

VOLUME LXXVI, ISSUE 4, APRIL 2023

ISSN 0043-5147

E-ISSN 2719-342X

# Wiadomości Lekarskie Medical Advances



Official journal of Polish Medical Association has been published since 1928



ALUNA Publishing House



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POLISH MINISTRY OF EDUCATION AND SCIENCE, POLISH MEDICAL BIBLIOGRAPHY

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The journal *Wiadomości Lekarskie* is cofinanced under Contract No.RCN/SN/0714/2021/1  
by the funds of the Minister of Education and Science

# EFFECT OF URBANIZATION ON DENSITY OF THE GENERAL PRACTITIONERS, AVERAGE LIFE EXPECTANCY AND MORTALITY FROM THE DISEASES OF CIRCULATORY SYSTEM

DOI: 10.36740/WLek202304117

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## ABSTRACT

**The aim:** Comparative analysis of average life expectancy, mortality from diseases of the circulatory system, gross regional product, and density of general practitioners in regions with different levels of urbanization.

**Materials and methods:** We compared the following characteristics of groups classified by level of urbanization: average density of general practitioners per 10,000, average life expectancy and mortality from diseases of the circulatory system per 1,000, average gross regional product per 1 person.

**Results:** The groups did not differ in average life expectancy. The highest rate of mortality from diseases of the circulatory system- in the group with average level of urbanization, the lowest- in the group with low level of urbanization ( $p < 0.05$ ). The highest value of gross regional product per person is in the group with high level of urbanization, and the lowest is in the group with low level ( $p < 0.05$ ). The lowest density of primary care doctors per 10,000 is in the group with high level of urbanization, and the highest is in the group with low level of urbanization ( $p < 0.05$ ).

**Conclusions:** When planning staffing of health care institutions, it is necessary to take into account the level of urbanization of the region and ensure status of the general practitioner as a leading medical specialist responsible for medical care during the first meeting with the patient and his subsequent follow-up.

**KEY WORDS:** urbanization, density of general practitioners, life expectancy, mortality from diseases of the circulatory system, gross regional product

Wiad Lek. 2023;76(4):811-816

## INTRODUCTION

Urbanization processes in the world cause significant changes in living standards, social behavior and population health [1]. Urbanization can create new dangers for human health (injuries, non-communicable diseases, unhealthy diet and lack of physical activity, harmful alcohol consumption), as well as risks of infectious diseases outbreaks [2].

Urbanization, is often cited as a key factor in the development of the diseases of circulatory system, an increase in body mass index (BMI), obesity, prevalence of type 2 diabetes, hyperlipidemia, and hypertension [3-5]. Urbanization leads to a change in the general requests for medical care, including medical appointments. However, its effect on the chronic diseases development decreases with advances in healthcare system and increase in its financing [6-9].

The urbanization and economic level of the region affect medical care provided to the population [7]. As we know, living in cities in high- and middle-income countries ensures for people affordable and high-quality medical care [2]. In contrast, poor people living in areas of highly urbanized cities have limited access to healthcare.

Urbanization provides certain features of the medical care organization in cities and villages. Traditionally, the main resources of health care system are concentrated in cities. Higher prevalence of the physicians treating people is observed in more urbanized and populated areas [10, 11]. In rural areas, lack of physicians is observed, which causes dependence on providers of primary medical care. In addition, cities are characterized by an extensive network of healthcare facilities, due to the medical service demands of highly populated urbanized regions.

As of 2020 year, 4,190,416 people lived in Ukraine, of which 69.5% were urban residents [12]. In 2020, general practitioners (GPs) provided primary medical care in 808 primary health care centers. The availability of medical care for the population is primarily ensured by a sufficient number of GPs [13-15].

Of great urgency are the studies of the urbanization effect on availability of primary medical care by GPs, assessment of the availability effect on the average life expectancy and mortality from cardiovascular diseases, as the leading health indicators of the population.

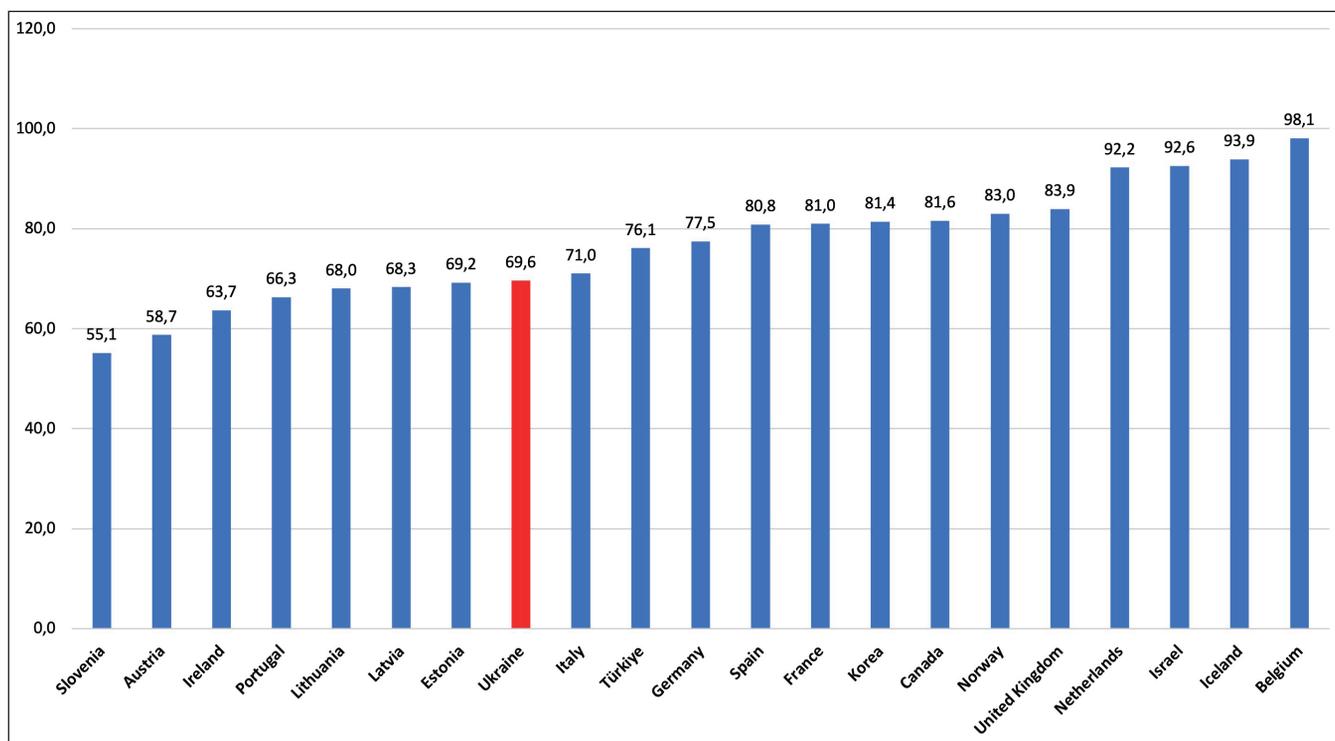


Fig. 1. The level of urbanization in the countries of the world (% of total population)

## THE AIM

The aim of the study was to compare the average life expectancy, the mortality rate from the diseases of circulatory system, gross regional product per 1 person, the density of GPs in regions with different levels of urbanization.

## MATERIALS AND METHODS

According to the share of the urban population in the 2020 population structure, the regions of Ukraine are divided into 3 groups, according to the urbanization level [12]. The first group, which belongs to a low level of urbanization, included up to 50% of the city population, the second group, which belongs to the average urbanization level - from 50 to 70%, the third group, which belongs to high urbanization level - more than 70%.

For each group, the density of GPs per 10,000 people was calculated according to the data of Standard 17 «Report on medical personnel» of the Public Health Center of the Ministry of Health of Ukraine for 2020 [13]. In addition, for each group, the average life expectancy, and the average value of the 2020 mortality rate due to circulatory diseases per 1,000 people were calculated, according to the State Statistics Service of Ukraine [12]. To calculate the 2020 average gross regional product (Per capita gross regional product) in groups, information from the website of the Ministry of Finance of Ukraine [14] was used.

The density of GPs in the world and share of the urban population was obtained from the website of the Organization for Economic Co-operation and Development (OECD) (<https://stats.oecd.org>) for the year 2020 [16].

The Kruskal-Wallis test was used to compare groups by mean value and standard deviation ( $\pm$  SD). A posteriori comparisons were made according to Dunn's test. Pearson coefficient was used for correlation matrix between the level of urbanization and density of GPs per 10,000 people in OECD countries, between the density of GPs per 10,000 people and average life expectancy in Ukraine.

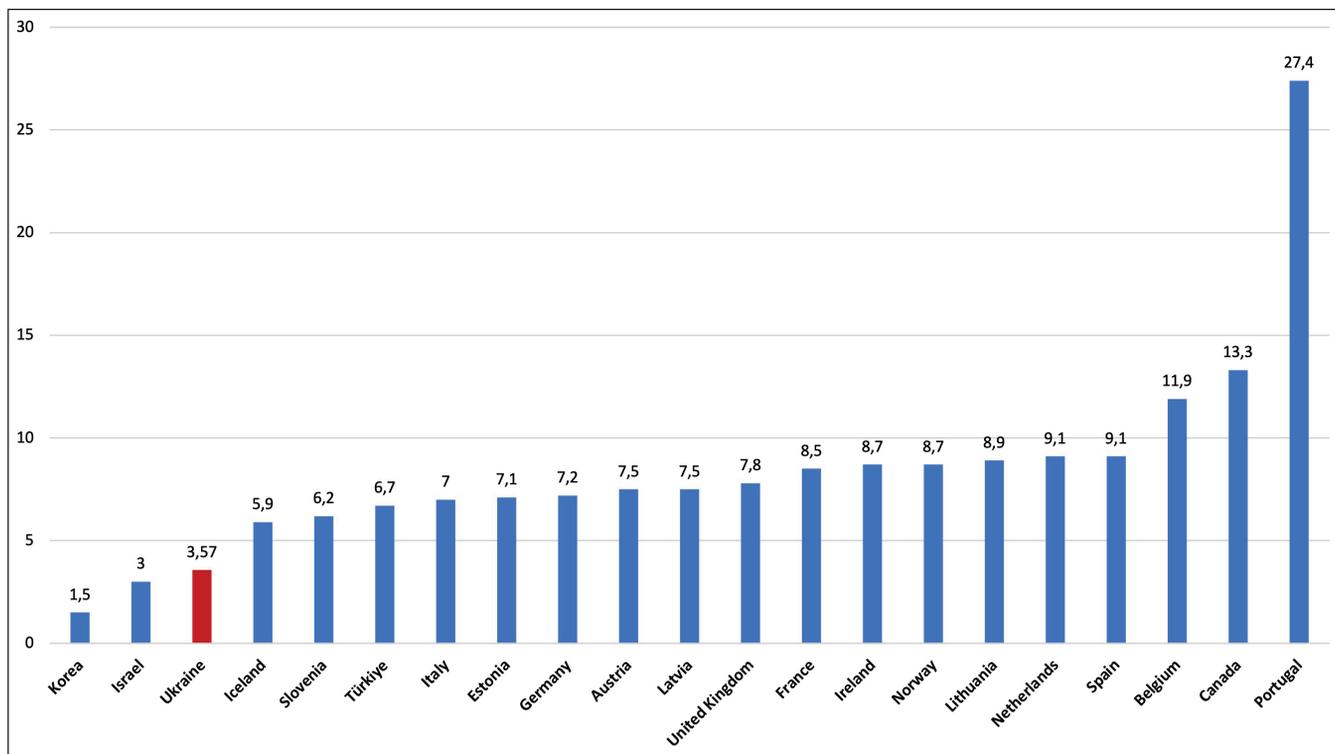
Statistical data treatment was by the statistical analysis package MedCalc v.19.4.1 (MedCalc Software Inc, Broekstraat, Belgium, 1993–2020).

## RESULTS

In 2020, the share of urban population in Ukraine was 69.6% of the total population, varying between regions from 36.8% to 100%. In the group of OECD countries, the 2020 value was 81.0% (from 55.1% to 98.1%), and ranged from 55.1 to 98.1% (Figure 1).

In Ukraine, the level of urbanization corresponds to that in Lithuania, Latvia, Estonia, Italy, exceeding that in Slovenia, Austria, Ireland and Portugal.

In 2020, the density of GPs in Ukraine was 3.57 per 10,000 people (Figure 2). This is one of the lowest values, compared to OECD countries.



**Fig. 2.** The density of general practitioners per 10,000 people, in the countries of the world, 2020

**Table I.** Density of GPs per 10,000 people, average life expectancy, mortality rate due to diseases of the circulatory system per 1,000 people, gross regional product per 1 person in regions from different urbanization groups

Value	Gr.1 (n=5)	Gr.2 (n=14)	Gr.3 (n=6)	p
Average life expectancy	72,1±1,2	71±0,9	71,4±1,5	0,217
Gross regional product per 1 person (\$)	2021±264	3158±734*	4289±3991*	0,017
Mortality rate from circulatory system diseases per 1000 people	14,1±0,8	16,8±1,6*	16±2,5	0,023
GPs density per 10,000 people	4,71±0,52	3,90±0,84	2,73±14,5*	0,024

\* - significant difference  $p < 0.05$

The correlation matrix between the density of GPs per 10,000 people, and the level of urbanization of countries indicates absence of a reliable correlation ( $r = -0.11$ ,  $p > 0.05$ ). However, in Ukraine, correlation matrix between the density of GPs per 10,000 people, and the level of the region urbanization indicates a reliable negative relation ( $r = -0.67$ ,  $p < 0.05$ ). The higher the level of urbanization of the region, the lower density of GPs per 10,000 people is.

To study the effect of the urbanization level on density of GPs, average life expectancy, mortality from diseases of the circulatory system, gross regional product per 1 person (\$), we divided regions of Ukraine into three groups by urbanization level.

The first group, with a low level of urbanization (up to 50% of the urban population), includes Zakarpattia (36.8%), Chernivtsi (42.9%), Ivano-Frankivsk (44.0%), Ternopil (45.3%), and Rivne (47.1%) regions. The second group, with an average level of urbanization (50%-70% of the urban population), includes Vinnytsia (51.4%),

Volynska (51.8%), Cherkasy (56.6%), Khmelnytsky (57.1%), Zhytomyr (59.1%), Lviv (60.6%), Kherson (61.2%), Kyiv (61.6%), Poltava (62.0%), Kirovohrad (63.2%), Chernihiv (65.0%), Odesa (66.7%), Mykolaiv (68.4%), and Sumy (69.1%) regions. The third group, with a high level of urbanization (more than 70% of the urban population), includes Zaporizhzhya (77.2%), Kharkiv (80.9%), Dnipropetrovsk (83.9%), Luhansk (87.0%), Donetsk (90.8%) oblasts, and the city of Kyiv (100.0%).

For each group, we assessed density of GPs per 10,000 people, gross regional product (GRP), average life expectancy, and mortality rate due to diseases of the circulatory system per 1,000 people (Table I).

The analysis of Table I values shows no significant difference in average life expectancy between different levels of urbanization. In group 1, with a low level of urbanization, average life expectancy slightly exceeds that one in groups 2 and 3 ( $p > 0.05$ ).

According to the mortality from diseases of the circulatory system per 1,000 people, groups 1 and 2 differ significantly ( $p < 0.05$ ). The highest mortality rate was in group 2, with an average level of urbanization ( $16.8 \pm 1.6$  per 1,000 people), while in group 1, with a low level of urbanization, it was the lowest ( $14.1 \pm 0.8$  per 1,000 people).

We established that three groups differ significantly in terms of gross regional product per person ( $p < 0.05$ ). The highest gross regional product value is in the group with high level of urbanization ( $4289 \pm 3991$  \$), and the smallest is in the group with low urbanization level ( $2021 \pm 264$  \$) ( $p < 0.05$ ).

The lowest density of GPs per 10,000 people is observed in the group with high level of urbanization,  $2.73 \pm 14.5$  per 10,000 people, and the highest - in the group with low level of urbanization ( $p < 0.05$ ).

The correlation matrix indicates a reliable relation between the density of GPs per 10,000 people and average life expectancy ( $r = 0.826$ ,  $p < 0.05$ ). We established that the greater the density of GPs in the region, the higher the average life expectancy is. There was no reliable correlation with other indicators ( $p > 0.05$ ).

However, there also was no reliable correlation between the density of GPs per 10,000 people, and average life expectancy in OECD countries ( $r = 0.09$ ,  $p > 0.05$ ).

## DISCUSSION

Ukraine has an average level of urbanization in terms of the share of the urban population. In Ukraine, the level of urbanization is higher than in Slovenia, Austria, Ireland and Portugal. In terms of the level of urbanization, Ukraine is close to Lithuania, Latvia, Estonia and Italy.

In Ukraine, the density of GPs is significantly lower than that in OECD countries, except for the Republic of Korea and Israel. In Ukraine, the density of GPs has a reliable negative relation with the level of urbanization. The higher the level of urbanization, the lower the density of GPs in Ukraine is. In OECD countries, such dependence is not observed. In addition, it was found that in regions with high level of urbanization in Ukraine, the density of GPs is significantly lower than in regions with a low level of urbanization.

The obtained data contradict the OECD data, regarding the inverse dependence of the density of GPs and level of urbanization [16]. On the contrary, in the OECD countries, the greatest concentration of GPs is in the cities, where there is a demand for medical services, and where the GP necessarily performs functions of the doctor of «first meeting», or «primary link» in healthcare system [17-23]. According to the decision of the Alma-Ata Declaration of the World Health Or-

ganization, GPs have the status of a leading medical specialty, «representatives of which are responsible for providing medical assistance during the first contact with the patient and follow-up of patients, as well as for issues of health promotion and disease prevention» [15]. In OECD countries, the availability of medical services at GPs in rural areas is a significant problem [22, 23]. According to OECD data, in many countries there is a particularly high concentration of doctors in national capital regions, in particular, in Austria, the Czech Republic, Greece, Hungary, Portugal, Slovakia, and Germany [23, 24].

Probably, in Ukraine, lower density of GPs in regions with high level of urbanization is due to two reasons. The first reason is that not only GPs, but also specialist doctors in Ukraine perform functions of the «first meeting» doctor in health care. A patient can choose both a GP and a specialist doctor for the «first meeting». Ukraine has the smallest share of primary care doctors (13.45%) compared to OECD countries (Portugal (53.26%), Canada (47.8%), the Netherlands (46.41%), France (43.86%), Belgium (36.93%), Turkey (32.76%), and Austria (27.86%)) [16]. The second reason is an extensive network of healthcare facilities providing specialized care, with a high density of specialist doctors in urbanized regions.

Availability of specialist doctors in regions with high urbanization in Ukraine is determined by the patients' economic capacity. According to our data, gross regional product per person is significantly higher in highly urbanized regions, than in regions with low urbanization. Regions with high urbanization due to high gross regional product have fewer financial constraints in the health care system.

A comparison of regions with different levels of urbanization in Ukraine revealed absence of a reliable relation between the level of urbanization, and average life expectancy. All groups did not differ in average life expectancy. In addition, there was no correlation between the level of urbanization and average life expectancy among OECD countries ( $p > 0.05$ ). This is because average life expectancy at birth depends on economic development and environmental conditions, lifestyle, and progress in health care [17-19]. According to Nakajima H, Yano K., the main components of mathematical prediction of average life expectancy are availability of significant medical resources, prevention of heart diseases mortality, and prevention of risk factors exposure (alcohol consumption, smoking, obesity, etc.) [18]. According to Johan P Mackenbach et al., the risk factors characteristics of average life expectancy, are smoking (19.8% among men, and 18.9% among women), low income (9.7% and 13.4%), and high body

weight (7.7% and 11.7%) (19). Ukraine has the lowest average life expectancy compared to OECD countries (71.3 years).

At the same time, a direct relation between the density of GPs and average life expectancy was found in Ukraine. The greater the density of GPs in Ukraine, the greater the average life expectancy of urbanized region is. Such dependence is not typical for OECD countries. It is likely, that dependence of the average life expectancy on the density of GPs in Ukraine is because life expectancy in Ukraine is significantly lower than in OECD countries, and its growth largely depends on the resources of the healthcare system, including personnel and financial ones.

In Ukraine, urbanization affects mortality from circulatory diseases per 1000 people. In regions with low urbanization, this mortality rate is significantly lower ( $p < 0.05$ ). Urbanization leads to an increase in cardio-

vascular diseases due to obesity and type 2 diabetes [3-5, 25]. According to the literature, obesity and diabetes are the main causes of mortality from circulatory diseases [20, 21]. It is likely, that in regions with low urbanization in Ukraine, lower mortality from diseases of the circulatory system is due to lower incidence of these diseases and lesser risk factors effect. This is a probable assumption, which involves a study of urbanization effect on the diseases of the circulatory system incidence in Ukraine.

## CONCLUSIONS

When planning healthcare staffing, it is necessary to mind the level of urbanization of the region, and ensure the status of the GP as a leading medical healthcare specialist, responsible for medical care during the first meeting with the patient, and his follow-up.

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*This article was performed in the framework of the scientific research work «Methodology of formation of the mechanism of state regulation of the use of health care technologies in medical institutions» (2020–2022, № state registration № 0120U101466).*

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#### **Conflict of interest:**

*The Authors declare no conflict of interest.*

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**Received:** 08.09.2022

**Accepted:** 17.03.2023

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**A** – Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis, **D** – Writing the article, **E** – Critical review, **F** – Final approval of the article

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