



A novel cardiovascular death prediction model for Chinese individuals: A prospective cohort study of 381,963 study participants



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ABSTRACT

Background and aims: We aimed at developing a novel risk prediction model for death from cardiovascular disease (CVD) for Chinese individuals, based upon a large cohort from Taiwan.

Methods: This Chinese cohort came from Taiwan, with 381,963 individuals free from CVD, recruited from a private health surveillance program. With a median follow-up of 8.8 years, 1894 CVD deaths out of a total of 10,829 deaths were identified by linking cohort ID with the National Death File.

Results: A novel CVD death risk prediction model for Chinese individuals was established from this cohort. An increase in the resting heart rate was the statistically independent predictor in this model. The discriminatory accuracy was measured by generating the receiver operating characteristic (ROC) curve, and the area under the ROC curve was 0.913 (95% CI = 0.907 to 0.920).

Conclusions: A novel cardiovascular death prediction model with high predictability for Chinese individuals was demonstrated in the present study.

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1. Introduction

Cardiovascular diseases (CVD), one of the leading contributors to mortality, impose a huge medical and economic burden worldwide [1,2]. Despite the improvement in the diagnosis and the management of CVD, the mortality attributed to CVD is still high [1,2]. To attenuate the CVD associated morbidity and mortality in the general population, there is an urgent need to institute an appropriate, accurate and easily accessible population-specific risk prediction model for death from CVD.

The conventional risk factors for CVD development have been well defined; furthermore, emerging biomarkers as predictors of CVD and CVD related death have also been proposed [3–7]. Indeed, numerous CVD risk prediction models have been reported [8–14]. However, most are derived from the studies conducted in the western population [8–14]; moreover, overestimation of the risk of developing CVD and CVD associated death for non-western population was observed [15–20]. To identify Chinese individuals at risk

of death attributable to CVD, this prospective study attempted to construct a CVD death prediction model specifically for Chinese individuals using a large number of study participants with an extended follow-up period.

2. Materials and methods

2.1. Data collection

All subjects aged 20 years or older, participating in a standard health-screening program (the MJ Health Group, Taiwan) between 1994 and 2008, were recruited. Individuals with known heart disease or with outliers of resting heart rate <40 beats per min were excluded. Finally, a study cohort of 381,963 apparently healthy individuals was established.

The study participants underwent blood and urine tests, body measurements, functional tests, physical examination and completed a comprehensive health history questionnaire to collect the medical history and demographic data. Smoking and drinking were identified according to the following questionnaires, “Do you now smoke cigarettes?” and “Did you drink alcohol at least 12 times per year?” Physical activity was defined as metabolic

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Table 1
Characteristics of subject and risk factors identified for cardiovascular disease mortality.

Characteristic	Total subjects		CVD mortality rate Death rate per 1000	Cause of deaths				OR ^a	95% CI
	N	(%)		Non CVD death		CVD death			
			n	(%)	n	(%)			
Age									
20–29	83751	(21.9)	0.2	312	(94.5)	18	(5.5)	0.04	(0.02,0.06)
30–39	116083	(30.4)	0.6	608	(89.9)	68	(10.1)	0.10	(0.08,0.13)
40–49	71737	(18.8)	1.8	915	(87.4)	132	(12.6)	0.31	(0.25,0.38)
50–59	60690	(15.9)	5.8	1931	(84.7)	350	(15.3)	1.00	–
60–69	36985	(9.7)	17.5	2950	(82.0)	647	(18.0)	2.96	(2.60,3.37)
≥70	12717	(3.3)	53.4	2219	(76.6)	679	(23.4)	9.14	(8.02,10.42)
Gender									
Male	178205	(46.7)	6.5	5422	(82.5)	1154	(17.5)	1.64	(1.49,1.80)
Female	203758	(53.3)	3.6	3513	(82.6)	740	(17.4)	1.00	–
BMI									
<18.5	30867	(8.1)	3.4	589	(85.0)	104	(15.0)	1.34	(1.08,1.67)
18.5 ≤ BMI < 23	169139	(44.3)	3.5	3367	(85.2)	585	(14.8)	0.94	(0.83,1.07)
23 ≤ BMI < 25	78038	(20.4)	5.5	1987	(82.1)	433	(17.9)	1.00	–
≥ 25	103919	(27.2)	7.6	2992	(79.5)	772	(20.5)	1.28	(1.13,1.44)
Smoking status									
Never	247112	(70.1)	3.4	4103	(83.0)	841	(17.0)	1.00	–
Ex-smoker	21755	(6.2)	10.3	1001	(81.8)	223	(18.2)	1.50	(1.27,1.77)
Current smoker	83573	(23.7)	6.6	2697	(83.1)	549	(16.9)	2.00	(1.76,2.28)
Drinking status									
Never or occasional	268020	(76.7)	3.8	4945	(82.9)	1022	(17.1)	1.00	–
Regular drinker	81405	(23.3)	6.8	2776	(83.4)	551	(16.6)	1.37	(1.22,1.54)
Physical activity									
Inactive	201440	(53.9)	4.8	3913	(80.3)	957	(19.7)	1.41	(1.28,1.55)
Active	172539	(46.1)	4.9	4660	(84.5)	852	(15.5)	1.00	–
Anemia									
No	352607	(92.3)	4.6	7475	(82.1)	1627	(17.9)	1.00	–
Yes	29356	(7.7)	9.1	1460	(84.5)	267	(15.5)	1.48	(1.29,1.69)
Systolic blood pressure (mmHg)									
<140	325969	(85.3)	2.4	5415	(87.4)	779	(12.6)	1.00	–
≥140	55994	(14.7)	19.9	3520	(75.9)	1115	(24.1)	2.43	(2.20,2.69)
Mean pulse pressure (± SE)			47.77					1.02	(1.02,1.02)
Mean arterial pressure (± SE)			88.38					1.04	(1.03,1.04)
Fasting glucose (mg/dL)									
<126	365071	(95.6)	4.2	7388	(82.7)	1542	(17.3)	1.00	–
≥126	16892	(4.4)	20.8	1547	(81.5)	352	(18.5)	1.81	(1.60,2.04)
Total cholesterol (mg/dL)									
<150	37201	(9.7)	3.2	841	(87.5)	120	(12.5)	1.34	(1.08,1.66)
150–179	104563	(27.4)	3.0	1992	(86.5)	311	(13.5)	1.00	–
180–199	84618	(22.2)	4.4	1760	(82.5)	373	(17.5)	1.14	(0.98,1.33)
200–239	112033	(29.3)	5.4	2790	(82.1)	607	(17.9)	1.08	(0.94,1.25)
240–299	39628	(10.4)	10.0	1333	(77.0)	398	(23.0)	1.60	(1.38,1.87)
≥300	3920	(1.0)	21.7	219	(72.0)	85	(28.0)	3.34	(2.61,4.28)
High-density lipoprotein									
<35	334770	(88.8)	4.2	6970	(83.2)	1405	(16.8)	2.10	(1.88,2.35)
≥35	42339	(11.2)	10.6	1772	(79.8)	449	(20.2)	1.00	–
Low-density lipoprotein									
<70	22214	(5.8)	5.6	681	(84.6)	124	(15.4)	1.78	(1.43,2.22)
70–99	87970	(23.0)	2.8	1607	(86.8)	245	(13.2)	1.00	–
100–129	138540	(36.3)	3.8	2898	(84.5)	533	(15.5)	1.02	(0.88,1.19)
130–159	89717	(23.5)	6.0	2269	(80.9)	536	(19.1)	1.21	(1.04,1.42)
160–189	32401	(8.5)	8.7	1027	(78.5)	281	(21.5)	1.47	(1.24,1.75)
≥190	11121	(2.9)	15.7	453	(72.1)	175	(27.9)	2.49	(2.04,3.04)
Triglycerides									
<200	340329	(89.1)	4.7	7351	(83.3)	1476	(16.7)	1.00	–
≥200	41527	(10.9)	10.2	1583	(79.1)	418	(20.9)	1.60	(1.43,1.78)
Proteinuria									
Normal	337277	(92.5)	4.2	6973	(83.1)	1422	(16.9)	1.00	–
Minimal proteinuria ^b	25037	(6.9)	14.1	1447	(80.4)	353	(19.6)	2.27	(2.02,2.57)
Overt proteinuria ^b	2261	(0.6)	45.1	396	(79.5)	102	(20.5)	4.70	(3.79,5.82)
Uric acid level									
<7	285915	(74.9)	4.0	6064	(84.1)	1145	(15.9)	1.00	–
≥7	96048	(25.1)	7.8	2871	(79.3)	749	(20.7)	1.48	(1.35,1.64)
AST, IU/L									
<25	277067	(72.5)	4.1	4668	(80.4)	1138	(19.6)	1.00	–
25–39	82157	(21.5)	6.9	2433	(81.0)	572	(19.0)	0.99	(0.89,1.09)
40–59	14475	(3.8)	13.7	822	(88.2)	110	(11.8)	1.12	(0.92,1.37)
≥60	8264	(2.2)	20.2	1012	(93.2)	74	(6.8)	1.21	(0.95,1.54)

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