Prevalence of Diabetes and IGT in Yonchon County, South Korea

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OBJECTIVE — To determine the prevalence of diabetes and impaired glucose tolerance (IGT) in Yonchon County of South Korea and to investigate their associated factors.

RESEARCH DESIGN AND METHODS — We performed a population-based cross-sectional study with random cluster sampling of residents ≥30 years of age. Among the 3,804 residents sampled, a total of 2,520 participants had a standard 75-g oral glucose tolerance test and answered a detailed questionnaire. We also collected standard anthropometric data.

RESULTS — If the data for participants in the age range of 30–64 years were adjusted to the standard world population, the prevalence of diabetes was 7.2% and the prevalence of IGT was 8.9%. It was observed that the significant factors associated with diabetes were waist-to-hip circumference ratio, serum triglyceride levels, age, systolic blood pressure, family history of diabetes, and locality.

CONCLUSIONS — The prevalence of diabetes in Yonchon County was substantially higher than was previously suggested. The risk of diabetes increased with the increased central obesity and metabolic disturbances associated with insulin resistance.

Chronic diseases represent a greater proportion of morbidity as well as of mortality in South Korea (1). Our clinical experiences suggest that, among chronic diseases, hypertension and diabetes are the two leading ones to be concerned about from a public-health perspective. But data on chronic diseases, especially diabetes, are very limited. It is very important to evaluate the frequency of diabetes in large representative samples. The age distribution in Yonchon was similar to that of the Korean general population. According to the National Bureau of Statistics, the unemployment rate, the distribution of professions, the average income, and the proportion of urban to rural areas in Yonchon County appear to reflect those of the whole country.

In 1989, we performed baseline surveys on 2,988 stratified, randomly sampled inhabitants of the county using questionnaires (unpublished observations). At that time, the perceived morbidity of diabetes was only 2.4%. Since Korea has been going through a rapid Westernization, however, we hypothesized that the rates of diabetes may be getting close to those seen in the U.S. or Europe. The present study was undertaken to determine the prevalence of diabetes and impaired glucose tolerance (IGT) and to find their associated factors in Yonchon County.

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BMI, body mass index; IGT, impaired glucose tolerance; NIDDM, non-insulin-dependent diabetes mellitus; OGTT, oral glucose tolerance test; WHR, waist-to-hip circumference ratio.

RESEARCH DESIGN AND METHODS

Yonchon County, located in the northern part of Kyunggi Province, occupies 733 km^2 and includes ~60,000 people. Random cluster sampling was applied to select the study subjects. We gathered information on all residents ≥30 years of age and divided residents into 144 neighborhoods, each of which consisted of ~100 families, with the administrative area and transportation taken into account. Then we selected 20 neighborhoods randomly. Eleven neighborhoods had the characteristics of rural areas (population <5,000 people/km^2), and the other nine neighborhoods had the characteristics of urban areas (population ≥5,000 people/km^2). A total of 3,804 eligible study subjects were selected in accordance with the 1991 household registration records.

The potentially eligible candidates were invited to the centers of the respective neighborhoods for examina-

Table 1—*Comparison of the proportion of the respondents and nonrespondents according to age*

Age (years)	Eligible subjects	Complete data	Non-respondents
30–39	1,225	609 (49.7)	608 (49.6)
40–49	749	518 (69.2)	223 (29.8)
50–59	925	691 (74.7)	227 (24.5)
60–69	530	441 (83.2)	91 (17.2)
≥70	375	240 (64.0)	135 (36.0)
Total	3,804	2,499* (65.6)	1,284 (33.7)

Data are *n* (%). Rates of those with complete data and those who were nonrespondents were expressed as percentages of the eligible subjects in each subgroup. *Twenty-one subjects were venipunctured but not interviewed or interviewed but not venipunctured. Therefore, a total of 2,520 inhabitants participated in the actual study.

tions that included structured questionnaires, measurement of the anthropometric indexes, and an oral glucose tolerance test (OGTT). Questionnaires were composed of details of sociodemographic information, indexes of urbanization, personal habits, and medical history. Physical activity was denoted as the average of daily active hours excluding the hours of sleep and light household activities. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2). Waist and hip circumferences were measured with participants standing relaxed in thin clothing, and waist-to-hip circumference ratio (WHR) was calculated.

The 1985 World Health Organization criteria were used to define the status of the subjects. For the international comparison, data within the truncated age range of 30–64 years were adjusted to the Segi's standard world population of 31 December 1985 using 5-year age intervals as the standard (2). The patients treated with insulin or oral hypoglycemic agents under a diagnosis of diabetes in some hospitals were also defined as diabetic.

For the associated factor analysis, we performed univariate analysis with the PC-SAS package. The Mantel-Haenszel χ^2 test was used to test the hypothesis controlling other covariates. Multivariate logistic regression model was used to analyze the relationship between the associated factors and diabetes via the EGRET systems.

RESULTS — Of 3,804 subjects scheduled for the survey, 2,520 (66%) underwent the actual examination (Table 1). Of those, 11 subjects were venipunctured but not interviewed, and another 10 subjects were interviewed but not venipunctured. Therefore, the complete data of 2,499 subjects were analyzed. The numbers of diagnosed diabetes cases, undiagnosed diabetes cases, and cases of IGT, along with age and sex, are shown in Table 2. With the data within the age range of 30–64 years adjusted to the standard world population of Segi, the prevalence of diabetes was 7.2% and the prevalence of IGT was 8.9%. The difference in the prevalence of diabetes by age was highly significant (χ^2 trend = 58.1, $P < 0.001$), and that of IGT by age was also significant. The prevalence of diabetes and IGT increased as BMI increased (χ^2 trend = 13.8, $P < 0.001$; χ^2 trend = 11.2, $P < 0.01$, respectively). The prevalence of diabetes and IGT also increased as WHR increased (χ^2 trend = 60.6, $P < 0.001$; χ^2 trend = 24.5, $P < 0.001$, respectively). The difference in the prevalence of diabetes by WHR still persisted even after controlling for age and sex (χ^2 trend = 32.9, $P < 0.001$), while that of IGT did not (Table 3). The differences in the prevalences of diabetes and IGT, respectively, by WHR after controlling for BMI were also significant. The difference in the prevalence of diabetes by physical activity was significant and was still significant after controlling for age, sex, WHR, and locality.

The difference in the prevalence of diabetes by family history of diabetes was significant, while that of IGT was not. From these univariate analyses, 10 variables were found to be significantly correlated with diabetes: age, sex, obesity,

Table 2—*Prevalence of diagnosed and undiagnosed diabetes and IGT by age and sex*

Age (years)	*n*		Diabetes diagnosed (%)		Diabetes undiagnosed (%)		IGT (%)		Total intolerance (%)
	Men	Women	Men	Women	Men	Women	Men	Women	
30–39	258	351	2 (0.8)	4 (1.1)	9 (3.5)	6 (1.7)	14 (5.4)	14 (4.0)	49 (8.0)
40–49	233	285	7 (3.0)	7 (2.4)	9 (3.9)	11 (3.8)	18 (7.7)	29 (10.2)	81 (15.6)
50–59	301	390	23 (7.6)	21 (5.4)	22 (7.3)	20 (5.1)	51 (16.9)	54 (13.8)	191 (27.6)
60–69	187	252	10 (5.3)	17 (6.7)	19 (10.2)	9 (3.6)	28 (15.0)	39 (15.5)	122 (27.8)
≥70	111	129	2 (1.8)	6 (4.6)	13 (11.7)	10 (7.7)	25 (22.5)	23 (17.8)	79 (32.9)
Total	1,090*	1,407*	44 (4.0)	55 (3.9)	72 (6.6)	56 (4.0)	136 (12.5)	159 (11.3)	522 (9.1)†

Data are *n* (%). *Two cases lacked sex information, and, therefore, a total of 2,497 cases were analyzed. †When adjusted for Segi's world population using the 30–64 age-group, age-adjusted prevalence of diabetes was 7.2%.

Table 3—*Prevalence of diabetes by WHR tertile controlling for age and sex in study population*

Age (years)	WHR tertile (men) I	II	III	Total (men)	WHR tertile (women) I	II	III	Total (women)
30–39	2 of 103 (1.9)	0 of 96 (0)	8 of 54 (14.8)	10 of 253 (3.9)	3 of 188 (1.6)	4 of 118 (3.4)	3 of 44 (6.8)	10 of 350 (2.8)
40–49	4 of 65 (6.1)	3 of 99 (3.0)	9 of 65 (13.8)	16 of 229 (7.0)	2 of 84 (2.4)	7 of 119 (5.9)	9 of 76 (11.8)	18 of 279 (6.4)
50–59	8 of 93 (8.6)	15 of 101 (14.8)	22 of 106 (20.7)	45 of 300 (15.0)	6 of 91 (6.6)	17 of 152 (13.6)	17 of 172 (9.9)	40 of 388 (10.3)
60–69	2 of 65 (3.1)	5 of 54 (9.2)	21 of 67 (31.3)	28 of 186 (15.0)	2 of 61 (3.3)	7 of 77 (9.1)	17 of 112 (15.2)	26 of 250 (10.4)
≥70	5 of 35 (14.3)	2 of 34 (5.9)	7 of 40 (17.5)	14 of 109 (12.8)	2 of 32 (6.2)	4 of 34 (11.8)	10 of 61 (16.4)	16 of 127 (12.6)
Total	21 of 361 (5.8)	25 of 384 (6.5)	67 of 332 (20.2)	113 of 1,077 (10.5)	15 of 456 (3.3)	39 of 473 (8.2)	56 of 465 (12.0)	110 of 1,394 (7.9)

Data are *n* (%). The difference in the prevalence of diabetes by WHR controlling for age and sex was significant (χ^2_{trend} = 32.9, $P < 0.001$).

Table 4—*Associated factors of diabetes*

Associated factors	People with diabetes (*n*)	Total in group (*n*)	Prevalence odds ratio	95% Confidence interval
WHR				
Quartile 1 (<0.83)	23	583	1.0	
Quartile 2 (<0.87)	44	622	1.29	0.58–2.89
Quartile 3 (<0.91)	43	604	2.66	1.18–5.99
Quartile 4 (≥0.91)	113	664	3.82	1.37–10.62
Serum triglyceride (mg/dl)				
Tertile 1 (<98)	43	870	1.0	
Tertile 2 (<159)	58	798	1.07	0.72–1.61
Tertile 3 (≥159)	122	705	2.02	1.41–2.89
Age (years)				
30–39	21	609	1.0	
40–49	34	518	1.86	0.99–3.52
50–59	86	691	3.66	2.06–6.53
60–69	55	441	3.34	1.81–6.18
≥70	31	240	3.27	1.65–6.48
Systolic blood pressure (mmHg)				
Quartile 1 (<110)	21	375	1.0	
Quartile 2 (<120)	24	496	1.13	0.75–1.71
Quartile 3 (<140)	76	938	1.62	1.03–2.56
Quartile 4 (≥140)	102	664	1.69	1.01–2.83
Family history of diabetes				
No	196	2,285	1.0	
Yes	31	214	2.1	1.34–3.34
Locality				
Rural	119	1,510	1.0	
Urban	108	1,010	1.56	1.15–2.12

Prevalence odds ratio was adjusted for other mentioned variables. For systolic blood pressure, treated hypertensives were assigned to highest quartile of the distribution.

central obesity, family history of diabetes, locality, systolic blood pressure, physical activity, serum triglyceride levels, and liver-function abnormality. With these variables, the best logistic regression model was fitted with a stepwise-forward strategy. The significant factors associated with the prevalence of diabetes were central obesity, serum triglyceride levels, age, systolic blood pressure, family history of diabetes, and locality (Table 4).

CONCLUSIONS— The impact of diabetes as a major and growing cause of prolonged ill health and premature mortality is great. A rising prevalence of diabetes is reported from areas changing from a traditional to a Westernized lifestyle (3). Unlike the worldwide trend, a limited number of standardized studies indicated that Koreans are less susceptible to diabetes. In most studies and in our previous data ascertained by questionnaires, the prevalences were underestimated because of the latent nature of diabetes. It is, therefore, very important to evaluate the frequency of diabetes by standard methods in large representative samples.

Our present study found that the prevalence of the diabetes among Koreans is substantially higher than that previously suggested. However, this figure is not much higher than the rates reported in some other nearby Asian populations (4–5). Considering our younger target population, the figure of 66% is considered generally acceptable in the assessment of the entire prevalence. But as for biases, we did not conduct sampling studies or surveys by questionnaires or capillary blood sampling on the population of nonrespondents. Therefore, their attributes are unknown. Since the prevalence of diabetes increases with age and the rate of participation is lower in the male 30- to 40-year-old age-group, the actual prevalence is assumed to be slightly lower when the untested segment of the population is stratified into age structures. When we exclude the age-group of 30–39 years, the prevalence of diabetes within the age range of 40–64 years would be 9.6%, and that of IGT 11.8%, with a participation rate of 73%.

We identified central obesity as a significant independent factor for diabetes in Korea, confirming the results of numerous other epidemiological studies. Our study also found a substantial rise in the prevalence of diabetes as serum triglyceride level increases. The prevalence of diabetes was also shown to be increasing with the increased average span of life and urbanization. Over the past 20 years, Korea has experienced rapid socioeconomic development reflected in changes of many aspects of lifestyle and dietary habits and, to a large extent, in disease patterns. Therefore, the high prevalence of diabetes, IGT superimposed on obesity, and hyperlipidemia appear to justify growing public health concern and the implementation of a full-fledged national program for diabetes.

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