

# 应高度重视我国中青年高血压

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**【摘要】** 近 20 年来我国中青年人群血压异常(正常血压高值、高血压 1~3 级)比例迅速增加,但高血压知晓率、治疗率和血压控制率仍普遍偏低。超重/肥胖、运动不足、不健康饮食、饮酒、吸烟、睡眠不足是造成中青年人群血压异常的主要原因。与此同时,高血压相关心脑血管疾病在中青年人群中呈快速上升趋势,虽然中青年缺血性卒中病例数和比例远高于出血性卒中,但出血性卒中的增长比例呈加速上升趋势。脑血管病作为高血压脑出血的基础病变,在脑卒中发生发展过程中表现不同,具有重要的风险和预后预测价值,因此,有必要在中青年血压异常人群中进行广泛的脑血管病检查。

**【关键词】** 高血压; 青年人; 中年人; 卒中; 大脑小血管疾病; 综述

## Hypertension in young and middle-aged adults, a big problem that should be paid great attention in China

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**【Abstract】** In the past 2 decades, there is rapid grow on the proportion of abnormal blood pressure (BP, including high normal BP and hypertension grade 1-3) in young and middle-aged Chinese population. On the contrary, the awareness, treatment and control of hypertension are obviously low. Overweight, inactivity, unhealthy eating habits, alcoholism, smoking and sleep insufficiency are the main causes of abnormal BP in young and middle-aged adults. At the same time, the incidence of hypertension attributable cardiovascular diseases (coronary heart disease, stroke) show a rapid upward trend in the young and middle-aged adults. Although the proportion of ischemic stroke in young and middle-adults is much higher than that of hemorrhagic stroke in absolute numbers, the growth rate of hemorrhagic stroke is accelerating, which composes a major threat to the health of young and middle-adults. As the base of hypertensive cerebral hemorrhage, cerebral small vessel disease has different manifestations in the formation and development stages of stroke, and has significant clinical risk indication and prognosis prediction value. Extensive screening should be advocated in young and middle-aged adults with abnormal BP.

**【Key words】** Hypertension; Young adult; Middle aged; Stroke; Cerebral small vessel diseases; Review

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据 2021 年国家统计局发布的《第七次全国人口普查公报(第五号)》,截至 2020 年我国 15~59 岁人

口为 894 376 020 人,占总人口的 63.35%,与 10 年前相比,该年龄段人口占比下降 6.79%<sup>[1]</sup>。由此可见,近 10 年来全国总人口数虽缓慢增加,但中青年人口占比却呈逐渐下降趋势。中青年人群作为社会劳动力的主要构成部分,其健康状况关系到国计民生,必须引起医务工作者的重视。

### 一、中国中青年人群高血压发病现状

2017 年,美国心脏病学会(ACC)/美国心脏协会(AHA)联合发布的新版《成人高血压防治指南》<sup>[2]</sup>

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**表 1** 2017 年美国心脏病学会/美国心脏协会成人血压分类\***Table 1.** 2017 ACC/AHA categories of blood pressure in adults\*

分类	收缩压(mm Hg)	和	舒张压(mm Hg)
正常血压	<120	和	<80
血压升高	120~129	和	<80
高血压			
1 级	130~139	或	80~90
2 级	≥140	或	≥90

\*Individuals with SBP and DBP in two categories should be designated to the higher category, 当个体收缩压和舒张压分属不同级别时,以较高级别为准

**表 2** 2018 版中国成人血压分类\***Table 2.** 2018 China categories of blood pressure in adults\*

分类	收缩压(mm Hg)	和	舒张压(mm Hg)
正常血压	<120	和	<80
正常高值血压	120~139	和(或)	80~90
高血压	≥140	和(或)	≥90
1 级	140~159	和(或)	90~99
2 级	160~179	和(或)	100~109
3 级	≥180	和(或)	≥110
单纯收缩期高血压	≥140	和	<90

\*Individuals with SBP and DBP in two categories should be designated to the higher category, 当个体收缩压和舒张压分属不同级别时,以较高级别为准

对高血压诊断标准做出重大修改,从原来的  $\geq 140/90$  mm Hg 修改为  $\geq 130/80$  mm Hg;同时对血压分类做出相应调整,调整后的血压水平分为正常血压、血压升高、高血压 1 级和 2 级共 4 类(表 1)。基于新版诊断和分类标准,世界各国高血压病例数占总人口的比例均显著升高<sup>[2-7]</sup>,但高血压知晓率、治疗率和血压控制率却呈现不同程度下降,特别是在中低收入发展中国家尤为突出<sup>[5-8]</sup>;国内最新流行病学调查显示,中国高血压患病率自 1991 年的 32.2% (95%CI: 0.310 ~ 0.333) 激增至 2015 年的 60.0% (95%CI: 0.586 ~ 0.613,  $P_{trend} < 0.001$ )<sup>[9]</sup>。

2019 年,《中国高血压防治指南(2018 年修订版)》<sup>[10]</sup> 发布,新版指南仍沿用既往的高血压定义,即在未应用降压药的情况下,诊室测量收缩压  $\geq 140$  mm Hg 和(或)舒张压  $\geq 90$  mm Hg;并根据血压升高水平,将高血压分为 1~3 级(表 2)。

中国健康与营养调查(CHNS)先后于 1991-2009 年在国内 9 个省级行政区(黑龙江省、辽宁省、

山东省、河南省、湖北省、湖南省、江苏省、贵州省、广西壮族自治区)进行成人血压横断面调查,发现近 20 年 18~39 岁人群的平均收缩压自 108.7 mm Hg 升至 113.8 mm Hg,平均舒张压自 71.4 mm Hg 升至 75.6 mm Hg,正常高值血压占比自 26.8% 增至 37.8%;40~59 岁人群平均收缩压自 117.3 mm Hg 升至 124.1 mm Hg,平均舒张压自 76.5 mm Hg 升至 81.4 mm Hg,正常高值血压占比自 33.6% 增至 42.8%;值得注意的是,与老年人群( $\geq 60$  岁)相比,正常高值血压在中青年人群中的占比更显著、增长更迅猛<sup>[11]</sup>。

2018 年,中国疾病预防控制中心慢病中心进行的中国慢性病及危险因素监测显示,仅 35.0% 的成年居民( $\geq 18$  岁)血压正常,在未诊断为高血压的人群中约 50.9% 为正常高值血压;高血压患病率为 27.5%,且男性(30.8%)高于女性(24.2%),知晓率、治疗率和血压控制率为 41.0%、34.9% 和 11.0%;进一步按照年龄分组,高血压患病率、知晓率、治疗率和血压控制率在 18~39 岁人群中分别为 11.8%、19.6%、13.9% 和 3.8%,在 40~59 岁人群中为 35.8%、41.9%、35.5% 和 11.7%<sup>[12]</sup>。2021 年,Ma 等<sup>[13]</sup> 基于中国健康与营养调查(1991-2015 年)数据的分析结果亦与之基本一致。由此可见,我国中青年人群的正常高值血压和高血压占比快速增加,但疾病知晓率、治疗率和血压控制率并未见相应提高,仍处于较低水平,与发达国家存在较大差距<sup>[14]</sup>。

二、中国中青年血压升高和高血压患病率增加的原因

中国肥胖问题工作组(WGOC)推荐,一般肥胖(general obesity)定义为体重指数(BMI)  $\geq 28$  kg/m<sup>2</sup>;中心性肥胖(central obesity)定义为腰围  $\geq 85$  cm(男性)/80 cm(女性);正常体重中心性肥胖(NWCO)定义为体重指数 18~24 kg/m<sup>2</sup> 和腰围/身高比(waist height ratio)  $\geq 0.5$  或腰臀比(waist to hip ratio)  $\geq 0.9$  (男性)/0.85(女性)或腰围  $\geq 85$  cm(男性)/80 cm(女性)<sup>[15]</sup>。据中国健康与营养调查(1991-2015 年)数据,我国成人一般肥胖占比自 1993 年的 20.81% 增至 2015 年的 50.57%,中心性肥胖自 19.23% 增至 56.15%,正常体重中心性肥胖自 27.20% 增至 49.07%,进而导致高血压患病率自 13.11% 增至 32.14%,其中,男性自 14.86% 增至 37.09%、女性自 11.54% 增至 27.92%,因此认为,高血压最高风险指标为一般肥胖( $RR = 3.71$ , 95%CI: 3.26 ~ 4.22;  $P =$

0.023), 其次分别为中心性肥胖( $RR = 3.62, 95\%CI: 3.19 \sim 4.12; P = 0.016$ )和正常体重中心性肥胖( $RR = 1.60, 95\%CI: 1.23 \sim 2.06; P = 0.011$ )<sup>[16]</sup>。此外,根据中国健康与养老追踪调查(CHARLS)数据,我国约有 1.177 亿例成人患者同时具有较高的体重指数和罹患高血压,其中,3853 万例推荐服用降压药但实际并未服药,3840 万例体重指数升高的高血压病患者血压控制并未达标<sup>[17]</sup>。

2017 年全国儿童青少年体育健身活动状况调查显示,超重和肥胖患病率分别为 15.10%(95%CI: 0.1509 ~ 0.1511)和 10.70%(95%CI: 0.1069 ~ 0.1071),仅 34.10%青少年达到中等至剧烈强度体育运动的要求(95%CI: 0.3409 ~ 0.3411)<sup>[18]</sup>。一项在国内高校进行的新型冠状肺炎(COVID-19)对生活方式改变的调查显示,疫情暴发前,大学生平均体重指数为 21.8 kg/m<sup>2</sup>,超重/肥胖和肥胖患病率为 21.3%和 10.5%,疫情暴发后上述 3 项指标分别增加 22.6%、25.1%和 12.9%,该项研究同时还发现,疫情期间大学生的生活方式发生重大变化,主要表现为用于主动通勤的体育运动(步行或骑行)以及中等至剧烈强度的家务劳动时间减少,休闲时间进行的中等至剧烈强度体育运动和步行频率减少,而久坐、睡眠和电子设备屏幕使用时间显著延长<sup>[19]</sup>。如果将用于主动通勤的体育运动(步行或骑行)强度以代谢当量(MET)分钟/周作为计量单位,与 213 ~ 394 MET 分钟/周的受试者相比,体育运动强度 < 213 MET 分钟/周的受试者新发高血压的风险显著增加( $HR = 1.29, 95\%CI: 1.15 \sim 1.44$ )<sup>[20]</sup>。

不健康饮食习惯是导致血压升高的危险因素,诸如高钠、高脂肪、高糖饮食等,尤其是高钠的摄入是高血压的主要危险因素之一<sup>[21-23]</sup>。根据 2018 年中国减盐行动(ASC)报告,我国成人 24 小时尿钠排泄量为(4318.1 ± 1814.1) mg/d,相当于钠摄入量达(11.0 ± 4.6) g/d<sup>[21]</sup>,远高于世界卫生组织(WHO)建议的 < 5 g/d 目标<sup>[22]</sup>。尿钠排泄量每增加 1000 mg,收缩压升高 1.32 mm Hg(95%CI: 0.92 ~ 1.81)、舒张压升高 0.34 mm Hg(95%CI: 0.09 ~ 0.60)<sup>[21]</sup>。通过减盐行动,山东省成人 24 小时尿钠排泄量自 2011 年的 5338 mg/d 减至 2016 年的 4013 mg/d( $P < 0.001$ ),平均收缩压自 131.8 mm Hg 降至 130.0 mm Hg( $P = 0.040$ ),平均舒张压自 83.9 mm Hg 降至 80.8 mm Hg( $P < 0.001$ )<sup>[23]</sup>。较高的胆固醇消耗可使高血压风险增加( $HR = 1.22, 95\%CI: 1.14 \sim 1.30; P < 0.05$ )<sup>[24]</sup>。

高残余胆固醇( $\geq 1.59$  mmol/L)是高血压的危险因素( $OR = 1.34, 95\%CI: 1.34 \sim 1.35; P < 0.001$ ),且残余胆固醇水平的升高可能早于高血压的发生<sup>[25]</sup>。基于中国健康与营养调查数据的分析,与摄入中等比例碳水化合物和脂肪饮食相比,摄入高碳水化合物和低脂饮食的个体罹患高血压的风险更高( $HR = 1.295, 95\%CI: 1.167 \sim 1.436; P = 0.012$ ),特别是青年人群( $HR = 1.422, 95\%CI: 1.106 \sim 1.828; P = 0.014$ ),而摄入低碳水化合物和高脂饮食则与高血压风险无关联性( $HR = 0.861, 95\%CI: 0.694 \sim 1.068; P = 0.852$ )<sup>[26]</sup>。通过分析高碳水化合物饮食与不同类型高血压之间的关系发现,随着饮食中碳水化合物供能比例的增加,收缩-舒张期高血压(SDH)风险增加( $HR = 1.54, 95\%CI: 1.18 \sim 2.00; P = 0.011$ ),而与单纯收缩期高血压( $HR = 0.89, 95\%CI: 0.67 \sim 1.19; P = 0.661$ )以及单纯舒张期高血压( $HR = 1.15, 95\%CI: 0.91 \sim 1.45; P = 0.638$ )风险增加无关联性<sup>[27]</sup>。此外亦证实,长期饮酒、吸烟、睡眠不足、工作压力增大导致的情绪异常均与高血压的发生密切相关。纵向数据(时间序列)分析(Time/Period Data)显示,与不饮酒者相比,饮酒频率  $\leq 2$  次/周的男性( $OR = 1.51, 95\%CI: 1.26 \sim 1.82; P < 0.001$ )和女性( $OR = 1.67, 95\%CI: 1.08 \sim 2.58; P < 0.05$ )均是高血压的危险因素,而对于饮酒频率  $> 2$  次/周的男性,高血压风险随饮酒频率的增加而升高( $OR = 2.13, 95\%CI: 1.77 \sim 2.56; P < 0.05$ )<sup>[28]</sup>。吸烟是高血压( $OR = 1.13, 95\%CI: 1.03 \sim 1.23; P < 0.05$ )和收缩期高血压( $OR = 1.15, 95\%CI: 1.05 \sim 1.25; P < 0.05$ )的危险因素<sup>[29]</sup>,特别是青少年被动吸烟可以导致收缩压绝对值显著升高(合并系数 = 0.26, 95%CI: 0.12 ~ 0.39)<sup>[30]</sup>。睡眠不足(< 7 h/d)者发生高血压的风险是正常睡眠时间(8 h/d)者的 1.13 倍(95%CI: 1.04 ~ 1.24,  $P = 0.015$ )<sup>[31]</sup>,尤其与收缩压升高显著相关,睡眠时间每缩短 2.57 分钟,24 小时平均收缩压升高 1 mm Hg( $P = 0.012$ ),平均心率增快 1 次( $P = 0.017$ )<sup>[32]</sup>。据《中国睡眠研究报告(2022)》,2021 年约有 64.75%的被调查者每日实际睡眠时间不足 8 小时,平均每日睡眠时间为 7.06 小时<sup>[33]</sup>。国内一项针对中青年科技工作者的问卷调查显示,高血压合并焦虑或抑郁的占比为 38.36%、合并失眠的占比为 43.15%,且高血压( $OR = 2.226, 95\%CI: 1.323 \sim 3.746; P = 0.003$ )、精神压力大( $OR = 4.484, 95\%CI: 2.592 \sim 7.756; P < 0.001$ )、失眠( $OR = 6.000, 95\%CI: 3.917 \sim$

9.191;  $P < 0.001$ ) 均是焦虑的危险因素<sup>[34]</sup>。

### 三、中青年高血压与脑卒中

1990–2019 年, 高血压导致的全球中青年人群心血管疾病发生率显著增加, 2019 年高血压相关心血管疾病致死亡病例数和残疾所致的健康寿命损失年 (YLD) 较 1990 年增加 43.0% 和 86.6%, 且男性病死率远高于女性, 其中缺血性心脏病和脑卒中是高血压相关死亡和健康寿命损失年增加的主要原因<sup>[35]</sup>。一项纳入 17 项临床队列研究计 450 万名中青年受试者的 Meta 分析显示, 约 23.8% 的受试者心血管疾病归因于高血压, 且随着血压级别的升高 (正常血压、正常高值血压、高血压 1 级和 2 级), 中青年罹患心血管疾病的风险呈增加趋势<sup>[36]</sup>。既往 20 年间, 中青年脑卒中 (主要是缺血性卒中) 发生率有所增加, 且其增加程度与高血压、吸烟、酗酒等传统脑卒中危险因素的增加呈平行关系, 与老年人群相比, 中青年缺血性卒中的病因更多样化, 其中 1/3 归类为病因不明的缺血性卒中, 这主要归结于对多样化病因和罕见病因的调查不足<sup>[37-38]</sup>。此外, 与老年人群相比, 中青年人群出血性卒中增加的比例更高<sup>[39-40]</sup>, 而高血压是成人非创伤性脑出血的主要原因<sup>[41]</sup>。对比分析中青年与老年脑出血发现, 中青年患者幕下血肿、过度饮酒和高体重指数比例更高, 而系统性高血压比例更低; 中青年患者神经功能预后 [改良 Rankin 量表 (mRS) 评分为 0 或 1 分] 优于老年患者 (51.79% 对 29.93%,  $P < 0.05$ ), 但二者发病后 1 个月病死率差异无统计学意义 (17.46% 对 18.01%,  $P > 0.05$ )<sup>[42]</sup>。中青年脑出血患者入院时收缩压和平均动脉压与较高的病死率相关, 入院时收缩压  $\geq 160$  mm Hg 可增加发病后 3 个月病死率 ( $HR = 2.5$ , 95%CI: 1.19 ~ 5.24;  $P < 0.05$ ) 和长期病死率 ( $HR = 2.02$ , 95%CI: 1.18 ~ 3.43;  $P < 0.01$ )<sup>[43]</sup>。入院时收缩压每升高 10 mm Hg, 既往无高血压病史的患者出院时医师开具的降压药种类增加 0.5 ( $P = 0.0011$ ), 既往有高血压病史的患者增加 1.3 ( $P = 0.0012$ ); 同时, 与出院时医师开具的降压药种类  $< 3$  的患者相比,  $\geq 3$  的患者入院时收缩压更高、年龄更小、病情更严重, 出院后神经功能预后更差<sup>[44]</sup>。

### 四、中青年高血压与脑小血管病

脑小血管病 (CSVD) 被认为是脑组织老化过程中慢性缺血的表现, 在影像学上主要表现为脑微出血 (CMBs)、脑白质高信号 (WMH)、扩大的血管周围间隙 (EPVS) 和腔隙性梗死 (LACI)<sup>[45]</sup>, 其严重程度

与男性、高龄和高血压 2 级呈正相关<sup>[45-49]</sup>。国外研究显示, 成人高血压患者脑微出血阳性检出率约为 36.7%, 此类患者年龄  $> 60$  岁占比 68.2%, 且其平均年龄高于无脑微出血患者 ( $P = 0.001$ ); 高血压 2 级患者脑微出血阳性检出率高达 61.8%, 另一方面, 脑微出血患者罹患高血压的平均时间为 25 年, 高于无脑微出血患者的 16 年 ( $P = 0.001$ ); 而对于高血压持续时间  $> 20$  年的患者, 不论其高血压级别是 1 级 ( $P = 0.000$ ) 还是 2 级 ( $P = 0.001$ ), 脑微出血阳性检出率均较高<sup>[50]</sup>。国内针对中青年高血压的报道表明, 脑微出血阳性检出率约 49.6%, 此类患者平均年龄大于无脑微出血患者 [(52.37  $\pm$  6.34) 岁对 (51.58  $\pm$  5.68) 岁,  $P = 0.121$ ], 男性高血压患者脑微出血阳性检出率高于女性 (55.7% 对 36.5%,  $P = 0.006$ ); 进一步分析提示, 脑白质高信号 ( $OR = 7.342$ , 95%CI: 1.550 ~ 34.786;  $P = 0.012$ )、脂质代谢异常 ( $OR = 3.672$ , 95%CI: 1.483 ~ 9.090;  $P = 0.005$ )、高同型半胱氨酸血症 ( $OR = 1.064$ , 95%CI: 1.005 ~ 1.127;  $P = 0.033$ )、吸烟 ( $OR = 3.632$ , 95%CI: 1.057 ~ 12.473;  $P = 0.041$ ) 以及应用抗血小板药 ( $OR = 3.372$ , 95%CI: 1.256 ~ 9.053;  $P = 0.016$ ) 是中青年高血压患者发生脑深部和小脑幕下微出血的危险因素, 仅脂质代谢异常是脑叶微出血的危险因素 ( $OR = 7.343$ , 95%CI: 2.040 ~ 26.428;  $P = 0.002$ )<sup>[51]</sup>。

2015 年发布的《中国脑小血管病专家共识》明确将高血压脑出血列为脑小血管病急性发作的表现形式之一<sup>[52]</sup>, 其中, 脑微出血灶数目  $\geq 5$  是自发性脑出血患者颅内血肿扩大以及缺血性卒中患者溶栓后出血性转化的独立危险因素<sup>[45, 53]</sup>, 而脑白质高信号<sup>[54]</sup>、扩大的血管周围间隙<sup>[54-55]</sup>和腔隙性梗死<sup>[56]</sup>的空间分布和数目均与颅内血肿部位密切相关。国外一项观察脑小血管病特征与颅内出血关系的队列研究显示, 颅内出血患者脑微出血阳性检出率更高, 脑室旁和脑深部白质高信号更严重, 基底节区和半卵圆中心扩大的血管周围间隙更明显, 腔隙性梗死阳性检出率更高、腔隙灶数目更多; 按照年龄分组, 各年龄段脑微出血 ( $OR = 15.089$ , 95%CI: 7.253 ~ 31.391;  $P < 0.001$ )、脑室旁白质高信号 ( $OR = 5.532$ , 95%CI: 1.541 ~ 19.856;  $P < 0.001$ ) 和基底节区扩大的血管周围间隙 ( $OR = 4.227$ , 95%CI: 1.676 ~ 10.656;  $P < 0.001$ ) 均为颅内出血的危险因素, 特别是脑微出血是颅内出血最强有力的预测因素<sup>[57]</sup>。进一步分析, 颅内出血部位与脑微出血灶位置具有

一致性,脑深部核团、小脑和脑干出血的微出血灶多见于脑深部,而脑叶出血的微出血灶则见于脑叶皮质下;颅内出血量与脑微出血灶数目亦呈正相关( $r=0.2, P=0.014$ ),其中,脑深部核团出血量与脑深部微出血灶数目呈正相关( $r=0.331, P=0.003$ ),脑叶出血量与脑叶皮质下微出血灶数目呈正相关( $r=0.415, P=0.004$ )<sup>[57]</sup>。韩国的一组中青年脑出血研究数据显示,脑微出血阳性检出率为 60.6%,其中 72.5% 为多发灶,主要位于脑深部(68.5%)和脑叶皮质下(31.5%),男性( $aOR=4.233, 95\%CI: 1.14 \sim 14.32; P=0.037$ )和高血压( $aOR=4.048, 95\%CI: 1.09 \sim 16.48; P=0.030$ )是脑微出血的危险因素<sup>[58]</sup>。

### 五、小结

近 10 年来,中国进入老龄化社会的速度逐步加快,主要表现为中青年人群在总人口的占比逐年下降<sup>[1]</sup>。中国中青年人群血压异常(正常血压高值、高血压 1~3 级)比例迅速增加,但高血压知晓率、治疗率和血压控制率普遍偏低<sup>[10-15]</sup>。高血压及相关心脑血管疾病成为我国成年居民的主要死因<sup>[10]</sup>,其发生率在中青年人群中呈快速上升趋势<sup>[35]</sup>。虽然中青年缺血性卒中的病例数和比例远高于出血性卒中,但出血性卒中的增长比例呈加速上升趋势。对天津市环湖医院病案资料的分析显示,2017-2021 年高血压脑出血病例数自 2557 例/年增至 2930 例/年,其中 16~59 岁年龄段病例数和占比自 1311 例/年和 51.27%(1311/2557)增至 1562 例/年和 53.31%(1562/2930);5 年间血肿位于基底节区、丘脑和脑干等重要功能区的病例数占全部高血压脑出血病例数的 64.23%(9033/14063),其在 16~59 岁年龄段占比为 68.89%(5041/7317),上述部位出血是发病 3 个月内死亡或遗留偏瘫、失语等严重神经功能障碍的重要原因。因此,高血压及相关脑卒中特别是出血性卒中是中青年人群健康的重大威胁,须对其进行深入研究。脑小血管病作为高血压脑出血的基础病变,在脑卒中发生发展过程中表现不同,具有重要的风险和预后预测价值,应在中青年血压异常人群中重视脑小血管病的检查。

利益冲突 无

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**下期内容预告** 本刊2022年第11期报道专题为神经康复,重点内容包括:神经调控技术;科技助力,创造奇迹;计算机辅助认知康复在脑卒中后认知功能障碍中的应用进展;迷走神经刺激术治疗脑卒中后上肢运动障碍研究进展;基于功能性近红外光谱成像技术的脊髓损伤患者脑激活及脑网络改变研究;前庭症状与非前庭症状脑梗死患者站立与步行特征分析;基于静息态fMRI的重复经颅磁刺激对低甲状腺激素水平脑卒中后认知功能障碍的疗效分析;虚拟现实技术结合小组治疗对脑卒中后抑郁患者康复疗效的影响;重复经颅磁刺激对神经病理性疼痛患者情绪的影响