·流行病与统计方法·

基于循证－实证因果框架构建中国中老年人卒中发病风险评分工具研究

沈明辉[1],金成[2,3],韩昕玥[4],陈硕华[2],兑欣阳[4],杨楠[4],刘小雪[4],胡梦婕[4],的机卓玛[4],杨会芳[4],
滕屹霖[4],马天佩[4],肖金雨[4],冯琬婷[4],吴寿岭[2],张韬[4],李佳圆[4]
1.四川省卫生健康信息中心,四川 成都 610041;2.开滦总医院心内科,河北 唐山 063003;
3.哈尔滨医科大学第二附属医院 黑龙江省泛血管疾病重点实验室;
4.四川大学华西公共卫生学院/四川大学华西第四医院,四川 成都 610041

摘要:目的　基于 meta 分析和基层医疗机构体检数据,构建中国中老年人卒中风险评分工具。**方法**　检索中国人群卒中发病危险因素队列研究,通过 meta 分析确定预测因子;参考弗明汉 10 年风险评分工具的构建方法,建立中国中老年人群的卒中风险评分工具;以开滦队列、红光体检队列为外部验证人群,采用受试者工作特征(receiver operator characteristic, ROC)曲线、灵敏度、特异度等指标评价评分工具的预测效能。**结果**　38 篇研究纳入 meta 分析,最终有 14 个因素为卒中预测因子:年龄大、男性、体重过轻、超重、肥胖、高血压 1 期、高血压史、糖尿病史、高总胆固醇、高甘油三酯、低水平高密度脂蛋白、房颤史、卒中家族史和当前吸烟。开滦队列纳入 137 501 人,随访期间发生 2 351 例卒中,曲线下面积(area under curve, AUC)为 0.74(95%*CI*:0.73～0.75),灵敏度为 0.78(95%*CI*:0.77～0.80),特异度为 0.59(95%*CI*:0.58～0.59);红光体检队列纳入对象 7 194 名,随访期间有 927 人发生卒中,AUC 为 0.61(95%*CI*:0.59～0.63),灵敏度和特异度分别为 0.52(95%*CI*:0.50～0.56)、0.65(95%*CI*:0.64～0.66)。**结论**　卒中风险评分工具在中老年体检人群中具有较好的预测效能,在基层医疗机构推广应用可行性高,可帮助识别卒中高风险人群,为卒中预防和干预策略提供依据。

关键词:卒中;风险预测;中老年
中图分类号:R743.3　　**文献标志码**:A　　**文章编号**:1003-8507(2025)09-1550-07
DOI:10.20043/j.cnki.MPM.202411061

Research on the construction of a stroke risk scoring tool for middle-aged and elderly Chinese people based on the evidence-based and empirical causal framework

SHEN Ming-hui*, JIN Cheng, HAN Xin-yue, CHEN Shuo-hua, DUI Xin-yang, YANG Nan, LIU Xiao-xue, HU Meng-jie, DEJI Zhuo-ma, YANG Hui-fang, TENG Yi-lin, MA Tian-pei, XIAO Jin-yu, FENG Wan-ting, WU Shou-ling, ZHANG Tao, LI Jia-yuan
Sichuan Health Information Center, Chengdu, Sichuan 610041, China

Abstract: Objective To construct a stroke risk scoring tool for middle - aged and elderly Chinese people based on meta-analysis and physical examination data from primary medical institutions. **Methods** Cohort studies on risk factors for stroke onset in the Chinese population were retrieved, and predictive factors were determined through meta-analysis. Referring to the construction method of the Framingham 10-year risk scoring tool, a stroke risk scoring tool for middle-aged and elderly Chinese people was established. The Kailuan cohort and the Hongguang physical examination cohort were used as external validation populations. Indicators such as the receiver operator characteristic (ROC) curve, sensitivity, and specificity were used to evaluate the predictive efficacy of the scoring tool. **Results** Thirty-eight studies were included in the meta-analysis, and finally 14 factors were identified as stroke predictive factors: old age, male gender, underweight, overweight, obesity, stage 1 hypertension, history of hypertension, history of diabetes, high total cholesterol, high triglycerides, low-level high-density lipoprotein, history of atrial fibrillation, family history of stroke, and current smoking. The Kailuan cohort included 137 501 people, and 2 351 cases of stroke occurred during the follow-up period. The area under the curve (AUC) was 0.74

基金项目:四川省科技计划项目－中央引导地方科技发展项目(2024ZYD0102);四川省科学技术厅项目(2022YFS0055);成都市科技局项目(2024-YF05-01784-SN)

作者简介:沈明辉(1981—),男,硕士,工程师,研究方向:数字健康医学人工智能,健康医疗大数据
通信作者:冯琬婷,E-mail:wantingf98@163.com;吴寿岭,E-mail:drwusl@163.com;冯琬婷与吴寿岭为共同通信作者

(95%*CI*: 0.73–0.75), the sensitivity was 0.78 (95%*CI*: 0.77–0.80), and the specificity was 0.59 (95%*CI*: 0.58–0.59). The Hongguang physical examination cohort included 7 194 subjects, and 927 people had strokes during the follow-up period. The AUC was 0.61 (95%*CI*: 0.59–0.63), and the sensitivity and specificity were 0.52 (95%*CI*: 0.50–0.56) and 0.65 (95%*CI*: 0.64–0.66), respectively. **Conclusion** The stroke risk scoring tool has good predictive efficacy in middle-aged and elderly people undergoing physical examinations. It has high feasibility for popularization and application in primary medical institutions, can help identify high-risk populations for stroke, and provide a basis for stroke prevention and intervention strategies.

Keywords: Stroke; Risk prediction; Middle-aged and elderly

卒中已成为国内位居首位的过早死亡原因[1]，预后较差，因此卒中的预防至关重要。风险评估是识别高危人群的有效工具，目前国内常见的卒中风险预测工具包括改良的弗明汉卒中量表、汇集队列方程、Essen 脑卒中风险评分量表等[2]，但大多数工具源自国外，应用于中国人适用性存疑，且预测因子的筛选和风险值会受到建模人群特征和研究设计的影响，有必要开发适合中国老年人的卒中预测工具。老年人健康体检服务是我国基本公共卫生服务（简称基公卫）的重要内容，对于基层医疗机构和个人，健康体检资料方便易得，具有较好的连续性。因此，基于基公卫体检条目进行疾病的风险预测，便于基层卫生服务人员早期识别重点人群，实现早期干预和精准健康管理。本研究通过 meta 分析，汇总中国队列研究重要卒中风险因素，结合基公卫体检条目构建中国中老年人卒中风险评分工具，并在开滦队列、红光体检队列中展开验证，以期为卒中一级预防提供科学依据。

1　资料与方法

1.1　危险因素确定

1.1.1　文献检索策略　通过计算机检索中国知网、万方数据知识服务平台、PubMed、EMbase、Medline、Web of Science 数据库中国人群卒中发病危险因素的相关研究，检索时限从建库至 2023 年 7 月。主题词与自由词相结合，中文检索词为“卒中”“危险因素”“队列研究”等，英文检索词为“stroke”“cohort study”“risk factor”“Chinese”等，语种限制中文和英文。meta 分析已完成 PROSPERO 注册，注册号 CRD42024491143。

1.1.2　纳入与排除标准　纳入标准：(1)大样本(样本量≥500)队列研究；(2)仅针对中老年人的研究少，故纳入≥30 岁人群的研究；(3)结局：经专业医疗机构诊断的卒中，包括缺血和出血性卒中；(4)常见发病风险因素研究，提供风险比(hazard ratio, *HR*)或相对危险比(relative risk, *RR*)及其 95%置信区间(*CI*)。排除标准：(1)特殊人群研究，如青少年、孕妇等；(2)综述、文献评述、会议摘要；(3)研究因素无法从基础体检资料获得，如遗传生物标志物等。

1.1.3　数据提取及质量评价　资料提取包括第一作者、年份、研究地、随访时长、样本量、研究对象年龄、研究因素及定义、调整混杂后影响因素的效应值及其 95%*CI*。质量评价采用纽卡斯尔－渥太华量表(NOS)，得分 6 分以下认为是低质量文献，不纳入分析。数据提取和质量评价均由两名研究者独立完成，若有分歧则通过协商或征求第三方意见。

1.1.4　Meta 分析　采用 R 4.3.3 软件进行 meta 分析，合并各危险因素效应值。通过 Q 检验、I^2 指数判断各研究之间的异质性，$I^2<50\%$ 或 Q 检验 $P>0.1$，认为异质性较小，采用固定效应模型，反之采用随机效应模型。研究因素的效应值 95%*CI* 未跨过 1 者被纳入评分工具构建。

1.2　风险评分工具构建及验证

1.2.1　验证人群来源　在开滦队列、红光老年人群健康体检队列(简称红光体检队列)中验证评分工具效能。开滦队列是在河北唐山基于开滦集团职工的一项长期的大型前瞻性队列，每隔两年进行健康体检和问卷调查。该研究通过开滦医疗集团伦理委员会审核批准([2006]医伦字 5 号)。人群纳入标准：(1)年龄≥30 岁；(2)2017—2022 年间至少参与两次体检；(3)基线未患卒中及严重心脑血管疾病；(4)体检资料完整。排除标准：(1)患恶性肿瘤、严重精神障碍等重大疾病；(2)入组 1 月内发生卒中。

红光体检队列是一项主要针对 60 岁及以上老年人的多社区前瞻性队列，在四川省成都市郫都区红光镇招募，该镇城镇和农村人口数相当，体检参与度高[3]。数据来自 2017—2022 年基公卫老年人体检及老年人健康管理调查问卷。体检包括一般体格检查和辅助检查(血常规、尿常规、腹部 B 超等)；问卷包括人口学特征、生活方式、疾病史等。从四川省卫生健康信息中心病案首页获得对象住院诊断信息，协助判断疾病史。所有信息收集均经参与者知情同意和伦理审查，伦理审批号 HXSY-EC-2022034。对象纳排标准同人群纳排标准。

1.2.2　卒中结局诊断　随访期间首次发生卒中为结局。卒中定义为持续超过 24 h 的因脑血管病引起的急性神经系统功能障碍，ICD-10 编码 I60～I64。开滦队列卒中信息从开滦社会保障信息系统获取，诊断均由专业医师确认。红光体检队列卒中诊断信息通过病案首页、问卷调查获得。

1.2.3　风险评分工具构建及验证　评分工具构建方法参考弗明汉 10 年风险预测评分工具[4]。构建步骤如下：（1）由 meta 分析获得预测因素的合并效应值，对数转换得到 βi 系数；（2）选择每个变量组内的中间值作为参考值 Wi，确定基础风险值 Wir 并记为 0 分；（3）计算每个因素的分组与基础风险值之间的距离 di，di = (Wi−Wr)*βi；（4）设定 1 分所对应的常数 B；（5）计算危险因素各分类对应分值 P，P=d/B=(W−Wr)*βi /B。将各因素得分相加得到风险总分。根据评分和随访期间是否发生卒中，绘制风险评分预测模型的受试者工作特征（receiver operator characteristic, ROC）曲线，计算曲线下面积（area under curve, AUC）及其 95%*CI*、最佳截断值、灵敏度、特异度等参数。应用 R 4.3.3 软件进行上述统计分析，检验水准 α=0.05。

2　结　果

2.1　Meta 分析结果　文献筛选流程见图 1。最终纳入 38 篇文献[5-42]，确定 25 个危险因素，合并效应值的森林图如图 2 所示。

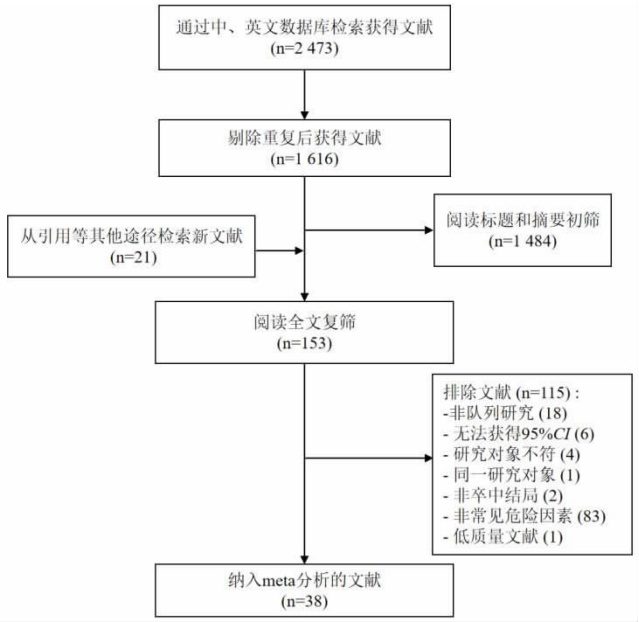
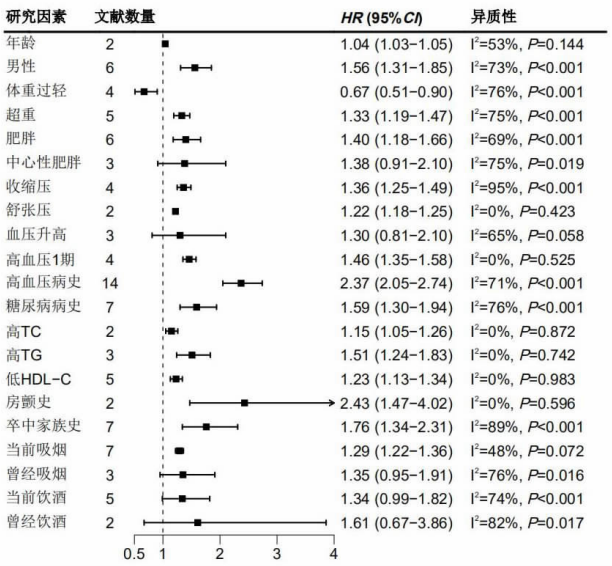


图 1　文献筛选流程及结果

Figure 1　Literature screening process and results

2.2　模型构建　综合考虑 meta 结果、研究因素的重要性和编制评分工具的方便性，纳入 14 个因素，构建卒中风险评分表，见表 1。

2.3　验证人群基线情况　以研究对象 2017—2022 年首次体检结果为基线，人群特征见表 2。开滦队列纳入研究对象 137 501 人，男性占比 81.08%，平均年龄（50.4 ± 12.2）岁，中位随访时间 60 月。2 351 人（1.71%）在随访期间发生卒中。红光体检队列共纳入 7 194 人，平均年龄（65.92 ± 8.30）岁，男性占比 43.27%。随访间新发卒中人数 927（12.89%）人，中位随访时间 40 个月。相比红光体检队列，开滦队列人群平均年龄低，男性占比高，吸烟率高，糖尿病、高血压患病率低。两个队列中，卒中发病组和未发病组在年龄、性别、收缩压、高血压患病和房颤疾病史存在显著差异（$P<0.05$）。



注：体重过轻，BMI＜18.5 kg/m²；超重，BMI 24 ~ 28 kg/m²；肥胖，BMI≥28 kg/m²；中心性肥胖，男性腰围＞90 cm，女性＞80 cm；收缩压、舒张压单位为每升高 10 mm Hg；血压升高，120≤SBP≤129 mm Hg 和 DBP＜80 mm Hg；高血压 1 期，130≤SBP≤139 mm Hg 或 80≤DBP≤89 mm Hg；高血压，经医生明确诊断为高血压或接受降压治疗；糖尿病，经医生明确诊断为糖尿病或接受降糖治疗；高总胆固醇（TC），TC≥6.22 mmol/L；高甘油三酯（TG），TG≥1.7 mmol/L；低水平高密度脂蛋白（HDL−C），男性＜1.03 mmol/L，女性＜1.29 mmol/L；卒中家族史，一级或二级亲属曾发生卒中。

图 2　中国人群卒中发病危险因素的 meta 分析森林图

Figure 2　Forest plot of risk factors for stroke in the Chinese population

表 1　卒中风险评分表

Table 1　Stroke risk score

影响因素	分组	分值
年龄（岁）	30 ~ 39，40 ~ 49，50 ~ 59，60 ~ 69，70 ~ 80，80 及以上	0，1，2，3，4，5
性别	女性，男性	0，1
BMI	体重过轻，正常，超重，肥胖	−1，0，0.5，1
高血压 1 期	否，是	0，1
高血压	否，是	0，2
糖尿病	否，是	0，1
高 TC	否，是	0，0.5
高 TG	否，是	0，1
低水平 HDL−C	否，是	0，0.5
房颤疾病史	无，有	0，2.5
卒中家族史	无，有	0，1.5
当前吸烟	否，是	0，0.5

表 2　模型验证人群基线特征表[$(\bar{x}\pm s)$,n(%)]

Table 2　Baseline characteristics of subjects for model verification [$(\bar{x}\pm s)$,n(%)]

变量	开滦队列			红光体检队列		
	总人群(n=137 501)	卒中发病		总人群(n=7 194)	卒中发病	
		未发病(n=135 150)	发病(n=2 351)		未发病(n=6 267)	发病(n=927)
年龄[ab](岁)	50.4 ± 12.2	50.3 ± 12.2	59.8 ± 10.3	65.92 ± 8.30	65.40 ± 8.31	69.45 ± 7.27
性别[ab]						
女	26 012 (18.92)	25 757 (19.06)	255 (10.85)	4 081 (56.73)	3 519 (56.15)	562 (60.63)
男	111 489 (81.08)	109 393 (80.94)	2 096 (89.15)	3 113 (43.27)	2 748 (43.85)	365 (39.37)
BMI[a]	25.0 ± 3.4	25.0 ± 3.4	25.6 ± 3.4	24.37 ± 3.23	24.38 ± 3.21	24.30 ± 3.40
收缩压[ab](mm Hg)	130.5 ± 20.2	130.2 ± 20.0	146.0 ± 24.1	138.09 ± 17.33	137.84 ± 17.30	139.78 ± 17.43
舒张压[a](mm Hg)	83.6 ± 11.5	83.5 ± 11.4	89.8 ± 13.6	82.55 ± 10.40	82.59 ± 10.52	82.28 ± 9.57
TC[a](mmol/L)						
正常	123 483 (89.81)	121 448 (89.86)	2 035 (86.56)	6 369 (88.53)	5 548 (88.53)	821 (88.57)
高 TC	14 018 (10.19)	13 702 (10.14)	316 (13.44)	825 (11.47)	719 (11.47)	106 (11.43)
TG[a](mmol/L)						
正常	93 696 (68.14)	92 192 (68.21)	1 504 (63.97)	4 918 (68.36)	4 295 (68.53)	623 (67.21)
高 TG	43 805 (31.86)	42 958 (31.79)	847 (36.03)	2 276 (31.64)	1 972 (31.47)	304 (32.79)
HDL-C[a](mmol/L)						
正常	121 204 (88.15)	119 092 (88.12)	2 112 (89.83)	5 916 (82.24)	5 155 (82.26)	761 (82.09)
低 HDL-C	16 297 (11.85)	16 058 (11.88)	239 (10.17)	1 278 (17.76)	1 112 (17.74)	166 (17.91)
高血压患病[ab]						
否	80 112 (58.26)	79 437 (58.78)	675 (28.71)	2 647 (36.79)	2 372 (37.85)	275 (29.67)
是	57 389 (41.74)	55 713 (41.22)	1 676 (71.29)	4 547 (63.21)	3 895 (62.15)	652 (70.33)
糖尿病患病[a]						
否	124 999 (90.91)	123 103 (91.09)	1 896 (80.65)	5 804 (80.68)	5 059 (80.72)	745 (80.37)
是	12 502 (9.09)	12 047 (8.91)	455 (19.35)	1 390 (19.32)	1 208 (19.28)	182 (19.63)
房颤疾病史[ab]						
否	136 998 (99.63)	134 685 (99.66)	2 313 (98.38)	6 997 (97.26)	6 149 (98.12)	848 (91.48)
是	503 (0.37)	465 (0.34)	38 (1.62)	197 (2.74)	118 (1.88)	79 (8.52)
当前吸烟[a]						
否	81 712 (59.43)	80 368 (59.47)	1 344 (57.17)	6 132 (85.24)	5 325 (84.97)	807 (87.06)
是	55 789 (40.57)	54 782 (40.53)	1 007 (42.83)	1 062 (14.76)	942 (15.03)	120 (12.94)
卒中家族史						
否	130 727 (95.07)	128 473 (95.06)	2 254 (95.87)	7 089 (98.54)	6 176 (98.55)	913 (98.49)
是	6 774 (4.93)	6 677 (4.94)	97 (4.13)	105 (1.46)	91 (1.45)	14 (1.51)

注：[a]开滦队列中，发病组和未发病组间差异有统计学意义(P<0.05)；[b]红光体检队列中，发病组和未发病组间差异有统计学意义(P<0.05)。

2.4　模型验证效果　将本研究构建的卒中风险评分工具分别在开滦队列和红光体检队列中进行验证。结果显示，评分工具在开滦队列中预测效能较好，AUC 为 0.74(95%*CI*:0.73 ~ 0.75)。红光体检队列验证效果一般，AUC 为 0.61(95%*CI*:0.59 ~ 0.63)。见表 3、图 3。

表 3　开滦队列与红光体检队列验证结果对比

Table 3　Comparison of validation results between the Kailuan Cohort and Hongguang Elderly Health Examination Cohort

验证人群	AUC (95%*CI*)	灵敏度 (95%*CI*)	特异度 (95%*CI*)	准确率	最佳截断值
开滦队列	0.74 (0.73 ~ 0.75)	0.78 (0.77 ~ 0.80)	0.59 (0.58 ~ 0.59)	0.59	5.25
红光体检队列	0.61 (0.59 ~ 0.63)	0.52 (0.50 ~ 0.56)	0.65 (0.64 ~ 0.66)	0.63	6.75

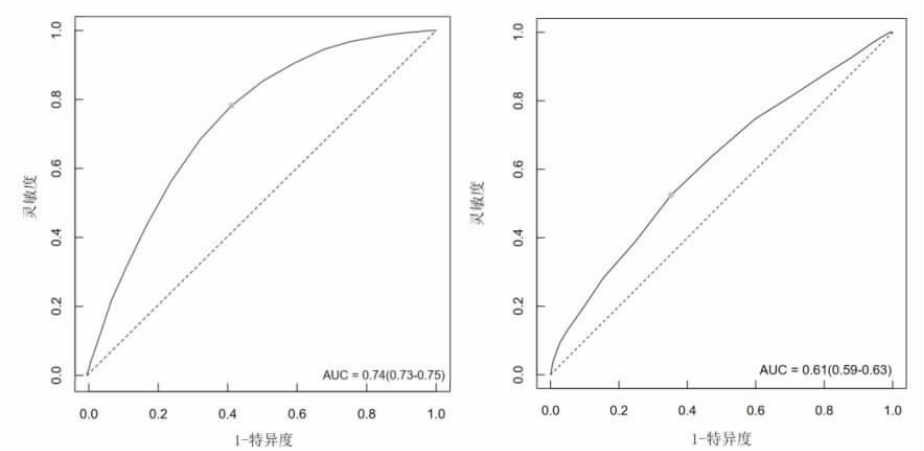


图 3　开滦队列(左)和红光体检队列(右)卒中风险预测 ROC 曲线

Figure 3　ROC curves for stroke risk prediction in the Kailuan Cohort (left) and the Hongguang Elderly Health Examination Cohort (right)

3　讨　论

本研究通过 meta 分析系统总结筛选出中国人群的卒中重要风险因素，开发中国中老年人群卒中发病风险评分工具。结果显示，该评分工具在开滦队列中预测效能良好，而在红光体检队列中效果较差。这可能与两个人群特征不同有关，开滦队列样本量大，平均年龄更小，随访时间更长。这提示本风险评分工具在单纯的老年人群体（65 岁及以上）中预测效果一般，更适合中老年人群长期卒中风险预测。

弗明汉卒中量表（Framingham stroke profile, FSP）是国外较为成熟，广泛应用的简易卒中风险评估工具，包含年龄、收缩压、糖尿病史、心血管病史、吸烟、心房颤动和左心室肥厚 7 项危险因素[43]，被我国指南推荐用于首发卒中的风险评估。黄久仪等人[44]在上海社区人群队列中应用改良 FSP，结果发现男性 AUC 为 0.726，女性为 0.656。黄晓芸等人[45]开展了病例对照研究评估效果，结果显示 AUC 仅为 0.588，灵敏度为 0.684。与本研究开滦队列预测结果相比，改良 FSP 在中国人群的预测效能相对不足。另外，本研究风险评分工具基本涵盖 FSP 纳入的因素，增加 BMI、家族史、血脂等重要的卒中危险因素，提升一定的预测效能。

相比复杂的预测模型，评分工具方便使用，易推广，可直观反映个体发病风险。近年，有学者推出了基于 12 万中国人开发的卒中预测模型 China-PAR[46-47]。China-PAR 考虑了地理因素和降压治疗，在验证队列中表现出较好的预测效能，五年风险预测 C 统计量在男女性中均接近 0.8。但唐迅等人[48]将该模型应用于中国北方农村人群，发现预测效能显著下降，C 统计量男性为 0.709（95%*CI*：0.675 ~ 0.743），女性为 0.713（95%*CI*：0.684 ~ 0.743）；Zhang 等人[49]发现该模型在老年人社区队列预测效能较差，男女性预测 AUC 仅为 0.60。另外，China-PAR 预测模型计算较为复杂，基层面临大量的服务对象应用起来较繁琐，而评分工具预测效能较好，同时可直观呈现各危险因素得分和权重，方便使用和理解。

应用卒中风险评分工具综合评估卒中风险，可帮助基层医务人员对体检者进行整体健康评估，及时分级管理，提供个性化的健康指导，体检者本人也能自测评估自身风险，根据评分表阳性条目采取针对性的措施。本研究也存在一定局限性。首先，红光体检队列的结局信息结合了自报和病案首页信息，可能与实际情况有差。同样，本研究的预测工具适用于未发生过卒中的中老年人，但由于信息偏倚，可能纳入了部分既往发生过卒中的人群。其次，基公卫体检信息收集存在局限性，缺少了饮食、睡眠等部分重要的预测因子，增加预测因素可能会提高评估工具的效果。最后，验证人群的随访时间为 5 年，长期的卒中风险预测效果还待验证。此外，红光体检队列的卒中发病率（12.9%）偏高，高于 Cui 等人[50]分析 2011—2017 年 CHARLS 数据得到的发病率（9.1%），这可能与队列平均年龄大、高血压患病率高有关。

综上所述，本研究构建的卒中风险评分工具在中老年体检人群中具有较好的预测效能，在基层推广应用的可行性高，有助于量化卒中风险，为中国中老年人群卒中的预防和干预策略提供参考。

利益冲突声明　本研究不存在任何利益冲突

参考文献

[1] 无，王陇德. 《中国脑卒中防治报告 2021》概要[J]. 中国脑血管病杂志，2023，20（11）：783-792.
Mo, Wang LD. Brief report on stroke prevention and treatment in China,2021 [J]. Chinese Journal of Cerebrovascular Diseases, 2023, 20(11): 783-792.(In Chinese)

[2] 中华医学会神经病学分会，中华医学会神经病学分会脑血管病学组. 中国缺血性脑卒中风险评估量表使用专家共识[J]. 中华神经科杂志，2016，49（7）：519-525.
Chinese Medical Association Neurology Section, Cerebrovascular Disease Group of the Neurology Section of the Chinese Medical Association. Expert consensus on the use of ischemic stroke risk assessment scale in China[J]. Chinese Journal of Neurology, 2016, 49 (7): 519-525.(In Chinese)

[3] 杨会芳，袁璐，吴结凤，等. 基于国家基本公共卫生服务体检的中老年人 2 型糖尿病风险预测模型构建[J]. 四川大学学报:医学版，2024，55（3）：662-670.
Yang HF, Yuan L, Wu JF, et al. Construction of a predictive model for diabetes mellitus type 2 in Middle-Aged and elderly populations based on the medical checkup data of National basic public health service[J]. Journal of Sichuan University: Medical Sciences, 2024, 55 (3): 662-670.(In Chinese)

[4] Wilson PW, D'Agostino RB, Levy D, et al. Prediction of coronary heart disease using risk factor categories [J]. Circulation, 1998, 97 (18): 1837-1847.

[5] 曹兆，刘相佟，吕世云，等. 脑卒中影响因素和风险评估的纵向队列研究[J]. 心肺血管病杂志，2022，41（4）：333-337.
Cao Z, Liu XT, Lv SY, et al. Risk assessment and prediction longitudinal cohort research for stroke [J]. Journal of Cardiovascular and Pulmonary Diseases, 2022, 41(4): 333-337.(In Chinese)

[6] 黄久仪，王桂清，沈凤英，等. 脑血管血液动力学积分与脑卒中风险的队列研究[J]. 中华流行病学杂志，2003，24（2）：89-93.
Huang JY, Wang GQ, Shen FY, et al. A cohort study on cerebral vascular hemodynamics accumulative score and risks of stroke [J]. Chinese Journal of Epidemiology, 2003, 24(2): 89-93.(In Chinese)

[7] 那布其，张星光，乔丽颖，等. 内蒙古居民缺血性脑卒中发病影响因素研究[J]. 中国慢性病预防与控制，2023，31（9）：680-684.
Na BQ, Zhang XG, Qiao LY, et al. Study on influencing factors of ischemic stroke in Inner Mongolia residents [J]. Chinese Journal of Prevention and Control of Chronic Diseases, 2023, 31 (9): 680-684.(In Chinese)

[8] 王艳,黄久仪,曹奕丰,等. 上海市奉贤社区脑卒中危险因素队列研究基线调查和随访分析[J]. 中华流行病学杂志,2007,28(12):1171-1174.
Wang Y, Huang JY, Cao YF, et al. Baseline study and analysis on a stroke risk factor-related cohort in Fengxian county of Shanghai[J]. Chinese Journal of Epidemiology, 2007, 28 (12): 1171-1174. (In Chinese)

[9] 赵连成,武阳丰,周北凡,等. 体质指数与冠心病、脑卒中发病的前瞻性研究[J]. 中华心血管病杂志,2002,30(7):430-433.
Zhao LC, Wu YF, Zhou BF, et al. A prospective study on the association of body mass index with incidence of coronary heart disease and stroke [J]. Chinese Journal of Cardiology, 2002, 30(7): 430-433.(In Chinese)

[10] Bazzano LA, Gu DF, Whelton MR, et al. Body mass index and risk of stroke among Chinese men and women [J]. Annals of Neurology, 2010, 67(1): 11-20.

[11] Bragg F, Li LM, Yang L, et al. Risks and population burden of cardiovascular diseases associated with diabetes in China: a prospective study of 0.5 million adults [J]. PLOS Medicine, 2016, 13 (7): e1002026.

[12] Chen YC, Sun CA, Yang T, et al. Impact of metabolic syndrome components on incident stroke subtypes: a Chinese cohort study[J]. Journal of Human Hypertension, 2014, 28(11): 689-693.

[13] Chen ZM, Iona A, Parish S, et al. Adiposity and risk of ischaemic and haemorrhagic stroke in 0·5 million Chinese men and women: a prospective cohort study [J]. LANCET GLOBAL HEALTH, 2018, 6 (6): e630-e640.

[14] Chien KL, Hsu HC, Sung FC, et al. Metabolic syndrome as a risk factor for coronary heart disease and stroke: an 11-year prospective cohort in Taiwan community [J]. Atherosclerosis, 2007, 194 (1): 214-221.

[15] Chien KL, Su TC, Hsu HC, et al. Atrial fibrillation prevalence, incidence and risk of stroke and all-cause death among Chinese[J]. International Journal of Cardiology, 2010, 139(2): 173-180.

[16] Chuang SY, Bai CH, Chen WH, et al. Fibrinogen independently predicts the development of ischemic stroke in a Taiwanese population: CVDFACTS study[J]. Stroke, 2009, 40(5): 1578-1584.

[17] Fang XH, Longstreth WTJ, Li SC, et al. Longitudinal study of blood pressure and stroke in over 37,000 People in China [J]. Cerebrovascular Diseases, 2001, 11(3): 225-229.

[18] Fang XH, Zhang XH, Yang QD, et al. Subtype hypertension and risk of stroke in middle-aged and older Chinese: a 10-year follow-up study[J]. Stroke, 2006, 37(1): 38-43.

[19] Gao JY, Dai Y, Xie YX, et al. The association of stage 1 hypertension defined by the 2017 ACC/AHA guideline with stroke and its subtypes among elderly Chinese [J]. BioMed Research International, 2020, 2020: 4023787.

[20] Gao QN, Li LX, Bai JJ, et al. Association of stage 1 hypertension defined by the 2017 ACC/AHA guideline with cardiovascular events and mortality in Chinese adults[J]. Chin Med J (Engl), 2024, 137(1): 63-72.

[21] Gu DF, Kelly TN, Wu XG, et al. Blood pressure and risk of cardiovascular disease in Chinese men and women [J]. American Journal of Hypertension, 2008, 21(3): 265-272.

[22] Gu XY, Li YZ, Chen SH, et al. Association of lipids with ischemic and hemorrhagic stroke: a prospective cohort study among 267 500 Chinese[J]. Stroke, 2019, 50(12): 3376-3384.

[23] Hsu HC, Pwu RF. Too late to quit? Effect of smoking and smoking cessation on morbidity and mortality among the elderly in a longitudinal study [J]. Kaohsiung Journal of Medical Sciences, 2004, 20(10): 484-491.

[24] Huang Q, Yin L, Liu Z, et al. Association of novel lipid indicators with the risk of stroke among participants in Central China: a population-based prospective study [J]. Frontiers in Endocrinology, 2023, 14: 1266552.

[25] Huangfu XF, Zhu ZB, Zhong CK, et al. Smoking, hypertension, and their combined effect on ischemic stroke incidence: a prospective study among inner mongolians in China [J]. Journal of Stroke and Cerebrovascular Diseases: the Official Journal of National Stroke Association, 2017, 26(12): 2749-2754.

[26] Kelly TN, Gu DF, Chen J, et al. Cigarette smoking and risk of stroke in the Chinese adult population[J]. Stroke, 2008, 39(6): 1688-1693.

[27] Kuo CY, Yen MF, Chen LS, et al. Increased risk of hemorrhagic stroke in patients with migraine: a population-based cohort study[J]. PLOS One, 2013, 8(1): e55253.

[28] Liu FC, Yang XL, Li JX, et al. Association of fasting glucose levels with incident atherosclerotic cardiovascular disease: An 8-year follow-up study in a Chinese population [J]. Journal of Diabetes, 2017, 9(1): 14-23.

[29] Tian T, Jin GF, Yu CQ, et al. Family history and stroke risk in China: evidence from a large cohort study [J]. J Stroke, 2017, 19 (2): 188-195.

[30] Wang AX, Wu JW, Zhou Y, et al. Measures of adiposity and risk of stroke in China: a result from the Kailuan study[J]. PLOS One, 2013, 8(4): e61665.

[31] Wei G, Lin F, Cao CC, et al. Non-linear dose-response relationship between body mass index and stroke risk in middle-aged and elderly Chinese men: a nationwide Longitudinal Cohort Study from CHARLS [J]. Frontiers in Endocrinology, 2023, 14: 1203896.

[32] Wu YN, Fan ZQ, Chen Y, et al. Determinants of developing stroke among Low-Income, rural residents: a 27-Year Population-Based, prospective cohort study in northern China[J]. Frontiers in Neurology, 2019, 10: 57.

[33] Xie Y, Ma M, Li Z, et al. Elevated blood pressure level based on 2017 ACC/AHA guideline in relation to stroke risk in rural areas of Liaoning province [J]. BMC Cardiovascular Disorders, 2019, 19(1): 258.

[34] Yu YB, Meng Y, Liu J. Association between the triglyceride-glucose index and stroke in middle-aged and older non-diabetic population: A prospective cohort study [J]. Nutrition, Metabolism, and Cardiovascular Diseases, 2023, 33(9): 1684-1692.

[35] Yu ZC, Liu ST, Guo RR, et al. Putting the glass down May keep the stroke away: Results from a prospective cohort study in rural China [J]. Nutrition Metabolism and Cardiovascular Diseases, 2021, 31(4): 1113-1120.

[36] Zhang WW, Liu CY, Wang YJ, et al. Metabolic syndrome increases the risk of stroke: a 5-year follow-up study in a Chinese population [J]. Journal of Neurology, 2009, 256(9): 1493-1499.

[37] Zhang Y, Wang C, Liu D, et al. Association of total pre-existing comorbidities with stroke risk: a large-scale community-based

（下转第 1567 页）

[18] 中国国家卫生和计划生育委员会. 中国居民营养与慢性病状况报告 (2020)[R]. 北京：中国国家卫生和计划生育委员会，2020.
National Health and Family Planning Commission of the People's Republic of China. Report on the nutrition and chronic disease status of Chinese residents (2020)[R]. Beijing: National Health and Family Planning Commission of the People's Republic of China, 2020. (In Chinese)

[19] 张明秋，王芳. 成都市双流区营养相关慢性病患病现状及危险因素分析[J]. 预防医学情报杂志，2018，34(7)：978-982.
Zhang MQ, Wang F. Prevalence and risk factors of nutrition-associated chronic diseases in Shuangliu district of Chengdu [J]. Journal of Preventive Medicine Information, 2018, 34 (7): 978-982.(In Chinese)

[20] 王琛琛，周海茸，王巍巍，等. 南京市居民社会经济状况与超重/肥胖关系的研究[J]. 职业与健康，2022，38(11)：1519-1522, 1527.
Wang CC, Zhou HR, Wang WW, et al. Study on relationship between socio-economic status and overweight and obesity in residents in Nanjing city[J]. Occup and Health, 2022, 38(11): 1519-1522, 1527. (In Chinese)

[21] Liu RY, Chen L, Zhang F, et al. Trends in alcohol intake and the association between Socio-Demographic factors and volume of alcohol intake amongst adult male drinkers in China[J]. International Journal of Environmental Research and Public Health, 2019, 16(4): 573.

[22] Pengo MF, Won CH, Bourjeily G. Sleep in women across the Life span[J]. CHEST, 2018, 154(1): 196-206.

[23] Lee MK, Oh J. The relationship between sleep quality, neck pain, shoulder pain and disability, physical activity, and health perception among middle-aged women: a cross-sectional study [J]. BMC Women's Health, 2022, 22(1): 186.

[24] 田园，李立明. 老年人睡眠障碍的流行病学研究[J]. 中华流行病学杂志，2017，38(7)：988-992.
Tian Y, Li LM. Epidemiological study of sleep disorder in the elderly [J]. Chinese Journal of Epidemiology, 2017, 38 (7): 988-992. (In Chinese)

收稿日期：2024-12-12

（上接第 1555 页）

cohort study from China[J]. BMC Public Health, 1910, 21(1): 1910.

[38] Zhao P, Liu J, Wang CL, et al. Strict target blood pressure management for reducing the stroke risk according to 2017 ACC/AHA blood pressure guideline[J]. Aging (Albany NY), 2019, 11 (16): 6522-6534.

[39] Zhao Y, Zhang JL, Chen CQ, et al. Comparison of six surrogate insulin resistance indexes for predicting the risk of incident stroke: The Rural Chinese Cohort Study[J]. Diabetes-Metabolism: Research and Reviews, 2022, 38(7): e3567.

[40] Zhong C, Zhong X, Xu T, et al. Combined effects of hypertension and heart rate on the risk of stroke and coronary heart disease:a population-based prospective cohort study among Inner Mongolians in China[J]. Hypertension Research, 2015, 38(12): 883-888.

[41] Zhou YP, Tian YF, Zhong CK, et al. Combined effects of family history of CVD and heart rate on ischemic stroke incidence among Inner Mongolians in China [J]. Neurological Research, 2016, 38(5): 441-447.

[42] Zhu ZB, Huangfu XF, Zhong CK, et al. Combined effects of family history of cardiovascular disease and serum c-reactive protein level on the risk of stroke: a 9.2-year prospective study among mongolians in China [J]. Biomedical and Environmental Sciences, 2017, 30(9): 632-640.

[43] D'agostino RB, Wolf PA, Belanger AJ, et al. Stroke risk profile: adjustment for antihypertensive medication. The Framingham Study [J]. Stroke, 1994, 25(1): 40-43.

[44] 黄久仪，曹奕丰，郭吉平，等. 应用改良弗明汉卒中风险评估工具预测中国人卒中的风险 [J]. 中国脑血管病杂志，2013，10(5)：228-232.
Huang JY, Cao YF, Guo JP, et al. Modified framingham stroke profile in the prediction of the risk of stroke among Chinese [J]. Chinese Journal of Cerebrovascular Diseases, 2013, 10 (5): 228-232. (In Chinese)

[45] 黄晓芸，付文金，梅志忠，等. 改良 FSP、CVHI 联合 Lp-PLA2 预测脑卒中[J]. 新医学，2017，48(7)：467-471.
Huang XY, Fu WJ, Mei ZZ, et al. Modified framingham stroke profile, cerebral vascular hemodynamic indexes and Lp-PLA2 in prediction of stroke [J]. New Medicine, 2017, 48 (7): 467-471.(In Chinese)

[46] Yang XL, Li JX, Hu DS, et al. Predicting the 10-Year risks of atherosclerotic cardiovascular disease in Chinese population: the China-PAR project (prediction for ASCVD risk in China) [J]. Circulation, 2016, 134(19): 1430-1440.

[47] Xing XL, Yang XL, Liu FC, et al. Predicting 10-Year and lifetime stroke risk in Chinese population [J]. Stroke, 2019, 50 (9): 2371-2378.

[48] 唐迅，张杜丹，刘晓非，等. China-PAR 脑卒中模型在北方农村人群中预测脑卒中发病风险的应用[J]. 北京大学学报:医学版，2020，52(3)：444-450.
Tang X, Zhang DD, Liu XF, et al. Application of the China-PAR stroke risk equations in a rural northern Chinese population [J]. Journal of Peking University (Health Sciences), 2020, 52 (3): 444-450.(In Chinese)

[49] Zhang Y, Fang X, Guan S, et al. Validation of 10-Year stroke prediction scores in a Community-Based cohort of Chinese older adults[J]. Front Neurol, 2020, 11: 986.

[50] Cui C, He C, Sun Q, et al. Association between visceral adiposity index and incident stroke: Data from the China Health and Retirement Longitudinal Study [J]. Nutrition, Metabolism, and Cardiovascular Diseases, 2022, 32(5): 1202-1209.

收稿日期：2024-11-06