

基于国家基本公共卫生服务体检的 20 岁及以上 高血压患者吸烟行为与糖尿病的关联研究

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摘要:目的 探讨 20 岁及以上成年高血压患者吸烟行为与糖尿病的关联情况。方法 基于南京市建邺区国家基本公共卫生服务项目高血压患者的年度健康体检数据(2019—2023 年), 采用 logistic 回归分析 ≥ 20 岁成年高血压患者中吸烟行为与糖尿病之间的关联性。利用限制性立方样条曲线探索高血压患者的日吸烟量、吸烟年限和吸烟指数与糖尿病之间的剂量-反应关系。结果 在 55 128 名研究对象中, 共有 14 102 名患有糖尿病。多因素 logistic 回归模型结果显示, 以不吸烟者为参照, 已戒烟者($OR = 1.17, 95\% CI: 1.01 \sim 1.35$)和现在吸烟者($OR = 1.18, 95\% CI: 1.10 \sim 1.26$)均与患糖尿病呈正相关。与不吸烟者相比, 日吸烟量 ≥ 30 支/天、吸烟年限 ≥ 50 年和吸烟指数 ≥ 20 包年的高血压患者糖尿病患病比例更高, 对应的 OR 值($95\% CI$)分别为 1.66(1.23 ~ 2.21)、1.13(1.01 ~ 1.26)和 1.21(1.12 ~ 1.31)。吸烟年限与糖尿病患病呈倒 U 型剂量-反应关系(非线性 P 值 = 0.029)。分层分析结果显示, 吸烟状况与糖尿病的关联在更年轻的亚组中更明显(交互作用 P 值 < 0.050)。结论 在 ≥ 20 岁的高血压患者中, 吸烟行为与糖尿病患病呈正相关, 吸烟年限与糖尿病患病呈倒 U 型关联。

关键词:吸烟; 高血压; 糖尿病; 基本公共卫生服务

中图分类号: R544.1; R587.1 文献标志码: A 文章编号: 1003-8507(2025)06-1085-07

DOI: 10.20043/j.cnki.MPM.202410174

Association between smoking behavior and diabetes among hypertensive patients aged 20 years and above based on the medical checkup data of national basic public health service

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Abstract: Objective To investigate the association between smoking behavior and diabetes among adult hypertensive patients aged 20 years and above. **Methods** Using annual health examination data from the National Basic Public Health Service Program for hypertensive patients in Jianye District, Nanjing (2019-2023), logistic regression was employed to analyze the association between smoking behavior and diabetes in adult hypertensive patients aged ≥ 20 years. Restricted cubic spline curves were used to explore the dose-response relationships between daily cigarette consumption, smoking duration, and smoking index with diabetes. **Results** Among 55 128 participants, 14 102 were identified as having diabetes. Multivariable logistic regression analysis showed that, compared with non-smokers, former smokers ($OR = 1.17, 95\% CI: 1.01 - 1.35$) and current smokers ($OR = 1.18, 95\% CI: 1.10 - 1.26$) were positively associated with diabetes. Compared with non-smokers, hypertensive patients who smoked ≥ 30 cigarettes/day, had a smoking duration of ≥ 50 years, or had a smoking index of ≥ 20 pack-years showed higher proportions of diabetes, with corresponding OR values ($95\% CI$) of 1.66 (1.23 - 2.21), 1.13 (1.01 - 1.26), and 1.21 (1.12 - 1.31). A U-shaped dose-response relationship was observed between smoking duration and diabetes prevalence (non-linear $P = 0.029$). Subgroup analysis revealed that the association between smoking status and diabetes was more pronounced in younger age groups (interaction $P < 0.050$). **Conclusion** Among hypertensive patients aged ≥ 20 years, smoking behavior is positively associated with diabetes prevalence, and smoking duration shows a U-shaped association with diabetes.

Keywords: Cigarette smoking; Hypertension; Diabetes; Basic public health service

基金项目: 江苏省卫生健康委员会医学科研项目(BJ23027)

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糖尿病是一种患病率高、致残率高且疾病负担严重的慢性非传染性疾病^[1-2]。既往证据表明^[3],高血压患者罹患糖尿病的风险是血压正常者的 2~3 倍。因此,在高血压患者中探索糖尿病的危险因素对于保护居民生命健康尤为重要。吸烟作为一种重要的可改变危险因素,已被证明与呼吸系统疾病^[4-5]、心血管疾病^[6-7]和代谢异常^[8-9]等多种健康问题有关。既往针对欧美一般人群的研究表明,吸烟与糖尿病风险增加相关^[10-11]。然而,对于中国人群,特别是基层健康体检中的高血压患者,吸烟行为与糖尿病的关联研究仍不足。此外,既往研究中对不同吸烟行为(日吸烟量、吸烟年限、吸烟指数)与糖尿病的剂量-反应关系探讨有限。本研究基于南京市建邺区国家基本公共卫生服务项目≥20 岁高血压患者的健康体检数据,旨在探索 20 岁及以上成年高血压患者中不同吸烟行为与糖尿病之间的关联。

1 对象与方法

1.1 研究对象 数据源于 2019—2023 年南京市建邺区国家基本公共卫生服务项目高血压患者的健康体检资料,该项目适用于中老年人、高血压、糖尿病患者等的年度健康检查,属于按照机构职能开展的常规工作范畴,因此无需经伦理审查。本研究纳入 20 岁及以上高血压患者 56 760 名,剔除吸烟状况和糖尿病患病状况缺失的参与者后,最终确定有效样本总计 55 128 例。在日吸烟量、吸烟年限和吸烟指数作为暴露变量时,分别额外剔除该项资料缺失者后,最终纳入分析的研究对象分别为 54 134 名、55 101 名和 54 120 名。

1.2 研究方法

1.2.1 数据收集 经过培训的调查员使用问卷开展面对面访问,收集的资料包括:①社会人口学特征:年龄、性别、文化程度、婚姻状况等;②生活方式:饮酒状况、吸烟状况、饮食状况、身体锻炼状况等;③常见慢性病史:糖尿病、高血压等。所有体格检查项目(身高、体重、血压等)由调查员按照标准化操作手册进行测量。BMI(kg/m²)根据体重(kg)除以身高(m)的平方计算得到。

1.2.2 指标及定义 ①高血压:参照《中国高血压防治指南(2024 年修订版)》诊断标准^[12],在未使用降压药的情况下,收缩压≥140 mmHg 和(或)舒张压≥90 mmHg 或调查前被乡镇及以上级别医院诊断为高血压者;②吸烟状况:现在吸烟者(调查时仍存在吸烟行为者)、戒烟者(过去曾经吸烟,但调查时已不在吸烟者)和不吸烟者(调查时不存在且过去曾经也不存在吸烟行为者);③日吸烟量:分为不吸烟、<10、10~

<20、20~<30 和≥30 支/天组;④吸烟年限:分为不吸烟、<30、30~<40、40~<50 和≥50 年组;⑤吸烟指数:每日吸烟包数(20 支/包)×吸烟年限,分为不吸烟、≤10、11~<20 和≥20 包年组^[13]。

1.2.3 统计学分析 使用 R 4.2.0 软件进行统计学分析。分类变量采用频数(构成比)表示,组间差异比较采用 χ^2 检验或秩和检验。采用 logistic 回归模型分析吸烟状况、日吸烟量、吸烟年限和吸烟指数与糖尿病的关联,并计算比值比(OR)值及其 95% CI。模型采用分步调整,模型 1:调整年龄(连续)和性别(男性、女性);模型 2:在模型 1 基础上调整婚姻状况(已婚、其他)、文化程度(小学以下、小学或初中、高中及以上)、BMI(<18.5、18.5~<24.0、24.0~<28.0、≥28.0 kg/m²)、饮酒状况(从不饮、偶尔饮、经常饮、每天饮)、饮食状况(荤素均衡、荤食为主、素食为主)、身体锻炼状况(每天锻炼、偶尔锻炼、每周锻炼一次以上、不锻炼)。使用四个节点的限制性立方样条(RCS)分别绘制日吸烟量、吸烟年限和吸烟指数与糖尿病的剂量-反应关系曲线。分层分析时,在模型 2 的基础上比较吸烟状况与糖尿病的关联在不同亚组(年龄、性别、BMI、饮酒状况、身体锻炼状况)间是否有差异,交互检验采用似然比检验。本研究采用双侧检验,检验水准 $\alpha=0.05$ 。

2 结果

2.1 基线特征 共纳入 55 128 名研究对象,已戒烟者 974 名(1.77%)和现在吸烟者 5 890 名(10.68%)。现在吸烟者平均吸烟量为(13.57±8.78)支/天,吸烟年限为(41.30±10.75)年,吸烟指数为(27.95±19.80)包年。与不吸烟者相比,现在吸烟者平均年龄较小、男性、已婚、BMI 更高、每天饮酒和不锻炼身体者的比例均较高。见表 1。

2.2 关联分析 进行多因素调整后发现,与不吸烟者相比,已戒烟者(OR=1.17,95% CI:1.01~1.35)和现在吸烟者(OR=1.18,95% CI:1.10~1.26)均与糖尿病患病呈正相关。以不吸烟者为参照,日吸烟量≥30 支/天、吸烟年限≥50 年和吸烟指数≥20 包年的研究对象糖尿病患病比例更高,对应的 OR 值(95% CI)分别为 1.66(1.23~2.21)、1.13(1.01~1.26)和 1.21(1.12~1.31)。见表 2。

2.3 剂量-反应关系 RCS 结果显示,在调整混杂因素后,吸烟年限与糖尿病患病呈倒 U 型剂量-反应关系(非线性 P 值=0.029),其中吸烟年限在约 41 年时达到关联顶点。日吸烟量和吸烟指数与糖尿病风险呈正向线性关系(非线性 P 值>0.05)。见图 1。

2.4 分层分析 吸烟状况和糖尿病的关联在不同年

龄组不完全一致(交互作用 P 值 <0.001)。与不吸烟的调查对象相比,已戒烟和现在吸烟与糖尿病的联系在更年轻(≤ 65 岁)的亚组中更明显,OR 值(95%

CI)分别为 1.34(1.01 ~ 1.77)和 1.29(1.15 ~ 1.44)。见表 3。

表 1 不同吸烟状况调查对象的基线特征

Table 1 Baseline characteristics of participants with different smoking statuses

特 征	吸烟状况			χ^2 值	P 值
	不吸烟 ($n=48\ 264$)	已戒烟 ($n=974$)	现在吸烟 ($n=5\ 890$)		
年龄(岁)				711.25	<0.001
<40	424(0.88)	3(0.31)	63(1.07)		
40~54	3 106(6.44)	23(2.36)	566(9.61)		
55~69	20 227(41.91)	418(42.92)	3 153(53.53)		
70~84	20 738(42.97)	498(51.13)	2 024(34.36)		
≥ 85	3 769(7.81)	32(3.29)	84(1.43)		
性别(%)				8 101.1	<0.001
男	19 029(39.43)	953(97.84)	5 729(97.27)		
女	29 235(60.57)	21(2.16)	161(2.73)		
婚姻状况(%) ^a				160.13	<0.001
已婚	44 010(91.19)	933(95.79)	5 632(95.62)		
其他	3 764(7.80)	39(4.00)	237(4.02)		
文化程度(%) ^a				207.38	<0.001
小学以下	2 330(4.83)	15(1.54)	100(1.70)		
小学或初中	20 260(41.98)	441(45.28)	2 606(44.24)		
高中及以上	24 551(50.87)	513(52.67)	3 128(53.11)		
BMI(kg/m^2) ^a				205.81	<0.001
<18.5	19 985(41.41)	290(29.77)	1 959(33.26)		
18.5 ~ <24.0	514(1.06)	6(0.62)	54(0.92)		
24.0 ~ <28.0	20 601(42.68)	490(50.31)	2 811(47.72)		
≥ 28.0	7 155(14.82)	188(19.30)	1 065(18.08)		
饮酒状况(%) ^a				13 922.53	<0.001
从不饮	45 782(94.86)	518(53.18)	2 770(47.03)		
偶尔饮	1 271(2.63)	248(25.46)	1 211(20.56)		
经常饮	294(0.61)	34(3.49)	396(6.72)		
每天饮	916(1.90)	174(17.86)	1 512(25.67)		
饮食状况(%) ^a				114.69	<0.001
荤素均衡	47 674(98.78)	942(96.71)	5 759(97.78)		
荤食为主	173(0.36)	14(1.44)	58(0.98)		
素食为主	304(0.63)	10(1.03)	34(0.58)		
身体锻炼状况(%) ^a				162.91	<0.001
每天锻炼	30 946(64.12)	760(78.03)	3 934(66.79)		
偶尔锻炼	1 788(3.70)	21(2.16)	207(3.51)		
每周锻炼一次以上	6 063(12.56)	63(6.47)	505(8.57)		
不锻炼	9 454(19.59)	130(13.35)	1 244(21.12)		

注:a 数据有缺失,合计不为 100%。

表 2 高血压患者中吸烟行为与糖尿病患病的 logistic 回归分析

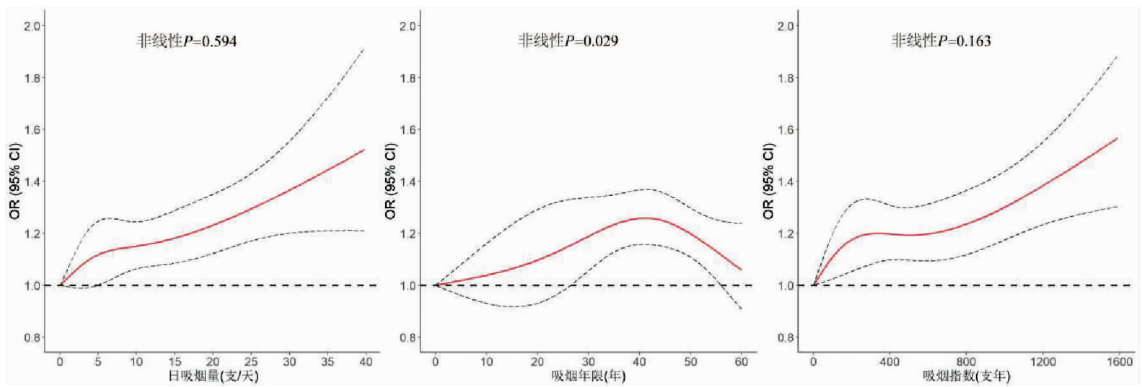
Table 2 Logistic regression analysis of smoking behavior and diabetes prevalence among hypertensive patients

变量	人数	模型 1		模型 2	
		OR 值(95% CI)	P 值	OR 值(95% CI)	P 值
不吸烟	48 264	1.00		1.00	
吸烟状况					
已戒烟	974	1.17(1.02 ~ 1.35)	0.028	1.17(1.01 ~ 1.35)	0.030
现在吸烟	5 890	1.18(1.10 ~ 1.26)	<0.001	1.18(1.10 ~ 1.26)	<0.001
日吸烟量(支/天)					
<10	3 191	1.12(1.03 ~ 1.21)	0.010	1.11(1.02 ~ 1.21)	0.013
10 ~ <10	2 285	1.24(1.13 ~ 1.37)	<0.001	1.24(1.13 ~ 1.37)	<0.001
20 ~ <30	191	1.11(0.79 ~ 1.52)	0.545	1.10(0.79 ~ 1.51)	0.576

(续表)

变量	人数	模型 1		模型 2	
		OR 值(95% CI)	P 值	OR 值(95% CI)	P 值
吸烟年限(年)					
≥30	203	1.67(1.24 ~ 2.22)	<0.001	1.66(1.23 ~ 2.21)	<0.001
<30	839	1.20(1.01 ~ 1.42)	0.033	1.20(1.01 ~ 1.42)	0.032
30 ~ <40	1 560	1.13(1.00 ~ 1.27)	0.046	1.13(1.00 ~ 1.27)	0.052
40 ~ <50	2 785	1.23(1.12 ~ 1.34)	<0.001	1.23(1.12 ~ 1.34)	<0.001
≥50	1 653	1.14(1.02 ~ 1.27)	0.023	1.13(1.01 ~ 1.26)	0.026
吸烟指数(包年)					
≤10	945	1.06(0.91 ~ 1.24)	0.432	1.06(0.91 ~ 1.23)	0.446
11 ~ <20	1 391	1.17(1.03 ~ 1.32)	0.014	1.16(1.03 ~ 1.32)	0.016
≥20	3 520	1.21(1.12 ~ 1.31)	<0.001	1.21(1.12 ~ 1.31)	<0.001

注:均以不吸烟为对照;模型 1 调整性别、年龄;模型 2 额外调整婚姻状况、文化程度、BMI、饮酒状况、饮食状况、身体锻炼状况。



注:红色实线表示 OR 值,黑色虚线表示 OR 值的 95% 置信区间。

图 1 高血压患者中日吸烟量、吸烟年限和吸烟指数与糖尿病患病的剂量 - 反应关系

Fig. 1 Dose - response relationship between daily cigarette consumption, smoking duration, smoking index, and diabetes prevalence among hypertensive patients

表 3 高血压患者中吸烟状况与糖尿病关联的分层分析

Table 3 Stratified analysis of the association between smoking status and diabetes among hypertensive patients

变量	不吸烟	已戒烟		现在吸烟		交互作用 P 值
		OR 值(95% CI)	P 值	OR 值(95% CI)	P 值	
性别						0.588
男	1.00	1.18(1.02 ~ 1.35)	0.027	1.15(1.07 ~ 1.23)	<0.001	
女	1.00	0.77(0.22 ~ 2.11)	0.643	1.38(0.96 ~ 1.95)	0.076	
年龄(岁)						<0.001
≤65	1.00	1.34(1.01 ~ 1.77)	0.039	1.29(1.15 ~ 1.44)	<0.001	
>65	1.00	1.09(0.92 ~ 1.28)	0.310	1.05(0.96 ~ 1.15)	0.259	
BMI(kg/m ²)						0.350
≤24.0	1.00	1.16(0.89 ~ 1.49)	0.271	1.09(0.97 ~ 1.24)	0.157	
>24.0	1.00	1.17(0.99 ~ 1.39)	0.071	1.22(1.13 ~ 1.33)	<0.001	
饮酒状况						0.509
否	1.00	1.18(0.97 ~ 1.42)	0.097	1.25(1.14 ~ 1.36)	<0.001	
是	1.00	1.19(0.95 ~ 1.48)	0.132	1.14(1.01 ~ 1.29)	0.039	
身体锻炼状况						0.110
每天	1.00	1.03(1.00 ~ 1.06)	0.057	1.04(1.03 ~ 1.06)	<0.001	
非每天	1.00	1.05(0.99 ~ 1.12)	0.088	1.02(1.00 ~ 1.05)	0.054	

注:模型调整性别、年龄、婚姻状况、文化程度、BMI、饮酒状况、饮食状况、身体锻炼状况。

3 讨论

本研究基于南京市建邺区国家基本公共卫生服

务项目 20 岁及以上成年高血压患者的健康体检数据,系统探讨了高血压患者中吸烟行为与糖尿病风险之间的关联性。结果显示,与不吸烟者相比,已戒烟

者、现在吸烟者、日吸烟量较大、吸烟年限较长及吸烟指数较高的高血压患者,其罹患糖尿病的比例增加。进一步的 RCS 表明,吸烟年限与糖尿病患病之间存在倒 U 型的剂量 - 反应关系。分层分析结果显示,吸烟与糖尿病患病的关联在更年轻的高血压患者中更为明显。

本研究发现,在高血压人群中,当前吸烟者与糖尿病患病呈正相关,这与国内外针对一般人群的研究结果一致。一项基于 25 项前瞻性研究的 Meta 分析显示,与不吸烟者相比,吸烟者的糖尿病发病风险增加了 44% ($RR = 1.44, 95\% CI: 1.31 \sim 1.58$)^[10]。国外一项随访 9 年的前瞻性研究同样发现,吸烟与糖尿病发病风险增加 40% 相关 ($HR = 1.40, 95\% CI: 1.20 \sim 1.64$)^[14]。一项针对 3 598 名中国人的前瞻性研究显示,吸烟者发生 2 型糖尿病的风险是不吸烟者的 4.16 倍 ($HR = 4.16, 95\% CI: 2.77 \sim 6.24$)^[15]。吸烟增加糖尿病风险可能与多种潜在的生物学机制有关。有证据表明,吸烟可以直接抑制胰岛 β 细胞功能,进而减少胰岛素的分泌^[16-17]。研究还显示,吸烟可引发体内的低度炎症^[18-19]和氧化应激^[20-22],这些因素不仅损害胰腺 β 细胞,还会干扰胰岛素信号通路,从而促进糖尿病的发生和进展^[23-24]。此外,有学者提出,吸烟者易出现腹部肥胖^[25-26],这一特征与糖尿病的高风险密切相关^[27]。

本研究发现,与不吸烟相比,已戒烟与糖尿病呈正相关,但这一结论在国内外的研究中仍存在争议。国外一项随访 8 年的前瞻性研究显示,已戒烟者与不吸烟者在 2 型糖尿病发生风险上的差异无统计学意义 ($HR = 1.22, 95\% CI: 0.96 \sim 1.55$)^[28]。国内一项基于 50 万参与者的前瞻性研究亦未发现相关性 ($HR = 1.05, 95\% CI: 0.96 \sim 1.16$)^[29]。一项针对 10 项前瞻性队列研究的 Meta 分析评估了戒烟年限对 2 型糖尿病风险的影响。结果显示,与不吸烟者相比,戒烟不足 5 年者的风险增加 54% ($RR = 1.54, 95\% CI: 1.36 \sim 1.74$)。随着戒烟时间的延长,这一风险逐渐降低:戒烟 5 ~ 9 年者的 RR 值降至 1.18 ($RR = 1.18, 95\% CI: 1.07 \sim 1.29$),戒烟 10 年以上者的 RR 值进一步降至 1.11 ($RR = 1.11, 95\% CI: 1.02 \sim 1.20$)^[11]。总体上,大多数研究表明,戒烟有助于降低糖尿病的长期风险^[14,30]。然而,在戒烟后的初期阶段,部分人群(特别是因健康问题而戒烟者)发生糖尿病的风险甚至比当前吸烟者更高^[14,31],这可能与反向因果关系以及戒烟后体重增加有关^[32-34]。因此,研究结果的差异可能源于不同样本戒烟年限的不同、横断面研究设计的局限、随访时间的差异以及残留的混杂因素等。

本研究显示,日吸烟量和吸烟指数与糖尿病风险

呈正线性相关,而吸烟年限与糖尿病患病之间存在倒 U 型的剂量 - 反应关系。美国一项对女性群体随访 24 年的队列研究表明,随着日吸烟量或吸烟指数的增加,研究对象糖尿病发病风险呈上升趋势(趋势检验 $P < 0.001$)^[35]。既往关于吸烟年限与糖尿病剂量 - 反应关系的研究较少。一项韩国研究发现,随着日吸烟量的增加,糖尿病的发生风险随之增加,然而研究人员并未观察到风险随着吸烟年限的延长而增加^[36]。在一些心血管疾病研究中也有观察到类似的现象,长期重度吸烟者的疾病风险在达到顶峰后出现下降趋势^[37-38]。本研究呈现的倒 U 型关系可能是由于健康筛选效应,即健康状况较差的长期吸烟者更早出现健康问题并停止吸烟或过早去世,剩余吸烟者的健康状况相对较好^[39]。未来仍需进一步的纵向研究来验证这一非线性关系。本研究分层分析显示,已戒烟和现在吸烟与糖尿病的关联在更年轻的亚组中更明显。我们的结果与国外一项研究相似,与当前吸烟者相比,更年轻的亚组中已戒烟者降低糖尿病风险更明显(交互作用 P 值 < 0.001)^[40]。这可能与年轻人群更容易受到吸烟对代谢和胰岛素抵抗的影响有关^[41-42]。

本研究的优势在于基于大规模体检数据,样本量较大,能够较为全面地评估 20 岁及以上成年高血压患者中吸烟行为与糖尿病的关联。此外,通过使用 RCS 探讨剂量 - 反应关系,较好地揭示了吸烟行为的复杂影响。然而,本研究也存在一定的局限性。首先,作为一项横断面研究,本研究无法明确因果关系。其次,吸烟行为和糖尿病的自报数据可能存在信息偏倚。此外,残留的混杂因素可能影响结果的解释。

综上所述,本研究显示在高血压患者中,吸烟行为与糖尿病风险呈正相关,其中吸烟年限与糖尿病患病呈倒 U 型正相关,吸烟与糖尿病的关联在年轻人群中更明显。因此,在高血压患者中,不吸烟和早戒烟对于预防糖尿病具有重要意义,针对更年轻的人群,通过不吸烟和早戒烟干预,预防糖尿病的效果可能更明显。

利益冲突声明 本研究不存在任何利益冲突

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收稿日期:2024-10-14

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收稿日期:2024-11-26