Diabetes, Hyperglycemia, and Decreased Glomerular Filtration Rate in a Taiwanese Metropolitan Adult General Population

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Introduction

- From the previous epidemiological study, the key predictors of CKD in Taiwan are age, female sex, diabetes, hypertension, and hyperlipidemia (Kuo, 2007)
- Since diabetes is the leading cause of end-stage renal disease and cardiovascular disease, we are interested in exploring the relationship of decreased kidney function with diabetes and hyperglycemia in a metropolitan population in central Taiwan

Objectives of the Study

- To assess cross-sectional association of renal function estimated by glomerular filtration rate with hyperglycemia (impaired fasting glucose [IFG]) and diabetes in a Taiwanese metropolitan adult general population

Methods

- **Study Population**
  - ✓ Residents aged 40 and over in Taichung
    October, 2004

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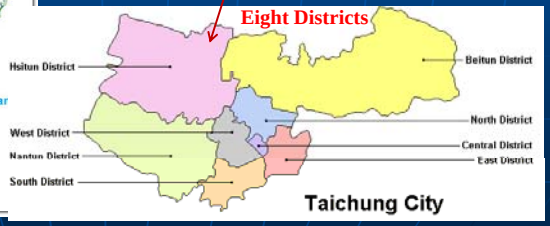
Taichung City

Eight Districts



Methods

- **Study Subjects**
  - ✓ A two-stage sampling design was used to draw residents, with a sampling rate proportional to size (SRPS) within each stage
    - ✓ The first stage: stratified sampling
      - ✓ Sampling unit was Li (administrative units, equivalent to blocks of household units)
      - ✓ Selection probability was set at 0.125.
      - ✓ Lis were randomly selected from each city district, yielding a total of 39 Lis selected
    - ✓ The second stage: simple random sampling
      - ✓ 110 individuals were randomly selected from each sample Li.
      - ✓ A total of 4280 individuals were selected

Methods

- **Study Subjects**
  - ✓ During household visits, we identified 750 individuals who were not eligible and excluded them from study sample
    - ✓ Exclusion : death (n=18), hospitalization or imprisonment (n=14), living abroad (n=39), moving out of the area (n=411), living in their children's home (n=7), sampling frame mistakes (n=59), and not being at home during 3 visits made by interviewers (n=202)
  - ✓ A total of 3,530 subjects were eligible, and 2,359 agreed to participate and provide complete information

Methods

- **Study Design**
  - ✓ Cross-sectional study design
- **Method of Data Collection**
  - ✓ Self-reported questionnaires (Sociodemographic and behavior factors)
  - ✓ Blood sample (triglyceride, HDL-C, glucose, creatinine, etc.)
  - ✓ Urine sample (urinary creatinine and albumin)
  - ✓ Trained staff measured anthrometric index (waist circumference, body weight and height) and blood pressure

Methods

- **Measurement**
  - ✓ **GFR : estimated on the basis of serum creatinine level, with the most recent expression of the MDRD prediction equation modified for Chinese (Xie, 2008)**

$$eGFR = 186.3 \times creatinine^{-1.154} \times age^{-0.203} \times 0.742\,(if\ \ female) \times 1.2331(if\ Chinese)$$

  - ✓ **Decreased GFR : The National Kidney Foundation proposed a cutoff point for decrease kidney function: GFR< 60 mL/min/1.73 m^2**
  - ✓ **Framingham risk score : based on the LDL-C level, the estimated total coronary heart disease risk over a 10-year period for every individual was calculated**
    - ✓ **Data on sociodemographic characteristics, including gender, age, smoking, drinking, physical activity, occupational activity, menopausal status, family history of cardiovascular-related diseases, physician-diagnosed diseases, and medication history were collected when the participants underwent a complete physical examination**

Methods

- **Measurement**
  - ✓ **Metabolic syndrome: according to American Heart Association and National Heart Lung and Blood Institute (AHA/NHLBI)**

Variable	Definition
High waist	>80 cm in women; >90 cm in men
High blood pressure	≥130 / ≥85 mmHg or drug treatment for hypertension
High fasting glucose	≥100 mg/dl or drug treatment for diabetes
Low HDL cholesterol	<40 mg/dl in men; <50 mg/dl in women; or drug treatment for this lipid abnormality
High triglyceride	≥150 mg/dl; or drug treatment for this lipid abnormality
Microalbuminuria	Urinary albumin-to-creatinine ratio (ACR) >30 mg/g cr

Methods

Markers	Unit	Measurement
Body mass index (BMI)	Kg/ m^2	Weight(kg) divided by height squared(m^2)
Waist circumference	cm	A midway point between the inferior margin of the last rib and the crest of the ilium in a horizontal plane
Blood pressure	mmHg	Measured in right arm using an appropriately sized cuff and a standard mercury sphygmomanometer in a seated position
Fasting plasma glucose, HDL cholesterol, Triglyceride	mg/dl	A biochemical autoanalyzer (Beckman Cou, Fullerton, CA, USA)
Microalbumin	mg/g cr	An autoanalyser (Beckman Coulter SYNCHRON system Lx20)
Brachial-ankle pulse wave velocity (baPWV), Ankle-brachial index (ABI)	cm/s	Automatic waveform analyzer (VP-1000; Colin Co., Komaki, Japan)

Methods

- **Statistical Analysis**
  - ✓ **Descriptive statistic: Mean, standard deviation, frequency, percent**
  - ✓ **Inferential statistic: Chi-square test, analysis of variance, hierarchical logistic regression**

Results

Table 1. Normal glycemia, hyperlipidemia and diabetes of the study subjects

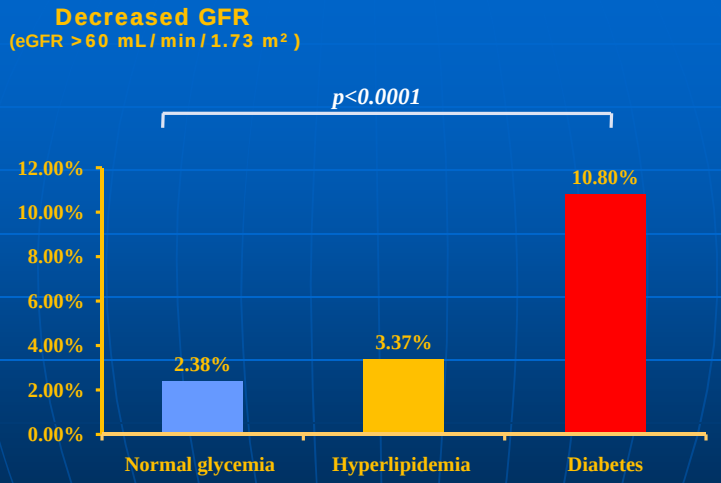
	N (%)			
	Normal glycemia (N=1470)	Hyperglycemia (N=593)	DM (N=287)	P-value
Sociodemographic factors				
Age (years) †	54.93±11.07	58.63±11.66	63.04±11.15	<0.0001
Age				<0.0001
≦65 (years)	1051 (71.50)	351 (59.19)	119 (41.46)	
>65 (years)	419 (28.50)	242 (40.81)	168 (58.54)	
Sex				<0.0001
Men	634 (43.14)	348 (58.68)	162 (56.45)	
Women	836 (56.87)	245 (41.32)	125 (43.55)	
Life style behaviors				
Smoking	225 (15.33)	100 (16.86)	47 (16.38)	0.6645
Drinking	307 (20.90)	180 (30.35)	55 (19.16)	<0.0001
Betel nut chewing	44 (3.00)	26 (4.38)	13 (4.53)	0.1923
Exercise	967 (65.83)	425 (71.67)	190 (66.20)	0.0342
Diabetes related variables				
Family history of diabetes	342 (23.27)	128 (21.59)	88 (30.77)	0.0086
Clinical Indexs				
ABI≦0.9	100 (6.81)	31 (5.23)	20 (6.97)	0.3845
baPWV>1400 (cm/s)	843 (57.86)	447 (75.76)	260 (91.23)	<0.0001
Microalbuminuria≧30 (mg/g cr)	158 (10.78)	80 (13.54)	100 (35.21)	<0.0001
Higher risk scores≧9	404 (27.48)	231 (38.95)	220 (76.66)	<0.0001
BMI≧24 (kg/m^2)	650 (44.22)	366 (61.72)	176 (61.32)	<0.0001
eGFR<60 (mL/min/1.73m^2)	35 (2.38)	20 (3.37)	31 (10.80)	<0.0001
eGFR †	170.61±102.89	181.93±72.27	183.55±75.60	0.0465

† : Mean±SD

Table 1. Normal glycemia, hyperlipidemia and diabetes of the study subjects (Cont.)

	N (%)			
	Normal glycemia (N=1470)	Hyperglycemia (N=593)	DM (N=287)	P-value
Metabolic syndrome component				
High triglyceride	316 (21.50)	181 (30.52)	145 (50.52)	<0.0001
High waist	335 (22.79)	212 (35.75)	135 (47.04)	<0.0001
High blood pressure	769 (52.31)	404 (68.13)	243 (84.67)	<0.0001
Low HDL cholesterol	754 (51.29)	340 (57.34)	205 (71.43)	<0.0001
Metabolic syndrome	306 (20.82)	363 (61.21)	235 (81.88)	<0.0001

	Definition of Metabolic Syndrome
Definition of MetS	Any 3 of 5 criteria listed below
Abdominal obesity (male/female)	Waist>90/80 cm
Triglycerides (mg/dl)	≥150 or drug treatment for this lipid abnormality
HDL cholesterol (mg/dl) (male/female)	<40/50 or drug treatment for this lipid abnormality
Blood pressure (mmHg)	≥130/≥85 or drug treatment for hypertension
Fasting glucose (mg/dl)	≥100



The prevalence of decreased glomerular filtration rate

Table 2. Odds ratios and their 95% confidence intervals of decreased glomerular filtration rate from multivariate logistic regression models

	eGFR OR (95% CI)			
	Model 1	Model 2	Model 3	Model 4
Hyperglycemia (Normal glycemia as reference)	1.43 (0.82-2.50)	0.99 (0.56-1.78)	1.02 (0.57-1.83)	0.90 (0.49-1.62)
DM (Normal glycemia as reference)	4.97*** (3.01-8.20)	2.82*** (1.67-4.76)	2.82*** (1.67-4.76)	2.05* (1.18-3.58)
Age		1.10*** (1.08-1.12)	1.10*** (1.08-1.12)	1.10*** (1.07-1.12)
Sex (Men as reference)		0.82 (0.51-1.31)	0.81 (0.49-1.34)	0.79 (0.48-1.32)
Smoking			1.27 (0.64-2.53)	1.17 (0.58-2.35)
Drinking			0.79 (0.41-1.52)	0.80 (0.41-1.57)
High triglyceride (<150 mg/dl as reference)				1.86* (1.12-3.08)
High waist (Men≦90cm, Women≦80cm as reference)				1.03 (0.63-1.66)
High blood pressure (<130 /85 mmHg as reference)				1.63 (0.79-3.37)
Low HDL cholesterol (Men≧40mg/dl, Women≧50mg/dl as reference)				1.29 (0.75-2.21)

*:p<0.05, **:p<0.01, ***p<0.001

Discussion & Conclusion

- Our findings show that dysglycemia is associated with decreased renal function estimated by GFR
- This association is consistent in diabetic individuals, but does not extend to those with IFG

Thank you for your attention