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Daily urinary sodium and potassium excretion in Chinese first-generation migrants in Italy

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ABSTRACT

Background: China has one of the highest salt intake levels in the world, and Chinese people form one of the largest foreign-born communities now living in Europe. The present study was performed to assess 24-hour urinary sodium and potassium excretion in Chinese migrants in Italy and to explore possible associations with hypertension, hypertension awareness, and length of residence in Italy.
Methods: A cross-sectional evaluation was conducted on 319 first-generation Chinese migrants (154 women and 165 men) aged 18–70 years. Subjects were asked to do a 24-hour urine collection and the relationships of urinary sodium and potassium and arterial blood pressure, hypertension (BP ≥ 140/90 mmHg or anti-hypertensive drug use), hypertension awareness, and years of residence in Italy were investigated with linear or logistic regression analysis.
Results: Sodium excretion was 145.2 mmol/day (95%CI 138.0–152.3) in men, and 134.7 (95%CI 127.6–141.8) in women corresponding to a dietary salt intake of 9.4 g/day (95%CI 9.0–9.9) and 8.8 (95%CI 8.3–9.2) respectively. Potassium excretion was 35.1 mmol/day (95%CI 33.6–36.5), with no significant difference by gender. At multivariable adjusted linear regression analysis body mass index, low education level, and hypertension were positive predictors of sodium urinary excretion; gender (women), and body mass index were positive predictors of potassium excretion. Sodium and potassium excretion were unaffected by hypertension awareness or years of residence in Italy.
Conclusions: Sodium excretion in Chinese workers is higher than recommended and in line with high salt intake in Italy. Potassium consumption remains low.

1. Introduction

Reduction of sodium (Na) intake is a key aspect of interventions to control high blood pressure (BP) [1,2], the leading cause of stroke [3,4]. According to a meta-analysis of 34 randomized intervention trials [5] a decrease of 75 mmol sodium per day (1.7 g) for at least four weeks results in a reduction of 4.18 and 2.06 mmHg for systolic and diastolic pressure respectively. Likewise, a sodium intake of <2 g/day versus ≥2 g/day [6] reduced the risk of stroke and fatal coronary heart disease in a meta-analysis of 14 cohort studies [7]. On these bases it has been estimated that should the current World Health Organization (WHO) limit of <2 g/day sodium in adults [8] be respected, incident strokes might reduce by 23% annually worldwide [9].

In addition, low dietary potassium (K) intake was also found to be associated with adverse effects on BP and excess risk of CVD in epidemiological studies and randomized clinical trials [10,11]. Finally, the Na to K ratio was found to be a superior metric to either Na or K alone in relation to BP [11,12], and a direct association between Na to K ratio and CVD was also observed [13,14]. Therefore, a minimum daily K intake of 3.5 g/day (90 mmol), with an optimal Na to K ratio of approximately 1.00, is now also suggested by WHO [15].

In Europe, where salt consumption ranges from 7 to 13 g per day and health policies aimed at reducing the salt consumption are now active in about half of the EU member states [16], eastern and southern EU countries exhibit the highest salt consumption rates. At the global level a meta-analysis of studies from 187 countries shows a mean sodium

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intake almost twice the WHO limits [17], and the highest salt consumption was measured in Asia. In particular China, which recognizes stroke as the leading cause of mortality with about 1.7 million deaths each year [18], has one of the highest sodium intake levels in the world, a low potassium intake, and a resultant high Na to K ratio [11,12]. More precisely in the INTERMAP study in which China participated in the 1990s, the average 24-hour urinary sodium excretion was 4.0 g/day varying from 4.7 g/day in northern China (Beijing and Shanxi) to 2.5 g/day in southern China (Guangxi) [19]. In the more recent report of the China Health and Nutrition Survey (CHNS), based on dietary records, the average sodium intake was still as high as 4.7 g/day g/day with the same North to South gradient [20]. Therefore, notwithstanding the different methods used to determine sodium intake [21], both studies consistently revealed a North to South gradient in sodium intake at population level [19,20], northern regions exhibiting the highest sodium consumption rates. These nutritional differences are closely associated with the geographical distribution of hypertension prevalence [22], and stroke incidence observed in China [18].

In the last few decades Chinese have been one of the fastest growing migrant populations in Europe, and their health has become a key issue to host nations [23]. In particular migration flows from China to Europe have been mainly directed towards Italy and Spain [24], and Chinese are now the third largest overseas-born population in Italy [25]. In general, Chinese enterprises on Italian territory are very small and usually comprise members of the family, and friends of the owner. The Chinese in Prato are employed predominantly in textile industries for fabric and clothing. The owner generally provides workers with food and accommodation [24,25]. We are not aware of studies investigating food habits in first generation migrants in Italy. Recent data [26] reveal a high prevalence of stroke risk factors, mainly hypertension [27,28], diabetes [29,30], and undiagnosed atrial fibrillation [31] among first generation Chinese migrants living in Italy. Evidence indicates that opportunities for appropriate treatment of risk factors are unequal at population level in culturally diverse minority groups [32] and socioeconomic inequality in sodium intake was found consistently [32–34]. However, no information is available on sodium and potassium excretion of Chinese migrants.

The present cross-sectional study was thus designed to evaluate the urinary excretion of sodium, potassium and sodium to potassium ratio of Chinese first-generation migrant workers living in Italy using one accurately collected 24-hour urine sample [8].

2. Methods

2.1. Study population

The CHinese In Prato (CHIP) is an ongoing participatory research project designed to investigate health needs of the Chinese community resident in Prato. Located in Tuscany, 30 Km from Florence, Prato has a population of approximately 200,000 inhabitants with the highest proportion of Chinese immigrants of any Italian province [26]. In order to develop a sensitive, culturally appropriate, non-coercive recruitment and enrolment process involving the general population a community–academic partnership composed by the Consulate General of Florence, the local four community-based Chinese organizations, and the Chinese and Italian Universities, was created [26]. To select a provincially representative sample of the Chinese adult population (aged 20–70 years) network sampling procedure was adopted [27, 29 35]. No financial incentives were offered to study participants. However, each participant received the results of all clinical and biochemical tests undergone, with a clear statement of whether the diagnostic criteria for hypertension, type 2 diabetes, or dyslipidaemia were met or not. Participants with screen-detected diseases then received assigned treatment through the Regional Health System, based on current recommendations [26].

For the purposes of the present sub-study a randomly selected subsample of 150 men and 150 women aged ≥20 years was invited to do a 24-hour urine collection, based on the WHO recommendation that a sample of 100–200 individuals is required to estimate sodium intake with a 95% CI about the mean of consumption of ±12 mmol/day using a single 24-hour urine collection. To be eligible for the present sub-study, the recruited participants had 1) to declare they were born in continental China and had grandparents born in that country; 2) to be aged between 20 and 70 years; and 3) to be permanently resident in Prato.

Field work was conducted from November 2016 to November 2017. This study received ethical approval from the "Comitato Etico Regione Toscana, Sezione Area Vasta Centro" ("The Ethics Committee of the Region of Tuscany, Section of the Vast Central Zone") (Rif. OSS 14.089). All participants provided written informed consent to participate in this study.

2.2. 24-hour urine collection

A 3-L container was supplied and participants were carefully instructed, through oral and written guidelines, to collect their urine over a 24-hour period. They were instructed to void the first urine stream upon waking, on the day of collection, and to collect all urine over the following 24 h, including the first void on the following morning, and to keep note of the time of the start and end of collection. Participants were requested to return the urine container to the researchers the day following urine collection. Urine samples were analysed for volume, creatinine, sodium (Na) and potassium (K). Urinary Na and K concentrations were measured with ion-selective electrode potentiometry (ATVIA 1800 Siemens, ISE buffer Siemens AG, Munich, Germany). Urinary creatinine was measured using the Jaffe method (ATVIA 1800 Siemens AG, Munich, Germany). Twenty-four-hour urinary Na and K excretions were derived from the product of the urinary Na and K concentrations and urine volume. Sodium to creatinine and potassium to creatinine ratios were calculated. Quartiles of creatinine-adjusted urinary sodium excretion were also calculated. Urine collections were rejected if a participant admitted that a sample was missing from the collection, if the timing of the collection fell outside 23–25 h, if the urinary volume was <600 mL, or if urinary creatinine was <2 standard deviations from the mean [34]. This resulted in the exclusion of the samples of 3 participants from data analysis.

2.3. Data acquisition

Data Acquisition and diagnostic procedures were also reported elsewhere [27,29,31]. In addition to the 24-hour urine collection, a questionnaire covering sociodemographic information (age, sex, level of education, occupation), lifestyles (alcohol consumption, smoking habits) was administered. BP was measured three times, after 5-min rest, using a clinically validated semiautomatic digital sphygmomanometer (M6; Omron Matsusaka Co. Ltd., Japan) [36], the average of the last two readings being used for analysis.

Hypertension was diagnosed if systolic BP (SBP) was ≥140 mmHg, or diastolic BP (DBP) was ≥90 mmHg, or if anti-hypertension medication had been taken in the previous 2 weeks. Self-reporting of any previous clinical diagnosis of hypertension was defined as awareness of hypertension. Self- reporting of the use of anti-hypertension medication was defined as treatment of hypertension. Control of hypertension was defined as antihypertensive treatment associated with average SBP and DBP values <140 mmHg and < 90 mmHg, respectively [36].

Anthropometric measurements of height and weight were taken in underwear according to standardized protocols [37]. Biochemical measurements were performed on finger-prick blood samples using validated dry chemistry methods [30,38].

Participants' smoking habits were coded as smoker, and non-smoker. Each participant's marital status was described by one of the following three categories: married/cohabiting, single, separated/divorced or widowed. Educational attainment level, was coded as primary school, secondary school, high school or university degree. All data were collected by trained certified staff.

2.4. Statistical methods

For descriptive statistics, means and standard deviations or percentages are given for each sample. Variables were analysed first using chi-squared tests for categorical variables or *t*-tests for continuous variables. Analysis of variance (ANOVA) with Bonferroni correction was used for multiple comparisons. Independent predictors of 24-hour urinary excretion of sodium, potassium, and sodium to potassium ratio were then investigated at multivariable adjusted linear regression analysis. The model included age, sex, years of residence in Italy, body mass index, current smoking habits, alcohol consumption (yes or no), education (3 categories), hypertension, and hypertension awareness. Associations of hypertension with quartiles of creatinine-adjusted urinary sodium excretion were explored with logistic regression analysis adjusted for age, sex, and BMI. For regression analysis ORs and 95% CI were calculated. Values of $p < 0.05$ were considered statistically significant. All analysis was carried out using SPSS version 25 (IBM, Chicago, Illinois, USA).

3. Results

3.1. General characteristics of the study population

In total, 154 women and 165 men were included in the analysis and main characteristics of the participants are presented in Table 1. The participants were born in the province of Zhejiang (80%), Fujian (12%), or Liaoning (5.2%) and had lived in Italy for an average of 12.3 years (95% CI 11.7–12.9). Only 18% had lived in Chinese urban areas, the large majority (82%) coming from rural China. Participants were mainly occupied doing light manual work in the textile industry (unskilled workers, 114 women and 130 men), only a minority being retired (21 women and 11 men), or managers/white collar/students (5 women and 9 men). Men were more likely to be current smokers or drinkers compared with women ($p < 0.001$ at Chi-Square tests for

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Table 1
Characteristics of the study sample in the whole cohort and by gender.

Variables	All ($n = 319$)	Men ($n = 165$)	Women ($n = 154$)	p^*
Demographic data				
Age (years), mean (SD)	49.4 (10.4)	48.6 (10.9)	50.4 (9.8)	0.117
Age group				0.664
<45 years	94	52	42	–
45 to 55 years	140	69	71	–
>55 years	85	44	41	–
Marital status				0.448
single	6	4	2	–
married	291	150	140	–
divorced	1	0	1	–
Socioeconomic data and lifestyle				
Time in Italy, years, mean (SD)	12.3 (5.5)	12.6 (5.2)	12.0 (5.9)	0.290
Education				0.002
primary school	126	49	76	–
secondary school	136	83	53	–
high school or university	10	6	4	–
Occupation				0.037
low skill worker	245	130	114	–
manager	6	3	3	–
white collar	4	4	0	–
housewife	2	0	2	–
student	2	2	0	–
retired	32	11	21	–
Alcohol use (yes)	140	108	31	0.001
Smoking habit (yes)	48	47	1	0.001
Anthropometric data				
Height, cm, mean (SD)	163.1 (7.1)	167.5 (5.7)	158.5 (5.3)	0.001
Body weight, kg, mean (SD)	65.7 (10.9)	71.0 (9.8)	60.2 (9.1)	0.001
Waist, cm, mean (SD)	88.5 (9.7)	90.1 (9.3)	86.8 (9.8)	0.002
BMI, kg/m^2, mean (SD)	24.6 (3.3)	25.3 (3.4)	23.9 (3.0)	0.001
Blood pressure				
Systolic BP, mmHg, mean (SD)	129.0 (21.3)	131.0 (19.4)	126.9 (23.0)	0.087
Diastolic BP, mmHg, mean (SD)	83.9 (12.0)	85.4 (10.9)	82.3 (12.8)	0.021
Hypertension	124	64	60	0.975
Aware of hypertension	90	50	40	0.391
Treated for hypertension	71	40	31	0.378
BP controlled by drugs	14	7	7	0.898
Blood				
Glucose, mg/dl, mean (SD)	105.0 (28.8)	101.9 (17.7)	108.3 (36.9)	0.050
Total cholesterol, mg/dl, mean (SD)	192.1 (21.8)	194.6 (20.5)	189.6 (22.9)	0.041
Triglycerides, mg/dl, mean (SD)	234.8 (132.3)	232.5 (132.1)	237.3 (133.0)	0.750

Legend. The data are presented as $n =$ unless otherwise indicated. BMI – Body Mass Index.
* Chi-squared tests for categorical variables or *t*-tests for continuous variables.

both). Gender differences were also observed as regards educational attainment level ($p = 0.002$ at Chi-Square test) (Table 1).

3.2. 24-hour urinary sodium and potassium excretion

Results from urine collection are shown in Table 2. Overall, 24-hour urinary Na excretion was 140.0 mmol/day (95% CI 134.9–145.0), approximately corresponding to 9.1 g (95%CI 8.8–9.4) of dietary salt per day. Average sodium excretions were 145.2 mmol/day (95%CI 138.0–152.3) in men, corresponding to a dietary salt intake of 9.4 g/day (95%CI 9.0–9.9), and 134.7 mmol/day (95%CI 127.6–141.8) in women (dietary salt of 8.8 g/day; 95%CI 8.3–9.2). Overall 96.5% of the participants (95.5% of men and 97.5% of women) did not meet the WHO recommendations for a maximum dietary sodium intake of 2 g/day. The median 24-hour urinary K excretion was 35.1 mmol/day (95%CI 33.6–36.5) (approximately 1 g of K per day, 1 mmol = 39 mg of K), with no significant difference by gender (Table 2). Only 2 participants (1 man and 1 woman) met the WHO recommendations for minimum potassium intake of 3.51 g/day. The average urinary sodium-to-potassium ratio was 4.4 (95% CI 4.2–4.6) in the whole group (Table 2), being higher in men than in women (4.7; 95%CI 4.4–5.4 and 4.0; 95%CI 3.7–4.2, $p < 0.001$). No participants reached the sodium-to-potassium ratio indicated by WHO.

The characteristics of participants by quartiles of creatinine-adjusted urinary sodium are shown in Table 3. Sodium excretion ranged from 94.9 mmol Na/g creatine (95%CI 92.6 to 97.4) in the lowest quartile to 232.2 mmol Na/g creatine (95%CI 214.7 to 231.6) in the highest quartile (Table 3). The urinary sodium-to-potassium ratio was 3.7 (95%CI 3.3 to 4.0) in the first quartile and rose to 5.2 (95%CI 4.7 to 5.7) in the highest quartile. A difference of 8.7 mmHg (95%CI 0.1 to 17.8) for median SBP was observed between the top and bottom quartiles of creatinine-adjusted urinary sodium excretion. At multivariate linear regression (age, gender, body mass index, and creatinine-adjusted K excretion included in the model) creatinine-adjusted urinary sodium excretion was positively associated with SBP both in the whole group ($n = 307$; B coefficient 0.381; 95% CI 0.116 to 0.645), and after exclusion of subjects aware of their hypertensive status ($n = 218$; B coefficient 0.460; 95% CI 0.054 to 0.866).

3.3. Hypertension awareness, treatment and control

Overall hypertension was diagnosed in 124 subjects (38%; 95% CI 33% to 44%) with no difference by gender (60 women, 39%; and 64 men, 39%; $p = 0.975$ at Chi squared test). Overall 72.0% (90/124) of subjects with hypertension were aware of being hypertensive, with no difference by gender (40 women, and 50 men; $p = 0.153$ at Chi squared test), and 78.9% of aware subjects (71/90) were on antihypertensive treatment. However, only 19% of subject treated with drugs had their BP controlled (7 women and 7 men). The proportion of Chinese migrants in whom hypertension was detected, those aware of hypertension, those treated with antihypertensive drugs, and controlled by drugs (i.e., BP <140 and < 90 mmHg) are reported in Supplementary Fig. S1. Among subjects with hypertension, 81 were registered in the Italian universal insurance system (National Health Service). At age- and sex-adjusted logistic regression analysis including only hypertensive subjects, drug treatment was not affected by registration to the National Health Service (OR 1.41; 95% Cl 0.61 to 3.29).

Table 2
Urine parameters in the whole cohort and by gender.

Variables	All ($n = 319$)	Men ($n = 165$)	Women ($n = 154$)	p^*
Measured 24-hour urine parameters. Mean (SD)				
Volume (mL)	1177 (439)	1197 (431)	1158 (447)	0.438
Urinary creatinine (mg/day)	955 (280)	1069 (296)	835 (201)	0.001
Na (mmol/day)	140.0 (45.4)	145.2 (46.0)	134.0 (44.3)	0.041
Na (mmol/g creatinine)	153.4 (51.2)	141.2 (47.8)	166.1 (51.9)	0.001
K (mmol/day)	35.1 (13.2)	34.1 (14.2)	36.1 (12.2)	0.167
K (mmol/g creatinine)	38.8 (16.1)	32.7 (12.0)	45.2 (17.3)	0.001
Compliance with WHO indications (n)				
Na < 2 g	11	4	7	0.309
K ≥ 3.5 g	2	1	1	0.967
Na/K ratio ≥ 1	0	0	0	–

* Chi-squared tests for categorical variables or *t*-tests for continuous variables.

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Table 3
Characteristics of Chinese participants by quartiles of creatinine-adjusted urinary sodium excretion.

Variables	Quartiles of urinary sodium (mmol/g creatinine)				p^*
	≤112.4	112.5 to 149.0	149.1 to 183.9	≥184.0	
Sex (men/women)	53/24	41/38	43/35	24/53	0.001
Age (years)	48.1 (10.4)	48.4 (10.4)	49.5 (11.0)	51.1 (9.1)	0.257
Body mass index (kg/m^2)	24.8 (3.1)	24.2 (3.4)	25.0 (3.0)	24.6 (3.6)	0.532
Waist (cm)	89.2 (8.8)	86.4 (10.3)	89.6 (8.4)	89.0 (10.3)	0.148
Systolic BP (mmHg)	126.5 (19.9)	126.9 (21.2)	127.1 (19.6)	135.3 (23.7)	0.030
Diastolic BP (mmHg)	83.7 (12.6)	82.7 (10.9)	82.5 (10.5)	86.9 (13.1)	0.078
Education (*n*)					0.001
primary school	23	35	34	39	
secondary school	34	34	32	33	
high school/University	4	3	4	0	
Blood glucose (mg/dl)	105.6 (20.3)	105.5 (32.4)	101.6 (23.6)	189.1 (35.4)	0.726
Total cholesterol (mg/dl)	194.1 (21.7)	189.9 (19.3)	193.8 (23.8)	267.7 (22.0)	0.372
Triglycerides (mg/dl)	229.2 (127.0)	215.6 (125.0)	236.9 (138.0)	176.1 (138.2)	0.097
Na (mmol/g creatinine)	95.0 (10.6)	132.3 (11.9)	162.5 (9.5)	223.2 (37.4)	0.001
K (mmol/g creatinine)	30.2 (11.7)	35.9 (9.4)	39.9 (15.2)	37.1 (20.0)	0.001
Na/K ratio	3.7 (1.6)	4.0 (1.5)	4.5 (1.3)	49.0 (2.1)	0.001
Hypertension (*n*)	23	28	25	45	0.001
Aware of hypertension (*n*)	16	25	16	31	0.019
Treated for hypertension (*n*)	14	22	12	21	0.151

Legend. The data presented as mean (SD) unless otherwise indicated.
* Chi-squared tests or ANOVA.

There was an increasing trend in the prevalence of hypertension, and hypertension awareness with increasing urinary creatinine-adjusted sodium excretion (Table 3). Results of logistic regression analysis (adjusted for age, gender, and BMI) of quartiles of creatinine-adjusted daily sodium excretion with hypertension is shown in Fig. 1 (upper panel) (307 subjects included in analysis). In particular odds ratio for hypertension of subjects in the highest quartile of creatinine-adjusted sodium excretion was 4.24 (95%CI 1.94 to 9.23). The odds ratio for hypertension was not modified when subjects aware of their hypertensive status were excluded from analysis (4.77; 95% CI 1.45 to 15.68) (219 subjects included in analysis) (Fig. 1, lower panel).

At multivariable adjusted linear regression analysis (age, gender, waist circumference, smoking habits, alcohol consumption, education, years of residence in Italy, level of Italian conversation, and hypertension included in the model) participants with a low level of education and hypertension were more likely to have higher creatinine-adjusted sodium excretion (Supplementary Table S1). Creatinine-adjusted potassium excretion was higher in women (Supplementary Table S1). Finally, Na/K ratio was negatively associated with age, female gender, and level of education, and positively associated with hypertension (Supplementary Table S1). Interestingly, the number of years of residence in Italy showed no association with electrolyte urinary excretion.

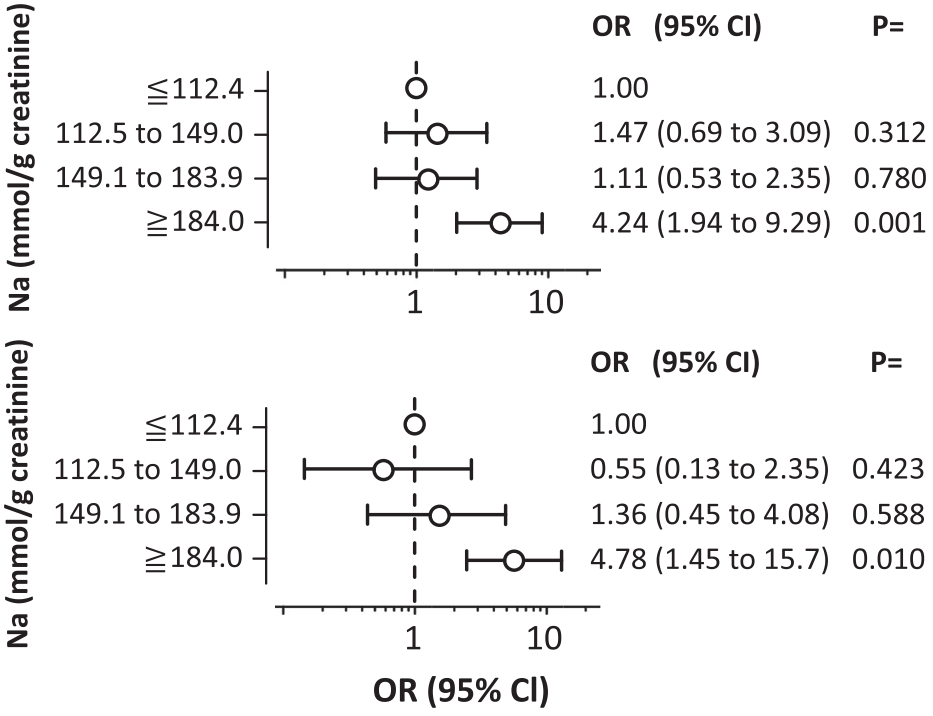

Fig. 1. Odds Ratio (95% CI) for hypertension by quartiles of creatinine-adjusted daily sodium excretion in the whole Chinese cohort at binary logistic regression adjusted for age, sex, and body mass index including all participants (upper panel) and after exclusion of subjects aware of their hypertensive status (lower panel).

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4. Discussion

According to the present results 1) urinary sodium excretion of Chinese first generation migrants was similar to that recently measured in Italian subjects residing in the same region (Tuscany) [34], while potassium excretion was markedly lower [34]; 2) urinary daily excretions measured in our migrant cohort were instead comparable, for both sodium and potassium, with those measured in Southern China, the area of origin of the Chinese population resident in Prato [19,39,40]; 3) finally, neither sodium nor potassium excretion in the Chinese cohort were related to the length of residency in Italy.

The large majority of our Chinese participants did not respect the sodium consumption limit (2 g/day) recommended by WHO. However, their average daily sodium excretion was comparable to values found in southern Europe and also in central Italy [34]. An evident discrepancy with the native population was conversely observed for potassium excretion because values measured in our Chinese cohort were markedly lower than in the Italian population [34], being in the same line of values measured in southern China. Although the average sodium intake did not differ between central Italy [34] and southern China [20], potassium intake in China is markedly low [11,12,19]. The estimated sodium intake of the sample is lower than the average estimation obtained in the INTERMAP China study (4.0 g/day) [19]. However, in the same INTERMAP China study an excretion of 2.5 g/day was measured in southern China (Guangxi) [19]. In particular, Chinese migrants living in Prato originate from two provinces of Southern China (Zhejiang and Fujian) where the average sodium intake in 2015 was found to be 3.6 g/day and 3.0 g/day respectively [40]. The net effect of migration cannot be assessed without baseline information on sodium intake before migration. However, sodium and potassium urinary excretion in our study cohort were not modified by the length of time spent in Italy.

We did not collect information on dietary nutritional components so we cannot distinguish between the preservation of original food habits and the presence of some changes in these habits. However, any eventual assimilation towards local diet, which would not have changed sodium excretion levels, has not included an increased assumption of potassium-rich foods as in Italian subjects. Therefore, when planning public health interventions directed at the Chinese first-generation migrant population, the area of origin in China could be considered as a proxy for sodium and potassium intake.

Dietary changes following migration are influenced by sociodemographic, economic, and cultural factors as well as by the extent of exposure to the host country [41,42]. Changes in urinary electrolytes, particularly the increase in sodium excretion, revealed rapid dietary changes in Sub Sahara subjects migrating into and from Africa [43,44]. Differently, the limited data on nutrition changes among Chinese immigrants in Europe showed only marginal change in dietary habits even as time spent living in the UK increased [45]. The possible preservation of original food habits in Chinese immigrants [46] is also consistent with the lack of relationship between increasing body mass index and length of residence observed both in the US [47] and in Italy [29,30]. The Chinese population in Prato could be unrepresentative of other Chinese migrant populations. As Prato has the highest proportion of Chinese immigrants of any Italian province, it may be different in some important ways. For example, in areas with a lower proportion of Chinese immigrants, assimilation of local food habits may be higher, due to lack of Chinese ingredients. Secondly, compared to other Chinese communities in Europe (Paris, London, Milan), the Chinese community of Prato is mainly composed of first-generation migrants born in China. Second-generation immigrants who have attended school in the host country and who have gained greater knowledge of local customs may behave differently.

The attention of the Chinese to risks of hypertension is high because as recently observed both in urban China [48] and in our CHIP cohort [27], hypertension awareness was a powerful drive to pharmacologic treatment and 79% of our Chinese participants aware of hypertension took antihypertensive drugs. However, in the present study hypertension awareness was not a drive to reduce sodium consumption. National population-based salt reduction programs have been active in China for at least 10 years [40,49], and specific informative messages have also to be released to the Chinese migrant communities living in Europe.

Detailed information on food consumption was not collected and the contribution of different dietary sources to sodium and potassium was not specifically investigated in the present study. It is to be considered that in a setting of Chinese migrants who usually do not consume their food at home, besides difficulties related to recall bias, and inaccuracy in estimating the amount of food in a portion, specific challenges with estimating average sodium content and regional variations of certain food items, may undermine the validity of investigations. However, detailed data on dietary factors in Chinese migrants need to be collected in future studies to guide public health intervention aimed at modifying the opinion of these migrants regarding the importance of reduced sodium intake in the prevention and treatment of hypertension.

The limited information available on Chinese communities living in Europe highlights the strength of the present survey that was based on a rigorous study design. Reliable collection of 24-hour urine of almost all participants was confirmed by measurement of creatinine excretion. However, the study also has potential limitations. As already discussed the data were cross-sectional, and information on food consumption was not collected so causal relationships could not be determined. Secondly, we are aware that the inclusion of undocumented migrants in the present survey bears an additional potential limitation. The conventional sampling procedure adopted in epidemiological studies leads to the exclusion of undocumented migrants because the ability to go back to a list of individuals in some form is lacking. This population is also excluded from healthcare provision for chronic disease in most EU countries which is an obstacle to prevention strategies [37]. In the CHIP survey being undocumented was not a criterion for exclusion from the study. A network sampling procedure was thus adopted [35], the identified informants serving as recruiters between relatives, friends, or neighbours, to produce a sample matching the target population for age groups and sex [26,30].

The great cooperation of Chinese local authorities and of the whole Chinese Community for the direct participation to a shared project is to be acknowledged representing a proof of their willingness to collaborate in public health actions and the CHIP cohort was reasonably found representative of the whole Chinese community living in Prato [27,29,30].

Third, although the 24-hour urine collection is considered to be the gold standard to assess sodium intake since 90% of ingested sodium is excreted in the urine [8], urinary excretion was estimated based on a single 24-hour urine sample. Besides rigorous validation through urinary creatinine excretion, which minimizes bias due to under- or over-collection, more than a single 24-h urine collection should have been obtained from each participant to decrease daily variability [21].

Notwithstanding limitations, the present study gives the first information on sodium and potassium daily excretion of a migrant population living in an area of Europe characterized by a high sodium intake. Importantly, hypertension awareness in the Chinese was frequently associated with drug treatment, whereas the reduction of sodium intake is not translated into actions at the patient level. Specific education plans for Chinese communities have to be considered also in Europe.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcard.2018.12.029.

Conflict of interest

The authors report no relationships that could be construed as a conflict of interest.

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