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Comparison of Glucose Tolerance Categories in the Korean Population According to World Health Organization and American Diabetes Association Diagnostic Criteria

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Objectives : *To compare the prevalence and metabolic profiles of glucose tolerance categories according to World Health Organization(WHO) and 1997 American Diabetes Association(ADA) fasting criteria for the diagnosis of diabetes mellitus and impaired glucose metabolism in the Korean population.*

Methods : *2251 subjects without previous history of diabetes, who participated in the Yonchon diabetes epidemiology survey in 1993, were classified according to both criteria. The prevalence of glucose tolerance categories and the agreement across all categories of glucose tolerance were calculated. Metabolic characteristics of different glucose tolerance categories were compared.*

Results : *The prevalence of diabetes and impaired fasting glucose(IFG) according to ADA fasting criteria was similar to those of diabetes and impaired glucose tolerance(IGT) according to WHO criteria, respectively. However, 35.5 % of the subjects who were diagnosed as diabetes by WHO criteria were reclassified as either IFG or normal fasting glucose (NFG), and 38.5 % of diabetic patients according to ADA fasting criteria were IGT or normal glucose tolerance (NGT) by WHO criteria. Only 31.3 % of IGT subjects remained as IFG and 62.1 % were reclassified as NFG. Similarly, 69.4 % of IFG subjects were NGT by WHO criteria. The agreement between the two criteria was poor (=0.31).*

Discordant diabetes groups had higher WHR, systolic and diastolic blood pressure, cholesterol and triglyceride levels than concordant non-diabetes group. Non-diabetes(WHO)/diabetes(ADA) group had higher WHR than diabetes (WHO)/non-diabetes(ADA) group. There were no differences in other metabolic characteristics between the two discordant diabetes groups. IGT/NFG and NGT/IFG group showed higher BMI, WHR, systolic and diastolic blood pressure, cholesterol and triglyceride levels than NGT/NFG group. Metabolic characteristics of IGT/NFG group were not different from those of NGT/IFG group except IGT/NFG subjects were older than NGT/IFG subjects.

Conclusion : *The agreement between WHO and ADA fasting criteria was poor. ADA fasting criteria can detect new diabetic patients and subjects with impaired glucose metabolism who are not classified as diabetes or IGT by WHO criteria. However, a substantial number of subjects, who may have increased cardiovascular risk and/or increased risk for the development of diabetes and its complication, will be missed when using ADA fasting criteria.*

Key Words : *diagnosis, diabetes mellitus, impaired glucose tolerance, impaired fasting glucose, fasting plasma glucose*

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INTRODUCTION

Diagnosis of diabetes mellitus has been based on fasting plasma glucose(FPG) value and glucose value

measured 2 h after a standard 75 g glucose load(2-h PG).[1,2] The cutpoint of these criteria is based mainly on the prevalence of microvascular complications. However, FPG cutpoint of 140 mg/dL has been challenged since it defined a greater degree of hyperglycemia than did the cutpoint of 2-h PG(200 mg/dL).[3] Recently, American Diabetes Association(ADA) has proposed a revised diagnostic criteria that lowers the FPG cutpoint to 126 mg/dL.[4] By lowering FPG cutpoint, cutpoints for the FPG and 2-h PG are believed to diagnose similar conditions, and ADA recommends that the FPG test is greatly preferred in clinical settings because of ease of administration, convenience, acceptability to patients and lower cost.

It is well established that diabetes mellitus and impaired glucose tolerance by WHO criteria(1985) are also associated with an increased risk of development of cardiovasular disease and form part of the metabolic syndrome.[5] At present, it is not clear whether metabolic characteristics of glucose tolerance categories based on FPG criteria are in agreement with those of WHO criteria(1985) or not. Larsson et al.[6] reported that the subjects with IGT and IFG are comparable in terms of body mass index, blood pressure and serum lipids in a group of middle-aged Caucasian women, while Gimeno et al.[7] showed that subjects with discordant diagnoses, who had IGT or diabetes by WHO criteria but who were normal by ADA fasting criteria, exhibited a higher number of cardiovascular risk factors (higher blood pressure and triglyceride and low HDL cholesterol) than those who were discordant (IFG/diabetes) by ADA fasting criteria but normal by WHO criteria.

In this study, we applied the revised ADA fasting criteria to data collected from a previously published population-based survey for diabetes in Korean subjects[8,9] and compared the prevalence and metabolic profile of glucose tolerance categories with those of WHO criteria.

RESEARCH DESIGN AND METHODS

The Yonchon Study is a population-based diabetes epidemiology survey in *the* Korean population. The study population and research design have been described in detail, previously.[8,9] Subjects were classified according to both WHO criteria and 1997 ADA fasting criteria. Subjects who were already using oral hypoglycemic agents, insulin or diet for diabetes were excluded from all analyses.

Prevalence of glucose tolerance categories were calculated for both sets of diagnostic criteria and to examine the agreement between the two criteria, all categories of glucose tolerance were calculated.[10] Metabolic characteristics of different glucose tolerance categories were compared. Differences among these groups were tested with analysis of variance. Statistical analyses were done using the Statistical Packages for Social Science(SPSS) 8.0 for windows. *P*-values < 0.05(two-tailed) were considered to be statistically significant.

RESULTS

1. Prevalence of glucose tolerance categories

The overall prevalence of diabetes did not differ between the two criteria. Prevalence of diabetes according to WHO(1985) criteria was 5.15 % and that according to ADA(1997) fasting criteria was 5.42 %. However, only 64.7%(75 of 116 subjects) of those who were diagnosed as diabetes according to WHO criteria were diagnosed as diabetes by ADA fasting criteria. 19.0 % of diabetes according to WHO criteria were reclassified as impaired fasting glucose(IFG) and 16.4 % as normal fasting glucose(NFG). Similarly, 38.5 % of diabetic patients according to ADA fasting criteria were IGT or normal glucose tolerance(NGT) by WHO criteria(Table 1).

Table 1. Agreement between WHO(1985) and ADA (1997) Diagnostic Criteria: the Yonchon Study

	WHO(1985)			
	NGT	IGT	Diabetes	Combine
AFG	1591	169	19	1779
IFG	243	85	22	350
Diabetes	29	18	75	122
Combined	1863	272	116	2251

NGT: normal glucose tolerance, IGT: impaired glucose tolerance, NFG: normal fasting glucose, IFG: impaired fasting glucose

The prevalence of IFG was 15.1%, while the prevalence of IGT was 12.1%. Only 31.3 %(85 of 272 subjects) of IGT subjects remained as IFG and 62.1 %(169 of 272 subjects) were reclassified as NFG and 6.8 %(18 of 272 subjects) as diabetes. Only 24.3 % of IFG subjects were IGT by WHO criteria and 69.4 % were

NGT by WHO criteria.

The agreement between the two criteria for the diagnosis of previously unknown diabetes was poor(= 0.31)

2. Metabolic profiles of glucose tolerance categories

Concordant and discordant diabetes groups were older than concordant non-diabetes group. They showed higher WHR, systolic and diastolic blood pressure, cholesterol and triglyceride levels than concordant non-diabetes group (Table 2). When comparing metabolic characteristics among diabetes groups, concordant diabetes [diabetes (WHO) / diabetes (ADA)] group showed higher triglyceride and lower HDL levels than discordant diabetes groups. Non-diabetes (WHO)/ diabetes(ADA) group had higher WHR than diabetes (WHO)/non-diabetes(ADA) group. There were no differences in other metabolic profiles between *the* two discordant diabetes groups.

Table 3. showed metabolic profiles of subjects with impaired glucose metabolism. Concordant and discordant impaired glucose metabolism groups were older and had higher BMI, WHR, systolic and diastolic blood pressure, cholesterol and triglyceride levels than NGT/NFG group. IGT/IFG subjects showed higher WHR and triglyceride levels than discordant impaired glucose metabolism groups(IGT/NFG, NGT/IFG). Metabolic profiles of IGT/NFG group were not different from those of NGT/IFG group, except that IGT/NFG group was older than NGT/IFG group.

Table 2. Comparison of Metabolic Profile Among Diabetic Subgroups According to WHO(1985) and ADA(1997) Diagnostic Criteria

	Non-DM/ Non-DM	DM(WHO)/ Non-DM(ADA)	Non-DM(WHO)/ DM(ADA)	DM(WHO)/ DM(ADA)
Age(years)	53 ± 13	62 ± 14*	59 ± 12*	58 ± 12*
Sex(M:F)	898/1190	21/20	29/18	44/31
BMI(kg/m2)	23.9 ± 3.3	24.8 ± 3.8	23.7 ± 3.3	25.3 ± 3.9*
WHR	0.86 ± 0.06	0.90 ± 0.05*†	0.94 ± 0.17*	0.91 ± 0.09*†
systolic BP(mmHg)	125 ± 21	139 ± 27*	133 ± 22*	136 ± 19*
diastolic BP(mmHg)	80 ± 13	88 ± 17*	85 ± 14*	87 ± 13*
Cholesterol §	4.03 ± 0.80	4.42 ± 0.88*	4.40 ± 1.03*	4.34 ± 1.11*
Triglyceride §	1.64 ± 1.16	2.20 ± 1.48*	2.36 ± 1.59*	2.83 ± 2.11*†‡
HDL §	0.96 ± 0.28	1.03 ± 0.41	0.98 ± 0.41	0.88 ± 0.34‡

§ *: mmol/L, BP: blood pressure, DM: diabetes mellitus*

* *: p < 0.05 vs Non-DM/Non-DM*, †: p < 0.05 vs Non-DM/DM, ‡: p < 0.05 vs DM/Non-DM

Table 3. Comparison of Metabolic Profile for Impaired Glucose Metabolism According to WHO(1985) and ADA(1997) Criteria

	NGT/NFG	IGT/NFG	NGT/IFG	IGT/IFG
Age(years)	51 ± 13	59 ± 11*†	54 ± 12*	59 ± 13*†
Sex(M:F)	655/936	62/107	128/115	50/35
BMI(kg/m2)	23.7 ± 3.1	24.6 ± 3.8*	24.2 ± 3.5*	25.0 ± 3.2*
WHR	0.86 ± 0.06	0.88 ± 0.06*	0.87 ± 0.06*	0.89 ± 0.06*†‡
systolic BP(mmHg)	123 ± 21	131 ± 23*	129 ± 20*	133 ± 22*
diastolic BP(mmHg)	79 ± 13	85 ± 15*	84 ± 12*	86 ± 14*
Cholesterol §	4.01 ± 0.78	4.14 ± 0.85	4.14 ± 0.80*	4.27 ± 0.75*
Triglyceride §	1.56 ± 1.04	1.83 ± 1.10*	1.83 ± 1.46*	2.26 ± 1.91*†‡
HDL §	0.96 ± 0.28	0.96 ± 0.34	0.96 ± 0.31	0.91 ± 0.31

§ *: mmol/L, BP: blood pressure, NGT: normal glucose tolerance, IGT: impaired glucose tolerance, NFG: normal fasting glucose, IFG: impaired fasting glucose*

* *: p < 0.05 vs NGT/NFG*, †: p < 0.05 vs NGT/IFG, ‡: p < 0.05 vs IGT/NFG

DISCUSSION

The revised ADA diagnostic criteria are intended to reduce the discrepancy between FPG and 2-h PG cutpoint and to encourage the use of FPG rather than the oral glucose tolerance test to diagnose diabetes. In this study, the prevalence of diabetes using ADA fasting criteria was similar with that using WHO(1985) criteria. However, the agreement between WHO and ADA fasting criteria was not good. A third of the subjects who were diagnosed as diabetes according to WHO criteria were reclassified as either IFG or NFG by ADA fasting criteria. Similarly 38.5 % of the subjects who were diagnosed as diabetes by ADA fasting criteria were not diagnosed as having diabetes according to WHO criteria. Our study also showed that about 2/3 of IGT subjects were reclassified as NFG, which is very similar to previous reports showing that 70-80 % of IGT subjects were reclassified as NFG.[10,11] Conversely, 2/3 of IFG subjects were NGT by WHO criteria. These results are consistent with the reports which showed only moderate to poor agreement between the two criteria[13,14]

Poor agreement between the two criteria raised the concern that a substantial number of glucose intolerant subjects, who have a increased risk of diabetic complications or increased risk of developing diabetes mellitus and cardiovascular disease, may be ignored when using ADA fasting criteria.

Our results showed that discordant diabetes groups had higher WHR, blood pressure, cholesterol and triglyceride than the concordant non-diabetes group. However, metabolic characteristics of diabetes (WHO)/non-diabetes(ADA) group was similar to those of non-diabetes(WHO)/diabetes(ADA) group. This implies that when we use ADA fasting criteria to diagnose diabetes, we will miss a similar number of subjects who may have increased risk for diabetic complications.

Subjects with IGT are known to have increased risk of developing diabetes and cardiovascular disorders.[15,16] In our population, IGT/NFG subjects had increased cardiovascular risk compared to NGT/NFG subjects. Although they were older than NGT/IFG subjects, other metabolic profiles were similar to those of NGT/IFG subjects. Thus, the discordant impaired glucose metabolism group may have a similar risk for the development of diabetes and cardiovascular disease. These results are similar to the observation in a group of middle-aged Caucasian women[6] while Gimeno et al.7) showed that subjects with discordant diagnoses, who had IGT or diabetes by WHO criteria but who were normal by ADA fasting criteria, exhibited a higher number of cardiovascular risk factors than those who were discordant (IFG/diabetes) by ADA fasting criteria but normal by WHO criteria. These results suggest that subjects with IGT who are reclassified as NFG by ADA fasting criteria have no less risk for development of diabetes and cardiovascular disease than subjects with NGT/IFG.

In conclusion, ADA fasting criteria can detect a similar number of diabetic patients and impaired glucose metabolism. It can pick up new subjects who are not classified as diabetes or impaired glucose tolerance by WHO criteria. However, a substantial number of subjects, who may have increased cardiovascular risk and/or increased risk for the development of diabetes, will be missed when using only FPG cutpoint. Long term study will be needed to evaluate whether glucose tolerance categories classified by ADA fasting criteria will result in decreased morbidity and mortality, compared to those according to WHO criteria.

REFERENCES

1. World Health Organization: Diabetes Mellitus: Report of a WHO study group. Geneva, World Health Org. 1985 (Tech Rep. Ser., no.727).
2. National Diabetes Data Group: Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. Diabetes 1979; 28: 1039-1057.
3. Harris MI, Hadden WC, Knowler WC, Bennett PH: Prevalence of diabetes and impaired glucose tolerance and plasma glucose levels in U.S. population aged 20-74 yr. Diabetes 1987; 36:523-34.
4. The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus: Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care 1997; 20:1183-1197.
5. Alberti KGMM: The clinical implications of impaired glucose tolerance. Diabetic Med 1996; 13:927-937.
6. Larsson H, Berglund G, Lindgarde F, Ahren B: Comparison of ADA and WHO criteria for diagnosis of diabetes and glucose intolerance. Diabetologia 1998; 41: 1124-5.
7. Gimeno SG, Ferreira SR, Franco LJ, Iunes M: Comparison of glucose tolerance categories according to World Health Organization and American Diabetes Association diagnostic criteria in a population-based study in Brazil. The Japanese-Brazilian Diabetes Study Group. Diabetes Care 1998; 21:1889-92.

8. Park Y, Lee H, Koh CS, Min H, Yoo K, Kim Y, Shin Y:Prevalence of diabetes and IGT in Yonchon County, South Korea. Diabetes Care 1995; 18:545-8.
9. Shin CS, Lee HK, Koh CS, Kim YI, Shin YS, Yoo KY, Paik HY, Park YS, Yang BG: Risk factors for the development of NIDDM in Yonchon County, Korea. Diabetes Care 1997; 20:1842-6.
10. Landis JR, Koch GG: The measurement of observer agreement for categorical data. Biometrics 1977; 33: 159-74.
11. Gomez-Perez FJ, Aguilar-Salinas CA, Lopez-Alvarenga JC, Perez-Jauregui J, Guillen-Pineda LE, Rull JA: Lack of agreement between the World Health Organization Category of impaired glucose tolerance and the American Diabetes Association category of impaired fasting glucose. Diabetes Care 1998; 21:1886-8.
12. Harris MI, Eastman RC, Cowie CC, Flegal KM, Eberhardt MS: Comparison of diabetes diagnostic categories in the U.S. population according to the 1997 American Diabetes Association and 1980-1985 World Health Organization diagnostic criteria. Diabetes Care 1997; 20:1859-62
13. de Vegt F, Dekker JM, Stehouwer CD, Nijpels G, Bouter LM, Heine RJ: The 1997 American Diabetes Association criteria versus the 1985 World Health Organization criteria for the diagnosis of abnormal glucose tolerance: poor agreement in the Hoorn Study. Diabetes Care 1998; 21:1686-90.
14. Unwin N, Alberti KG, Bhopal R, Harland J, Watson W, White M :Comparison of the current WHO and new ADA criteria for the diagnosis of diabetes mellitus in three ethnic groups in the UK. American Diabetes Association. Diabet Med 1998; 15: 554-7.
15. Fuller JH, Shipley MJ, Rose G, Jarrett RJ, Keen H: Coronary-heart-disease risk and impaired glucose tolerance. The Whitehall Study. Lancet 1998; 8183:1373-6
16. Saad MF, Knowler WC, Pettitt DJ, Nelson RG, Mott DM, Bennett PH: The natural history of impaired glucose tolerance in the Pima Indians. N Engl J Med 1988; 319:1500-6.