

CKB-CVD 模型

(1) 简介

基于中国慢性病前瞻性 (CKB) 研究, 我国学者开发了 30-79 岁国人的 10 年缺血性心脏病、缺血性卒中和出血性卒中风险的预测模型 (CKB-CVD 模型)。

(2) 危险因素

危险因素: 年龄、收缩压、舒张压、降压治疗、当前吸烟、糖尿病和腰围。

(3) 评分规则

根据下图的具体系数, 代入公式, 就可以获得 10 年心血管疾病风险。预测变量的中心点如下: 年龄 55 岁, sbp 120 mmHg, dbp 80 mmHg, wai 80 cm。具体计算方法可见示例。

Predictor	Women Ischemic heart disease	Women Ischemic stroke	Women Hemorrhagic stroke	Men Ischemic heart disease	Men Ischemic stroke	Men Hemorrhagic stroke
Baseline age (age), years	0.0666511	0.0740794	0.0820293	0.0716554	0.0835158	0.0820196
Systolic blood pressure (sbp), mmHg	0.0022094	0.0087970	0.0147824	0.0052816	0.0124603	0.0168301
Diastolic blood pressure (dbp), mmHg	0.0052584	0.0100736	0.0280181	0.0091778	0.0140617	0.0287048
Use of blood pressure-lowering treatment (hpt), Y/N	-0.4381349	0.4315641	0.4797150	0.4660422	0.4656016	0.3949390
Current daily smoker (sms), Y/N	0.1601188	0.2590549	0.2458049	0.2024671	0.2512960	0.0962472
Self-reported diabetes (dia), Y/N	0.4633056	0.5991041	0.4047413	0.5971099	0.6059128	0.3715960
Waist circumference (wai), cm	0.0146348	0.0100013	-0.0084531	0.0125664	0.0077610	-0.0081349
age × sbp	-0.0000259	-0.0004318	-0.0003590	0.0000168	-0.0004323	-0.0002353
age × dbp	-0.0001553	-0.0001013	-0.0007176	-0.0006826	-0.0003044	-0.0009919
age × hpt	-0.0101449	-0.0089527	-0.0089115	-0.0053771	-0.0116475	-0.0100336
age × sms	-0.0067592	-0.0155619	-0.0062883	-0.0037854	-0.0050969	-0.0009236
age × dia	-0.0115995	-0.0208146	-0.0094574	-0.0183296	-0.0127534	-0.0078866
age × wai	-0.0006227	-0.0004689	-0.0001766	-0.0006205	-0.0001151	-0.0004154
Baseline survival estimate at 10 years*	0.8996251	0.9103525	0.9858385	0.9287638	0.9275716	0.9825860

Predictor variables were centered as follows: age at 55 years, sbp at 120 mmHg, dbp at 80 mmHg, and wai at 80 cm.

* The Cox models were stratified by 10 regions. Baseline survival estimate at 10 years ($S_0(10)$) was estimated by pooling the $S_0(10)$ across regions weighted by the number of events by 10 years.

The individual is a man aged 57 years without diabetes. He is a current daily smoker. His systolic blood pressure is 121 mmHg, and his diastolic blood pressure is 72 mmHg. He is not receiving any hypertension treatment. His waist circumference is 95 cm.

Step 1: Centralization of continuous variables and assignments of categorical variables

- Continuous variables:
Age is centered at 55 years: $age = 57 - 55 = 2$
Systolic blood pressure is centered at 120 mmHg: $sbp = 121 - 120 = 1$
Diastolic blood pressure is centered at 80 mmHg: $dbp = 72 - 80 = -8$
Waist circumference is centered at 80 cm: $wai = 95 - 80 = 15$
- Categorical variables:
Not use of blood pressure-lowering treatment is coded as 0: $hpt = 0$
A current daily smoker is coded as 1: $sms = 1$
Without diabetes is coded as 0: $dia = 0$

Step 2: Choosing corresponding beta coefficients and baseline survival estimate

This individual is a man, so we should choose the beta coefficients and baseline survival estimate at 10 years (S) for men (eAppendix 2).

Step 3: Calculating the linear predictors (lp) for three CVD subcategories

- Ischemic heart disease
 $lp_{ihd} = 0.0716554 \times age + 0.0052816 \times sbp + 0.0091778 \times dbp + 0.4660422 \times hpt + 0.2024671 \times sms + 0.5971099 \times dia + 0.0125664 \times wai + 0.0000168 \times age \times sbp - 0.0006826 \times age \times dbp - 0.0053771 \times age \times hpt - 0.0037854 \times age \times sms - 0.0183296 \times age \times dia - 0.0006205 \times age \times wai \approx 0.4509025$
- Ischemic stroke
 $lp_{is} = 0.0835158 \times age + 0.0124603 \times sbp + 0.0140617 \times dbp + 0.4656016 \times hpt + 0.251296 \times sms + 0.6059128 \times dia + 0.007761 \times wai - 0.0004323 \times age \times sbp - 0.0003044 \times age \times dbp - 0.0116475 \times age \times hpt - 0.0050969 \times age \times sms - 0.0127534 \times age \times dia - 0.0001151 \times age \times wai \approx 0.4250683$
- Hemorrhagic stroke
 $lp_{hs} = 0.0820196 \times age + 0.0168301 \times sbp + 0.0287048 \times dbp + 0.394939 \times hpt + 0.0962472 \times sms + 0.371596 \times dia - 0.0081349 \times wai - 0.0002353 \times age \times sbp - 0.0009919 \times age \times dbp - 0.0100336 \times age \times hpt - 0.0009236 \times age \times sms - 0.0078866 \times age \times dia - 0.0004154 \times age \times wai \approx -0.0734548$

Step 4: Calculating the originally predicted 10-year risks for three CVD subcategories

- Ischemic heart disease
 $risk_{ihd} = 1 - S_{ihd}^{exp(lp_{ihd})} = 1 - 0.9287638^{exp(0.4509025)} \approx 11.0\%$
- Ischemic stroke
 $risk_{is} = 1 - S_{is}^{exp(lp_{is})} = 1 - 0.9275716^{exp(0.4250683)} \approx 10.9\%$
- Hemorrhagic stroke
 $risk_{hs} = 1 - S_{hs}^{exp(lp_{hs})} = 1 - 0.9825860^{exp(-0.0734548)} \approx 1.6\%$

Step 5: Calculating the originally predicted 10-year risks of total cardiovascular disease

$$risk_{cvd} = 1 - (1 - risk_{ihd}) \times (1 - risk_{is}) \times (1 - risk_{hs}) \approx 21.9\%$$

Therefore, the predicted 10-year risk of total cardiovascular disease calculated using the CKB-CVD models without recalibration for this man is 21.9%.

参考文献

[1]. Yang S, Han Y, Yu C, et al. Development of a Model to Predict 10-Year Risk of Ischemic and Hemorrhagic Stroke and Ischemic Heart Disease Using the China Kadoorie Biobank. *Neurology*. 2022;98(23):e2307-e2317.

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