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Diabetes prevalence, awareness and treatment and their correlates in older persons in urban and rural population in the Astana region, Kazakhstan

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ABSTRACT

Aims: The evidence on the prevalence and distribution of diabetes and its determinants in Central Asia is sparse. The aim of the present study was to investigate the prevalence, awareness, treatment, and control of diabetes and factors associated with these characteristics in the population of Astana (capital) city and adjacent rural area in Kazakhstan.

Methods: Participants aged 50-75 years old, residing in Astana city (the capital) and Akmol village were invited to participate in a cross-sectional study. The subjects were randomly selected from polyclinic registers. A total of 953 adults were interviewed (response rate 59%), and their fasting plasma glucose, blood pressure, height and weight were measured. Diabetes was defined as fasting plasma glucose (FPG) $\geq$7.0 mmol/l (126 mg/dl) and/or being on diabetes medication.

Results: The overall prevalence of diabetes was 12.5%, and it was almost twice higher in the urban residents (16.3%) than in the rural population (8.6%). Diabetes prevalence was associated with age, men sex, hypertension, obesity, and Russian ethnicity. Among subjects with diabetes, 72.3% were aware of their condition; 65.6% were on treatment and 27.7% had controlled fasting plasma glucose. The awareness, treatment and control of diabetes were substantially higher in the urban population and among women.

Conclusions: The large differences in all diabetes indices between urban and rural regions, if confirmed in larger studies, may suggest an impact of westernised and urbanised lifestyle as well as access to health care.

1. Introduction

Diabetes is a serious chronic metabolic disorder and an important modifiable risk factor for cardiovascular diseases. [1] According to WHO, the prevalence of diabetes has been increasing rapidly over the last decades and at present time the estimated global prevalence of diabetes is around 9%. [2] The International Diabetes Federation projections predict that the prevalence of diabetes will increase to 8.8% by 2035 worldwide [3]. The burden of ill health due to diabetes has also been increasing, primarily in developing world; in 2014,

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diabetes caused 1.5 million deaths worldwide and more than 80% of these deaths occurred in low- and middle-income countries [4].

Most of the research on diabetes and related cardio-metabolic risk factors has been conducted in western countries. There is very little evidence on the situation in Central Asia and Kazakhstan. [5–8] Based on routine statistics, the age-standardized prevalence of diabetes (raised fasting blood glucose $>$ = 7.0 mmol/l or on medication for raised blood glucose) in Kazakhstan was estimated as 13.2% [9], which is higher compared to Europe (8.3%) but also higher than in the Russian Federation (9.0%). Similarly, age-standardized mortality from diabetes in Kazakhstan is about double of that in Russia (10.1 vs. 4.5 per 100,000) [9].

A number of risk factors have been found to be associated with the increased risk of diabetes, such as eating behaviours, physical activity and obesity [10], as well as a wide range of socioeconomic factors. [11,12] Many risk factors for non-communicable diseases, including diabetes, are linked with urbanization [13,14], but there is little evidence on the levels of diabetes and related factors in urban and rural populations in Central Asia. The rapid societal transformation after the dissolution of USSR was accompanied by fast introduction of western diet and lifestyle, particularly in urban settings, and growing social and economic differences between urban and rural areas. Providing the evidence on the rates of diabetes and associated factors in these rapidly changing societies is important, since modifying these risk factors may provide many opportunities to prevent diabetes and appropriate management of diabetes reduces diabetes-attributable complications and mortality [15,16].

The aim of the study was to address this evidence gap and to investigate prevalence, awareness, treatment, and control of diabetes and to identify the factors associated with these characteristics in the general population samples of urban and rural areas in the Astana region, Kazakhstan.

2. Materials and Methods

2.1. Study population

We conducted a cross-sectional study in Astana city (the new state capital, population 858,302, population density 1188 persons/km^2) and the Akmol village (about 50 km from Astana, population 6,000, population density in the region 7.7 persons/km^2) between November 2012 and March 2015.

The study sample was randomly selected (after stratifying for age and 5-year age group) from lists of all inhabitants in the age range 50-74 years (reflecting the overall focus on healthy ageing) who were registered at a local polyclinic (such registration is mandatory in Kazakhstan). Participants were invited by calling their landline telephone; if there was no landline telephone number, then participants were visited at home and invited to participate in the study. A total of 953 of adults aged 50-75 years were recruited (478 in Astana city and 475 in Akmol). The response rate was 59% (56% urban and 63% in rural area). The study protocol was approved by the ethical committee of the Center for Life Sciences, Nazarbayev University, and each participant provided a signed informed consent.

Data were collected during a visit to a polyclinic by standardized questionnaire administered by trained practitioners and a brief physical examination. The questionnaire included an overall assessment of the patient's health, medical history, lifestyle and socio-economic indicators. All questions were translated from English into both Russian and Kazakh languages and back into English to check for accuracy. Blood pressure and anthropometric measures were taken (including height, weight, waist and hip circumference). A venous blood sample was collected.

2.2. Measurements

Diabetes was defined as fasting plasma glucose (FPG) concentration $\geq$7.0 mmol/l (126 mg/dl) or self-reported diabetes medication use; the questionnaire did not specify the type of diabetes (1 or 2). For assessment of FPG, subjects were invited to visit the polyclinic early in the morning after an overnight fast. The fasting status of the subjects was recorded, and those who did not meet the above requirements were invited to visit the polyclinic on another day. Diabetes awareness was assessed by the question whether the subjects had been told by a doctor that they had diabetes. Subjects taking regular hypoglycemic medication or insulin were considered to be on treatment for diabetes. Control of diabetes among those with diabetes was defined as fasting plasma glucose $<$7.0 mmol/l (126 mg/dl).

In both Astana city and Akmol village, all blood samples were collected in vacutainers with coagulation activator and serum separation gel. After blood was collected, the tubes were gently shaken up, centrifuged and serum was separated into micro-tubes. Cooled serum samples were delivered to Astana city, and blood glucose concentration was measured using automatic modular analyzer Cobas 6000, Roche Diagnostics (Germany). We did not use fluoride plasma, since the serum measurements have been shown to be satisfactory [17]. The maximum delay time of the biochemical analysis was no more than 4 hours after blood collection. The minimum fasting period was 8 hours.

Body mass index (BMI) and waist to hip ratio (WHR) were used to assess obesity and abdominal obesity, respectively. BMI was categorized based on WHO classification: normal (BMI 18.5–24.9 kg/m2), overweight (BMI 25–29.9 kg/m2), and obese (BMI over 30 kg/m2). Waist and hip circumferences were measured with one layer of clothes using a standard tape measure. The tape was applied halfway between the costal margin and iliac crest to measure waist, and over the greater trochanter to measure hip. The tape was pulled tight and measurements were taken to the nearest 0.1 cm and recorded. WHR was categorized into two groups based on WHO cut-off points: abdominal obesity is defined as a waist–hip ratio above 0.90 for men and above 0.85 for women. [18]

Prior to blood pressure measurement participants were asked to sit quietly for 5 minutes. Blood pressure was measured three times on the right arm in the sitting position, with a two minute interval between measurements. The average of the second and third measurements was used in the analyses. Hypertension was defined as SBP $\geq$140 mmHg and/or DBP $\geq$90 mmHg, and/or the use of antihypertensive medication in the last two weeks.

In addition to age and sex, we used the following socio-demographic characteristics. Urban and rural locations were

defined as Astana city vs. Akmol village, respectively. Marital status was classified as married vs. unmarried (widowed, divorced and single). Education was categorized into primary or less; vocational/secondary and university. The ethnicity was categorized as Kazakh, Russian and other. Car ownership and three categories of household amenities ownership based on the sum of items owned by the household (microwave, DVD player, TV, washing machine, dishwasher, freezer, second house ''dacha'', video camera, cable TV, land phone, mobile phone) were used as markers of material conditions.

2.3. Statistical analysis

In descriptive analyses, unadjusted frequencies of all covariates were stratified by region (urban or rural). The crude distribution of all outcomes (diabetes prevalence, awareness, treatment and control) was shown by region and sex. The association between each outcome and covariate (socio-economic characteristics, BMI, WHR, hypertension and family history of diabetes) were estimated using logistic regression adjusted for age and sex. A final model for each outcome adjusting for all covariates was also estimated. All analyses were performed using STATA software, version 12 (College Station, Texas, USA).

3. Results

Table 1 shows descriptive characteristics of the urban and rural population samples. The overall prevalence of raised fasting plasma glucose was 8.9%, 72% had hypertension and 44% were obese (no individuals were underweight in the

Table 1 – Descriptive characteristics of the study sample by urban and rural area.			
Variable name	Astana city (urban)	Akmol village (rural)	Both
Total number of participants	N = 478	N = 475	N = 953
Sex, (%)			
Men	46.7%	41.7%	44.2%
Women	53.4%	58.3%	55.8%
Fasting plasma glucose, mean (SD)	5.81 (2.27)	5.28 (2.028)	5.54 (2.17)
Fasting plasma glucose >= 7 mmol/l, (%)	9.8%	8.0%	8.9%
Hypertension, (%)	70.6%	73.6%	72.1%
Systolic BP, mean (SD), mmHg	135.0 (22.8)	138.4 (21.1)	136.7 (22.0)
Diastolic BP, mean (SD), mmHg	87.8 (13.7)	91.8 (12.8)	89.8 (13.4)
BMI, mean (SD), kg/m^2	29.8 (4.9)	29.2 (5.3)	29.5 (5.1)
BMI categories, (%)			
18.50 - 24.99 kg/m^2 (normal)	16.0%	22.2%	19.1%
25.00 - 29.99 kg/m^2 (overweight)	38.2%	35.7%	37.0%
Over 30 kg/m^2 (obese)	45.8%	42.1%	44.0%
Waist–hip ratio categories, (%)			
< 0.9 in men and < 0.85 in women	18.0%	38.3%	28.2%
≥ 0.9 in men and ≥ 0.85 in women	82.1%	61.7%	71.9%
Family history of diabetes among all, (%)			
No	79.7%	91.9%	85.8%
Yes	20.3%	8.1%	14.2%
Age, mean (SD)	61.2 (7.3)	60.2 (7.2)	60.7 (7.3)
Age groups, (%)			
50-54	25.6%	28.5%	27.0%
55-59	20.5%	25.4%	22.9%
60-64	22.1%	19.0%	20.6%
65-69	16.2%	13.6%	14.9%
70-75	15.6%	13.4%	14.5%
Marital status, (%)			
Married	73.2%	73.8%	73.5%
Unmarried	26.8%	26.2%	26.5%
Education, (%)			
1 primary	35.5%	39.0%	37.2%
2 secondary	20.9%	45.8%	33.2%
3 higher	43.6%	15.2%	29.6%
Car ownership, (%)			
No	38.5%	50.1%	44.2%
Yes	61.5%	49.9%	55.8%
Ethnicity, (%)			
Kazakhs	57.8%	58.5%	58.1%
Russians	25.9%	26.9%	26.4%
Others	16.3%	14.7%	15.5%
Household possessions, (%)			
1 Low score (1-6)	13.5%	32.2%	22.9%
2 Intermediate score (7-8)	36.5%	50.4%	43.5%
3 High score (9-11)	50.0%	17.4%	33.7%

Table 2 – Prevalence, awareness, treatment and control of diabetes (DM) in Astana city and Akmol village.								
	Men (n = 415)			Women (n = 538)			Both sexes (n = 953)		
	Prevalence	95% CI	Cases/ All	Prevalence	95% CI	Cases/ All	Prevalence	95% CI	Cases/ All
Combined Astana city and Akmol village									
Prevalence of diabetes among all	**12.8%**	9.5-16.0	53/415	**12.3%**	9.5-15.0	66/538	**12.5%**	10.4-14.6	119/953
Awareness among all cases of DM	**66.0%**	52.9-79.2	35/53	**77.3%**	66.9-87.7	51/66	**72.3%**	64.1-80.4	86/119
Treatment among all cases of DM	**58.5%**	44.8-72.2	31/53	**71.2%**	60.0-82.4	47/66	**65.6%**	56.9-74.2	78/119
Treatment among aware	**85.7%**	73.5-97.9	30/35	**88.2%**	79.1-97.4	45/51	**87.2%**	80.0-94.4	75/86
Control among all cases of DM	**22.6%**	11.0-34.3	12/53	**31.8%**	20.3-43.4	21/66	**27.7%**	19.6-35.9	33/119
Control among treated	**38.7%**	20.5-56.9	21/31	**44.7%**	29.9-59.4	21/47	**42.3%**	31.1-53.5	33/78
Astana city (urban)									
Prevalence of diabetes among all	**15.5%**	10.7-20.4	34/219	**17.0%**	12.4-21.6	44/259	**16.3%**	13.0-19.6	78/478
Awareness among all cases of DM	**82.4%**	68.9-95.9	28/34	**86.4%**	75.8-96.9	38/44	**84.6%**	76.4-92.8	66/78
Treatment among all cases of DM	**73.5%**	57.9-89.2	25/34	**90.9%**	82.1-99.8	40/44	**83.3%**	74.9-91.8	65/78
Treatment among aware	**89.3%**	77.1-101.5	25/28	**100.0%**		38/38	**95.5%**	90.3-100.4	63/66
Control among all cases of DM	**29.4%**	13.3-45.5	10/34	**47.7%**	32.4-63.1	21/44	**39.7%**	28.6-50.8	31/78
Control among treated	**40.0%**	19.4-60.6	10/25	**52.5%**	36.3-68.7	21/40	**47.7%**	35.2-60.2	31/65
Akmol village (rural)									
Prevalence of diabetes among all	**9.7%**	5.5-13.9	19/196	**7.9%**	4.7-11.1	22/279	**8.6%**	6.1-11.2	41/475
Awareness among all cases of DM	**36.8%**	13.0-60.7	7/19	**59.1%**	36.8-81.4	13/22	**48.8%**	32.8-64.8	20/41
Treatment among all cases of DM	**31.6%**	8.6-54.6	6/19	**31.8%**	10.7-53.0	7/22	**31.7%**	16.8-46.6	13/41
Treatment among aware	**71.4%**	26.3-116.6	5/7	**53.9%**	22.5-85.2	7/13	**60.0%**	36.5-83.5	12/20
Control among all cases of DM	**10.5%**	0.0-25.7	2/19	**0.0%**		0/22	**4.9%**	0.0-11.8	2/41
Control among treated	**33.3%**	0.0-87.5	2/6	**0.0%**		0/7	**15.4%**	0.0-38.1	2/13

study), and 71.9% fulfilled the criterion for central obesity. Fasting plasma glucose, BMI and waist-hip ratio and family history of diabetes were higher in Astana city than in Akmol. Higher education, car ownership and household amenity ownership were also higher in urban vs. rural areas.

Table 2 presents the prevalence, awareness, treatment and control of diabetes. From the total sample of 953 respondents from Astana city and Akmol village, 119 (12.5%) were classified as having diabetes; the proportion of subjects with diabetes was twice as high in Astana city than in Akmol village. Among subjects with diabetes, 72.3% were aware of their condition, 65.6% took medication, and 27.7% had fasting glucose level controlled (i.e. fasting plasma glucose <7 mmol/l). Among those aware of the condition, 87.2% were taking medication (only 4 persons aware of diabetes reported to be on diet without medication), among those taking medication, 42.3% had controlled diabetes. Again, there were marked differences between urban and rural areas. The prevalence of awareness and treatment of diabetes were two times higher in urban area. Successful control of diabetes in the rural area was very low (4.9%) compared with the city (39.7%); the difference was less dramatic among those aware of having diabetes (47.7% vs. 15.4%).

Table 3 shows age-sex-adjusted odds ratios for covariates and diabetes prevalence, awareness, treatment and control. The prevalence of diabetes was associated with higher age, increasing body mass index, central obesity and family history of diabetes. The odds of diabetes was less than half in rural Akmol compared to urban Astana. The odds of awareness, treatment and control were also substantially lower in the rural vs. urban area. Among the socio-demographic measures, only household items were statistically significantly associated with (increased) diabetes prevalence and control of diabetes. In addition, Russian ethnicity had marginally increased prevalence of diabetes.

Multivariable analysis was only possible for diabetes prevalence (Table 3, column 3), as the numbers of subjects were too small for multivariate analysis of awareness, treatment and control of diabetes. For diabetes prevalence, the main difference was that the odds ratio for rural vs. urban residence was attenuated from 0.49 increased to 0.60 (95% confidence interval 0.37-0.99), the odds ratio for Russian vs. Kazakh ethnicity increased to 1.59 (0.99-2.57), and the association with BMI and central obesity were both reduced.

4. Discussion

In the present study we estimated the prevalence, awareness, treatment and control of diabetes among middle-aged and older residents of Astana city (urban) and Akmol village (rural) in Kazakhstan. The overall prevalence of diabetes was 12.5% (close to WHO estimate of 13.2%) but we detected marked differences between urban and rural areas, with all outcome measures being higher in urban residents. As expected, diabetes prevalence was also positively associated with higher age, higher BMI and WHR and family history of diabetes. There was also a suggestion that diabetes prevalence was higher among Russians.

Several limitations that should be taken into account when interpreting the results. First, the diagnosis of diabetes used in the study may be imprecise, as only one measurement of FPG was used; for logistic and financial reasons, other markers for diabetes diagnosis (oral glucose tolerance test and glycated hemoglobin) were not measured. However, FPG is widely recognized as an acceptable screening test for diabetes and a good measure of diabetes control [19,20]

Second, the response rate was modest, although the real response may have been higher, as some selected subjects may not have received the invitation to participate in the study

Table 3 – Odds ratios (95% confidence intervals) for selected covariates and the prevalence, awareness, treatment and control of diabetes.					
	Prevalence [1] OR (95% CI)	Prevalence [2] OR (95% CI)	Awareness [1,*] OR (95% CI)	Treatment [1,*] OR (95% CI)	Control [1,*] OR (95% CI)
Sex					
Men	1	1	1	1	1
Women	0.95 (0.64-1.40)	0.80 (0.50-1.27)	2.07 (0.86-4.99)	1.82 (0.82-4.02)	1.58 (0.68-3.67)
Age groups					
50-54	1	1	1	1	1
55-59	1.69 (0.95-3.00)	1.51 (0.82-2.79)	3.74 (0.84-16.76)	2.04 (0.64-6.56)	1.37 (0.39-4.90)
60-64	1.64 (0.91-2.95)	1.43 (0.75-2.72)	0.54 (0.16-1.81)	1.37 (0.43-4.42)	1.95(0.54-6.97)
65-69	1.30 (0.66-2.56)	1.07 (0.52-2.22)	1.70 (0.36-8.08)	2.12 (0.51-8.72)	1.11 (0.24-5.07)
70-75	1.98 (1.06-3.71)	1.48 (0.72-3.02)	0.50 (0.14-1.81)	0.77 (0.23-2.60)	0.93 (0.22-3.89)
Urban/Rural					
Astana	1	1	1	1	1
Akmol	0.49 (0.32-0.73)	0.60 (0.37-0.99)	0.12 (0.05-0.34)	0.08 (0.03-0.20)	0.08 (0.02-0.34)
BMI					
18.5-24.9	1	1	1	1	1
25-29.9	2.66 (1.15-6.16)	1.61 (0.67-3.86)	1.71 (0.27-11.07)	0.41 (0.06-2.69)	0.58 (0.08-4.04)
≥30	6.19 (2.77-13.85)	3.13 (1.33-7.40)	1.64 (0.28-9.73)	0.53 (0.09- 3.26)	0.81 (0.13-5.17)
WHR, obesity					
No	1	1	1	1	1
Yes	5.39 (2.67-10.87)	4.19 (1.93-9.12)	2.73 (0.61-12.17)	1.96 (0.47-8.20)	1.23 (0.23-6.55)
Hypertension					
No	1	1	1	1	1
Yes	1.50 (0.93-2.43)	1.19 (0.70-2.01)	0.93 (0.31-2.81)	0.75 (0.27-2.08)	0.44 (0.16-1.20)
Family history					
No	1	1	1	1	1
Yes	2.19 (1.35-3.54)	1.58 (0.93-2.68)	3.43 (0.89-13.17)	1.57 (0.57-4.33)	1.60 (0.61-4.20)
Marital status					
Married	1	1	1	1	1
Unmarried	1.02 (0.63-1.64)	0.90 (0.53-1.54)	1.80 (0.56-5.81)	2.80 (0.93-8.39)	1.91 (0.65-5.56)
Education					
1 Primary	1	1	1	1	1
2 Vocational	0.65 (0.41-1.05)	0.68 (0.41-1.15)	0.50 (0.18-1.39)	0.34 (0.13-0.91)	0.65 (0.22-1.90)
3 Higher	0.87 (0.55-1.39)	0.68 (0.40-1.15)	2.44 (0.66-9.07)	2.34 (0.74-7.39)	1.23 (0.45-3.40)
Ethnicity					
Kazakh	1	1	1	1	1
Russian	1.48 (0.96-2.30)	1.59 (0.99-2.57)	1.28 (0.49-3.35)	0.80 (0.33-1.94)	1.74 (0.69-4.41)
Other	1.11 (0.63-1.97)	0.80 (0.43-1.49)	1.84 (0.48-7.08)	1.48 (0.44-5.01)	1.44 (0.42-4.95)
Car ownership					
yes	1	1	1	1	1
no	1.27 (0.84-1.90)	1.09 (0.67-1.78)	0.94 (0.36-2.42)	1.03 (0.44-2.41)	1.63 (0.67-3.96)
Possessions					
1 Low	1	1	1	1	1
2 Medium	1.60 (0.90-2.84)	1.30 (0.69-2.43)	0.21 (0.04-1.02)	0.38 (0.10-1.38)	0.20 (0.05-0.83)
3 High	1.92 (1.07-3.46)	1.08 (0.53-2.20)	0.53 (0.11-2.56)	1.19 (0.31-4.58)	1.93 (0.55-6.74)

[1] adjusted for age, [2] adjusted for all variables in table, * among persons with diabetes

due to inaccurate information in the polyclinic registers. It has been suggested that 60% response rate is satisfactory [21] and response rates similar to our study are common for recent studies in Europe and elsewhere but some at least selection bias is likely. Typically, participants in epidemiological studies usually have higher socio-economic status and better health than non-participants [22]. It is also possible that a study based in polyclinics may have attracted less healthy patients with perceived higher need for medical care. Therefore, the lower response rates may lead to both under- and overestimation of diabetes prevalence. However, since response rates were higher in women and in older age groups, some overestimation of diabetes prevalence is possible. The response rates were slightly higher in Astana but the difference was not large enough to introduce serious selection bias.

Third, the rural and urban areas in this study were chosen for practical reasons. Astana is a modern capital city, with a large proportion of civil servants and well educated population. Akmol, although rural, it is relatively close to Astana and it is possible that more remote areas would show even more extreme differences from Astana. Finally, the survey had a relatively small sample size and especially among persons with diabetes (only 119 subjects) the statistical power to detect associations with covariates was very low.

On the other hand, it is reassuring that high BMI, high WHR and family history of diabetes were associated with diabetes, in a manner consistent with published studies. [23,24] This supports the validity of the diabetes classification used in this paper and generally suggests a good quality of the data.

To our best knowledge there were no previously published studies on the awareness, treatment and control of diabetes in Kazakhstan, and there is only limited evidence in other Central Asian republics. [5,6] The high levels of awareness, treatment and control of diabetes in this study are similar to previously reported levels of these indices for hypertension in the Astana city [25]. This pattern of high awareness and treatment are likely to reflect the affluent and better educated population in Astana city with good access to health care.

The high levels of diabetes indices in our study are similar to recently published estimates for other low- and middle-income countries [26,27]. For example, data from India suggest a prevalence of diabetes among older persons of 16%, and levels of awareness, treatment and control of 72%, 54%, and 40%, respectively. [28] In the US, as an example from a high income country, the estimates in elderly population were even higher, with a prevalence of 21% and awareness, treatment and control reported as 71%, 51% and 50%, respectively. [29]

The inclusion of the rural Akmol village into this study revealed a huge gap between two populations. All diabetes indices were several times lower in Akmol village than in the capital city. Interestingly, awareness was very low and there were very few cases of controlled diabetes in the rural area. Although there are no reliable data on levels and distribution of lifestyle factors in Kazakhstan, the high prevalence of diabetes, obesity and hypertension in Astana city may reflect the urbanised and affluent life style, with easily available elements of westernised diet and high density to fast food outlets is consistent with higher rates of different non-communicable diseases in urban vs. rural areas reported from other Asian populations in lower and middle income countries [13,14]. Although obesity was common in both urban and rural areas in our study, the mean BMI and the prevalence of obesity were higher in Astana than in the rural area. It is possible that rapid urbanization, introduction of western life style and economic development in Kazakhstan are associated with accelerated nutrition transition, as seen in other populations [30].

Regarding the social and economic determinants of diabetes indices, residence in an urban or rural setting exerted the greatest influence. Surprisingly, we found only modest differences in diabetes prevalence by education and car ownership; in addition, in age-sex-adjusted analyses, higher household item ownership was associated with increased odds of prevalent diabetes. This pattern may potentially reflect the current position of Kazakhstan in terms of epidemiological and nutritional transition. There is evidence that the social gradient in obesity changes with affluence and development; at earlier stages of transition, obesity shows a positive association with socioeconomic status but at later stages the gradient becomes inverse. [31]

The higher prevalence of diabetes in ethnic Russians is analogous to previously reported lower self-rated health in the Russian vs. Kazakh ethnicity [32,33], however, in contrast to self-rated health, the difference for diabetes prevalence was only marginally statistically significant. While the increased risk in Russians may be related to life style of socioeconomic status, it was not attenuated in the fully adjusted model. Persons with high education had a clear advantage in terms of

awareness, treatment and control of diabetes; this pattern most likely reflects the better access to health care.

In summary, this study showed relatively high prevalence of diabetes in this Kazakhstan population sample, with large differences in all diabetes indices between urban and rural areas. These results require confirmation in a larger study, preferably using a large number of urban and rural areas. If confirmed, the urban/rural differences suggest a need for a diabetes screening and management programme, focusing on access to health care in rural areas and on prevention in the cities.

Ethical approval

Funding

Competing interests

The authors declare that they have no competing interests.

Authors' contribution

AS, AP and MB jointly designed the study, analyzed the data, drafted and finalized the manuscript. TN and ZZ participated in the study design, helped to obtain funding to set up field work, and critically revised the manuscript. AKo and AKa participated in data collection and data management and critically revised the manuscript.

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