Urbanization and noncommunicable disease (NCD) risk factors: WHO STEPwise Iranian NCD risk factors surveillance in 2011

Zahra Khorrami,[1] Koorosh Etemad,[1] Shahin Yarahmadi,[2] Soheila Khodakarim,[1] Mohammadesmail Kameli,[3] Alireza Mahdavi Hezaveh [4] and Ebrahim Rahimi [1,5]

التحضُّر وعوامل الخطر المتعلقة بالأمراض غير السارية: ترصد عوامل الخطر المتعلقة بالأمراض غير السارية في إيران في 2011 وفقاً للنهج المتدّرج لمنظمة الصحة العالمية

زهرا خرمي، كورش اعتماد، شهين يارا أحمدي، سهيلا خداكريم، محمد إسماعيل كاملي ، عليرضا مهدودي هزاوه، ابراهيم رحيمي

الخلاصة: أجريت هذه الدراسة للنظر في العلاقة بين التحضر وعوامل الخطر المرتبطة بالأمراض غير السارية وفقاً للنهج المتدرّج لمنظمة الصحة العالمية لمراقبة الأمراض غير السارية. وتأتي هذه الدراسة ضمن عملية ترصد عوامل الخطر المرتبطة بالأمراض غير السارية لما مجموعه 10,069 شخصاً في جميع محافظات جمهورية إيران الإسلامية، في الفئة العمرية فوق 20 عاماً، خلال عام 2011. وباستخدام بيانات التعداد السكاني لعام 2011، حددت مستويات التحضر في جميع المحافظات واستخدم الانحدار اللوجستي لدراسة العلاقة بين التحضر وعوامل الخطر. وفي صفوف الذكور، ظهر ارتباط موجب بين التحضر وانخفاض النشاط البدني (OR=1.7, CI %95 = 1.42 – 2.09)، وانخفاض معدل استهلاك الفاكهة والخضر (OR=1.8, CI %95 = 1.09 – 2.96)، وارتفاع مؤشر كتلة الجسم (OR=1.4;a 1.70 – 1.20 = CI %95). أما في صفوف الإناث، فسُجِّل ارتباط موجب وذو دلالة بين التحضر وانخفاض النشاط البدني (OR=1.2; CI = %95 = 1.08 – 1.49)، وانخفاض معدل استهلاك الفاكهة والخضر (OR=1.3; CI %95 = 1.14 – 1.53)، وارتفاع مؤشر كتلة الجسم (OR=1.22; CI %95 = 0.78 – 1.91). ومن ثمَّ، يتضح أن التحضر يرتبط ارتباطاً ذا دلالة مع زيادة عوامل الخطر المرتبطة بالأمراض غير السارية في جمهورية إيران الإسلامية.

ABSTRACT This study was conducted to examine the relationship between urbanization and risk factors of noncommunicable diseases (NCDs) according to the World Health Organization stepwise approach to surveillance of NCDs. This study is part of a NCD risk factor surveillance of 10 069 individuals in all provinces of the Islamic Republic of Iran, aged over 20 years, during 2011. By utilizing 2011 census data, urbanization levels were determined in all provinces and logistics regression was used to examine the relationship between urbanization and risk factors. Among males, urbanization had a positive correlation with low physical activity (OR=1.7; 95% CI: 1.42-2.09), low fruit and vegetable consumption (OR=1.8; 95% CI: 1.09-2.96), and high BMI (OR=1.4; 95% CI: 1.20-1.70). Among females there was a positive and significant correlation with low physical activity (OR=1.2; 95% CI: 1.08-1.49), low fruit and vegetable consumption (OR=1.22; 95% CI: 0.78-1.91) and high BMI (OR=1.3; 95% CI: 1.14-1.53). Thus, urbanization has a significant correlation with increases in NCD factors in the Islamic Republic of Iran.

Urbanisation et facteurs de risque de maladies non transmissibles (MNT) : approche STEPwise de l'OMS pour la surveillance des facteurs de risque de MNT en République islamique d'Iran en 2011

RÉSUMÉ La présente étude a été menée afin d'examiner la relation entre l'urbanisation et les facteurs de risque de MNT, selon le modèle de l'approche STEPwise de l'OMS pour la surveillance des maladies non transmissibles. L'étude s'inscrit dans la surveillance des facteurs de risque de MNT opérée sur 10 069 personnes âgées de plus de 20 ans dans l'ensemble des provinces de la République islamique d'Iran en 2011. À l'aide de données du recensement de 2011, les niveaux d'urbanisation ont pu être déterminés pour toutes les provinces, et la régression logistique a été utilisée afin d'examiner la relation entre l'urbanisation et les facteurs de risque. Parmi les hommes, l'urbanisation avait une corrélation positive avec une faible activité physique (OR = 1,7, IC à 95 % : 1,42-2,09), une faible consommation de fruits et légumes (OR = 1,8, IC à 95 % : 1,09-2,96) et un indice de masse corporelle élevé (OR = 1,4, IC à 95 % : 1,20-1,70). Parmi les femmes, il existait une corrélation positive et significative avec une faible activité physique (OR = 1,2, IC à 95 % : 1,08-1,49), une faible consommation de fruits et légumes (OR = 1,22, IC à 95 % : 0,78-1,91) et un indice de masse corporelle élevé (OR = 1,3, IC à 95 % : 1,14-1,53). L'urbanisation a donc une corrélation significative avec l'augmentation des facteurs de MNT en République islamique d'Iran.

[1]Department of Epidemiology, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran (Correspondence to: Koorosh Etemad: etemadk@gmail.com). [2]Endocrine and Metabolic Office; [3]Office of Hospital Management and Clinical Service Excellence; [4]Diabetes Control and Prevention Program, Center for Noncommunicable Diseases Control, Ministry of Health & Medical Education, Tehran, Islamic Republic of Iran; [5]Department of Epidemiology, Mamasani Higher Education Complex for Health, Shiraz University of Medical Sciences, Shiraz, Islamic Republic of Iran.

Received: 13/01/16; accepted: 16/11/16

Introduction

It has been predicted that over 60% of the world population in low- and middle-income countries will be living in cities by 2030 (*1*). Certain lifestyle and environmental factors related to urbanization have a significant effect on health and noncommunicable diseases (NCDs). Urbanization is one of the main socioenvironmental factors which has a relationship with changing lifestyles as an important risk factor for NCDs (*2*). Previous research in low- and middle-income countries has indicated that NCD risk factors are more common in urban than in rural areas (*3*). In recent years, the increase in NCDs has been a common concern as a major cause of morbidity and mortality worldwide (*4*). It has been estimated that 33 million deaths in 2008 were due to NCDs, and this is predicted to reach 52 million by 2030 (*5*). Urbanization has an association with lifestyle and behavioural risk factors such as unhealthy diet and low physical activity (*6–8*). Evidence from South-East Asia has indicated that urbanization has a is associated with NCD risk factors such as low physical activity, unhealthy diet, overweight and high blood pressure (*9,10*). In the past few decades, traditional communities in low- and middle-income countries have experienced rapid, unplanned urbanization, which changed lifestyles and resulted in unhealthy diets, a sedentary lifestyle and smoking (*11*). In the past, urban and rural environments were significantly different; however, the distinction is less clear now due to recent advances (*12*). Many definitions of urbanization only use the simple dichotomous variable of urban and rural, making it difficult to understand the specific changes within the urbanization process that have led to changes in the main risk factors for NCDs (*13*).

In recent years, there has been a rapid change in lifestyle and demographic and socioeconomic status in the Iranian community due to the escalation in urbanization and industrialization. The aim of this study was to investigate the association between urbanization and the risk factors for NCDs, which may lead to the identification of new, more effective interventions in the prevention of chronic diseases.

Method

Study population and sampling

We assessed the association between urbanization and NCD risk factors using the data from the 2011 survey of NCD risk factor surveillance (STEPS) conducted by the Ministry of Health and Medical Education in the 31 provinces of the Islamic Republic of Iran (*14*). The study population was 10 069 people aged 20–70 years. A multistage random cluster sampling method with probability proportional to size sampling was used.

Measuring urbanization

Principal component analysis is a multivariate statistical method to reduce the number of variables (*15*). This method was used to create the urbanization variable; overall score is based on the score obtained using the xtile quint command in *SPSS* (percentiles of 33.3 and 66.7) in 3 categories low, medium and high.

There is no global standard indicator to measure urbanization because the factors associated with urbanization in one region of a country are different from those of others countries. From analysis of previous studies, the indices that had the greatest effect on urbanization were identified and included in this study (*13,16,17*). Data on 24 variables measuring multiple aspects of urbanization (e.g. demographic and socioeconomic indices, human resources, communication, energy, the human development index for the province, and health and treatment indicators) were used to extract their underlying constructs. The principal components analysis-based index is a simple and robust measure whose values and groupings can only be moderately affected by changes in the urbanization landscapes. This multivariate statistical technique is used to reduce the number of variables in a data set into a smaller number of "dimensions" that are linear combinations of the original variables. Principal components analysis provides an objective way of aggregating the indicators so that variation in the data can be accounted for as concisely as possible .The urbanization index for all 31 provinces was calculated using this method and every province was classified into 3 urbanization levels. Variables such as average household size, population density, urbanization rate, average floor area of the dwelling unit per family member, economic participation rate, unemployment rate, employment in agriculture and industry, internet penetration, telephone and mobile penetration rate, percentage of villages with telephone communication, gas and electricity energy use per 1000 population, percentage of cities and rural areas with gas facilities, proportion of physicians per 1000 population, proportion of nurses per 1000 population, proportion of specialist physicians per 1000 population, and the human development index for each province were included in the analysis.

Risk factors

The data from the first and second stages of the 6th survey of risk factors for NCDs in 2011 in the Islamic Republic of Iran were used in this study (*14*). The NCD risk factors suggested by WHO such as demographic (residential location, age, gender, education, and job), nutrition (fruit and vegetable consumption), behavioural (smoking and physical activity), and anthropometric and blood pressure measurements were used in this survey. Anthropometric measurements include height, weight and body mass index (BMI) as an

indicator of obesity. Blood pressure was measured 3 times at 3 minute intervals in a sitting position using an Omron electronic sphygmomanometer with an accuracy of 1 mmHg. Smoking was defined as daily cigarette and/or water-pipe consumption, low fruit and vegetable consumption as < 5 units per day, and low physical activity as < 150 min of moderate intensity physical activity per week. The Global Physical Activity Questionnaire was used in this survey (*18*). High BMI was defined as ≥25 kg/m^2, and high blood pressure as systolic blood pressure > 140 mmHg and/or diastolic blood pressure > 90 mmHg (*16*).

Outcome variable

We calculated the risk factor prevalence for each outcome within each level of urbanization. In addition, we investigated the relationship between risk factor and level of urbanization. Following WHO guidelines (*19*), we calculated the average consumption unit of fruits and vegetables a day, BMI, systolic and diastolic blood pressure, and age of starting smoking.

Statistical methods

The principal components analysis method was used to calculate the urbanization variable. Descriptive analysis was reported using descriptive statistics for every level of urbanization. The Kolmogorov–Smirnov test was utilized to assess the normality of variables. The 2-way Kruskal–Wallis test was used to assess the association between every continuous exposure variable and level of urbanization. Binary logistic regression analysis was used to explore the association between NCD risk factors and urbanization level. *P*-value < 0.05 was considered significant, and *SPSS*, version 21, was used for all computations.

Results

Urbanization index

Urbanization scores ranged from –1.34 to 3.83 (Table 1). These were divided based on the scores obtained from xtile quint command (percentile of 33.3 and 66.7) into 3 categories: low, medium and high. Table 1 shows the distribution of provinces according to urbanization index. In the principal components analysis, variables such as internet penetration and provincial human development index achieved the greatest weight in comparison with other variables related to urbanization.

Demographic characteristics

The study population was aged 20–70 [overall mean 43.00 (standard deviation 15.34)] years (Table 2). Individual education levels were higher with greater urbanization: 35.7% of those living in areas of low urbanization were illiterate while only 20.2% of those living in areas of high urbanization were illiterate.

Table 1 Urbanization index score of each province (each province to the new index score of urbanization)

Province	Urbanization score	Urbanization level
Sistan and Baluchestan	–1.348	Low
North Khorasan	–0.931	
Ardebil	–0.889	
Chaharmahal and Bakhtiari	–0.829	
Kordestan	–0.794	
Lorestan	–0.783	
Ilam	–0.695	
Western Azarbayjan	–0.690	
SouthKhorasan	–0.655	
Hamedan	–0.521	
Kohgiloyeh and Boyerahmad	–0.931	Medium
Kerman	–0.351	
East Azarbayjan	–0.436	
Golestan	–0.344	
Kermanshah	–0.342	
Markazi	–0.306	
Gilan	–0.004	
Qazvin	0.012	
Fars	0.013	
Khuzestan	0.127	
Hormozgan	0.149	
Yazd	0.156	
Mazandaran	0.157	
Khorasan Razavi	0.259	High
Zanjan	0.434	
Booshehr	0.543	
Semnan	0.594	
Esfahan	0.757	
Qom	1.000	
Alborz	2.208	
Tehran	3.837	

Table 2 Demographic characteristics of participants in the study of noncommunicable disease risk factors according to urbanization level, Islamic Republic of Iran, 2011

Characteristic	Urbanization level			Total
	Low	Medium	High	
Participants, no. (%)	2025 (20.1)	4071 (40.4)	3973 (39.5)	10 069
Mean (SD) age (years)	42.70 (15.57)	43.03 (15.18)	43.14 (15.38)	43.00 (15.34)
Age range (years)	20–70	20–70	20–70	20–70
Sex, no. (%)*				
Male	786 (38.8)	1712 (42.1)	1637 (41.2)	4135 (41.1)
Female	1239 (61.2)	2359 (57.9)	2335 (58.8)	5933 (58.9)
Education status, no.(%)				
Illiterate	722 (35.7)	1060 (26)	801 (20.2)	2583 (25.7)
Elementary	387 (19.1)	884 (21.7)	923 (23.2)	2194 (21.8)
Junior high school	270 (13.3)	663 (16.3)	583 (14.7)	1516 (15.1)
Diploma	406 (20.0)	928 (22.8)	960 (24.2)	2294 (22.8)
Higher education	237 (11.7)	535 (13.1)	701 (17.6)	1473 (14.6)
Work status, no. (%)*				
Public sector employee	92 (4.5)	257 (6.3)	271 (6.8)	620 (6.2)
Private sector employee	93 (4.6)	265 (6.5)	296 (7.5)	654 (6.5)
Employed, self-employed	412 (20.3)	819 (20.1)	688 (17.3)	1919 (19.1)
Student, soldier	129 (6.4)	237 (5.8)	292 (7.3)	658 (6.5)
Housewife, retired, unpaid work, unemployed, disabled	1275 (63.0)	2490 (61.2)	2415 (60.8)	6180 (61.4)

Values are expressed as mean and standard deviation (SD) for normally distributed data and % for non-normally distribute data.
**Significance defined as P < 0.05.*

There was also a significant difference in terms of employment among different urbanization levels ($P < 0.05$) (Table 2).

Urbanization and noncommunicable disease risk factors

Tobacco

The prevalence of smoking among men was similar in all 3 urbanization levels (Table 3). In univariate logistic regression analysis, there was no significant association between smoking and urbanization among men (OR = 1.02, 95% CI: 0.84–1.24 for medium and OR = 0.90, 95% CI: 0.74–1.10 for high versus low levels of urbanization) or women (OR = 0.70, 95% CI: 0.50–0.99 for medium and OR = 0.85, 95% CI: 0.61–1.19 for high versus low levels of urbanization) (Table 4). In multiple logistic regression analysis after adjustment for age, there was still no significant association between smoking and urbanization in men and women. Among those living in higher levels of urbanization, the average age of starting smoking was lower in both sexes, and

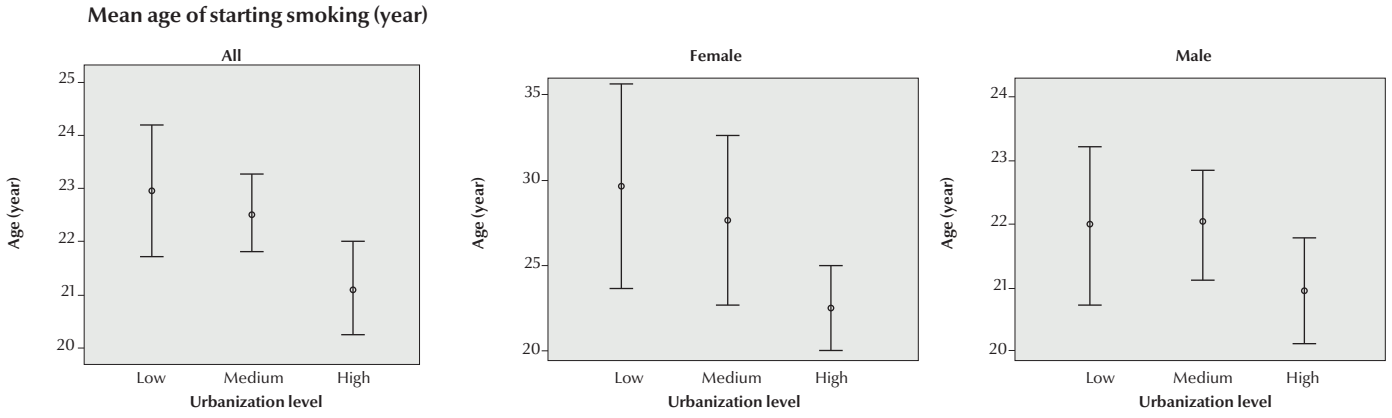

Figure 1A Mean of noncommunicable disease risk factor variables in urbanicity groups, Islamic Republic of Iran, 2011

Table 3 Prevalence of noncommunicable disease risk factors according to urbanization level, Islamic Republic of Iran, 2011

Risk factor	Urbanization level	Males			Females			All		
		No.	%	95% CI	No.	%	95% CI	No.	%	95% CI
Daily tobacco use	Low	208	26.5	23.42–29.58	59	4.8	3.63–5.97	267	13.2	11.73–14.67
	Medium	471	27.5	25.39–29.61	80	3.4	2.67–4.13	551	13.5	12.46–14.54
	High	414	25.3	23.20–27.40	96	4.1	3.30–4.90	510	12.8	11.77–13.83
Low physical activitya*	Low	252	32.1	30.44–33.76	536	43.3	40.56–46.04	788	38.9	36.78–41.02
	Medium	666	38.9	36.61–41.19	999	42.3	40.32–44.28	1665	40.9	39.40–42.41
	High	690	42.2	39.81–44.59	1103	47.2	45.19–49.21	1793	45.1	43.56–46.64
Low fruit & vegetable intakeb*	Low	609	77.5	74.59–80.41	1012	81.7	79.56–83.14	1621	80.0	78.26–81.74
	Medium	1455	85.0	83.31–86.96	2042	86.6	85.23–87.97	3497	85.9	84.84–86.96
	High	1370	83.7	81.92–85.57	1959	83.9	82.41–85.39	3330	83.8	82.66–84.94
High BMIc*	Low	356	45.3	41.83–48.77	711	57.4	54.65–60.15	1067	52.7	50.53–54.87
	Medium	866	50.6	48.24–52.96	1461	61.9	59.95–63.85	2327	57.2	55.69–58.71
	High	910	55.6	53.20–58.00	1488	63.7	61.75–65.65	2399	60.4	58.88–61.92
High blood Pressured*	Low	125	15.9	13.35–18.45	210	16.9	14.82–18.98	335	16.5	14.89–18.11
	Medium	335	19.6	17.73–21.47	489	20.7	19.07–22.33	824	20.2	18.97–21.43
	High	237	14.5	12.81–16.20	310	13.3	11.93–14.67	547	13.8	12.73–14.87

Low fruit & vegetable intake significant only for men.
CI = confidence interval.
BMI = body mass index.
[a]< 150 min of moderate or intense physical activity per week.
[b]< 5 servings of fruit and vegetables per day.
[c]BMI ≥ 25 kg/m.
[d]Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg.
**Kruskall–Wallace test, significant at P < 0.05.*

smoking was more prevalent among women (Figure 1A).

Low physical activity

Urbanization had an inverse association with physical activity in both sexes: the prevalence of low physical activity increased significantly with increased urbanization (Table 3). In multiple logistic regression analysis after adjustment for age, there was a statistically significant association between low physical activity and urbanization in men (OR = 1.58, 95% CI: 1.30–1.91 for medium and OR = 1.72, 95% CI: 1.42–2.09 for high versus low levels of urbanization) and women (OR = 1.36, 95% CI: 1.15–1.60 for medium

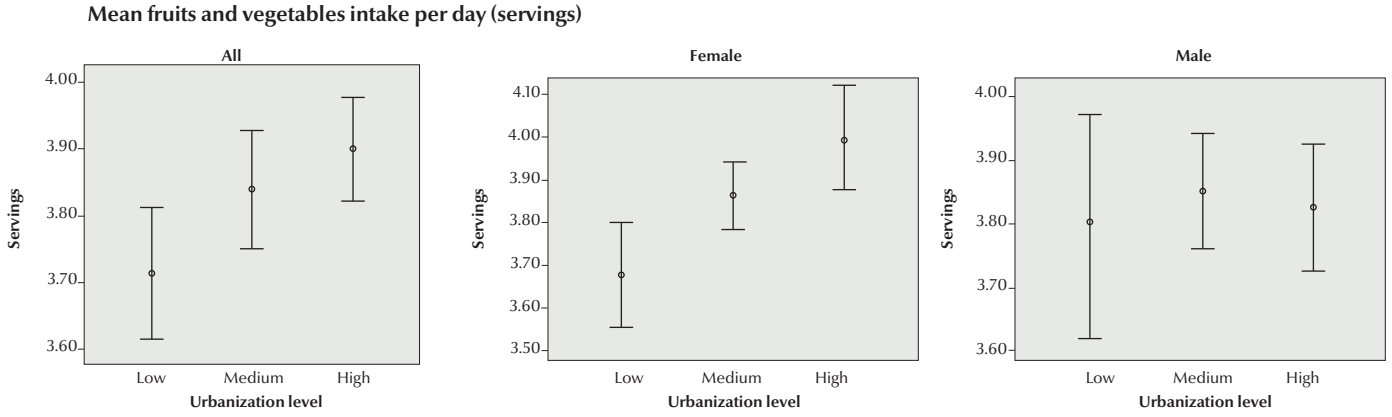

Figure 1B

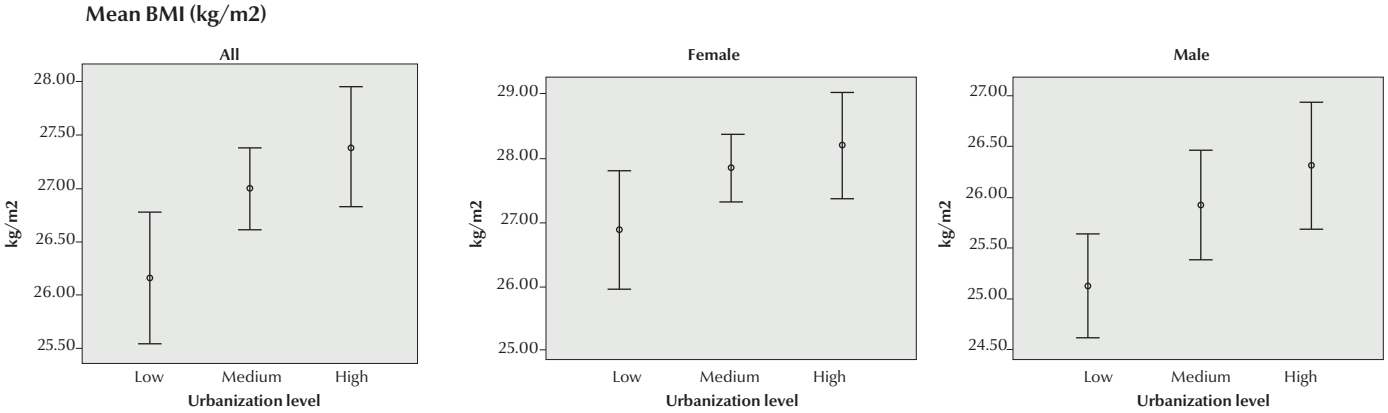

Figure 1C

and OR = 1.26, 95% CI: 1.08–1.49 for high versus low levels of urbanization) (Table 4).

Low fruit and vegetable consumption

In both sexes, the prevalence of low fruit and vegetable consumption increased with increased urbanization, but this was significant only for men (Table 3). With increasing urbanization, the odds of low consumption of fruits and vegetables increased. Men who were living in provinces with a medium level of urbanization were 2.10 times more likely (crude OR = 2.10, 95%CI: 1.26–3.48) and those living in provinces with a high level of urbanization 1.81 times more likely (crude OR = 1.81, 95%CI: 1.10–2.98) to have low fruit and vegetable consumption in comparison with those living in areas with a low level of urbanization. This association did not change after adjustment for age in multiple logistic regression. This positive relationship was also seen in women, but it was not statistically significant (Table 4). We also found a small difference between the mean servings of fruits and vegetables consumed per day for both sexes at different levels of urbanization ($P < 0.05$) (Table 5 and Figure 1B).

High body mass index

The prevalence of higher BMI levels (obese and overweight) in both sexes was positively related to increased urbanization (Table 3). The odds of men having high BMI levels in medium and high levels of urbanization were 1.18 (crude OR = 1.18, 95% CI: 0.99–1.40) and 1.44 (crude OR = 1.44, 95% CI: 1.21–1.71) in comparison with lower levels of urbanization (Table 4). There was also a significant association between high BMI and urbanization in women (OR = 1.21, 95% CI: 1.05–1.29 for medium and OR = 1.30, 95% CI: 1.13–1.50 for high versus low levels of urbanization). These associations did not change after adjustment for age in multiple logistic regressions. Moreover, a statistically significant association was observed between urbanization and mean BMI in both sexes as a continuous variable ($P < 0.001$) (Table 5 and Figure 1C).

High blood pressure

A higher prevalence of high blood pressure was observed in areas with medium

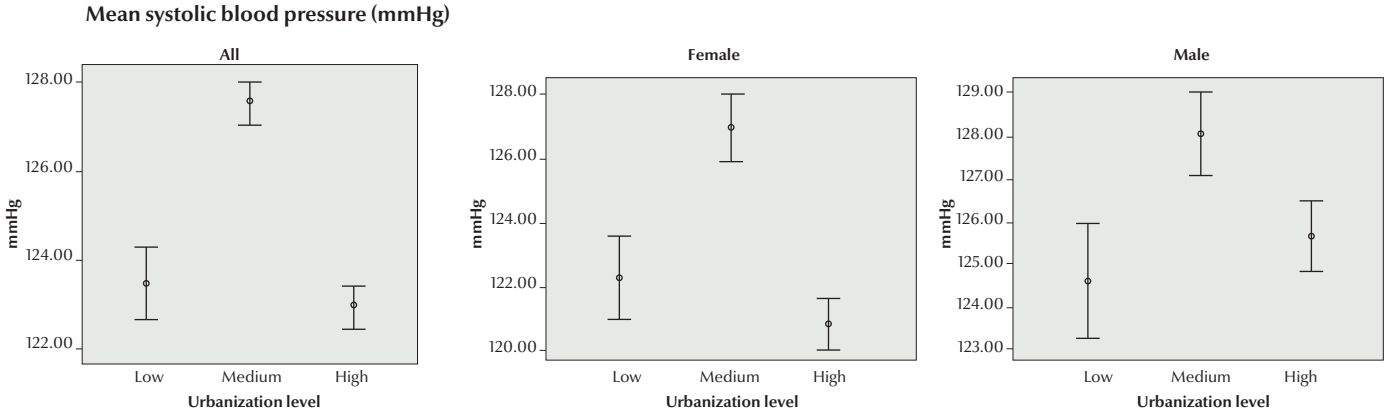

Figure 1D

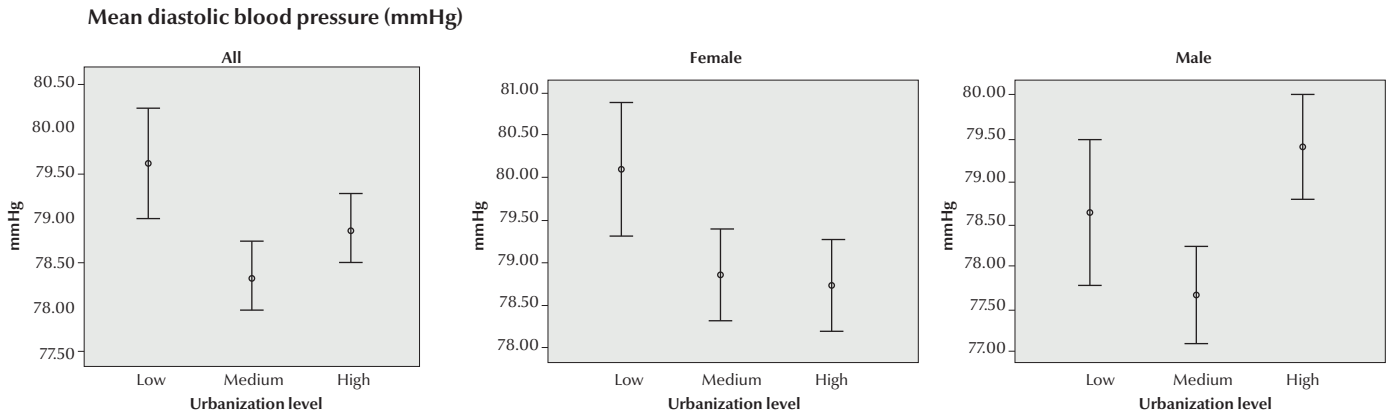

Figure 1E

levels compared with areas with low levels of urbanization for both sexes (Table 3). The same observation was not seen for areas with high levels of urbanization. In univariate logistic regression analysis, there was a significant association between high blood pressure and urbanization in men (OR = 1.25, 95% CI: 1.00–1.57) for medium versus low levels of urbanization and women for medium (OR = 1.29, 95% CI: 1.08–1.54) and for high (OR = 0.78, 95% CI: 0.64–0.94) versus low levels of urbanization. This association did not change after adjustment for age in multiple logistic regression (Table 4). In addition, using the Kruskal–Wallis test, mean systolic and diastolic blood pressure had a significant association with level of urbanization in both sexes ($P < 0.001$) (Table 5 and Figures 1D and 1E).

Discussion

Our findings support the hypothesis that there is a relationship between urbanization and NCD risk factors: urbanization had a positive association with low physical activity, low intake of fruit and vegetables, BMI and hypertension in both sexes. In 2009, a study conducted in the Islamic Republic of Iran reported a relationship between urbanization and risk factors of NCD, such that prevalence of NCD risk factors increased with increasing urbanization, consistent with our findings (*20*). A study conducted in India indicated that there was a relationship between smoking and urbanization in men (*21*). In our study, however, no such significant association was observed. Nevertheless, the results showed that with increasing urbanization the age of starting smoking decreased; this relationship was more evident in women, suggesting that preventive measures should be taken along with education about the dangers and side-effects of smoking in high-risk groups. In Qingdao, China, researchers found that urbanization was related to a number of risk factors such as low physical activity, unhealthy diet and obesity (*21*), consistent with the results of this study. Liu et al. found that urban development significantly reduced daily physical activity and increased the consumption of high calorie foods (fast food) (*22*). It has consequently led to a rapid increase in obesity and overweight due to changes in diet and lifestyle which significantly affect health (*12,23,24*). A study from India showed no significant relationship between the prevalence of low fruit and vegetable consumption and different levels of urbanization in either sex (*16*). Unlike the Indian study, we found significant differences in the prevalence of low fruit and vegetable consumption among different levels of urbanization before and after age-adjusted analyses. In a study conducted in Greenland, no relationship was found between unhealthy dietary patterns and urbanization or socioeconomic status (*25*). In a study in 100 countries, Ezzati et al. found that BMI increased with increasing urbanization (*26*). Our findings indicate that with increasing urbanization, average BMI, high blood pressure, and low physical activity increased, consistent with previous studies (*27–29*). We found the prevalence of physical activity was higher in areas with low urbanization than in areas with high urbanization, consistent with the results of other studies (*30,31*). In a study in Sri Lanka, men and women in areas with high urbanization had respectively 3 and 2 times lower physical activity than those living in other urban areas, which was significant after age adjustment (*32*). Monda et al. also found that low physical activity increased with increasing urbanization (*33*). Our findings are consistent with those of other studies in that as a result of office jobs in the city and the use of technology, physical activity is reduced and the city population has a sedentary rather than an active lifestyle. Therefore, it is suggested that in areas with high levels of urbanization, the focus should be on environmental characteristics and providing facilities such as trails, parks, swimming pools, and gyms. Walking teams, teams for

Table 4. Crude odds ratios and age-adjusted odds ratios for noncommunicable disease risk factors according to urbanization level, Islamic Republic of Iran, 2011

Risk factor	Urbanization level	Crude OR			Age-adjusted OR		
		OR	95% CI	*P*-value	OR	95% CI	*P*-value
Males							
Daily tobacco use	Low	1.00	–	–	1.00	–	–
	Medium	1.02	0.84–1.24	0.805	1.01	0.83–1.22	0.885
	High	0.90	0.74–1.10	0.330	0.90	0.74–1.09	0.299
Low physical activity[a]	Low	1.00	–	–	1.00	–	–
	Medium	1.60	1.33–1.94	< 0.001	1.58	1.30–1.91	< 0.001
	High	1.72	1.42–2.08	< 0.001	1.72	1.42–2.09	< 0.001
Low fruit & vegetable intake[b]	Low	1.00	–	–	1.00	–	–
	Medium	2.10	1.26–3.48	0.004	2.08	1.25–3.46	0.005
	High	1.81	1.10–2.98	0.019	1.80	1.09–2.96	0.021
High BMI[c]	Low	1.00	–	–	1.00	–	–
	Medium	1.18	0.99–1.40	0.056	1.15	0.97–1.37	0.107
	High	1.44	1.21–1.71	< 0.001	1.43	1.20–1.70	< 0.001
High blood pressure[d]	Low	1.00	–	–	1.00	–	–
	Medium	1.25	1.00–1.57	0.046	1.22	0.96–1.55	0.099
	High	0.90	0.71–1.14	0.386	0.85	0.66–1.09	0.214
Females							
Daily tobacco use	Low	1.00	–	–	1.00	–	–
	Medium	0.70	0.50–0.99	0.046	0.70	0.50–1.00	0.050
	High	0.85	0.61–1.19	0.370	0.85	0.61–1.19	0.360
Low physical activity[a]	Low	1.00	–	–	1.00	–	–
	Medium	1.36	1.15–1.60	< 0.001	1.36	1.15–1.60	< 0.001
	High	1.26	1.08–1.49	0.004	1.26	1.08–1.49	0.004
Low fruit & vegetable intake[b]	Low	1.00	–	–	1.00	–	–
	Medium	1.44	0.92–2.27	0.110	1.44	0.92–2.28	0.109
	High	1.22	0.78–1.91	0.362	1.22	0.78–1.90	0.367
High BMI[c]	Low	1.00	–	–	1.00	–	–
	Medium	1.21	1.05–1.39	0.006	1.25	1.08–1.44	0.003
	High	1.30	1.13–1.50	< 0.001	1.32	1.14–1.53	< 0.001
High blood pressure[d]	Low	1.00	–	–	1.00	–	–
	Medium	1.29	1.08–1.54	0.005	1.44	1.18–1.76	< 0.001
	High	0.78	0.64–0.94	0.011	0.72	0.59–0.89	0.003

OR = odds ratio.
CI = confidence interval.
BMI = body mass index.
[a] *< 150 min of moderate or intense physical activity per week.*
[b] *< 5 servings of fruit and vegetables per day.*
[c] *BMI ≥ 25 kg/m.*
[d] *Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg.*

beautifying green spaces, and increasing street lighting are effective in increasing physical activity (*32,33*). In some studies, the likelihood of having high blood pressure was greater for residents of areas with high urbanization than for residents of other areas, after age adjustment (*26,29,30,34*). Mathenge et al. found that likelihood of having hypertension was greater in urban residents than in rural residents after age and sex adjustment (*27*). A 2015 Chinese study concluded that environmental changes have a potential impact on systolic and diastolic blood pressure (*35*). Increased prevalence of high blood pressure can be attributed to increased environmental risk factors parallel to increased urbanization, while globally, high blood pressure is one of

Table 5. Distribution of noncommunicable disease risk factors according to urbanization level, Islamic Republic of Iran, 2011

Outcome	Urbanization level	No. of people in group	Mean	SD	95% CI	*P*-value
			Males			
No. of servings of fruit and vegetables per day	Low	638	3.79	2.31	3.60–3.97	0.007
	Medium	1488	3.84	1.84	3.75–3.94	
	High	1406	3.82	2.04	3.71–3.93	
BMI (kg/m*2)	Low	763	25.08	0.71	24.58–25.59	0.0001
	Medium	1704	25.88	1.13	25.34–26.42	
	High	1632	26.28	1.28	25.65–26.90	
Systolic blood pressure (mmHg)	Low	763	124.57	19.12	123.21–125.92	0.0001
	Medium	1693	128.06	17.36	127.23–128.89	
	High	1580	125.69	16.85	124.86–126.52	
Diastolic blood pressure (mmHg)	Low	763	78.63	12.49	77.74–79.51	0.0001
	Medium	1693	77.67	11.48	77.12–78.22	
	High	1580	79.37	11.67	78.79–79.94	
			Females			
No. of servings of fruit and vegetables per day	Low	1045	3.66	2.07	3.53–3.79	0.0001
	Medium	2088	3.83	1.88	3.75–3.91	
	High	2011	3.95	2.39	3.84–4.05	
BMI (kg/m*2)	Low	1235	26.83	1.67	25.89–27.76	0.0001
	Medium	2347	27.79	1.30	27.26–28.32	
	High	2330	28.15	2.06	27.32–28.99	
Systolic blood pressure (mmHg)	Low	1234	122.45	21.68	121.23–123.66	0.0001
	Medium	2334	126.93	20.82	126.08–127.77	
	High	2247	120.85	19.96	120.03–121.66	
Diastolic blood pressure (mmHg)	Low	1232	80.12	13.14	79.39–80.86	0.004
	Medium	2334	78.74	12.15	78.24–79.23	
	High	2247	78.66	12.31	78.15–79.17	

Means were compared using the Kruskal–Wallis test when assumptions for analysis of variance were not met.
SD = standard deviation.
CI = confidence interval.
BMI = body mass index.
**P-value for Kruskal–Wallis test.*

the risk factors associated with number of deaths (*36*).

Our study has a cross-sectional nature, and thus no causality association can be deduced from it. In terms of the scale of urbanization, 2 provinces can have the same urbanization level, but may differ in other environmental dimensions that are likely to differentially affect health. Thus, more environmental research is needed to understand the implications of urbanizing the environment to develop an exposure measure for NCDs. Moreover, possible differences in factors probably caused by urbanization, such as stress levels and environmental factors, were not investigated; these could be considered valid for future population studies. Further development is required to understand the relative contribution of internet penetration, human development index, and each scale element for risk of chronic diseases. As self-reported information was received from participants regarding nutrition (fruit and vegetable consumption) and behavioural factors (smoking and physical activity), there is the possibility that information bias may have affected the results.

Our findings indicate that increasing urbanization is related to the increased prevalence of several modifiable NCD risk factors that couldn serve as a basis for future studies, planning in order to manage health problems, determining the distribution of financial resources and human resources, and coordinating prevention and intervention strategies

for NCDs based on different levels of urbanization.

Conclusion

In this study, urbanization was described and classified using different factors instead of the known rural/urban dichotomy, and a clear association was observed between different levels of urbanization and NCD risk factors. Increasing urbanization and its consequent complications requires policies and preparations by local governments to meet the needs of the community, which requires an intersectoral agreement and cooperation with other academic and administrative sectors.

Funding: This study was part of the MSc thesis of Zahra Khorrami, supported by Shahid Beheshti University of Medical Sciences (grant No.: /A/9294/36).

Competing interests: None declared.

References

1. Godfrey R, Julien M. Clin Med (Lond). 2005;5(2):137–41. PMID:15847005
2. Global status report on noncommunicable disease. Geneva: World Health Organization; 2010.
3. Al-Moosa S, Allin S, Jemiai N, Al-Lawati J, Mossialos E. Diabetes and urbanization in the Omani population: an analysis of national survey data. Popul Health Metr. 2006;4(1):5. PMID:16635266
4. UN high-level meeting on NCDS (New York, 19–20 September 2011): summary report of the discussions at the round tables. Geneva: World Health Organization; 2011 (http://www.who.int/nmh/events/moscow_ncds_2011/round_tables_summary.pdf, accessed 7 May 2017).
5. Cheema A, Adeloye D, Sidhu S, Sridhar D, Chan KY. Urbanization and prevalence of type 2 diabetes in Southern Asia: a systematic analysis. J Glob Health. 2014;4(1). PMID:2497696
6. Angkurawaranon C, Jiraporncharoen W, Chenthanakij B, Doyle P, Nitsch D. Urbanization and noncommunicable disease in Southeast Asia: a review of current evidence. Public Health. 2014;128(10):886–95. PMID:25369353
7. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. Lancet. 2006;367(9524):1747–57. PMID:16731270
8. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ. Selected major risk factors and global and regional burden of disease. Lancet. 2002;360(9343):1347–60. PMID:12423980
9. Banwell C, Lim L, Seubsman S-A, Bain C, Dixon J, Sleigh A. Body mass index and health-related behaviours in a national cohort of 87,134 Thai open university students. J Epidemiol Community Health. 2009;63(5):366–72. PMID:19151014
10. Son P, Quang N, Viet N, Khai P, Wall S, Weinehall L, et al. Prevalence, awareness, treatment and control of hypertension in Vietnam—results from a national survey. J Hum Hypertens. 2012;26(4):268–80. PMID:21368775
11. McDade TW, Adair LS. Defining the "urban" in urbanization and health: a factor analysis approach. Soc Sci Med. 2001;53(1):55–70. PMID:11380161
12. Mohan V, Mathur P, Deepa R, Deepa M, Shukla D, Menon GR, et al. Urban rural differences in prevalence of self-reported diabetes in India—The WHO–ICMR Indian NCD risk factor surveillance. Diabetes Res Clin Pract. 2008;80(1):159–68. PMID:18237817
13. Dahly DL, Adair LS. Quantifying the urban environment: a scale measure of urbanicity outperforms the urban–rural dichotomy. Soc Sci Med. 2007;64(7):1407–19. PMID:17196724.
14. Noshad S, Abbasi M, Etemad K, Meysamie A, Afarideh M, Khajeh E, et al. Prevalence of metabolic syndrome in Iran: A 2011 update. J Diabetes. May 2017;9(5):518-25.PMID: 27262869
15. Allender S, Foster C, Hutchinson L, Arambepola C. Quantification of urbanization in relation to chronic diseases in developing countries: a systematic review. J Urban Health. 2008;85(6):938–51. PMID:18931915
16. Allender S, Lacey B, Webster P, Rayner M, Deepa M, Scarborough P, et al. Level of urbanization and noncommunicable disease risk factors in Tamil Nadu, India. Bull World Health Organ. 2010;88(4):297–304. PMID:20431794
17. Groth D, Hartmann S, Klie S, Selbig J. Principal components analysis. Methods Mol Biol. 2013;930:527-47.PMID: 23086856
18. Global physical activity surveillance. Geneva: World Health Organization; 2017 (http://www.who.int/chp/steps/GPAQ/en/, accessed 8 May 2017).
19. STEPwise approach to surveillance (STEPS). Geneva: World Health Organization; 2017 (http://www.who.int/chp/steps/en/, accessed 8 May 2017).
20. Effects of urbanization on incidence of noncommunicable diseases. Cairo: World Health Organization; 2012 (Community-Based Initiatives Series 16).
21. Dong Y, Gao W, Nan H, Yu H, Li F, Duan W, et al. Prevalence of type 2 diabetes in urban and rural Chinese populations in Qingdao, China. Diabet Med. 2005;22(10):1427–33. PMID:16176207
22. Liu S, Wang W, Yang X, Lee ET, Zhang J, He Y, et al. Prevalence of diabetes and impaired fasting glucose in Chinese adults, China National Nutrition and Health Survey, 2002. Prev Chronic Dis. 2011;8(1)A13. PMID:21159225
23. Yarahmadi S, Etemad K, Hazaveh AM, Azhang N. Urbanization and noncommunicable risk factors in the capital city of 6 big provinces of iran. Iran J Public Health. 2013;42(Suppl. 1):113–8. PMID:23865027
24. Siddiqui ST, Kandala NB, Stranges S. Urbanisation and geographic variation of overweight and obesity in India: a cross-sectional analysis of the Indian Demographic Health Survey 2005–2006. Int J Public Health. 2015;60(6):717–26. PMID:26198774
25. Bjerregaard P, Jeppesen C. Inuit dietary patterns in modern Greenland. Int J Circumpolar Health. 2010;69(1):13–24.
26. Ezzati M, Hoorn SV, Lawes CM, Leach R, James WPT, Lopez AD, et al. Rethinking the "diseases of affluence" paradigm: global patterns of nutritional risks in relation to economic development. PLoS Med. 2005;2(5):404. PMID:15916467
27. Mathenge W, Foster A, Kuper H. Urbanization, ethnicity and cardiovascular risk in a population in transition in Nakuru, Kenya: a population-based survey. BMC Public Health. 2010;10(1):569. PMID:20860807
28. Christensen DL, Eis J, Hansen AW, Larsson MW, Mwaniki DL, Kilonzo B, et al. Obesity and regional fat distribution in Kenyan populations: impact of ethnicity and urbanization. Ann Hum Biol. 2008;35(2):232–49. PMID:18428015

29. Addo J, Smeeth L, Leon D. Hypertension in sub-Saharan Africa: a systematic review. Hypertension. 2007;50(6):1012–8. PMID:17954720

30. Reis JP, Bowles HR, Ainsworth BE, Dubose KD, Smith S, Laditka JN. Nonoccupational physical activity by degree of urbanization and US geographic region. Med Sci Sports Exerc. 2004;36(12):2093–8. PMID:15570145

31. Parks S, Housemann R, Brownson RC. Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. J Epidemiol Community Health. 2003;57(1):29–35. PMID:12490645

32. Allender S, Wickramasinghe K, Goldacre M, Matthews D, Katulanda P. Quantifying urbanization as a risk factor for noncommunicable disease. J Urban Health. 2011;88(5):906–18. PMID:21638117

33. Monda KL, Gordon-Larsen P, Stevens J, Popkin BM. China's transition: the effect of rapid urbanization on adult occupational physical activity. Soc Sci Med. 2007;64(4):858–70. PMID:17125897

34. Kamadjeu RM, Edwards R, Atanga JS, Kiawi EC, Unwin N, Mbanya JC. Anthropometry measures and prevalence of obesity in the urban adult population of Cameroon: an update from the Cameroon Burden of Diabetes Baseline Survey. BMC Public Health. 2006;6:228. PMID:16970806

35. Attard SM, Herring AH, Zhang B, Du S, Popkin BM, Gordon-Larsen P. Associations between age, cohort, and urbanization with SBP and DBP in China: a population-based study across 18 years. J Hypertens. 2015;33(5):948–56. PMID:25668349

36. Choh AC, Nahhas RW, Lee M, Choi YS, Chumlea WC, Duren DL, et al. Secular trends in blood pressure during early-to-middle adulthood: the Fels Longitudinal Study. J Hypertens. 2011;29(5):838-45. PMID:21430562