by policymakers.<sup>6</sup>

This paper is the first to our knowledge to provide estimates of cancer diagnosis prevalence for rural-to-urban migrants, as well as access to care among rural-to-urban migrants with diagnosed cancer. These data yield new and important information to support cancer control in China. We use a large, nationally representative survey dataset that provides information on migration status and place of residence, health, demographic factors and socioeconomic status. These data, although large for survey data, are not sufficiently large to detect very small differences in cancer diagnosis rates between groups; this underscores the urgency of collecting and releasing administrative data on cancer detection and outcomes among migrant workers for use in future research.

The prevalence of diagnosed cancer among rural-to-urban migrants in China was significant, at 9.9 per 1000, population among middle-aged and older adults, and was lower than that of urban residents. Compared with urban residents, rural-to-urban migrants had higher tobacco use, a key cancer risk factor, but lower use of physical exams. Additionally, rural-to-urban migrants may have been less likely than urban residents to be diagnosed for cancer at tumour sites amenable screening, although this relationship was only significant at the 10% level. The similar levels of healthcare access across migrants and non-migrants after cancer diagnosis suggest that diagnosis, in particular, could be a key bottleneck to improving cancer outcomes. Together, these data suggest the possibility of undiagnosed cancer in the rural-to-urban migrant group, and highlights the importance of including rural-to-urban migrants in cancer screening initiatives.

In addition to shedding light on health of rural-to-urban migrants, our data yield new insights related to the burden of cancer in rural China. Administrative data show higher age-adjusted cancer mortality rates in rural than urban China,<sup>1 12</sup> whereas our survey data show higher age-adjusted cancer diagnosis rates in urban China. Unlike administrative data on incidence of diagnosed cancer, survey data capture prevalence of diagnosed cancer. Prevalence data disproportionately reflect cancer cases with early diagnosis and long postdiagnosis survival. Thus, the ‘missing’ cancer diagnoses in rural China in survey data suggest the possibility of late diagnosis and shorter postdiagnosis survival in rural China. Further matching this possibility are our findings that people diagnosed with cancer in rural China were less likely than urban residents to have a screen-detectable tumour.

Gradients in cancer risk and diagnosis by migration status have also been documented in studies of international migration. Patterns from the international literature suggest that selection into migration, acculturation, lifestyle changes and access to care may all play a role in determining the links between migration and health. Studies from the USA, Canada and Denmark have found lower rates of cancer incidence among immigrants, matching the possibility that people self-select into immigration when they are healthy.<sup>29–32</sup> Compared with non-immigrant counterparts in Denmark, immigrants in Denmark experienced significantly lower risk of tobacco-related cancers such as lung cancer.<sup>30</sup> Evidence from Japan, the USA and Canada suggests that the health advantage of immigrants narrows with longer duration of residence in the host countries, younger age at immigration and increasing acculturation.<sup>32–34</sup> Adoption of unhealthy lifestyles in the host countries, such as tobacco use and alcohol consumption, has been associated with increases in cancer risk after migration.<sup>29 34 35</sup>

Our finding of a lower prevalence of diagnosed cancer among migrants matches this international literature on the health advantage of migrants. However, the lower take-up of preventive visits and higher tobacco use among migrants suggest that some of the gaps in diagnosed cancer rates by migration status could reflect gaps in diagnosis of prevalent cancer. In a study that compared Mexican immigrants in the USA to local counterparts, one-third of the observed ‘immigrant health advantage’ in diabetes and hypertension actually comprised gaps in diagnosis of prevalent disease in the immigrant population.<sup>36</sup> Unfortunately, undiagnosed cancer is less readily measured than undiagnosed diabetes or hypertension, and therefore the hypothesis that gaps in diagnosis vary by migration status is untestable in our research context.

Under recent reforms, there is no longer a standard national *hukou* policy.<sup>37</sup> However, the phenomenon of living in a place where one lacks local *hukou* remains highly prevalent and relevant in China. The gap between the number of urban residents and number of urban *hukou* has remained nearly unchanged since the *hukou*

reform took place in 2014, as the majority of migrant workers live in cities where local *hukou* are unattainable to them.<sup>38 39</sup> Over half of migrant workers live in the top 10 cities in China, and around one-fourth in top 4 cities; these large or mega-cities use a 'point' system to attract highly educated workers while limiting opportunities for other workers. Although medium and small size cities have become more open to migrants under recent reforms, the number of rural *hukou* actively converted to urban *hukou* remains extremely small. For example, in Zhuzhou, a medium size city in Hunan Province, only 3% of the 220 000 million new urban *hukou* issued by the city in 2016 were active conversions from rural *hukou*.<sup>39</sup> Our study follows a standard definition of rural-to-urban migrant, based on place of residence and place of *hukou*, also used in previous research.

Our study has limitations. First, this is a descriptive study and does not measure the impact of migration on cancer risk. Instead, we provide descriptive data about prevalence of diagnosed cancer and access to care by migration status. Second, our analysis is based on self-reported survey data and does not capture the decreased or people with undiagnosed cancer. Yet, this limitation of survey data can become a strength when results are compared against administrative data on cancer mortality, because missing cancer patients in survey data are indicative of short survival after diagnosis, as noted above.

Cancer screening is not measured in the CHARLS data or other publicly available, nationally representative survey data in China to our knowledge. To account for the importance of access to care in determining cancer diagnosis, we use general measures of receipt of physical exams as the closest available proxy measure. Given that cancer is among the top causes of death in China,<sup>1 40 41</sup> adding measures of cancer screening to nationally representative survey data on older adults would be beneficial for future research.

Our analysis also has strengths. We use a large, publicly available, and nationally representative dataset with rich information on individual-level migration status, access to needed care, and key cancer risk factors such as age and tobacco use. The descriptive data we provide on prevalence of detected cancer provide important insights for planning of public policies and support hypothesis generation related to cancer among migrants in the absence of administrative data covering this group.

In summary, rural-to-urban migrants have lower use of preventive health check-ups as compared with urban residents, leading to a higher risk of missing early cancer diagnosis. Diagnosis of screen-detectable tumours also indicates such a gap against the rural-to-urban migrants. Administrative data systems that monitor cancer outcomes among rural-to-urban migrants, and programmes to enhance timely detection and close gaps in diagnosis of screen-detectable tumours, should be prioritised to optimise cancer control policy and improve cancer outcomes in China.

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