BIOLOGICAL RISK FACTORS RELEVANT TO CHRONIC DISEASE IN THREE ETHNIC GROUPS IN TAIWAN: RESULTS FROM LI-SHIN OUTREACHING NEIGHBORHOOD SCREENING (LIONS A1)

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Objectives: Few population-based studies have compared risk factors related to chronic diseases across multiethnic groups of Chinese people. Consequently, we report the prevalence of common chronic disorders that make up the metabolic syndrome and compare their distribution in three ethnic subgroups: the offspring of Hakka, Minnan, and mainlander women.

Methods: We included 6854 participants in the Li-Shin Outreaching Neighborhood Screening (LIONS) project: 3088 (45.1%) Hakkas, 2461 (35.9%) Minnans, and 1305 (19.0%) mainlanders. Information on demographic features and recognized lifestyle factors was collected by using questionnaires; data on biological markers of metabolic syndrome were collected from serum samples by using standard biochemical analyses.

Results: Miscegenation averaged 22%. Smoking, alcohol consumption, and betel chewing varied across the three subpopulations. After controlling for demographic features and these three risk factors, men with mainlander mothers had more body fat. Compared with offspring with Hakka mothers, attendees whose mothers were from Minnan had higher uric acid concentrations.

Conclusions: Despite the rarity of racial miscegenation in the three ethnic groups, most biological markers of metabolic syndrome were identical across the groups. Disparities were found for hyperuricemia in attendees whose mothers were from Minnan and for obesity in men whose mothers were mainlanders. These findings can help design health policy for the early detection of chronic disease in different ethnic Chinese groups. (*Ethn Dis*. 2008;18:228–234)

Key Words: Ethnic Group, Biological Markers, Risk Factors, Chronic Disease, Chinese, Taiwanese, Hakka, Minnan

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INTRODUCTION

The relationships between common biological markers (eg increases in cholesterol, triacylglycerol, central obesity and uric acid) and the development of overt chronic diseases including type 2 diabetes, hypertension, and heart disease are well documented.[1–10] More importantly, these risk factors may vary with ethnic/racial group, time and place of residence. For example, Mapuche Indians aged 20 years or older living in rural area of Chile had a lower prevalence rate of diabetes (<1%)[11] compared to Pima Indians in the USA with a prevalence rate of diabetes of up to 50%;[11,12] Mexican Americans had a 2.5-fold increased risk of type 2 diabetes[13] compared with non-Hispanic white Americans[11] and the prevalence of type 2 diabetes is very low in some Africa rural tribes[14] and in the Eskimo people.[15] However, the prevalence rate in Eskimo people has increased fourfold over the last two decades.[16] These findings strongly suggest that the risk factors responsible for chronic disease may include the interplay of genetic heterogeneity and manifold varieties of life-style in different ethnic/racial groups but few population-based studies have compared biological markers of metabolic syndrome and its sequelae between ethnic groups in Asia.

Recently, however, the community-based Li-Shin Outreaching Neighborhood Screening (LIONS) service that was established by Li-Shin Hospital in Pingjen, Taoyuan, northern Taiwan, has targeted three major ethnic subgroups: Hakka, Minnan, and mainlanders. The LIONS project addressed a wide range of chronic diseases, their markers, and risk factors; consequently, the project provided an opportunity to compare a series of biological markers of metabolic syndrome, type 2 diabetes, and heart disease in different groups.

METHODS

Study Population and Ethnic Group

This study was conducted in two townships, Jungli City and Pingjen City (Figure 1), two major administrative regions of Taoyuan, a county located in northern Taiwan with the third largest population (1,880,316 residents) according to data from population household registry of the year 2006 in Taiwan. The two cities are very similar in terms of lifestyle and habits and have a population size of approximately 350,000 and 190,000, respectively.

Taoyuan County has a diverse ethnic makeup, including Minnans, Hakkas, and Mainlanders. All three are considered Han Chinese, but they immigrated to Taiwan at different times and from different regions of mainland China. The Mainlanders, accounting for 13% of population in Taiwan, came from all geographic regions of Mainland China between 1949 and 1951 following the defeat of the Nationalists by the

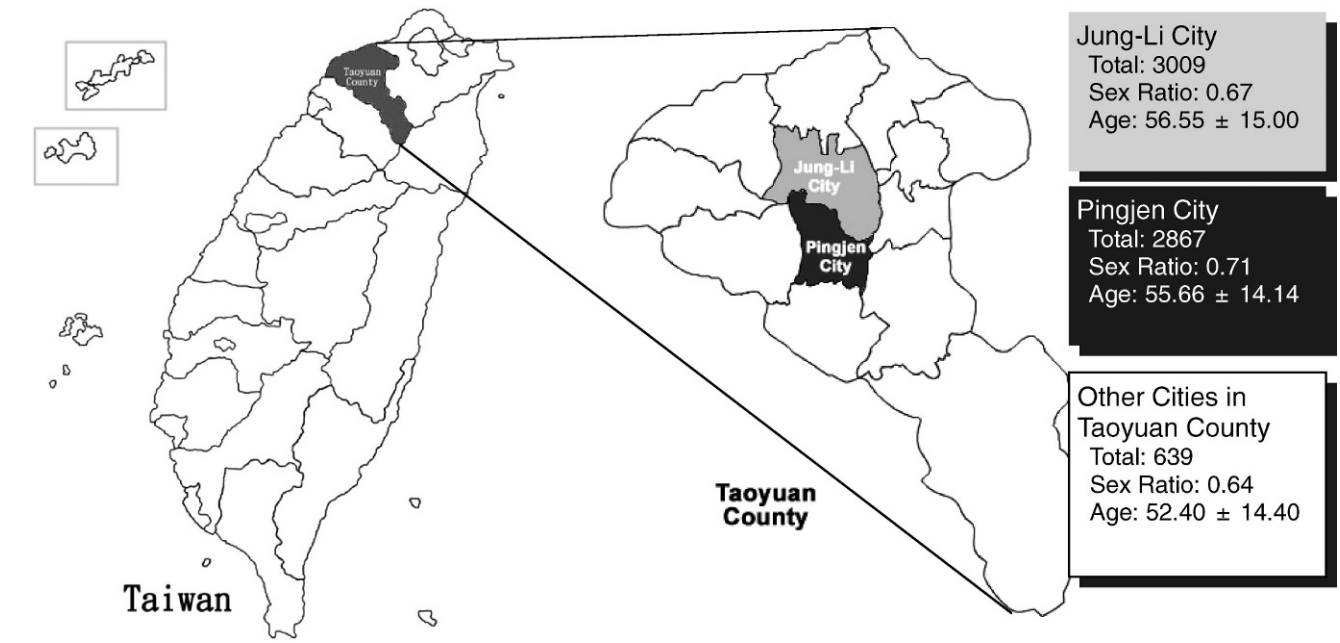

Fig 1. Geographic area and location of two areas covered by LIONs project

Communists in Mainland China. Accordingly, this group is likely to be representative of people living in Mainland China. The origin of the Minnan and Hakka people (so-called ''Taiwanese''), accounting for 85% of the population of Taiwan, is uncertain, but may derive from the Hundred Yueh, Burmese or Thais in southern China.[17–19] According to the Hakka Committee of Executive Administration Yuan national population-based survey, a variety of criteria for defining the Hakka ethnic exists and uses broad criteria (self-reported, maternal or paternal origin; 21.3% reporting both parents to be from the Hakka group and 30% having one parent from the Hakka group).[20] Using the criteria of Hakka origin as a Hakka mother, we estimated the ethnic composition of Taoyuan County to be 32.2% Hakka, 51.7% Minnan, 11.1% Mainlander, 1.8% aboriginal, and 2% others.

Implementation of the Screening Program

This screening program was conducted by Li-Shin Hospital, one of the largest community-based regional hospitals in Taoyuan, between 2002 and 2005. The preventive service model was modified from the integrated multiple community-based screening model[21,22] developed in Keelunga. Because the population in the two cities may be too small to evaluate the effectiveness of cancer screening in early followup, LIONS has, for now, focused on only chronic disease. Residents were invited to be screened through the LIONS project. The screening program was implemented in four phases.

1. Preparation. Appropriate facilities for on-site screening were located and prepared in each community.
2. Implementation. Attendees at the screenings were offered 10 tests: Pap smear for cervical cancer, fecal occult blood test for colorectal cancer, liver enzymes and hepatitis C virus antibodies for liver cancer, fasting blood glucose test for type 2 diabetes, blood pressure for hypertension, fasting lipid tests for hyperlipidemia, bone mineral density for osteoporosis, body mass index and fat distribution to assess obesity, and urine test for proteinuria. In addition, attendees completed a questionnaire on demographic information, medical history, and risk factors.
3. Dissemination of reports. Persons who required consultation and health education were identified according to predetermined criteria.[1]
4. Case management. High-risk participants or those with abnormal screening values were followed by the nurses who organized the LIONS program.

In addition to the biochemical test, questionnaire data included demographic information, medical history of chronic disease and medication, smoking, alcohol drinking and betel chewing habits, physical activity during past year, family history of diabetes and ethnicity. Height, weight and body fat were also recorded.

Criteria and Definitions of Abnormality

Type 2 diabetes and impaired fasting glucose were diagnosed according to

the guidelines of the American Diabetes Association.[23] Hypertension was diagnosed according to criteria established by the Fifth Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of Hypertension.[24] Cut-off points for other biological markers were defined according to the Taiwan Department of Health: total cholesterol ≥200 mg/dL, high-density lipoprotein cholesterol ≥35 mg/dL; triglyceride ≥150 mg/dL, and body mass index ≥27 kg/m^2 (obese) or 24–27 kg/m^2 (overweight).[25] All laboratory values were measured by the pathology laboratory in Li-Shin Hospital according to standard methods.

Statistical Methods

The prevalence of abnormalities was expressed as percentages and standard deviations. The multi-variable logistic regression model was used to estimate adjusted odds ratios with 95% confidence intervals for each risk factor after controlling for age, education, smoking, alcohol consumption, and betel nut chewing.

RESULTS

One hundred thirty-six sites were available for LIONS screening and 13,775 subjects participated in the neighborhoods of Jungli and Pingjen between 2002 and 2005. Since information on ethnic group was only collected between 2004 and 2005, the 4874 participants between 2002 and 2004 were excluded together with 111 subjects age ≤30 years and 1936 participants without information on maternal ethnicity or whose maternal ethnicity was different from the three groups examined in the present study leaving 6854 participants with complete data sets for analysis.

Table 1 shows the frequencies of parental miscegenation across the three ethnic groups of interest. Both parents were of the same ethnic origin in 88% (40% for Hakkas, 29% for Minnans and 19% for Mainlanders). Disparity of parental ethnic origin, present in 12% of subjects consisted of various combinations of parental ethnicity (see Table 1). The 21 participants (0.3%) whose mothers' ethnicity was in the groups of interest but whose fathers were not were excluded from further analysis.

Table 1. Distribution of the combination of mother and father ethnic group

The combination of mother and father ethnic group	Number	%
Both parents from Hakka ($M_{HA}F_{HA}$)	2730	39.8%
mother from Hakka and father from Minna ($M_{MI}F_{HA}$)	218	3.2%
mother from Hakka and father from Mainlanders ($M_{HA}F_{MA}$)	133	1.9%
mother from Minnan and father from Hakka ($M_{MI}F_{HA}$)	178	2.6%
Both parents from Minnan ($M_{MI}F_{MI}$)	1997	29.1%
mother from Minnan and father from Mainlander ($M_{MI}F_{MA}$)	279	4.1%
mother from Mainlanders and father from Hakka ($M_{MA}F_{HA}$)	5	0.1%
mother from Mainlanders and father from Minna ($M_{MA}F_{MI}$)	10	0.1%
Both parents from Mainlander ($M_{MA}F_{MA}$)	1283	18.7%
Others	21	0.3%
Total	6854	100.0%

Since the frequency of the heterogeneous ethnic origin of two parents, particularly for Mainlander mothers coupled with fathers from the two other ethnic groups was very low, the classification of ethnic group was defined by maternal origin as recommended by the Hakka Committee of the Executive Administration of Yuan.[20]

Table 2 shows females with Hakka and Minnan mothers were more likely to participate in the screening program than males, whereas males with Mainlander mothers were more likely to participate in the screening program. Age distribution varied among participants (Table 2). Younger participants were found in the Minnan and Hakka groups, whereas the Mainlander group had more elderly people. Participants with mothers from Minnan had a higher education level compared with the other two groups. Smoking, alcohol drinking, and betel quid chewing varied across the three subpopulations, with higher rates of smoking and alcohol drinking in Mainlanders but higher rates of betel nut chewing in Minnans and Hakkas. Since these are significant differences, these findings suggest that associations between biological risk markers and ethnicity may need to be adjusted for age, sex, educational level, smoking, alcohol drinking, and betel nut chewing.

Table 3 shows crude rates for abnormality of each biological risk marker. Rates of abnormality of body fat (P=.0208) and cholesterol (P=.0016) in female, and those of fasting glucose (P=.0004) and hypertension (P<.0001) were statistically significantly higher in Mainlanders than in Hakkas and Minnas. Rates of abnormality of triglyceride (P<.0001) and uric acid levels (P=.0029) in male were higher in Minnas than in Hakkas and Mainlanders. Rate of abnormality of cholesterol in male was higher in Hakkas and Minnas than in Mainlanders (P<.0001).

Table 4 shows adjusted odds ratios for the association between ethnic group and abnormality in biological risk markers by sex after controlling for age, education level, smoking, alcohol drinking, and betel quid chewing. Mainlanders had higher prevalence rate of obesity in the light of BMI and body fat composition than the two other subpopulations. Minnans had a higher abnormality rate of uric acid concentration than the two other ethnic groups.

DISCUSSION

This study used a community-based integrated screening program to deter-

Table 2. Distributions of age, sex, and education level by three ethnic groups

	Mother from Hakka		Mother from Minnan		Mother from Mainlander		Total		
	N	%	*N*	%	*N*	%	*N*	%	*P* value
Gender									<.0001
Female	1941	(62.9)	1703	(69.2)	422	(32.3)	4066	(59.3)	
Male	1147	(37.1)	758	(30.8)	883	(67.7)	2788	(40.7)	
Total	3088	(100.0)	2461	(100.0)	1305	(100.0)	6854	(100.0)	
Age Group									<.0001
30–39	537	(17.4)	724	(29.4)	111	(8.5)	1372	(20.0)	
40–49	828	(26.8)	659	(26.8)	143	(11.0)	1630	(23.8)	
50–59	764	(24.7)	558	(22.7)	138	(10.6)	1460	(21.3)	
60–69	607	(19.7)	323	(13.1)	83	(6.4)	1013	(14.8)	
70+	352	(11.4)	197	(8.0)	830	(63.6)	1379	(20.1)	
Total	3088	(100.0)	2461	(100.0)	1305	(100.0)	6854	(100.0)	
Education Level									<.0001
Graduate	40	(1.3)	81	(3.3)	27	(2.1)	148	(2.2)	
Undergraduate	518	(16.9)	539	(22.0)	224	(17.3)	1281	(18.8)	
Senior High School	843	(27.4)	667	(27.2)	305	(23.5)	1815	(26.6)	
Junior High School	490	(16.0)	326	(13.3)	224	(17.3)	1040	(15.3)	
Primary School	816	(26.6)	520	(21.2)	286	(22.1)	1622	(23.8)	
Literate	92	(3.0)	69	(2.8)	104	(8.0)	265	(3.9)	
Illiterate	273	(8.9)	248	(10.1)	126	(9.7)	647	(9.5)	
Total	3072	(100.0)	2450	(100.0)	1296	(100.0)	6818	(100.0)	
Smoking									<.0001
No	2537	(82.2)	2061	(83.7)	942	(72.2)	5540	(80.8)	
Ever	172	(5.6)	100	(4.1)	138	(10.6)	410	(6.0)	
Current	379	(12.3)	300	(12.2)	225	(17.2)	904	(13.2)	
Total	3088	(100.0)	2461	(100.0)	1305	(100.0)	6854	(100.0)	
Alcohol drinking									<.0001
No	2134	(81.3)	1750	(82.2)	902	(74.3)	4786	(80.2)	
Ever	96	(3.7)	52	(2.4)	74	(6.1)	222	(3.7)	
Current	396	(15.1)	328	(15.4)	238	(19.6)	962	(16.1)	
Total	2626	(100.0)	2130	(100.0)	1214	(100.0)	5970	(100.0)	
Betel quid chewing									.0010
No	2953	(95.6)	2348	(95.4)	1280	(98.1)	6581	(96.0)	
Ever	74	(2.4)	64	(2.6)	12	(0.9)	150	(2.2)	
Current	61	(2.0)	49	(2.0)	13	(1.0)	123	(1.8)	
Total	3088	(100.0)	2461	(100.0)	1305	(100.0)	6854	(100.0)	

mine the distribution of abnormality in common biological risk markers across three ethnic groups living in two townships of northern Taiwan. Taking mothers' ethnicity as the criterion for classification, only BMI, measures of body fat and serum uric acid varied with ethnicity.

One strength of our study was using participants from a community-based outreach screening program rather than subjects recruited from hospitals, thereby avoiding possible bias arising from enrollment of symptomatic patients, differences in socio-economic status and different health behaviors. Since our LIONS study consisted of three major ethnic groups and covered a wide range of chronic disease risks, we were able to compare the prevalence of abnormality in biological risk markers among the different ethnic groups. Another strength of the study concerns the etiology of abnormalities of common biological risk markers, which can be genetic or environmental, and the use of stratification by maternal origin can be regarded as a surrogate for genetic influences. However, variations with maternal ethnicity may also reflect differences in maternal diet or lifestyle or other factors during pregnancy or in early childhood that reflect differences in maternal approach to childcare and to the feeding of young children between the three groups. For example, Table 3 shows smoking, alcohol drinking and betel nut chewing vary with three subpopulations. However, after adjustment for demographic features and three risk factors, the abnormality rate of uric acid concentration was higher in Minnans whereas the prevalence rate of obesity in terms of BMI and body fat composition was higher in Mainlanders. These differences may reflect genetic differences though disparity in dietary habits is not excluded. Each ethnic group has retained dialect, customs, and social organization. However, the offspring of the three subpopulations, particularly Minnans and Hakks, have been assimilated after migration in many respects, including

Table 3. Crude abnormal rate of biological risk factors by three ethnic groups

	Mother from Hakka		Mother from Minnan		Mother from Mainlander		Total		
	N Abnormal/*N*	Abnormal rate%	*N* Abnormal/*N*	Abnormal rate%	*N* Abnormal/*N*	Abnormal rate%	*N* Abnormal/*N*	Abnormal rate%	*P* value*
BMI (>25)									
Female	657/1932	34.0%	551/1693	32.5%	151/422	35.8%	1359/4047	33.6%	.3893
Male	511/1142	44.7%	316/753	42.0%	405/876	46.2%	1232/2771	44.5%	.2176
Total	1168/3074	38.0%	867/2446	35.4%	556/1298	42.8%	2591/6818	38.0%	
Body fat distribution (female >30, male >25)									
Female	1098/1920	57.2%	911/1678	54.3%	256/417	61.4%	2265/4015	56.4%	.0208
Male	405/1127	35.9%	264/748	35.3%	266/855	31.1%	935/2730	34.2%	.0631
Total	1503/3047	49.3%	1175/2426	48.4%	522/1272	41.0%	3200/6745	47.4%	
HDL (<35)									
Female	11/1343	0.8%	19/1245	1.5%	2/326	0.6%	32/2914	1.1%	.1520
Male	30/794	3.8%	33/568	5.8%	34/603	5.6%	97/1965	4.9%	.1476
Total	41/2137	1.9%	52/1813	2.9%	36/929	3.9%	129/4879	2.6%	
CHO (>200)									
Female	959/1792	53.5%	760/1590	47.8%	219/402	54.5%	1938/3784	51.2%	.0016
Male	536/1078	49.7%	353/716	49.3%	331/827	40.0%	1220/2621	46.5%	<.0001
Total	1495/2870	52.1%	1113/2306	48.3%	550/1229	44.8%	3158/6405	49.3%	
TG (>150)									
Female	374/1792	20.9%	289/1590	18.2%	90/402	22.4%	753/3784	19.9%	.0613
Male	331/1078	30.7%	242/716	33.8%	169/827	20.4%	742/2621	28.3%	<.0001
Total	705/2870	24.6%	531/2306	23.0%	259/1229	21.1%	1495/6405	23.3%	
UA (female >6.0, male >7.0)									
Female	389/1792	21.7%	392/1590	24.7%	90/402	22.4%	871/3784	23.0%	.1207
Male	366/1078	34.0%	299/716	41.8%	318/827	38.5%	983/2621	37.5%	.0029
Total	755/2870	26.3%	691/2306	30.0%	408/1229	33.2%	1854/6405	28.9%	
HBP (SBP >140 or DBP >90)									
Female	465/1928	24.1%	373/1687	22.1%	94/417	22.5%	932/4032	23.1%	.3452
Male	365/1138	32.1%	210/752	27.9%	358/877	40.8%	933/2767	33.7%	<.0001
Total	830/3066	27.1%	583/2439	23.9%	452/1294	34.9%	1865/6799	27.4%	
GLU (>126)									
Female	95/1773	5.4%	83/1585	5.2%	27/399	6.8%	205/3757	5.5%	.4700
Male	73/1061	6.9%	29/709	4.1%	76/826	9.2%	178/2596	6.9%	.0004
Total	168/2834	5.9%	112/2294	4.9%	103/1225	8.4%	383/6353	6.0%	

* Comparison across ethnicity groups with chi-squared test

common languages (ie Mandarin) learned at school, training, education, modernization in lifestyle.

Limitations in our study included the unequal distribution of sex and age between ethnic groups. Also, ours is a screening program, variations in recruitment into or exit from the study cannot be excluded or indeed avoided. The higher proportion of Hakka and Minnan females reflects the high uptake of Pap smear examination that is a nationwide screening policy for prevention of cervical cancer. This may also contribute to the higher proportion of young participants in the Hakka and Minnan groups while the higher proportion of elderly people in the Mainlander group may be accounted for by the fact that the majority of young Mainlander offspring have already moved away to seek work. This can also account for the phenomenon that Minnan mothers had higher education level as they were younger and therefore more likely to have been exposed to better educational provision. However, since all analyses are stratified by sex and controlled for age and education, we believed that these biases are unlikely to have confounded our results. Thirdly, we were able to consider the combination of parental ethnicity, as seen in Table 1 but since we have classified ethnicity by maternal origin we cannot comment on the possible effects of paternal origin. Although miscegenation is rare the small number of such cases makes investigation of the effects of both parents impossible. However, re-analysis of the data by father's origin using stratification of mother's origin by ethnicity showed no major variation by maternal origin in any paternal group though those with Hakka mothers and Minnan fathers had a lower prevalence of hyperglycemia (OR=0.20, 95%CI=0.05–0.83, P=0.027). Thus, while paternal ethnicity may affect glycemia, lifestyle may be more important than genetic factors in determination of biological risk factor abnormality for obesity, body fat, uric acid, lifestyle, and especially diet are traditionally dominated by mothers in Chinese people. One concern may be whether the difference in BMI or fat distribution

Table 4. Adjusted odd ratios for the association between ethnic group and biological risk factors after controlling for age, sex, education level, smoking, alcohol drinking, and betel quid chewing

Variable	Male			Female		
	OR	95% CI	*P* value	OR	95% CI	*P* value
BMI (>25 kg/m^2 vs <25 kg/m^2)						
mother from Minnan	0.92	0.76, 1.12	.3977	1.04	0.89, 1.20	.6422
mother from Mainlander	1.30	1.02, 1.66	.0312	1.11	0.88, 1.40	.3858
Body fat distribution (male >25% or female >30% vs male <25% or female <30%)						
Mother from Minnan	0.87	0.71, 1.07	.1776	0.97	0.85, 1.12	.6958
Mother from Mainlander	1.60	1.23, 2.09	.0005	1.26	1.01, 1.59	.0437
HDL (<35 mg/dL vs >35 mg/dL)						
mother from Minnan	1.59	0.95, 2.68	.0805	2.09	0.98, 4.47	.0568
mother from Mainlander	1.32	0.68, 2.58	.4140	0.67	0.14, 3.16	.6167
CHO (>200 mg/dL vs <200 mg/dL)						
mother from Minnan	1.03	0.85, 1.25	.7500	0.91	0.79, 1.05	.1954
mother from Mainlander	0.91	0.71, 1.16	.4247	1.05	0.83, 1.32	.6818
TG (>150 mg/dL vs <150 mg/dL)						
mother from Minnan	1.12	0.91, 1.38	.2793	0.93	0.78, 1.11	.4211
mother from Mainlander	0.82	0.62, 1.09	.1707	1.07	0.81, 1.41	.6329
UA (male >7 mg/dL or female >6 mg/dL vs male<7 mg/dL or female<6 mg/dL)						
mother from Minnan	1.36	1.10, 1.68	.0049	1.32	1.11, 1.56	.0013
mother from Mainlander	1.15	0.88, 1.50	.3107	1.03	0.78, 1.34	.8599
HBP (SBP>140 mm Hg or DBP >90 mmHg vs SBP<140 mmHg or DBP<90 mmHg)						
mother from Minnan	0.98	0.79, 1.21	.8305	1.05	0.89, 1.25	.5479
mother from Mainlander	0.96	0.75, 1.23	.7348	0.80	0.60, 1.06	.1144
GLU (>126 mg/dL vs <126 mg/dL)						
mother from Minnan	0.69	0.44, 1.08	.1028	1.12	0.82, 1.54	.4640
mother from Mainlander	0.93	0.60, 1.45	.7468	1.29	0.81, 2.05	.2794

* Reference group: mother from Hakka

and uric acid across three subpopulations is caused by chance (type 1 error). However, it seems unlikely because of the 95% confidence interval and small *P* values (see Table 4), even after adjustment for both demographic factors and risk factors.

Implications for Future Research and Clinical Practice

Since abnormalities of the common biological risk markers examined (such as obesity and uric acid) are well-established risk factors for CVD, which are caused by both genetic and life-style factors, the current findings suggest significant requirements for the provision of advice on lifestyle modification. In Minnans, reduction in uric acid and in Mainlanders anti-obesity programs targeted at males appear the most necessary, while Hakkas appear to be more healthy than the two other groups as far as metabolic syndrome risk is concerned.

In conclusion, despite the rarity of miscegenation among the three main ethnic groups in Taiwan over the past four decades, most biological risk markers of diabetes and heart disease did not vary with ethnicity though more hyperuricemia was found in those with mothers from Minnan and more obesity was found in men with Mainlander mothers. Such findings are likely to be of value for the design of health policy for the prevention and early detection of chronic diseases in specific ethnic groups among Chinese peoples.

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