Chin-Shan Community Cardiovascular Cohort in Taiwan—baseline data and five-year follow-up morbidity and mortality

Yuan-Teh Lee^{a,*}, Ruey S. Lin^b, Fung C. Sung^b, Chi-Yu Yang^a, Kuo-Liong Chien^a,
Wen-Jone Chen^a, Ta-Chen Su^a, Hsiu-Ching Hsu^a, Yuh-Chen Huang^a

^aDepartment of Internal Medicine, National Taiwan University College of Medicine, 7 Chung-Shan South Road, Taipei, Taiwan 100

^bNational Taiwan University College of Public Health, Taipei, Taiwan

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Abstract

A cohort consisting of 3602 residents (82.8% of the target population) aged 35 years and older was established in 1990 in the Chin-Shan Community, a suburb 20 miles outside of metropolitan Taipei, Taiwan. The long-term objective was to investigate the prospective impact on cardiovascular health in a society undergoing transition from a developing to a developed nation. This article presents the study design, selected baseline risk factors of cardiovascular diseases (CVD), and CVD events at the 5-year follow-up evaluation with an emphasis on sociodemographic differences. The multivariate logistic regression analyses revealed that white-collar individuals were more likely than blue-collar workers to have dyslipidemia including high-density lipoprotein cholesterol (HDL-C) levels <35 mg/dl [odds ratio (OR) = 1.7, 95% confidence interval (CI) = 1.2–2.4] and low-density lipoprotein cholesterol (LDL-C) levels ≥ 160 mg/dl (OR = 1.3, 95% CI = 1.0–1.7). However, they were at slightly lower risk for stroke and CVD/sudden death, and at moderately higher risk for coronary artery disease and diabetes, although both these trends were not significant. Men were more likely than women to have HDL-C levels <35 mg/dl (OR = 1.8, 95% CI = 1.4–2.2), but they were less likely to have LDL-C levels ≥ 160 mg/dl (OR = 0.7, 95% CI = 0.6–0.8). The risk of CVD/sudden death was higher for men than for women during the follow-up period (OR = 1.9, 95% CI = 1.3–2.9). This could be due to risk factors such as a much higher prevalence of tobacco (61.9% vs. 4.5%) and alcohol (43.7% vs. 6.4%) use in men. In conclusion, individuals of higher socioeconomic status have a higher prevalence of dyslipidemia but slightly lower 5-year incidence of CVD events. © 2000 Elsevier Science, Inc. All rights reserved.

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1. Introduction

Since the Framingham Study [1,2], considerable research efforts have been expended to conduct prospective studies investigating factors associated with the development of cardiovascular diseases (CVD). Such efforts have provided important information, increased the awareness of cardiovascular risk factors, and helped to develop strategies for lipid, hypertension, and diabetes control, exercise, and smoking prevention [3–15]. It has been documented that mortality from strokes and ischemic or coronary heart disease has declined in developed Western countries since the mid-1960s [16]. However, few well-designed prospective studies have examined risk factors for cardiovascular diseases in populations of developing and underdeveloped areas.

Beaglehole [17] named cardiovascular disease “a haunting epidemic” in developing countries ever since the World Health Organization encouraged CVD prevention in 1991 [18]. By the year 2000, cardiovascular disease will be the leading cause of death in many developing countries [19]. For example, mortality from ischemic heart disease doubled in Singapore from 1959 through 1983. Hughes [20] considered this increase to be the consequence of increasing wealth. Rapid economic development over the past few decades has caused Singapore to become the highest ranking nation in Asia in terms of per capita income, second only to Japan. Taiwan, like many Asian countries, has seen a decline in deaths related to infectious diseases but has experienced a rapid increase in deaths resulting from chronic diseases, especially from cancer and cardiovascular diseases. Relative to the populations of Western countries, the Taiwanese population has a higher mortality rate from strokes and a lower death rate from coronary heart disease. Among CVD deaths in Taiwan (142 per 100,000 in 1990), 49.1% were from stroke, 39.4% from

* Corresponding author. Tel.: 886-2-2356-2000; fax: 886-2-2321-7522.
E-mail address: ytleee@ha.mc.ntu.edu.tw

heart disease, and 11.4% from hypertensive disease [21]. The risk of a stroke-associated death is four times higher in the Taiwanese population than in the American population [22].

Taiwan currently has the second highest population density in the world and the third highest per capita income in Asia. According to recent projections, this island nation will soon be able to classify itself as a developed country [23]. It is interesting to study the trends in cardiovascular diseases associated with this socioeconomic change, as well as to investigate the multiple interrelated characteristics of lifestyle, selected biochemistries of blood and urine, imaging studies, and other physiological conditions in this transitional society.

In 1990, a longitudinal study cohort was established in Chin-Shan, a suburban community 20 miles outside of Taipei, Taiwan. The primary objective of the Chin-Shan Community Cardiovascular Cohort (CCCC) Project was to measure the trends in and determinants of cardiovascular morbidity and mortality in a community that is experiencing rapid socioeconomic transition. The recent development of reliable blood chemistry analyses and ultrasonic imaging of heart and soft tissues has permitted the study team to initiate a thorough prospective investigation, identifying biochemical and physiological factors for cardiovascular diseases in this population. This report describes the study design, different findings by sociodemographic factors at baseline, and CVD events that occurred in the 5-year follow-up evaluation.

2. Methods

2.1. Study design and recruitment

Recruitment of study participants was initiated through extensive contacts with local population authorities to identify households with individuals of eligible age, excluding those in institutions. About 36% of the population in the Chin-Shan area were aged 35 and above in 1990; this percentage was reflective of the entire population in Taiwan. We contacted 4349 individuals of whom 747 (17.2%) did not respond, including 95 refusals and 652 individuals who could not be reached due to *working* outside of the local community. Of the 3602 (response rate 82.8%) individuals who participated in the baseline survey, 47.3% were men and 52.7% were women. Female participants were, on average, younger and usually not employed outside the home (Table 1). The level of education reported by participants also demonstrated a typical characteristic of developing Asian countries: individuals, especially women, who had not received formal education, were usually senior citizens. Most participants belonged to families headed by blue-collar employees. A new cohort is being recruited every 5 years and included into the project in order to distinguish the possible cohort effect existing in the population.

2.2. Home visiting and baseline examination

A clinic was set up at the Chin-Shan Community Health Center (CCHC) by the study team, which consisted of 20

Table 1

Percentage distribution of demographic characteristics of participants by gender in the Chin-Shan Community Cardiovascular study at baseline

Characteristics	Male (n = 1703)	Female (n = 1899)
Ages		
35–44	23.7	28.0
45–54	23.1	26.7
55–64	28.9	24.0
65–74	18.0	15.4
75+	6.3	5.9
Married		
Yes	89.4	82.7
No	10.6	17.3
Occupation		
White collar	15.2	11.8
Blue collar	52.4	18.0
Other	2.3	2.4
None	30.1	67.5
Insurance		
Government	6.1	5.0
Labor/farmer/fisherman	83.2	79.9
Others	10.7	15.1
Education		
None	28.1	51.7
1–9 years	63.2	45.1
10–12 years	5.6	2.6
13+ years	3.1	0.6

Gender differences of all variables were all significant at the 0.05 level.

senior medical students, 2 assistant nurses, 10 cardiologists and local practitioners, and the officers of CCHC. Fourteen community leaders who were familiar with the families in the community also assisted with the identification and recruitment of potential participants. A letter describing the purpose and procedure of the study was delivered to each potential participant as an invitation to the clinic. For nonrespondents, trained medical students were sent door-to-door, with the assistance of community leaders, to conduct a 2-h interview with each participant. These interviews collected baseline information such as demographic characteristics, lifestyle factors, dietary characteristics, and personal and family histories of diseases and hospitalization. With the consent of the participants, a physician and senior medical students conducted physical examinations and laboratory tests including electrocardiography, echocardiography, fundoscopic examination, and sonographic measurement of abdominal subcutaneous fat. Achilles tendon thickness was also measured using ultrasonic images.

Various data collected from the interviews, physical examinations, laboratory tests, and biochemical examinations are shown in Appendix 1. Urine and blood specimens were collected to determine levels of creatinine, uric acid, serum total cholesterol, serum triglycerides, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), lipoprotein(a), and apolipoproteins. Fasting blood samples for diabetes screening were also obtained from participants. Additionally, a 75-g oral dextrose test was given and glucose and insulin levels were determined 2 h after the glucose load [24]. Participants were later in-

formed of their blood pressure and plasma lipid results. Calibration was conducted for every 20 specimens in the laboratory for blood and urine analyses. The methods of specimen and analyses are listed in Appendix 2. The results of the physical exams, laboratory tests, and imaging studies were reviewed independently by senior cardiologists.

Participants whose physical exams or laboratory test results revealed abnormal findings were requested to have a second examination at the Chin-Shan Community Health Center or the National Taiwan University Hospital (NTUH). Those with elevated blood pressure, cholesterol, or other findings were advised to seek medical follow-up, which was provided by the CCHC, local practitioners, and NTUH on an as-needed basis. Interventions were also available to participants on a voluntary basis for hypertension control and lipid management [25].

2.3. Follow-up, study team, and diagnoses

The study team invited all participants to have biennial follow-up visits and examinations in 1992–93 and 1994–95 at the CCHC. The core personnel met every other week to discuss the field tasks being conducted, and medical students again participated in the study team as interviewers. Prior to joining the field tasks, all students were required to undergo a 2-week training course in internal medicine related to this study at the Department of Internal Medicine,

NTUH. Techniques in measuring blood pressure, taking notes, interviewing, teaching, interpersonal skills, as well as some public health issues, were emphasized in the training course. During the survey period, staff and students usually held discussion sessions after home visits. The medical students were responsible for administering the questionnaire and interviewing participants. Information on general health, events of cardiovascular illness (hypertension, stroke, and coronary heart disease), and hospitalizations and anthropometric measurements were collected at this time.

Urine and blood specimens were requested again during the follow-up visits. In the first follow-up examination, measurements of apolipoprotein A1, apolipoprotein B, lipoprotein(a), and coagulation factors (including fibrinogen, plasminogen activator inhibitor, tissue plasminogen activator, factor VII antigen, factor VII, and factor VIII) were taken. All samples collected were stored at -76°C using liquid nitrogen if not shipped at 4°C to NTUH clinic laboratory within 8 h for analyses.

2.4. Monitoring morbidity and mortality

Events of selected CVDs (identified in the follow-up visits) and deaths (identified from the government vital registry) were reviewed by physicians on the Committee of Mortality and Morbidity within the study team. Medical records were used to determine the likely cause of death. Four cardiologists were responsible for reviewing the questionnaires, medical records, and laboratory reports to determine

Table 2

Percentage distribution of lifestyle and baseline health status by gender in the Chin-Shan Community Cardiovascular study at baseline

	Male (<i>n</i> = 1703)	Female (<i>n</i> = 1899)	Difference ^a (95% CI)
Smoking: current	61.9	4.5	57.4 (54.9, 59.9)
Alcohol: current	43.7	6.4	37.3 (34.7, 39.9)
Betel nut: current	3.6	0.05	3.5 (2.2, 4.8)
Tea: current	31.4	18.5	12.9 (10.1, 15.7)
Coffee: current	6.9	8.8	−1.9 (−0.1, −3.7)
Exercise or laborious job:			
yes	69.4	49.3	20.1 (17.0, 23.2)
Body mass index, kg/m ²			
Mean $\pm$ SD	23.0 $\pm$ 3.3	24.6 $\pm$ 5.7	−1.6 (−1.8, −1.4)
75th percentile	25.0	26.0	
90th percentile	27.2	28.3	
Diabetes mellitus: yes	8.5	8.6	−0.1 (−1.9, 1.7)
CVA: yes	2.5	1.9	0.6 (−0.2, 1.4)
CAD: yes	4.5	3.5	1.0 (−0.3, 2.3)
Blood pressure (mmHg)			
Hypertension (Yes)			
Crude	25.7	30.8	−5.1 (−8.0, −2.2)
Age-adjusted	25.0	32.0	−7.0 (−10.0, −4.0)
Systolic $\geq$ 140			
Crude	19.7	25.7	−6.0 (−8.7, −3.3)
Age-adjusted	18.9	26.9	−8.0 (−10.7, −5.2)
Diastolic, $\geq$ 90			
Crude	14.1	15.5	−1.4 (−0.9, 3.7)
Age-adjusted	14.0	15.8	−1.8 (−0.5, 5.1)

All numbers are in percent except body mass index. CI: confidence interval; SD: standard deviation; CVA: cerebrovascular accident; CAD: coronary artery disease.

^aMale-to-female difference.

Table 3

Means, standard deviations (in parentheses) for selected levels of lipid and other factors by gender in the Chin-Shan Community Cardiovascular study at baseline

Factor	Male (<i>n</i> = 1703)	Female (<i>n</i> = 1899)	Difference ^a (95% CI)
Total cholesterol (mg/dl)	192.5 (44.7)	202.8 (45.8)	−10.3 (−13.3, −7.3)
Triglycerides (mg/dl)	128.5 (99.2)	123.4 (92.0)	6.3 (−0.2, 11.8)
Lipoprotein cholesterol (mg/dl)			
HDL-C	46.3 (12.9)	48.5 (12.4)	−2.2 (−3.8, −1.4)
LDL-C	132.7 (43.3)	142.2 (44.5)	−9.5 (−15.2, −3.8)
Lipoprotein(a)	14.0 (15.3)	14.5 (15.5)	−0.5 (−1.5, 0.5)
HDL/LDL ratio	0.40 (0.2)	0.38 (0.2)	0.02 (0.01, 0.03)
Uric acid (mg/dl)	6.4 (1.6)	5.0 (1.5)	1.4 (1.3, 1.5)
Blood pressure (mmHg)			
Systolic	124.2 (19.4)	126.9 (21.8)	−2.7 (−4.1, −1.3)
Diastolic	77.0 (11.2)	77.3 (11.2)	−0.3 (−1.1, 0.4)
Belly-skin-fold (mm)	12.0 (7.4)	17.6 (8.9)	−5.6 (−6.2, −5.0)
Left upper arm girth (cm)	25.7 (5.1)	26.0 (4.1)	−0.3 (−0.5, −0.1)
Total protein (mg/dl)	7.72 (0.7)	7.84 (0.7)	−0.12 (−0.2, −0.1)
Albumin (mg/dl)	4.67 (0.5)	4.67 (0.6)	0.0 (−0.04, 0.04)
Pre-albumin (mg/dl)	29.3 (9.8)	25.0 (6.4)	3.7 (3.2, 4.2)
Trans-ferritin (mg/dl)	270.5 (51.4)	283.1 (52.7)	−12.6 (−16.1, −9.1)

CI: confidence interval; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol.

^aMale-to-female difference.

whether each event met the protocol established by the project steering committee. Relatives of nonrespondents were contacted to obtain information on the health status of uncooperative individuals. Medical records were reviewed at CCHC, local clinics, and National Taiwan University Hospital. Using national vital statistics records, the study team was able to obtain information about deceased participants and determine the attributed cause of death.

Diagnostic criteria for cardiovascular diseases and deaths were adapted from the recommendations of the New York Heart Association and the American Heart Association [26–28]. Hypertension was diagnosed in individuals with systolic blood pressure at or above 140 mmHg and/or diastolic blood pressure at or above 90 mmHg, and in persons who were on antihypertension medications. Diabetes mellitus was diagnosed in those with fasting blood sugar levels higher than 140 mg/dl and in those with oral hypoglycemic agents or insulin treatment. Cerebrovascular disease was defined as a history of hemiparesis or hemiplegia confirmed by neurologists from NTUH by physical examination. Coronary heart disease was diagnosed by a history of myocardial infarction or electrocardiographic evidence of definite Q wave was found by the Minnesota Code [29].

2.5. Evaluation

For the baseline information reported in this article, we briefly described the study populations by gender, sociodemographic characteristics, lifestyle, baseline health status, and lipid profiles using either mean differences or differences in proportion to abnormal values. The 95% confidence intervals (CI) were provided for comparisons. An individual with a total cholesterol level ≥ 240 mg/dl, triglyceride level ≥ 200 mg/dl, HDL-C < 35 mg/dl, LDL-C ≥ 160 mg/dl, or lipoprotein(a) ≥ 32.5 mg/dl was considered to have dyslipidemia, in accordance with the Adult Treatment Panel II in the National Cholesterol Education Program (NCEP) of the U.S. [30]. Multivariable logistic regression analyses were also used to measure the relative risk of hypertension (yes vs. no), high LDL-C (≥ 160 vs. < 160 mg/dl), low HDL-C (< 35 vs. ≥ 35 mg/dl), and high TG (≥ 200 vs. < 200 mg/dl). Odds ratios (OR) and 95% CIs were estimated for different sociodemographic factors: gender, age, marital status, occupation, insurance status, and education level. In addition to reporting the incidence of selected CVDs and mortality from selected deaths in the follow-up period, logistic regression analyses were also used to measure the risk of CAD, stroke, DM, and mortality from CVD/sudden deaths for the above-mentioned sociodemographic factors.

3. Results

3.1. Baseline lifestyle and health status of study participants

Cigarette, alcohol, and tea use was prevalent in male study participants (Table 2): 61.9% of males were current

smokers and 43.7% were regular users of alcohol. About 5% of female participants were smokers and 6% were alcohol users. Women had a higher prevalence of hypertension (32.0% vs. 25.0%; 95% CI of the difference = 4.0–10.0%) and a higher average body mass index (24.6 vs. 23.0 kg/m², 95% CI of the difference = 1.4–1.8 kg/m²) than men. The prevalence of diabetes mellitus was similar between men and women; 8.5% for men and 8.6% for women. About 2.5% of the men had had a cerebrovascular accident (CVA) and 4.5% of the men had coronary artery disease (CAD). While both events were more prevalent in men than in women (1.9% and 3.5%, respectively), these differences were not statistically significant.

3.2. Blood biochemistries

Table 3 shows the average levels of lipid profiles and blood pressure. The average total cholesterol was significantly higher in women than in men (202.8 vs. 192.5 mg/dl; 95% CI of the difference = 7.3–13.3 mg/dl). Average levels of both HDL-C (48.5 vs. 46.3 mg/dl; 95% CI of the difference = 1.4–3.8 mg/dl) and LDL-C (142.2 vs. 132.7 mg/dl; 95% CI of the difference = 3.8–15.2 mg/dl) were significantly higher in women than in men. There was no significant difference between men and women in average level of lipoprotein(a). However, the average triglyceride level was higher in men than in women (128.5 vs. 123.4 mg/dl) at a borderline significance level. Average systolic blood pressure was also higher in women than in men (126.9 vs. 124.2 mmHg; 95% CI of the difference = 1.3–4.1 mmHg). Other average measurements that were significantly greater in women than in men included average belly-skin fold (17.6 vs. 12.0 mm), left upper arm girth (26.0 vs. 25.7 mm), total protein (7.84 vs. 7.72 mg/dl), and trans-ferritin (283.1 vs. 270.5 mg/dl). Men had higher levels of pre-albumin than women (29.3 vs. 25.0 mg/dl).

Table 4 compares the percentage of individuals with abnormal lipid profiles and other selected blood measurements between males and females. Calculation of crude and age-adjusted differences in the percentage of participants with dyslipidemia also revealed that the abnormalities were generally significantly more prevalent in women than in men in all categories. However, the largest gender difference in lipoprotein cholesterol was observed in prevalence of low levels of HDL-C with an age-adjusted difference of 8.9%, higher in men than in women.

Logistic regression analyses were constructed to estimate the predictability of gender, age, marital status, occupation, education level, and health insurance status in hypertension and dyslipidemia at baseline (Table 5). White-collar individuals, compared with blue-collar individuals, were at elevated risk of having higher LDL-C and TG, and lower HDL-C, but not hypertension. Retired or unemployed individuals showed a similar risk profile. This table also shows that compared with women, men were less likely to have a higher LDL-C level (OR = 0.7, 95% CI = 0.6–0.8), but

Table 4

Crude and age-adjusted percent of study participants with dyslipidemia and elevated levels in other components by gender in the Chin-Shan Community Cardiovascular study at baseline

Factor	Male (<i>n</i> = 1703)	Female (<i>n</i> = 1899)	Difference ^a (95% CI)
Total cholesterol (≥240 mg/dl)			
Crude	13.9	19.6	−5.7 (−8.1, −3.3)
Adjusted	13.8	20.3	−6.5 (−9.0, −4.0)
Triglycerides (≥200 mg/dl)			
Crude	25.2	23.1	2.1 (0.7, 3.5)
Adjusted	25.6	23.6	2.0 (0.6, 4.4)
Lipoprotein cholesterol (mg/dl)			
HDL-C, <35			
Crude	21.8	13.6	8.2 (5.7, 10.7)
Adjusted	22.9	14.0	8.9 (6.4, 11.4)
LDL-C, ≥160			
Crude	23.3	28.4	−5.1 (−8.9, −2.3)
Adjusted	23.1	31.3	−8.2 (−11.1, −5.3)
Lipoprotein(a), ≥32.5			
Crude	9.5	12.2	−2.7 (−4.7, −0.7)
Adjusted	9.5	12.3	−2.8 (−4.8, −0.8)
HDL/LDL Ratio, <0.20			
Crude	10.0	8.6	1.4 (−0.5, 3.3)
Adjusted	9.9	8.4	1.5 (−0.4, 3.4)
Uric acid (≥7.9 mg/dl)			
Crude	16.9	4.3	12.6 (10.6, 14.6)
Adjusted	16.9	4.4	12.5 (10.5, 14.5)
Total protein (≥8.5 mg/dl)			
Crude	8.5	12.2	−3.7 (−5.7, −1.7)
Adjusted	8.5	12.2	−3.7 (−5.7, −1.7)
Albumin (≥5.3 mg/dl)			
Crude	10.5	9.7	−0.8 (−2.8, 1.2)
Adjusted	10.7	9.8	−0.9 (−2.9, 1.1)
Pre-albumin (≥36 mg/dl)			
Crude	16.3	5.0	11.3 (9.3, 13.3)
Adjusted	16.6	5.1	11.5 (9.5, 13.5)
Trans-ferritin (≥341 mg/dl)			
Crude	7.6	11.9	−4.3 (−5.3, −3.3)
Adjusted	7.7	11.5	−3.8 (−4.8, −2.8)

CI: confidence interval; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol.

^aMale-to-female difference.

more likely to have a lower HDL-C level (OR = 1.8, 95% CI = 1.4–2.2), and a higher TG level (OR = 1.2, 95% CI = 1.0–1.4).

3.3. Cardiovascular events found in the follow-up surveys

The study team completed the first follow-up survey in September 1993 and the second follow-up survey in October 1995 with a response rate of 88.7% among the 3368 survivors in the 1995 survey (*n* = 2,988, 45.3% males and 54.7% females). Most of the nonrespondents (*n* = 380 or 11.3%) had either moved away or were unreachable. In these two follow-up surveys, 752 individuals with 969 new events of cardiovascular disease and 217 new cases of diabetes were diagnosed (Table 6). As of February 1996, the

national vital statistics identified 369 deaths. Overall, men tended to have higher event rates than women in both mortality and incidence of diseases, except for strokes where men and women had similar incidence rates. Table 7 shows that men were more likely than women to have a higher rate from CVD/sudden death (OR = 1.9, 95% CI = 1.3–2.9). White-collar workers were less likely than blue-collar workers to have stroke or CVD/sudden deaths, but these differences were not statistically significant. White-collar workers also exhibited moderately elevated odds ratios for the incidence of CAD and DM, but this effect was not at a statistically significant level. Individuals with at least a primary school education had higher incidence of DM than did individuals with no formal education.

4. Discussion

The baseline recruitment (82.8% response rate) and the follow-up (response rate 88.7%) were successful for at least two reasons: (a) the study team was able to organize an enthusiastic group to make door-to-door visits to eligible individuals' participation, and (b) community leaders' assistance in the project made participant recruitment much easier. In addition, community residents with higher awareness of individual health were pleased to receive a comprehensive examination to look for precursors of cardiovascular events. The nonrespondents were mainly young individuals who worked outside the Chin-Shan area.

There are many population-based prospective studies in North America (e.g., Framingham, Bogalusa, Evans County, Stanford, Minnesota, ARIC, Honolulu, and Manitoba) and Europe [e.g., World Health Organization Monitoring and Cardiovascular (MONICA) Projects] [1–15,31–33]. While they have certainly provided important epidemiologic clues for understanding the pathophysiology of CVD, few studies have prospectively examined CVD in Asian populations. Although the MONICA Projects include Sino-MONICA and Japan-MONICA [33], the basic objective of MONICA is to measure a 10-year trend in cardiovascular mortality and morbidity and the associated population-based risk factors. The Taiwan CCCC study is unique because its objective is to observe the impacts of socioeconomic change on the development of CVD in a society in transition. In addition, this study was designed to add a new cohort to the study pool every 5 years. Newly eligible 35- to 39-year-old residents in Chin-Shan are being recruited into the study at 5-year intervals, allowing for future investigation of the cohort effect.

In addition, the CCCC study is distinct from other studies because it primarily consists of blue-collar workers and includes a large number of housewives and other female participants. This population is representative of the general Taiwanese population, but has a lower overall education level than the urban population. This difference in education level may be linked to higher rates of risky behaviors such as smoking in men and higher fat consumption. Even if this is the case, it is still a valid goal to study dyslipidemia and

Table 5

Odds ratios of hypertension and dyslipidemia by sociodemographic factors in the Chin-Shan Community Cardiovascular study at baseline

	Hypertension OR (95% CI)	LDL-C OR (95% CI)	HDL-C OR (95% CI)	TG OR (95% CI)
Gender				
Male	0.96 (0.8–1.2)	0.7 (0.6–0.8)	1.8 (1.4–2.2)	1.2 (1.0–1.4)
Female	1.0	1.0	1.0	1.0
Age				
35–54	1.0	1.0	1.0	1.0
55–64	2.0 (1.5–2.5)	1.9 (1.6–2.3)	1.4 (1.1–1.8)	1.2 (1.0–1.4)
65+	2.5 (1.9–3.3)	1.8 (1.5–2.3)	1.4 (1.0–1.8)	1.1 (0.9–1.4)
Married				
No	1.0	1.0	1.0	1.0
Yes	1.0 (0.6–1.6)	1.3 (0.8–2.0)	0.7 (0.4–1.2)	1.6 (1.0–2.7)
Occupation				
Blue collar	1.0	1.0	1.0	1.0
White collar	1.1 (0.8–1.5)	1.3 (1.0–1.7)	1.7 (1.2–2.4)	1.4 (1.1–1.9)
Others ^a	1.1 (0.9–1.5)	1.2 (1.0–1.5)	1.4 (1.1–1.9)	1.4 (1.1–1.7)
School Education				
None	1.0	1.0	1.0	1.0
Yes	1.1 (0.9–1.4)	1.1 (0.9–1.3)	1.1 (0.9–1.4)	1.2 (1.0–1.5)
Insurance				
Government	1.0	1.0	1.0	1.0
Labor ^b	1.1 (0.7–1.8)	0.9 (0.7–1.3)	0.9 (0.6–1.4)	0.9 (0.7–1.3)
Other	1.2 (0.7–2.0)	0.9 (0.7–1.4)	1.2 (0.8–1.9)	1.0 (0.7–1.5)

LDL-C: low-density lipoprotein cholesterol ≥ 160 mg/dl; HDL-C: high-density lipoprotein cholesterol < 35 mg/dl; TG: triglycerides ≥ 200 mg/dl; OR: odds ratio; CI: confidence interval.

^aRetired and unemployed.

^bLabor insurance covered also farmers and fishermen.

other factors associated with the development of hypertension, ischemic heart disease, atherosclerosis, and other cardiovascular events. In planning this investigation, the study team observed that this target population is different from those of other studies. This population was in a higher risk group in terms of lipid profile according to the team's historical experience in this area. On the other hand, the population in this community devotes a large amount of time to farming, fishing, and other labor-intensive occupations.

In two studies done in the rural village of San-Chih, Taipei County, the prevalence of hyperlipidemia (total cholesterol level ≥ 250 mg/dl) increased twofold from 5.5% in 1973 to 10.8% in 1991 [34,35]. A fivefold increase in CAD prevalence, from 0.6% to 3.1%, was reported during the same time period. Chin-Shan is a more urban community than San-Chih; the Chin-Shan study cohort had a prevalence rate of 16.9% for hyperlipidemia (total cholesterol ≥ 240 mg/dl) and a prevalence rate of 4.1% for CAD. As Taiwan makes its transition to a developed nation, the per capita daily energy consumption from fat has increased from 22% in 1971 to 28% in 1981, 37% in 1991, and 40% in 1995 [36]. As fat consumption continues to increase in Taiwan, we predict that the prevalence of dyslipidemia will also increase, particularly among uninformed populations.

Similar to blood lipid levels, smoking levels among participants of the CCCC study were consistent with those of the general population of Taiwan as reported by other cross-sectional studies [37–40]. The prevalence rate of smoking in

Chin-Shan was lower than the rates in areas of mainland China such as Beijing and Quanzhou (71% and 78% for men and 3.2% and 31% for women, respectively). But the prevalence of abnormal total cholesterol was much lower for people in Beijing and Quanzhou (about 175 mg/dl on average) [41]. The average blood cholesterol level for this study cohort may be comparable with that of the U.S. population [6,7,41]. In addition, the prevalence of hypertension for men in the CCCC project was similar to that found in a study conducted in the U.S. [42]. CCCC women, though, were found to have a higher prevalence of hypertension than U.S. women [42]. Further-

Table 6

Incidence cases and rates (per 1000 person-years) of cardiovascular diseases, diabetes mellitus, and death identified in the follow-up surveys, Chin-Shan Community Cardiovascular study

Events	Male No. (rate)	Female No. (rate)	Male-to-Female RR (95% CI)
Disease			
CAD	51 (8.7)	48 (7.2)	1.21 (0.82–1.79)
Hypertension	290 (49.2)	289 (43.4)	1.13 (0.96–1.33)
Stroke	35 (5.9)	39 (5.9)	1.00 (0.63–1.58)
Diabetes	112 (19.0)	105 (15.8)	1.20 (1.08–3.57)
Death			
CVD/sudden death	67 (7.0)	42 (5.3)	1.32 (0.90–1.94)
Cancer	72 (7.5)	38 (4.8)	1.56 (1.07–2.35)
Others	90 (9.4)	60 (7.5)	1.25 (0.90–1.73)

RR: relative risk, a rate ratio; CI: confidence interval.

Table 7

The estimated relative risk of CAD, stroke, and DM incidence, and CVD/sudden death at follow-up evaluation by baseline sociodemographic factor, Chin-Shan Community Cardiovascular study

	CAD OR (95% C.I.)	Stroke OR (95% C.I.)	CVD/sudden death OR (95% C.I.)	DM OR (95% C.I.)
Gender				
Male	1.1 (0.8–1.6)	1.1 (0.6–1.8)	1.9 (1.3–2.9)	1.3 (0.9–1.8)
Female	1.0	1.0	1.0	1.0
Age				
35–54	1.0	1.0	1.0	1.0
55–64	2.4 (1.5–3.7)	2.4 (1.2–4.9)	2.5 (1.2–5.0)	1.6 (1.2–2.3)
65+	2.7 (1.6–4.4)	4.9 (2.3–10.2)	11.3 (5.9–21.7)	1.4 (0.9–2.3)
Married				
No	1.0	1.0	1.0	1.0
Yes	0.9 (0.4–2.4)	0.5 (0.2–1.3)	2.6 (0.8–8.5)	0.9 (0.4–2.0)
Occupation				
Blue collar	1.0	1.0	1.0	1.0
White collar	1.5 (0.9–2.7)	0.8 (0.3–2.5)	0.8 (0.3–2.0)	1.4 (0.9–2.3)
Others ^a	1.0 (0.7–1.7)	1.2 (0.6–2.3)	1.2 (0.7–2.0)	1.5 (1.0–2.2)
School Education				
None	1.0	1.0	1.0	1.0
Yes ^b	0.8 (0.6–1.2)	0.6 (0.4–1.1)	0.8 (0.5–1.2)	1.3 (1.0–1.9)
Insurance				
Government	1.0	1.0	1.0	1.0
Labor ^c	1.1 (0.5–2.2)	1.3 (0.4–3.6)	0.6 (0.3–1.1)	0.9 (0.5–1.5)
Other	1.0 (0.5–2.3)	1.1 (0.3–3.4)	0.6 (0.3–1.3)	1.2 (0.6–2.3)

CAD: coronary artery disease; DM: diabetes mellitus; OR: odds ratio; CI: confidence interval.

^aRetired and unemployed.

^bSix years and above.

^cLabor insurance covered also farmers and fishermen.

more, smoking rates among men in Chin-Shan and Taiwan were more than double the rate of American men, although smoking rates were much lower among Taiwanese women than among American women [43,44]. Smoking cigarettes, particularly American cigarettes, has become fashionable for men in Taiwan and has increased from 40% in 1987 to the current rate of 60% [31,43]. Smoking has traditionally been considered inappropriate behavior for women in Taiwan, which accounts for the low smoking rate among women.

Some of the interesting findings revealed by the baseline information and lipid results were that although white-collar individuals had an elevated risk of having dyslipidemia (Table 5), with insignificantly elevated risk of diabetes and death from CAD (Table 7), they were not at an elevated risk of stroke or CVD/sudden death. This phenomenon suggests no strong evidence of a relationship between dyslipidemia and the likelihood of CVD events among social classes in this community cohort. Individuals with at least a primary school education are slightly less likely to hold blue-collar jobs and also have a slightly increased likelihood of having dyslipidemia because they are more affluent and presumably consume more calories from fat. White-collar individuals in general have received a school education and have better access to health care. These factors lead to a small and insignificant reduction from stroke and CVD/sudden death. On the other hand, they may have a higher risk of diabetes and death from CAD, although this finding was also not statistically significant.

Thus, the sociodemographic status in this cohort may have a significant association with the risk of dyslipidemia, but this effect is not strong enough to alter the overall risk of cardiovascular events. As the majority of the study population received no more than 9 years of education, the overall awareness of cardiovascular disease prevention may be low, yet at the same time this cohort is at risk for developing dyslipidemia because of improved economic status in recent years.

Although women in this study were generally younger than men, they were more likely than men to have hyperlipidemia. Similarly, hypertension was more prevalent in women, although they had lower prevalence rates of CVA and CAD than in men at baseline. Women also had a lower incidence of hypertension and CAD than men in the follow-up years. However, multivariate logistic regression analysis for the follow-up surveys revealed that men were 1.9 times more likely than women to have CVD/sudden death. We found that hypertension was the most important risk factor (risk ratio, $RR = 5.20$, 95% $CI = 3.16, 8.58$; data not shown), followed by smoking status ($RR = 2.34$, 95% $CI = 1.23, 4.46$) and lower levels of HDL-C ($RR = 1.59$, 95% $CI = 1.0, 2.55$). Because the smoking rate was as high as 62% in men, it is possible that patients with CVD have followed their physicians' suggestions to quit smoking but that they did not quit soon enough.

Based on the Chin-Shan baseline data, the population in Taiwan is at a higher risk than ever for CVD. Without modifications in dietary behavior and lifestyle, the incidence of CVD

will remain at a peak level [21]. However, it is also important to identify the difference between men and women for incidence of dyslipidemia and CVD and deaths from cardiovascular events. The longitudinal nature of the CCCC project enhances its ability to identify risk factors for CVD. Further analyses will emphasize the secular changes in lipid profiles and other biomarkers from baseline to follow-up surveys, stratified by sociodemographic factors, and will investigate their associations with the development of new CVD cases and

deaths. Intervention referrals have been provided to the study cohort and will be followed for individuals at higher risk.

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Appendix 1

Elements of baseline survey and examination in the *Chin-Shan Community Cardiovascular* study

Demographic variables	Sex, birth date, ethnicity, education, marital status, religion, insurance, occupation
Lifestyle factors	Smoking, alcohol, tea/coffee, betel nut, exercise, stress
Personal/family health history	Hypertension, diabetes, stroke, CAD, heart disease, arrhythmia, rheumatism, lipidemia, etc.
Blood pressure/anthropometry	Weight, height, skinfold, bellyfold, etc.
Physical examination	Heart, lung, extremities, spine, arcus senilis xanthelasma/xanthoma, other chest/heart/cardiovascular exams
Ultrasound/electrocardiogram	2-Dimensional, M-mode measurement, Color and Doppler mapping, echocardiography
Eye fundography	Macular, eye ground, vessels characteristics
Blood/urine chemistry	Lipid profiles ^a , uric acid, blood urea nitrogen, creatinine, pre-albumin, blood cell count, sugar, electrolytes.

^aTotal cholesterol, triglycerides, high-density lipoprotein, low-density lipoprotein, lipoprotein(a), lipoprotein, apolipoprotein A1, apolipoprotein B, and coagulation factors.

Appendix 2

Laboratory measurements and methods used in the *Chin-Shan Community Cardiovascular* study

Specimen	Measurement	Method
Blood	Total cholesterol	Enzymatic [45]
	Lipoprotein phenotyping	Precipitation [46, 47]
	Total triglycerides	Enzymatic [48]
	Blood count	Counter [49]
	Electrolytes	ISE (ion-selective-electrode) [50]
	Proteins	Biuret [51]
	Apolipoproteins	Turbidimetric immunoassay [52]
	Lipoprotein(a)	ELISA [53]
Urine	Glucose	Enzymatic [54]
	Electrolytes	ISE (ion-selective-electrode) [50]

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