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Rural–urban disparities in the prevalence of diabetes and diabetic eye complications in Hungary

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Summary
Background To examine the rural–urban differences in the prevalence of diabetes mellitus (DM) and diabetic retinopathy (DR) in the population aged 50 years and older in Hungary.
Methods 105 clusters of 35 people aged 50 years or older were randomly selected. Standardized rapid assessment of avoidable blindness (RAAB) with the diabetic retinopathy module was performed. Participants were classified as diabetic if they had a previous diagnosis of DM or a random blood glucose level ≥200 mg/dl. Each individual with DM who agreed underwent dilated fundus examination and DR grading.
Results The prevalence of DM was higher in rural (21.8%) than in urban (18.6%) areas ($p = 0.016$). The prevalence of DR did not differ significantly between rural and urban areas in DM cases. Blindness (0.9% vs. 0.1%; $p = 0.048$) and blindness due to DM (0.3% vs. 0.0%; $p = 0.021$) in diabetic participants was significantly more common in rural than in urban areas. Diabetic eye screening coverage was significantly lower in rural than in urban areas ($p \leq 0{,}007$).
Conclusion Based on our results and the high rate of blindness and blindness due to DR in rural areas, primary eye care should be improved and a telemedical eye screening program should be undertaken, especially concentrating on rural areas.

Keywords Diabetes mellitus · Diabetic retinopathy · Epidemiology · Blindness · Prevention

Unterschiede der Prävalenz bei Diabetes und diabetischen Augenkomplikationen zwischen Stadt und Land in Ungarn

Zusammenfassung
Hintergrund Untersuchung der Unterschiede zwischen Stadt und Land in der Prävalenz bei Diabetes mellitus (DM) und diabetischer Retinopathie (DR) in der Bevölkerung ab 50 Jahren in Ungarn.
Methoden Nach dem Zufallsprinzip wurden 105 Cluster von 35 Personen ab 50 Jahren ausgewählt. Ein standardisiertes Rapid Assessment of Avoidable Blindness (RAAB) mit dem DR-Modul wurde eingesetzt. Die Teilnehmer wurden als Diabetiker (DM) eingestuft, wenn sie zuvor eine DM-Diagnose oder einen zufälligen Blutzuckerspiegel von ≥200 mg/dl hatten. Im Fall einer Einverständniserklärung wurden Personen mit DM einer Funduskopie und einer DR-Einstufung unterzogen.
Ergebnisse Die Prävalenz von DM war in ländlichen Gebieten (21,8 %) höher als in städtischen Gebieten (18,6 %; $p = 0{,}016$). Die Prävalenz von DR unterschied sich bei DM-Patienten nicht signifikant zwischen städtischen und ländlichen Gebieten. In ländlichen Regionen waren bei DM-Patienten Blindheit (0,9 % vs. 0,1 %; $p = 0{,}048$) und Blindheit infolge DM (0,3 % vs. 0,0 %; $p = 0{,}021$) signifikant häufiger als in städtischen Gebieten. Die Reichweite diabetischer Augenunter-

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suchungen war in ländlichen Gebieten signifikant niedriger als in städtischen Gebieten ($p \leq 0{,}007$).
Schlussfolgerung Aufgrund der weiten Verbreitung von Blindheit sowie Blindheit durch DR in ländlichen Gebieten sollte die primäre augenärztliche Versorgung verbessert und ein telemedizinisches Augenscreeningprogramm durchgeführt werden, das sich insbesondere auf ländliche Gebiete konzentriert.

Schlüsselwörter Diabetes mellitus · Diabetischer Retinopathie · Epidemiologie · Blindheit · Prävention

Introduction

Diabetes mellitus (DM) is one of the most common chronic diseases and a major global health problem, affecting 8.3% of adults worldwide [1]. It was estimated that about 59.8 million persons were living with DM in Europe in 2015, an average prevalence of 9.1%, and that that number will increase to 71.1 million by 2040 [2]. Diabetic retinopathy (DR) is an important long-term complication of DM and a leading cause of visual impairment and blindness in industrialized countries among middle-aged people [3]. Nearly one third of people with DM have some degree of DR [4] and DR is responsible for 1.0–4.8% of blindness globally [5, 6]. The proportion of diabetic ophthalmic complications can be reduced with timely diagnosis and effective treatment of DM [3, 4]. Early detection and treatment of DR could also reduce the health care costs of DM, which require almost 10% of the global health care budget [7].

Findings from the Hungarian rapid assessment of avoidable blindness (RAAB) survey with the diabetic retinopathy module (DRM) were recently published, with a focus on the prevalence of DM and DR among people aged 50 years and older [8–10]. RAAB with DRM is a quick and efficient population-based survey method to estimate the prevalence of DM and DR among persons aged 50 years and older in a defined geographic area [11]. Reliability and validity of the RAAB + DRM method were demonstrated recently [12–15].

Rural–urban differences or gradients in the prevalence of DM and DR can enhance the rate of eye complications leading to visual impairment and blindness, especially if availability of primary care and eye care is insufficient in the affected area. With screening programs, regular control of DM, and timely treatment of DR, visual impairment and blindness due to DM can be largely prevented, and their incidence can be decreased [16].

Only few data are available on rural–urban differences in the prevalence of DM and DR, as is the case for disparities in DR screening coverage in Europe, especially in East-Central Europe [14, 17, 18]. Recognition of such disparities can focus attention on the possible insufficiencies and disparities in primary care and primary eye care. Reliable epidemiological data are essential to support planning and implementation of public health programs and development of primary care [19].

We aimed to determine with our RAAB + DRM study the rural–urban disparities in DM and DR prevalence, as well as in coverage of eye care services in people aged 50 years and older in Hungary.

Patients, materials, and methods

The RAAB + DRM survey was undertaken in Hungary from April through July 2015 [8, 9]. The sample size was calculated using an estimated prevalence of blindness of 2.5% (as in Moldova [14]) among people aged 50 years and older, with a variation of 25%, a non-compliance of 10%, and a 95% confidence limit. This gave a sample size of 3675 individuals over the age of 50. The sample size meant that 105 clusters of 35 people were selected for the study. The Hungarian Central Statistical Office (HCSO) in Budapest has used the RAAB algorithm to randomly select 105 census enumeration areas in the entire country, with a probability proportional to their size.

Prior to the fieldwork, the five survey teams, each consisting of one doctor (senior residents or specialized ophthalmologist), one nurse, and one assistant were trained for 5 days in the use of the eye examination protocol, blood sugar testing, grading of DR according to the Scottish DR grading scheme, and uploading data to the RAAB software. Both for the clinical examination of RAAB as well as for the DR grading, inter-observer variation assessment tests were conducted until a required agreement was achieved (kappa at least 0.75).

In each cluster, a survey team visited households door-to-door. If an eligible participant was absent after two more attempts, neighbors were asked about the status of the non-responders.

All subjects underwent a random blood sugar test using a Dcont® Trend digital glucometer (77 Elektronika Co, Budapest, Hungary). All participants with a history of DM or a random blood glucose level of ≥200 mg/dL were considered to have DM. All people with DM who agreed were examined after pupil dilatation with a portable indirect ophthalmoscope and underwent DR grading using the Scottish DR grading system [20].

According to the laws of Hungary, participants living in a settlement with 10,000 or more inhabitants were designated as urban and people living in a settlement with less than 10,000 inhabitants were considered as rural. Population data of the HCSO from 2015 were used to differentiate between urban and rural areas.

The Regional and Institutional Committee of Science and Research Ethics of Semmelweis University (Budapest, Hungary) granted approval for this study. The research followed the tenets of the Declaration of Helsinki. Written informed consent was obtained

Table 1 Demographic characteristics of the full survey rural and urban population in Hungary

	Rural *n* (%)	Urban *n* (%)
Clusters	46 (43.8)	59 (56.2)
Participants enumerated	1610 (43.8)	2065 (56.2)
Participants examined	1573 (44.6)	1950 (55.4)
Sex		
Male	569 (36.2)	704 (36.1)
Female	1004 (63.8)	1246 (63.9)
Age groups (years)		
50–59	424 (27.0)	482 (24.7)
60–69	569 (36.2)	646 (33.1)
70–79	385 (24.5)	575 (29.5)
80+	195 (12.4)	247 (12.6)
	Rural (SD)	*Urban (SD)*
Mean age (years)	66.5 (9.9)	67.4 (10.0)

DM diabetes mellitus, *SD* standard deviation

from all participants. Those whom it was thought would benefit from further management, including DM and/or DR, were referred to a general practitioner (GP) or ophthalmologist for further care.

Statistical analyses were carried out using RAAB v.6 (Health Information Services, Grootebroek, The Netherlands) and Statistica 11.0 (StatSoft Inc., Tulsa, OK, USA) software.

RAAB v.6 software allows sample size calculation, data entry, and standardized data analysis. Prevalence data were examined with the chi-square test and age data were analyzed with Welch two-sample *t*-test. *P* values <0.05 were considered statistically significant.

Results

In total, 3675 persons aged 50 years or older were included in survey, of whom 3523 (95.9%) were examined, 1573 (44.6%) in rural and 1950 (55.4%) in urban areas (Table 1). There was no significant difference between rural and urban groups in the sample regarding sex and age distribution.

Of the 1573 examined rural participants, 343 had DM (21.8%). Of the 1950 examined urban participants, 362 had DM (18.6%). The difference was significant between these two groups ($p = 0.016$; Table 2).

The proportion of known and newly diagnosed DM was not different in rural and urban areas. Among people with known DM, 78.1% of rural and 81.9% of urban participants had a blood glucose level lower than 200 mg/dl (Table 3). Among known diabetic participants, the mean duration of DM was 9.9 years (standard deviation [SD], 9.0 years) among rural and 11.4 years (SD 10.7 years) among urban participants (the difference was not significant between the two groups).

Of the participants with known DM in rural areas, 129 (40.3%) had had an ophthalmic examination for DR once during the past 12 months, 24 (7.5%) 13–24 months ago, 62 (19.4%) more than 24 months ago, and 105 (32.8%) had never had an eye examination. Of the subjects with known DM in urban areas, 173 (50.7%) had had a fundus examination for DR once during the past 12 months, 42 (12.3%) 13–24 months ago, 50 (14.7%) more than 24 months ago, and 76 (22.3%) had never had an eye examination. People who were living in urban areas were significantly more likely ($p = 0.007$) to have had a fundus examination in the past 12 months for DR compared to those living in rural areas, and significantly more participants ($p = 0.002$) had never had a fundus examination for DR in rural than in urban areas.

Table 2 Rural and urban prevalences of diabetes by age group and gender in the full survey population in Hungary

Age	Rural						Urban					
	Males		Females		Full rural sample		Males		Females		Full urban sample	
	N	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)
50–59	24	15.0 (10.3–21.4)	36	13.6 (10.0–18.3)	60	14.2 (11.2–17.8)	29	14.3 (10.1–19.8)	29	10.4 (7.3–14.5)	58	12.0 (9.4–15.2)
60–69	53	25.0 (19.7–31.2%)	78	21.9 (17.9–26.4)	131	23.0 (19.8–26.7)	50	21.3 (16.5–27.0)	67	16.3 (13.0–20.2)	117	18.1 (15.3–21.3)
70–79	40	28.2 (21.4–36.1)	63	25.9 (20.8–31.8)	103	26.8 (22.6–31.4)	40	20.7 (15.6–27.0)	91	23.8 (19.8–28.3)	131	22.8 (19.5–26.4)
80+	11	20.0 (11.6–32.4)	38	27.1 (20.5–35.0)	49	25.1 (19.6–31.7)	15	20.6 (12.9–31.2)	41	23.6 (17.9–30.4)	56	22.7 (17.9–28.3)
All ages	128	22.5 (19.3–26.1)	215	21.4 (19.0–24.1)	343	21.8 (19.8–23.9)	135	19.2 (16.4–22.3)	227	18.2 (16.2–20.5)	362	18.6 (16.9–20.4)

Table 3 People with known and newly diagnosed diabetes mellitus (DM) and random blood sugar level in rural and urban areas in people with known DM

	Rural *n* (%)	Urban *n* (%)
People with known DM	320 (93.3)	341 (94.2)
Blood sugar ≥200 mg/dL	70 (21.9)	62 (18.2)
Blood sugar <200 mg/dL	250 (78.1)	279 (81.9)
People with new DM	23 (6.7)	21 (5.8)

DM diabetes mellitus

Table 4 Rural and urban prevalences of diabetic retinopathy by age group and gender in participants with diabetes mellitus

Age	Rural						Urban					
	Males		Females		Full rural sample		Males		Females		Full urban sample	
	N	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)	*N*	% (95% CI)
50–59	3	17.7 (6.2–41.0)	6	20.7 (9.9–38.4)	9	19.6 (10.7–33.2)	9	39.1 (22.2–59.2)	3	12.5 (4.3–31.0)	12	25.5 (15.3–39.5)
60–69	12	30.0 (18.1–45.4)	9	16.1 (8.7–27.8)	21	21.9 (14.8–31.1)	9	22.5 (12.3–37.5)	14	25.0 (15.5–37.7)	23	24.0 (16.5–33.4)
70–79	7	20.0 (10.0–35.9)	9	18.8 (10.2–31.9)	16	19.3 (12.2–29.1)	14	36.8 (23.4–52.7)	23	29.1 (20.3–39.9)	37	31.6 (23.9–40.5)
80+	4	80.0 (37.6–96.4)	8	29.6 (15.9–48.5)	12	37.5 (22.9–54.8)	5	35.7 (16.3–61.2)	11	36.7 (21.9–54.5)	12	27.3 (16.3–41.9)
All ages	26	26.8 (19.0–36.4)	32	20.0 (14.5–26.9)	58	22.6 (17.9–28.1)	37	32.2 (24.3–41.2)	51	27.0 (21.2–33.7)	88	29.0 (24.1–43.3)

Significantly more participants with DM had refused fundus examination in rural (86, 25.1%) than in urban areas (58, 16.0%; $p = 0.002$). Altogether 257 (74.9%) rural and 304 (84.0%) urban participants had undergone fundus examination. There was no significant difference between the areas for prevalence of DR and/or diabetic maculopathy (DMP; 22.6% vs. 29.0%; Table 4). Sixteen rural- and 14 urban persons had sight-threatening DR (STDR; R4 [proliferative retinopathy] and/or M2 [referable maculopathy]), their prevalence (6.2% vs. 4.6%) did not differ significantly among people with DM.

Significantly more people ($p = 0.048$) with DM were blind (pinhole-corrected visual acuity [PCVA], <3/60) in rural (6, 0.9%) than in urban (1, 0.1%) areas. Blindness due to DM in people with DM was also significantly more common ($p = 0.021$) in rural (2, 0.3%) than in urban areas (0, 0%).

Discussion

As far as we know, our RAAB + DRM survey is the first population-based survey on rural–urban disparities in prevalence of DM and DR in Hungary and in the European Union. The aim of this sub-study was to estimate the rural–urban disparities in DM and DR prevalences as well as DR screening coverage among people aged 50 years and older in Hungary. Our study showed that the prevalence of DM was higher and DR screening coverage was lower in rural than in urban areas in Hungary among people aged 50 years and older.

DM prevalence was 9.1% in Europe in 2015 [2]. The prevalence of DM was estimated to be 6.2% in 2002 [21], 8.6% in 2010 [22], and 11.7% in 2012 [23] in the adult population of Hungary. DM prevalence is predicted to rise worldwide due to the increasing rate of obesity and aging of the population [24, 25]. It increased by 89% between 2002 and 2012 in Hungary [23]. However, the prevalence of DM in people older than 50 is even more important, because the prevalence of blindness and severe visual impairment due to DM is the highest in this population [12]. Recently, we reported a 20.0% prevalence of DM in people aged 50 years and older in Hungary [8]. The rural–urban difference in prevalence of DM is important for assessing the needs and deficiencies of the healthcare system in different types and sizes of settlements.

It is known that the prevalence of DM is higher in areas of low socioeconomic status [26]. The prevalence of DM in rural areas of developing countries is estimated to be higher than in urban areas [27]. On the other hand, an earlier Nigerian study reported an almost ten-times higher urban (7%) than rural (0.6%) DM prevalence value [28]. Other RAAB + DRM surveys from developing countries also reported a higher urban than rural DM prevalence [12, 13]. Rural and urban DM prevalences are considered similar in developed countries, because risk factors do not differ markedly [29]. In 2012 a study from the USA reported higher prevalence of DM in rural than in urban areas (9.7% vs 9.0%) [25]. The results are thus contradictory, which may be explained by different survey methods, social structures, and pattern of settlements, as well as by variant rural–urban definitions. Therefore, comparisons between results are not easy. Data on rural–urban disparities from developed countries, especially from East-Central Europe, are rare.

In Moldova, the geographically closest country, the prevalence of DM was higher in urban (13.5%) than in rural (10.3%) areas in people aged 50 years and older [14]. An earlier Hungarian survey from 2002 reported similar DM prevalence data among adults in rural and in urban areas (6.2% vs. 6.1%) [21]. We found a significantly higher prevalence of DM in rural (21.8%) than in urban (18.6%) areas among people aged 50 years and older in Hungary. The difference may be explained by the special socioeconomic characteristics of Hungary. Since the fall of the communist economic system in 1989, Hungary has experienced meaningful social and economic progress, as well as changes in settlement structure and migration patterns. Due to the collapse of collective farming and the decline of heavy industry, essential changes took place in the Hungarian society. The impoverished, unskilled urban labor migrated to rural areas because of the lower cost of living, while young, skilled workers tended to migrate to urban areas because of the lack of rural job opportunities. New business investments are mostly implemented in urban setting [30]. As a result, people in rural areas usually have lower income and worse living conditions in Hungary [31]. Rural–urban migration or immigration into Western Europe among young people has even increased since 2004, when Hungary became a member of the European Union [32]. These circumstances contribute to a concentration of unskilled, unemployed people, increasing the unemployment rate and aging of the population in rural areas in Hungary [33]. Such living conditions and lower level of subjective well-being are associated with a high-calorie diet, poor nutrition, obesity, and tobacco use, which may also contribute to a higher DM prevalence in rural areas [9].

We recently reported [8] that almost 27.4% of people with DM had never had a fundus examination in Hungary. Only 45.7% of people with known DM had had an eye examination in the past 12 months in Hungary. An important finding in terms of diabetic eye care programs in Hungary could be that 32.8% of rural and 22.3% of urban people with DM had never had a fundus examination. Only 40.3% of rural and 50.7% of urban participants with known DM had had an eye examination in the past year, which is the basic requirement of the Hungarian national guidelines for diabetic patients. Lower rural than urban diabetic screening coverage can be explained by limited availability of eye care services and long waiting lists in rural areas. Possibly, ophthalmological consultations or examinations are more accessible in urban areas and larger cities than in rural settlements. For these reasons, better-organized primary eye care or a national screening program (e.g., telemedicine services) would be necessary—especially in rural areas—to increase screening coverage in the entire country and ensure equal access to eye care services in every part of Hungary.

The global prevalence of DR was estimated to be 34.6% in 2012 [4]. DR is the leading cause of blindness among working-age people in developed countries. Visual impairment or blindness due to DR can occur in different ways, such as macular edema, vitreous hemorrhage, secondary glaucoma, retinal vein occlusion, and retinal detachment [34].

As we reported in a recent study, the prevalence of DR among participants with DM is lower in Hungary (20.1%) [8] compared to the results of RAAB + DRM surveys from other countries (Saudi Arabia: 34.5% [15]; Mexico: 38.9% [12]; Jordan: 48.0% [35]; Moldova: 55.9% [14]). Neither the DR nor STDR prevalence differed significantly between urban and rural areas. Other studies reported different DR prevalence values in different ethnicities, with the highest rate among Afro-Americans and lowest among Asians [4]. Lower socioeconomic status and deprivation are associated with an increased prevalence of DR [36]. As Ruta reported, the DR prevalence is higher in developing countries and among minority groups in developed countries [19]. However, the reported results and risk factors are contradictory, and comparisons between studies are difficult due to different survey methods, screening techniques (indirect ophthalmoscope or digital photography), and population characteristics [4].

Interestingly, blindness were more common among rural participants with DM compared to urban diabetic subjects and blindness caused by DM was even more common in rural areas. This survey result also strengthens the recommendation that diabetic eye screening coverage should be increased, first of all in rural areas to decrease the prevalence of avoidable blindness in rural settlements.

There were a number of limitations to the survey. Almost one fifth of participants with DM did not agree to complete a fundus examination for DR. Otherwise this refusal rate is not high compared with earlier RAAB + DRM surveys, and we did not find any significant difference between dilated and non-dilated participants [8, 37]. Diagnosis of DM was based on one measurement of blood glucose level and only subjects 50 years of age or older were examined.

Our data demonstrated that the prevalence of DM and blindness due to DM were higher in rural than in urban areas. Diabetic screening coverage was lower in rural areas. Our result may draw attention not only to the Hungarian circumstances, but also to the situation in other central Eastern European countries with similar socioeconomic and historical environments. Secondary prevention as well as collaboration between general practitioners and ophthalmologists should be strengthened in primary care to increase diabetic eye screening coverage, especially in rural areas, in Hungary. Improving the availability of eye care as well as timely detection and treatment of DR is essential to prevent and treat eye complications due to DM.

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References

1. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Res Clin Pract. 2014;103:137–49.
2. International Diabetes Federation. IDF Diabetes Atlas. 7th ed. Brussels, Belgium: IDF Excutive Office. 2015. http://www.diabetesatlas.org. Accessed 10 July 2018.
3. Bunce C, Wormald R. Leading causes of certification for blindness and partial sight in England & Wales. BMC Public Health. 2006;6:58.
4. Yau JW, Rogers SL, Kawasaki R, et al. Global prevalence and major risk factors of diabetic retinopathy. Diabetes Care. 2012;35:556–64.
5. Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bull World Health Organ. 2008;86:63–70.
6. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol. 2012;96:614–8.
7. Zhang P, Zhang X, Brown J, et al. Global healthcare expenditure on diabetes for 2010 and 2030. Diabetes Res Clin Pract. 2010;87:293–301.
8. Tóth G, Szabó D, Sándor GL, et al. Diabetes and diabetic retinopathy in people aged 50 years and older in Hungary. Br J Ophthalmol. 2017;101:965–9.
9. Tóth G, Szabó D, Sándor GL, et al. Regional disparities in the prevalence of diabetes and diabetic retinopathy in Hungary in people aged 50 years and older. Orv Hetil. 2017;158:362–7.
10. Szabó D, Sándor GL, Tóth G, et al. Visual impairment and blindness in Hungary. Acta Ophthalmol. 2018;96:168–73.
11. Kuper H, Polack S, Limburg H. Rapid assessment of avoidable blindness. Community Eye Health. 2006;19:68–9.
12. Polack S, Yorston D, Lopez-Ramos A, et al. Rapid assessment of avoidable blindness and diabetic retinopathy in Chiapas, Mexico. Ophthalmology. 2012;119:1033–40.
13. Minderhoud J, Pawiroredjo JC, Bueno de Mesquita-Voigt AT, et al. Diabetes and diabetic retinopathy in people aged 50 years and older in the Republic of Suriname. Br J Ophthalmol. 2016;100:814–8.
14. Zatic T, Bendelic E, Paduca A, et al. Rapid assessment of avoidable blindness and diabetic retinopathy in Republic of Moldova. Br J Ophthalmol. 2015;99:832–6.
15. Al Ghamdi AH, Rabiu M, Hajar S, Yorston D, Kuper H, Polack S. Rapid assessment of avoidable blindness and diabetic retinopathy in Taif, Saudi Arabia. Br J Ophthalmol. 2012;96:1168–72.
16. Szabó D, Fiedler O, Somogyi A, et al. Telemedical diabetic retinopathy screening in Hungary: a pilot programme. J Telemed Telecare. 2015;21:167–73.
17. Tentolouris N, Andrianakos A, Karanikolas G, et al. Type 2 diabetes mellitus is associated with obesity, smoking and low socioeconomic status in large and representative samples of rural, urban, and suburban adult Greek populations. Hormones. 2012;11:458–67.
18. Lopatynski J, Mardarowicz G, Nicer T, et al. The prevalence of type II diabetes mellitus in rural urban population over 35 years of age in Lublin region (Eastern Poland). Pol Arch Med Wewn. 2001;106:781–6.
19. Ruta LM, Magliano DJ, Lemesurier R, Taylor HR, Zimmet PZ, Shaw JE. Prevalence of diabetic retinopathy in Type 2 diabetes in developing and developed countries. Diabet Med. 2013;30:387–98.
20. Wilkinson CP, Ferris FL, Klein RE, et al. Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. Ophthalmology. 2003;110:1677–82.
21. Vamos EP, Kopp MS, Keszei A, Novak M, Mucsi I. Prevalence of diabetes in a large, nationally representative population sample in Hungary. Diabetes Res Clin Pract. 2008;81:e5–e8.
22. Jermendy G, Nadas J, Szigethy E, et al. Prevalence rate of diabetes mellitus and impaired fasting glycemia in Hungary: cross-sectional study on nationally representative sample of people aged 20–69 years. Croat Med J. 2010;51:151–6.
23. Domjan BA, Ferencz V, Tanczer T, et al. Large increase in the prevalence of self-reported diabetes based on a nationally representative survey in Hungary. Prim Care Diabetes. 2017;11:107–11.
24. Boyle JP, Thompson TJ, Gregg EW, Barker LE, Williamson DF. Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. Popul Health Metr. 2010;8:29.
25. O'Connor A, Wellenius G. Rural-urban disparities in the prevalence of diabetes and coronary heart disease. Public Health. 2012;126:813–20.
26. Connolly V, Unwin N, Sherriff P, Bilous R, Kelly W. Diabetes prevalence and socioeconomic status: a population based study showing increased prevalence of type 2 diabetes mellitus in deprived areas. J Epidemiol Community Health. 2000;54:173–7.
27. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27:1047–53.
28. Kyari F, Tafida A, Sivasubramaniam S, Murthy GV, Peto T, Gilbert CE. Prevalence and risk factors for diabetes and diabetic retinopathy: results from the Nigeria national blindness and visual impairment survey. BMC Public Health. 2014;14:1299.
29. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. Diabetes Care. 1998;21:1414–31.
30. Brown DL, Kulcsár LJ, Kulcsár L, Obádovics C. Post-socialist restructuring and population redistribution in Hungary. Rural Sociol. 2005;70:336–59.
31. Kovács T. Magyarország területi szerkezete és folyamatai az ezredfordulón. In: Horváth G, Reschnitzer G, editors. Magyarország területi szerkezete és folyamatai az ezredfor-

dulón. Pécs: MTA Regionális Kutatások Központja; 2000. pp. 431–42.
32. Hungarian Central Statistical Office. Nemzetközi vándorlás az Európai Unió országaiban. Stat Tükör. 2010;4:1–5.
33. Ladányi J, Szelényi I. A kirekesztettség változó formái. Budapest: Napvilág Kiadó; 2004.
34. Zhang X, Saaddine JB, Chou CF, et al. Prevalence of diabetic retinopathy in the United States, 2005–2008. JAMA. 2010;304:649–56.
35. Rabiu MM, Al Bdour MD, Ameerh AMA, Jadoon MZ. Prevalence of blindness and diabetic retinopathy in northern Jordan. Eur J Ophthalmol. 2015;25:320–7.
36. Evans JM, Newton RW, Ruta DA, MacDonald TM, Morris AD. Socio-economic status, obesity and prevalence of Type 1 and Type 2 diabetes mellitus. Diabet Med. 2000;17:478–80.
37. Németh J, Szabó D, Tóth G, et al. Feasibility of the rapid assessment of avoidable blindness with diabetic retinopathy module (RAAB+DR) in industrialised countries: Challenges and lessons learned in Hungary. Ophthalmic Epidemiol. 2018;25:273–9.