Association between age at arrival, duration of migration, and overweight/obesity in Chinese rural-to-urban migrants: the Yi migrant study

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Abstract

Background: Urbanization in China is rapidly proceeding, but rural-to-urban migration and its association with overweight and obesity is not well studied. This study aimed to explore the age at arrival, duration of migration, and the corresponding association with overweight/obesity in Yi migrants in China.

Methods: A cross-sectional study was conducted in rural and urban areas in 2015 in Sichuan province, China. Demographic characteristics, lifestyle factors, and anthropometry were collected. General linear regression models were used to assess the effect of duration of migration (1–10, 11–20, 21–30, and >30 years) on body mass index (BMI). Multi-variable logistic regression was used to examine the association between duration of migration and overweight/obesity (BMI ≥ 25 kg/m^2).

Results: A total of 3056 Yi people (1894 Yi farmers and 1162 Yi migrants) aged 20 to 80 years were enrolled. After adjusting for age, sex, and other potential confounders, Yi migrants had 1.71 kg/m^2 (95% confidence interval [CI]: 1.36–2.06) higher BMI and a 2.13-fold (95% CI: 1.71–2.65) higher risk of overweight/obesity than Yi farmers. In Yi migrants, stratified by age at arrival, no significant association between duration of migration and overweight/obesity was observed in those who were 0 to 20 years old at arrival. In comparison, in migrants >20 years old at arrival, compared with the reference group (1–10 years), long-term migration (>30 years) was found to be associated with overweight/obesity after adjustment (odds ratio: 1.85, 95% CI: 1.04–3.29).

Conclusions: Yi migrants were observed to have greater risk of overweight/obesity than Yi farmers. In Yi migrants, the risk of overweight/obesity increased according to the duration of migration, especially in those who were older upon their arrival.

Keywords: Migration epidemiology; Overweight/obesity; Rural-to-urban; Yi people

Introduction

Overweight and obesity are fast-growing health problems worldwide. The increasing trend of overweight and obesity has been reported in both developed and developing countries.[1] The high prevalence of overweight and obesity has led to a major burden of obesity-related illness.[2]

Obesity is influenced by both genetic[3,4] and environmental[5] factors. Previous studies showed that international and domestic rural-to-urban migrants tended to suffer from increased risk of non-communicable diseases such as obesity.[6,7] Such conditions may be due to the adoption of an unhealthy diet and lifestyle in the new living environment. Previous studies reported that age at arrival and duration of migration were important determinants of overweight or obesity risk among migrants.[8,9] In China, urbanization has been ongoing for decades.[10] Large numbers of farmers move from rural to urban areas for economic reasons. Despite this fact, urban living and its association with overweight/obesity has not been well studied in China, especially regarding the effect of age at arrival and duration of migration on overweight/obesity.

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Yi people are an ethnic minority residing in remote mountain areas in southwest China. Yi farmers live scattered across isolated villages, keeping a rather primitive lifestyle. Since the 1950s, some of them began to migrate to urban areas and changed their lifestyle. Disparities in non-communicable diseases risks between Yi farmers and Yi migrants have been described by our previous studies,[11-13] but the relationship between overweight/obesity and acculturation is still unclear. Therefore, using data from the Yi migrant study, the present study aims to evaluate the risk of overweight/obesity in Yi farmers and rural-to-urban Yi migrants, and further examine the association between age at arrival, duration of migration and overweigh/obesity in Yi migrants. We hypothesize that Yi migrants would be at higher overweight/obesity risk than Yi farmers, and in Yi migrants, age at arrival and duration of migration would be associated with overweight/obesity risk.

Methods

Ethical approval

This study was conducted according to the guidelines laid down in the *Declaration of Helsinki* and all procedures involving research study participants were approved by the bioethics committee of Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences, Beijing, China. Written informed consent was obtained from all subjects.

Study population

Data used for this study were from the Yi migrant study, which was designed to assess cardiovascular risk factors in Yi farmer and rural-to-urban Yi migrants in Liangshan Yi Autonomous Prefecture, Sichuan province, southwest China. The present study was based on data obtained from a cross-sectional survey in 2015. Details of this survey have been published elsewhere.[13,14] Briefly, a stratified cluster sampling method was used to enroll participants aged 20 to 80 years. In the first stage, Xichang city and Puge county were selected from Liangshan Yi Autonomous Prefecture. Secondly, three urban districts in Xichang city and the town with county administration seats in Puge county were selected to enroll Yi migrants, and ten rural townships were select to enroll Yi farmers. In the third stage, residents in the selected areas were all invited to participate in the study. Individuals whose parents were both of Yi ethnicity were identified as Yi people. Yi farmers were defined to be Yi people living in rural areas since birth. Yi migrants were defined to be Yi people who were born in rural areas and then migrated to urban areas for ≥1 year.

Data collection

A standard questionnaire was administered by well-trained staff to obtain information on demographic characteristics (age, sex, education level, personal annual income, etc) and lifestyle factors (smoking status, drinking status, physical activity, etc).

Weight was measured in light clothing using an electronic scale (BC-420; Tanita, Tokyo, Japan) with an accuracy of 0.1 kg. Height was measured with barefeet by a fixed stadiometer (TZG-2; Henglong, Shanghai, China) with an accuracy of 0.1 cm. The average of two height measurements was recorded.

Definitions

Body mass index (BMI) was calculated as measured weight in kilograms divided by measured height in meters squared. The outcomes of interest in this study were BMI and overweight/obesity (BMI ≥ 25 kg/m^2).[15]

Duration of migration was calculated by asking Yi migrants the year and month they first moved from rural to urban areas. Duration was then classified as follows: 1 to 10, 11 to 20, 21 to 30, and >30 years. Age at arrival was calculated by subtracting duration from current age and then was classified into two categories: 0 to 20 and >20 years.

Education level was categorized according to the last educational institution attended into three categories: low (illiterate or primary school), moderate (middle or high school), and high (collage or higher). Personal annual income was categorized into three groups in accordance to tertiles (low: ≤2000 Chinese Yuan [CNY], moderate: 2001–12,000 CNY, and high: >12,000 CNY). Ever smoking was defined as ever smoking at least one cigarette per day for at least 6 months. Ever drinking was defined as ever drinking at least twice per month with intake of more than 640 mL (one bottle) beer or 100 mL liquor for at least 6 months.[16] Based on the occupational and leisure-time physical activity in the past year, physical activity was classified into: light (light level of both), moderate (light level of one with moderate level of the other), and heavy (moderate level of both, or heavy level of either).

Statistical analysis

Descriptive results were stratified by migration status (farmer and migrant), and additionally by duration (1–10, 11–20, 21–30, and >30 years) in Yi migrants. Differences in the characteristics were compared using analysis of variance for continuous variables and Chi-squared test for categorical variables.

As a previous study indicated that the association between duration of migration and overweight/obesity varied by age at arrival,[9] an interaction term was included to test interaction. The results showed statistical significance ($P = 0.027$); therefore, data were stratified by age at arrival for further analysis.

General linear regression models were used to assess the effect of migration on BMI in Yi migrants. Confounding factors included in models were as follows: age, sex, education, income, smoking status, drinking status, and physical activity. A direct method was to assess the standardized prevalence of overweight/obesity according to the age and sex distribution of the 2010 China census data.

Multi-variable logistic regression analyses with overweight/obesity as the dependent variable were used to assess the risk of overweight/obesity in Yi migrants compared to Yi farmers, and further to examine the association between

duration of migration and overweight/obesity. The adjusted variables were consistent with what were described in general linear regression models.

All *P* values presented were two-sided, with $P < 0.05$ being considered statistically significant. All analyses were conducted using SAS statistical software (Version 9.4; SAS Institute Inc., Cary, NC, USA).

Results

Characteristics of the participants

A total of 3056 Yi people aged 20 to 80 years were enrolled in the study, including 1894 Yi farmers and 1162 Yi migrants. 647 (34.16%) of the Yi farmers and 384 (33.05%) of the Yi migrants were male participants. The mean age of Yi farmers and Yi migrants were 45.36 ± 12.69 and 48.91 ± 14.38 years, respectively. The mean duration of migration and age at arrival of Yi migrants were 20.00 ± 14.69 and 28.91 ± 14.67 years, respectively. The BMI of Yi migrants was significantly higher than that of Yi farmers (24.48 ± 3.80 *vs.* 22.28 ± 3.62, $P < 0.0001$). Characteristics profiles of Yi farmers and Yi migrants by duration are presented in Table 1.

BMI and prevalence of overweight/obesity

Figure 1 shows significant correlation between duration of migration and BMI in Yi migrants ($R = 0.13$, $P = 0.0074$ in 0–20 years old at arrival; $R = 0.11$, $P = 0.0030$ in >20 years old at arrival).

Table 1: Characteristics of Yi farmers and Yi migrants by duration of migration.

Items	Yi famers ($n = 1894$)	Yi migrants					P^*	$P^\dagger$
		Total ($n = 1162$)	1–10 years ($n = 386$)	11–20 years ($n = 321$)	21–30 years ($n = 199$)	>30 years ($n = 256$)		
Sex							0.5272	<0.0001
Male	647 (34.16)	384 (33.05)	110 (28.50)	88 (27.41)	61 (30.65)	125 (48.83)		
Female	1247 (65.84)	778 (66.95)	276 (71.50)	233 (72.59)	138 (69.35)	131 (51.17)		
Age (years)	45.36 ± 12.69	48.91 ± 14.38	44.9 ± 14.43	43.64 ± 12.9	48.12 ± 11.36	62.16 ± 9.04	<0.0001	<0.0001
Age group (years)							<0.0001	<0.0001
20–29	182 (9.61)	97 (8.35)	57 (14.77)	37 (11.53)	3 (1.51)	0 (0.00)		
30–39	484 (25.55)	257 (22.12)	97 (25.13)	108 (33.64)	48 (24.12)	4 (1.56)		
40–49	603 (31.84)	271 (23.32)	103 (26.68)	83 (25.86)	67 (33.67)	18 (7.03)		
50–59	324 (17.11)	210 (18.07)	50 (12.96)	48 (14.95)	43 (21.60)	69 (26.95)		
60–69	218 (11.51)	234 (20.14)	60 (15.54)	31 (9.66)	31 (15.58)	112 (43.76)		
70–80	83 (4.38)	93 (8.00)	19 (4.92)	14 (4.36)	7 (3.52)	53 (20.70)		
Age at arrival (years)	NA	28.91 ± 14.67	39.14 ± 14.82	28.04 ± 13.33	22.81 ± 11.33	19.3 ± 6.66	–	<0.0001
Age at arrival categories (years)							–	<0.0001
0–20	NA	423 (36.40)	43 (11.14)	113 (35.20)	102 (51.26)	165 (64.45)		
>20	NA	739 (63.60)	343 (88.86)	208 (64.80)	97 (48.74)	91 (35.55)		
Education							<0.0001	<0.0001
Low	1679 (88.65)	630 (54.22)	270 (69.95)	186 (57.94)	91 (45.73)	83 (32.42)		
Moderate	194 (10.24)	362 (31.15)	89 (23.06)	99 (30.84)	58 (29.15)	116 (45.31)		
High	21 (1.11)	170 (14.63)	27 (6.99)	36 (11.22)	50 (25.12)	57 (22.27)		
Income							<0.0001	<0.0001
Low	995 (52.53)	96 (8.26)	54 (13.99)	17 (5.30)	19 (9.55)	6 (2.35)		
Moderate	670 (35.38)	274 (23.58)	125 (32.38)	86 (26.79)	40 (20.10)	23 (8.98)		
High	229 (12.09)	792 (68.16)	207 (53.63)	218 (67.91)	140 (70.35)	227 (88.67)		
Smoking status							0.4884	<0.0001
Never	1268 (66.95)	792 (68.16)	275 (71.24)	232 (72.27)	147 (73.87)	138 (53.91)		
Ever	626 (33.05)	370 (31.84)	111 (28.76)	89 (27.73)	52 (26.13)	118 (46.09)		
Drinking status							0.1286	<0.0001
Never	1254 (66.21)	738 (63.51)	272 (70.47)	209 (65.11)	123 (61.81)	134 (52.34)		
Ever	640 (33.79)	424 (36.49)	114 (29.53)	112 (34.89)	76 (38.19)	122 (47.66)		
Physical activity							<0.0001	<0.0001
Light	420 (22.18)	341 (29.40)	139 (36.01)	100 (31.25)	60 (30.15)	42 (16.47)		
Moderate	137 (7.23)	335 (28.88)	123 (31.87)	112 (35.00)	51 (25.63)	49 (19.22)		
Heavy	1337 (70.59)	484 (41.72)	124 (32.12)	108 (33.75)	88 (44.22)	164 (64.31)		
BMI (kg/m^2)	22.28 ± 3.62	24.48 ± 3.80	23.86 ± 3.75	24.29 ± 3.78	25.28 ± 4.23	25.04 ± 3.38	<0.0001	<0.0001

Data were presented as mean ± standard deviation or number (percentage). * Comparison between Yi farmers and Yi migrants. † Comparison among duration groups in Yi migrants. NA: Not applicable; BMI: Body mass index.

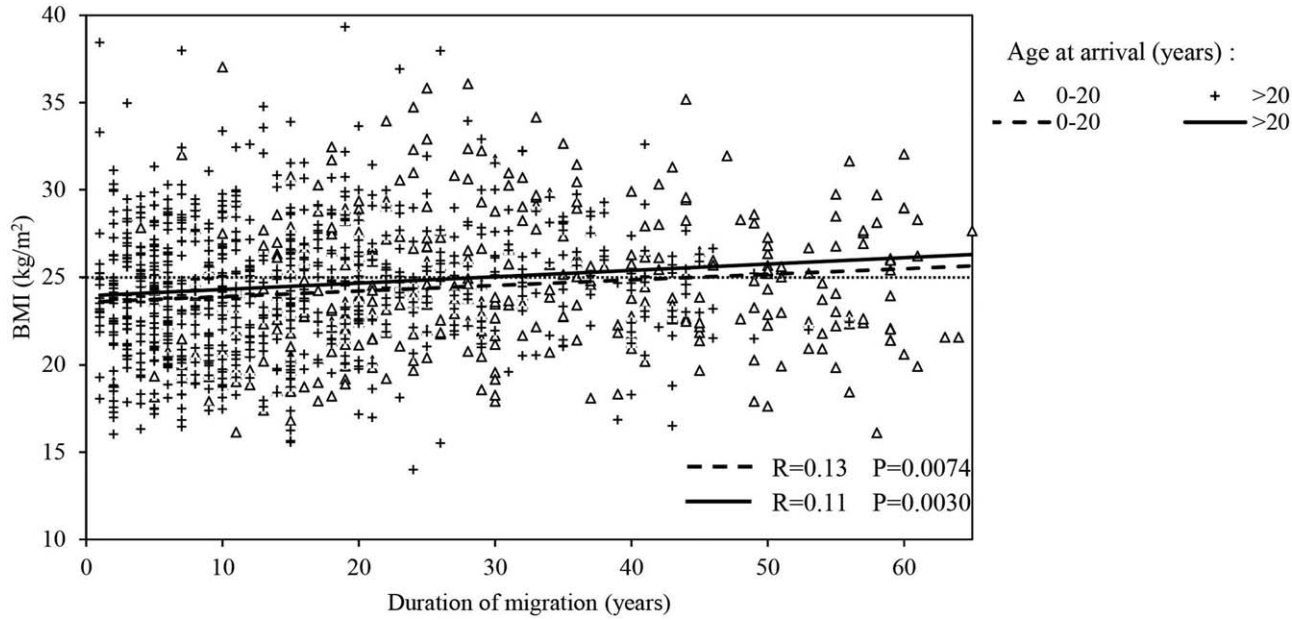

Figure 1: Correlation between duration of migration and body mass index (BMI) by age at arrival in Yi migrants.

Table 2: Effect of migration on BMI by general linear regression analysis.

			Unadjusted			Model 1			Model 2		
Items	***N***	**BMI (kg/m²)**	β	**95% CI**	***P***	*β*	**95% CI**	***P***	*β*	**95% CI**	***P***
Yi farmers (reference)	1894	22.28 ± 3.62	0.00	–	–	0.00	–	–	0.00	–	–
Yi migrants	1162	24.48 ± 3.80	2.20	1.93–2.47	<0.0001	2.27	2.00–2.54	<0.0001	1.71	1.36–2.06	<0.0001
Age at arrival: 0–20 years											
Duration (years)											
1–10 (reference)	43	23.20 ± 4.05	0.00	–	–	0.00	–	–	0.00	–	–
11–20	113	23.62 ± 3.46	0.42	–0.87–1.70	0.5221	0.36	–0.98–1.69	0.5977	0.36	–0.98–1.71	0.5970
21–30	102	25.00 ± 3.94	1.80	0.50–3.10	0.0069	1.68	0.18–3.18	0.0282	1.61	0.07–3.16	0.0410
>30	165	25.12 ± 3.47	1.92	0.70–3.15	0.0022	1.64	–0.49–3.76	0.1302	1.65	–0.56–3.85	0.1422
Age at arrival: >20 years											
Duration (years)											
1–10 (reference)	343	23.95 ± 3.71	0.00	–	–	0.00	–	–	0.00	–	–
11–20	208	24.65 ± 3.91	0.70	0.04–1.36	0.0365	0.82	0.16–1.48	0.0151	0.71	0.04–1.37	0.0373
21–30	97	25.59 ± 4.52	1.64	0.78–2.50	0.0002	2.04	1.16–2.93	<0.0001	1.70	0.78–2.62	0.0003
>30	91	24.89 ± 3.21	0.94	0.06–1.83	0.0362	1.66	0.68–2.63	0.0009	1.36	0.31–2.40	0.0111

Model 1 adjusted for age. Model 2 adjusted for age, sex, education, income, smoking status, drinking status, and physical activity. BMI: Body mass index; CI: Confidence interval.

Yi migrants had 1.71 kg/m^2 (95% confidence interval [CI]: 1.36–2.06) higher BMI than Yi farmers, controlled for age, sex and other potential confounders [Table 2]. In Yi migrants who were 0 to 20 years old at arrival, after adjustment, BMI in those with 21 to 30 years of migration was 1.61 kg/m^2 (95% CI: 0.07–3.16) higher than migrants with 1 to 10 years of migration. In Yi migrants who were >20 years old at arrival, compared with more recent migrants (1–10 years), BMI among longer-term migrants increased by 0.71 kg/m^2 (95% CI: 0.04–1.37), 1.70 kg/m^2 (95% CI: 0.78–2.62), and 1.36 kg/m^2 (95% CI: 0.31–2.40), respectively.

Age and sex standardized prevalence of overweight/obesity in Yi migrants was found more likely to be overweight/obese than Yi farmers (19.78% *vs.* 39.92%, $P < 0.0001$) [Figure 2]. In Yi migrants, the standardized prevalence was not significantly different by duration of migration among migrants who were 0 to 20 years of age at arrival. By comparison, among those >20 years old at arrival, overweight/obese in migrants with 11 to 20 and 21 to 30 years of migration were more prevalent than migrants with 1 to 10 years of residence (48.00% *vs.* 28.84%, $P = 0.0108$; 61.26% *vs.* 28.84%, $P = 0.0143$).

Odds ratio for overweight/obesity

Adjusted odds ratios for overweight/obesity in Yi migrants compared with Yi farmers are shown in Figure 3. In general, after adjusting for demographic characteristics

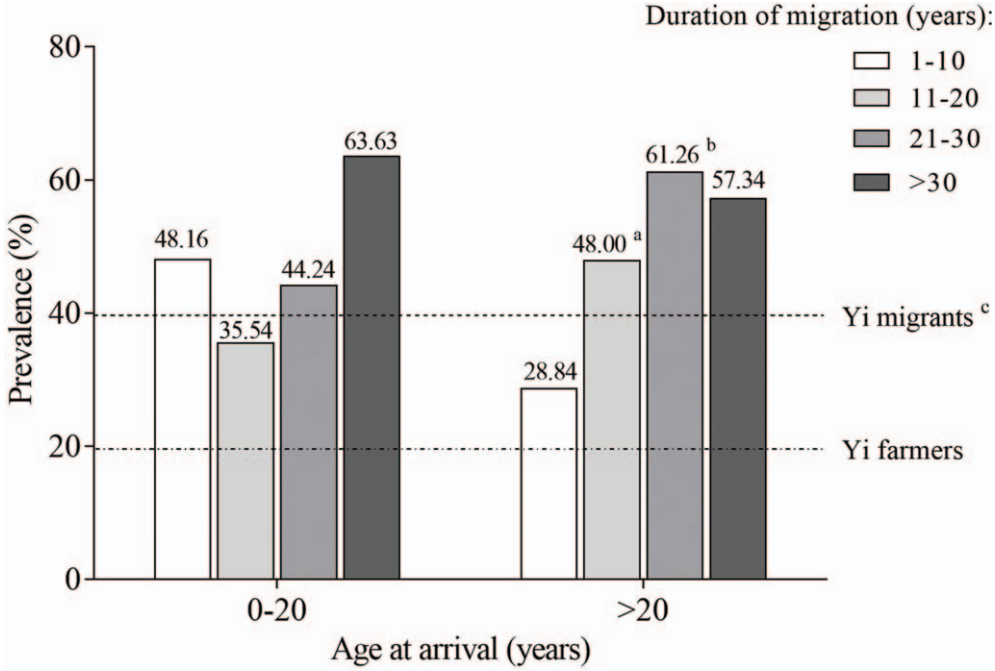

Figure 2: Age and sex standardized prevalence of overweight/obesity by age at arrival and duration of migration. [a]$P = 0.0108$ compared with 1 to 10 years of migration. [b]$P = 0.0143$ compared with 1 to 10 years of migration. [c]$P < 0.0001$ compared with Yi farmers.

and lifestyle factors, Yi migrants were at a 2.13-fold (95% CI: 1.71–2.65) odds of being overweight/obese than Yi farmers.

When stratified by age at arrival, the association between duration of migration and overweight/obesity in Yi migrants differed. Among migrants who were 0 to 20 years old at arrival, no significant association was found after adjustment. Multi-variable analysis conducted in migrants >20 years of age at arrival reveals that, compared with short-term migrants (1–10 years), long-term residence (>30 years of migration) was associated with increased risk of overweight/obesity (odds ratio: 1.85, 95% CI: 1.04–3.29).

Discussion

In this present study, we explored the duration of migration, age at arrival, and the corresponding association with overweight/obesity in Yi migrants. The results illustrated the higher BMI values and higher risk of overweight/obesity in Yi migrants than in Yi farmers. This study supports the hypothesis that among Yi migrants, longer duration of urban residence was associated with increased risk of being overweight/obese. The relationship was significant after adjusting for potential confounding factors. The association deferred by age at arrival, which was only significant in those >20 years old at arrival.

Previous studies demonstrated consistent positive association between duration and overweight or obesity found in our study, both for international migrants such as in the United States,[7,8,17] and for rural-to-urban migrants in low- and middle-income countries.[18,19] For example, migrants residing in the United States for >15 years showed three times higher risk of being overweight (BMI ≥ 25 kg/m^2) than those residing in the United States for <5 years.[20] A study conducted in India revealed two- and three-times higher risk of being obese (BMI ≥ 25 kg/m^2) compared to rural residents among male rural-to-urban migrants with ≤10 years and those with >10 years of urban residence, respectively.[18] However, there are also studies with inconsistent results. In Spain, the duration of residence was not associated with frequency of obesity (BMI ≥ 30 kg/m^2).[21] In Peruvian rural-to-urban migrants, there was no significant association between duration of urban residence and obesity, which was not defined by BMI or waist circumference.[22] The discrepancy may partly be due to the differences in definition of obesity and classification of duration.

The adverse impact of health in host areas may be attributed to lifestyle habits, including unhealthy food intake[23-25] and physical inactivity.[26,27] In the Yi Migrant Study, due to the difficulty in obtaining reliable data in field survey, we did not collect data on dietary pattern. As to physical activity, when merging occupational and leisure-time physical activity, we found the proportion of low-level physical activity to decline and heavy-level physical activity to rise with duration increase. Looking at occupational activity alone, an inverse trend was found. As a previous study pointed out that work-related physical activity primarily determines the daily activity energy expenditure.[5] we speculate that the declined level of occupational physical activity played a role in weight gain. In addition, migrants in urban areas tend to be at higher socioeconomic status than rural residents. In our study, Yi migrants with longer urban residence were better educated and had higher personal income, which means that they were more likely to take part in low-level occupational physical activity and were more accessible to high-fat and

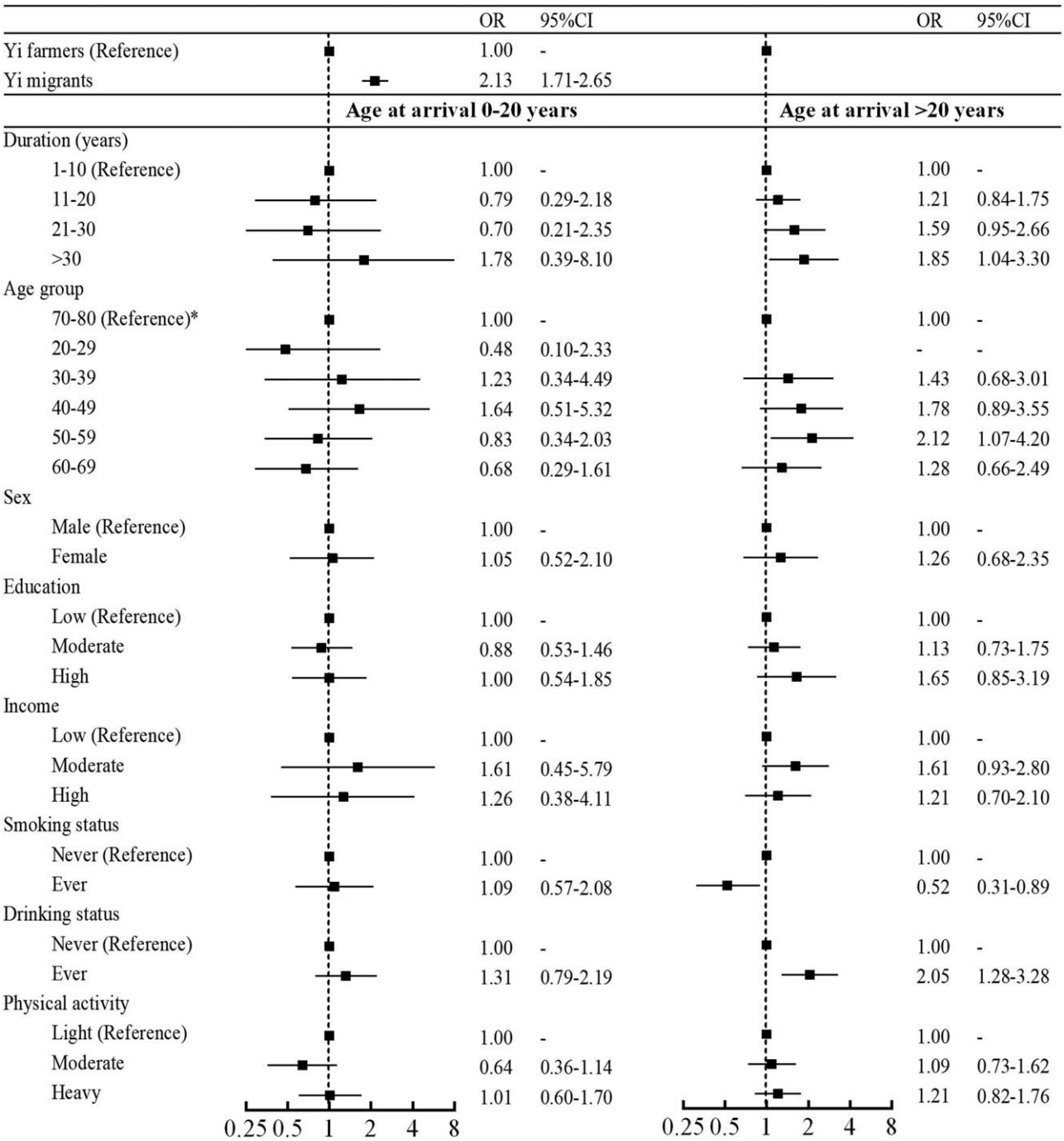

Figure 3: Adjusted odds ratios of overweight/obesity stratified by age at arrival. CI: Confidence interval; OR: Odds ratio. *The reference group is 70 to 80 years due to limited sample size in 20 to 29 years group in >20 years at arrival.

energy-dense food. Notably, when compared to Yi farmers, the odds ratios for overweight/obesity weakened after adjusting for education, income, smoking status, drinking status, and physical activity, which indicates the crucial role of socioeconomic status and lifestyle changes on overweight/obesity risk in Yi migrants compared to their farmer counterparts.

The association between age at arrival and obesity is controversial between studies. Earlier studies found that younger age at migration appeared to increase the odds of overweight and obesity in the United States immigrants.[9,20] However, inverse results were found in the Peru migrant study,[22] which showed the same relationship as our study. The different risk between younger and older age at arrival groups may be partially explained by the disparity in education level and the awareness of health. In our study, those who were younger at arrival (0–20 years) had higher education level than those >20 years old at arrival. Previous study showed particularly strong association between duration of residence and overweight with lower education levels.[28] Thus, better education may be related to better

awareness of healthier lifestyle, which could also be supported by the relative low prevalence of ever smoking and ever drinking in this study. On the contrary, the limited sample size in the reference group ($n = 43$) may also restrict the statistical power.

In present study, using data from the Yi migrant study, by dividing migrants into groups with different duration of migration and age at arrival, we looked deep into the effects of moving from rural to urban areas on BMI and overweight/obesity in Yi people. Data in this study were obtained from a cross-sectional survey, the high-level quality control measures in field survey guaranteed the reliability of the data. Height and weight in our study were measured rather than self-reported, which minimized the recalled bias. Another strength of our study lies in the collection of data from population with the same genetic background in diverse living environment. The data allow us to conduct comprehensive study in the effects of transformed lifestyle on health independent of genetic factor.

However, several limitations in our study are present. Firstly, because of the cross-sectional nature of our study, we cannot make any causal inference. Secondly, the BMI values, which were used to define overweight and obesity, do not distinguish fat and lean tissue or body fat distribution. However, BMI is a well-recognized parameter and is widely used in epidemiologic surveys and international comparisons. Thirdly, several important factors related to obesity such as dietary practice was not available in present study, which limits us from looking into the dietary changes with duration of residence. Lastly, we are in lack of data on local urban Han people, who also reside in the same urban areas as Yi migrants. Thus, we are not able to detect the theory of "Health Migrant Effect"[29] and compare the importance between environmental and genetic factors. Future prospective studies are expected to collect integrated data and investigate the relationship between migration, lifestyle transition, and health outcomes.

Conclusion

In summary, Yi migrants were at higher risk of overweight/obesity than Yi farmers, and the risk increased with longer duration of residence in urban areas, especially among those who migrated to urban areas at an older age. Our study calls for the urgent need for overweight/obesity prevention programs emphasizing healthy lifestyle suitable for rural-to-urban migrants.

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Conflicts of interest

None.

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