



1990–2021年中国吸烟所致慢性呼吸系统疾病负担分析与预测*

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【摘要】目的 分析1990–2021年中国吸烟所致慢性呼吸系统疾病(chronic respiratory diseases, CRD)的疾病负担变化趋势,并预测其2022–2035年发展情况,为优化控烟策略与公共卫生决策提供科学依据。**方法** 基于全球疾病负担研究(Global Burden of Disease, GBD)2021数据,收集1990–2021年中国、日本、欧盟、美国及全球吸烟归因CRD的流行病学数据,包括伤残生存年(years lived with disability, YLDs)、过早死亡损失年(years of life lost, YLLs)、伤残调整寿命年(disability-adjusted life years, DALYs)等指标,涵盖30岁及以上人群。采用Joinpoint回归模型估计平均年度变化百分比(average annual percentage change, AAPC),并应用贝叶斯年龄-时期-队列(Bayesian age-period-cohort, BAPC)模型进行趋势预测。**结果** 2021年,中国吸烟所致CRD的DALYs为10 320 279[95%不确定性区间(uncertainty interval, UI): 7 806 610 ~ 12 875 089]人年,年龄标准化DALYs率(age-standardized disability-adjusted life years rate, ASDR)为522.34(95%UI: 394.50 ~ 653.32)/10万人年;死亡数为566 446(95%UI: 416 802 ~ 720 431)例,年龄标准化死亡率(age-standardized mortality rate, ASMR)为31.34(95%UI: 23.10 ~ 39.69)/10万人;YLLs与YLDs分别为8 983 486(95%UI: 6 547 449 ~ 11 421 727)人年和1 336 793(95%UI: 981 768 ~ 1 699 656)人年,对应年龄标准化率(age-standardised rates, ASR)为458.96(95%UI: 337.53 ~ 582.19)/10万人年和63.38(95%UI: 46.17 ~ 80.72)/10万人年。疾病负担在性别与年龄上差异明显,男性与中老年群体风险更高。1990–2021年,中国各项负担率指标均呈下降趋势,预计未来十余年ASMR与ASDR将持续下降。**结论** 中国在CRD防控和控烟方面已取得积极进展,但人口老龄化等挑战仍需关注。应加强针对性预防干预措施,特别是面向高风险人群,减轻疾病负担。中国的控烟经验亦可为其他发展中国家提供政策借鉴。

【关键词】 吸烟 呼吸系统疾病 疾病负担 伤残调整寿命年

Analysis and Projection of the Burden of Chronic Respiratory Diseases Attributable to Smoking in China, 1990–2021

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[Abstract] Objective To analyze trends in the disease burden of chronic respiratory diseases (CRD) attributable to smoking in China from 1990 to 2021 and to project its development from 2022 to 2035, providing scientific evidence for optimizing tobacco control strategies and public health decision-making. **Methods** Using Global Burden of Disease (GBD) 2021 data, epidemiological data on smoking-attributable CRD were collected for China, Japan, the European Union, the United States, and the global population from 1990 to 2021. Indicators included years lived with disability (YLDs), years of life lost (YLLs), and disability-adjusted life years (DALYs), covering individuals aged 30 years and older. Joinpoint regression models estimated average annual percentage changes (AAPCs), while Bayesian age-period-cohort (BAPC) models projected future trends. **Results** In 2021, smoking-attributable CRD DALYs in China reached 10 320 279 (95% uncertainty interval [UI]: 7 806 610–12 875 089) person-years, with an age-standardized disability-adjusted life years rate (ASDR) of 522.34 (95% UI: 394.50–653.32) per 100 000 person-years. The number of deaths was 566 446 (95% UI: 416 802

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-720431), with an age-standardized mortality rate (ASMR) of 31.34 (95% UI: 23.10-39.69) per 100 000 population. YLLs and YLDs were 8 983 486 (95% UI: 6 547 449-11 421 727) person-years and 1 336 793 (95% UI: 981 768-1 699 656) person-years, corresponding to age-standardized rates (ASR) of 458.96 (95% UI: 337.53-582.19) per 100 000 person-years and 63.38 (95% UI: 46.17-80.72) per 100 000 person-years, respectively. The disease burden showed significant differences by gender and age, with higher risks among males and middle-aged and elderly populations. From 1990 to 2021, all burden indicators in China showed a declining trend, with ASMR and ASDR projected to continue decreasing over the next decade. **Conclusion** China has made positive progress in CRD prevention and tobacco control, but challenges such as population aging require continued attention. Targeted prevention interventions, particularly for high-risk populations, should be strengthened to reduce disease burden. The experience and challenges documented in China could offer valuable lessons and policy insights for other countries undergoing similar epidemiological transitions.

[Key words] Smoking Respiratory disease Disease burden Disability-adjusted life years

慢性呼吸系统疾病(chronic respiratory diseases, CRD)是一类对肺部和气道健康造成持续损害的非传染性疾病,主要包括慢性阻塞性肺疾病、支气管哮喘、支气管扩张症和原发性支气管肺癌等。作为全球疾病负担最重的非传染性疾病之一,CRD在全球范围内造成了大量死亡与健康损失。当前,哮喘和慢性阻塞性肺疾病是最常见的两种CRD,分别影响约3.5亿人和2亿人,给患者及社会均带来了沉重负担^[1-3]。因此,改善CRD的防治现状显得尤为迫切^[4]。

CRD已知的几种常见风险因素包括吸烟、二手烟、室内外污染、过敏原以及职业因素^[5]。根据世界卫生组织报告,全球范围内烟草使用所致健康负担呈上升趋势^[6-7]。因此,了解吸烟这一风险因素的趋势并规划相应的预防措施,将对减轻CRD疾病负担产生重要影响,有助于政策制定者在资源分配中做出明智的决策。

本研究基于全球疾病负担研究(Global Burden of Disease, GBD)2021数据,系统评估1990-2021年中国吸烟所致CRD的死亡、过早死亡损失年(years of life lost, YLLs)、伤残生存年(years lived with disability, YLDs)、伤残调整寿命年(disability-adjusted life years, DALYs)及年龄标准化率(age-standardised rates, ASR),并采用贝叶斯年龄-时期-队列(Bayesian age-period-cohort, BAPC)模型预测2022-2035年趋势。进一步探讨其在人群层面的时空变化特征,同时与美国、日本、欧盟及全球进行对比,旨在为中国控烟政策优化与资源配置提供循证依据。

1 资料与方法

1.1 数据来源

本研究所用吸烟所致CRD负担数据均来自GBD 2021数据库,该数据库涵盖371种疾病和87个风险因素,具有良好的数据完整性与可比性^[8]。相关数据由GBD研究团队基于DisMod-MR 2.1模型按年龄、性别、年份和国家系统建模估算,本研究在此基础上开展分析。

1.2 健康指标与风险定义

在本研究中,吸烟定义为每天或偶尔使用任何形式的烟草制品,以及曾经使用任何烟草制品,包括但不限于香烟、烟斗、雪茄、水烟以及其他烟草制品。需要指出的是,该定义未涵盖无烟烟草、电子烟、喷雾产品或加热烟草产品。本研究所称“CRD”依据GBD 2021三级疾病分类,具体包括:①慢性阻塞性肺疾病;②尘肺(进一步细分为矽肺、石棉肺、煤工尘肺及其他尘肺);③哮喘;④间质性肺疾病和肺结节病;⑤其他慢性呼吸系统疾病^[9]。研究收集了1990-2021年间中国、日本、欧盟、美国及全球总体水平(global level,指GBD 2021对204个国家和地区人口加权平均后的汇总结果)吸烟所致CRD数据,包括死亡、YLLs、YLDs以及DALYs,涵盖了30岁及以上的不同年龄段和不同性别。GBD研究中的所有估计值均附带95%不确定性区间(uncertainty interval, UI),该区间依据后验分布,通过对模型参数进行1 000次蒙特卡罗抽样后取第2.5与97.5百分位值计算得出。GBD研究的设计和方法细节已在相关文献中进行了广泛描述^[10-11]。

1.3 统计学方法

GBD采用多风险分摊法(mediated percentage attribution)对同一结局的重叠暴露进行归因分配,确保各风险归因分数之和不超过100%,本研究仅提取“smoking-CRD”风险-结果对。为消除人口年龄构成差异对吸烟所致CRD负担分析的影响,采用ASR来量化不同历史时期、地理区域以及性别之间吸烟所致CRD负担的差异。具体而言,通过Joinpoint回归模型拟合ASR的自然对数与日历年的关系,模型表达式为 $\ln(\text{ASR}) = \alpha + \beta \times \text{年} + \epsilon$,进而基于公式 $100 \times (\exp(\beta) - 1)$ 估计平均年度变化百分比(average annual percentage change, AAPC)及其95%置信区间(confidence interval, CI)^[12]。采用BAPC,并结合R程序(4.4.2)中的集成嵌套拉普拉斯近似(INLA)包进行预测分析^[13]。所有统计分析与图表绘制均在R环境中完成, $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 2021年中国吸烟所致CRD负担

结果见表1。2021年,中国因吸烟所致的CRD共造成DALYs 10 320 279(95%UI: 7 806 610 ~ 12 875 089)人年,年龄标准化DALYs率(age-standardized disability-adjusted life years rate, ASDR)为522.34(95%UI: 394.50 ~ 653.32)/10万人年。死亡人数为566 446(95%UI: 416 802 ~ 720 431)例,年龄标准化死亡率(age-standardized mortality rate, ASMR)为31.34(95%UI: 23.10 ~ 39.69)/10万人。同期,吸烟所致CRD的YLLs和YLDs分别为8 983 486(95%UI: 6 547 449 ~ 11 421 727)人年和1 336 793(95%UI: 981 768 ~ 1 699 656)人年,对应的ASR分别为458.96(95%UI: 337.53 ~ 582.19)/10万人年和63.38(95%UI: 46.17 ~ 80.72)/10万人年。

2.2 1990–2021年中国吸烟所致CRD的时间变化趋势

结果见表1、图1。1990–2021年间,中国因吸烟导致的CRD死亡人数变化不大,2021年为1990年的1.04倍,但其ASMR呈持续下降趋势,AAPC为−2.220(95%CI: −2.279, −2.161)。同期,CRD造成的DALYs的ASDR显著下降,AAPC为−37.973(95%CI: −38.783, −37.162)。其中,YLLs总量明显减少,YLDs则略有上升,但二者的ASR均下降,AAPC分别为−36.374(95%CI: −37.472, −35.275)和−0.529(95%CI: −0.546, −0.513),YLLs降幅明显大于YLDs。

2.3 1990–2021年中国吸烟所致CRD疾病负担的年龄与性别差异分析

结果见表1、图2。在1990年和2021年,男性在几乎所有年龄段的CRD负担总量及ASR均显著高于女性。2021年,男女两性因吸烟导致的CRD负担随年龄呈上升

表 1 1990年与2021年中国吸烟所致CRD负担及Joinpoint分析结果
Table 1 Burden of smoking-attributable CRD and joinpoint analysis results in China, 1990 and 2021

Burden metric	Stratification	Group	1990		2021		1990–2021 AAPC (95% CI)
			Cases or person-years (95% UI)	ASR/per 100 000 (95% UI)	Cases or person-years (95% UI)	ASR/per 100 000 (95% UI)	
Deaths	Sex	Both	543 651 (442 036, 652 386)	97.10 (77.16, 116.15)	566 446 (416 802, 720 431)	31.34 (23.10, 39.69)	−2.220 (−2.279, −2.161) [*]
		Female	107 097 (70 841, 148 727)	38.65 (25.48, 54.27)	71 119 (42 471, 113 993)	7.07 (4.17, 11.24)	−1.037 (−1.062, −1.011) [*]
		Male	436 554 (356 885, 526 385)	188.05 (154.54, 223.62)	495 327 (361 436, 628 793)	68.57 (50.38, 86.12)	−3.923 (−4.008, −3.838) [*]
	Age	30–49 yr.	11 453 (8 913, 14 464)	4.23 (3.30, 5.35)	4 077 (2 816, 5 436)	0.89 (0.62, 1.19)	−0.012 (−0.013, −0.012) [*]
		50–69 yr.	158 940 (125 831, 196 179)	106.22 (83.62, 130.90)	85 952 (60 513, 113 893)	22.57 (15.85, 29.92)	−0.732 (−0.748, −0.716) [*]
		≥70 yr.	375 265 (294 529, 472 565)	1 342.82 (1 051.51, 1 651.75)	601 874 (472 023, 712 659)	467.16 (345.40, 595.26)	−15.555 (−15.971, −15.139) [*]
YLLs	Sex	Both	10 785 997 (8 745 988, 13 053 333)	1 571.47 (1 277.50, 1 887.69)	8 983 486 (6 547 449, 11 421 727)	458.96 (337.53, 582.19)	−36.374 (−37.472, −35.275) [*]
		Female	1 820 071 (1 203 337, 2 522 226)	549.61 (367.69, 763.90)	1 004 744 (627 161, 1 580 198)	95.49 (59.07, 152.16)	−14.805 (−15.083, −14.527) [*]
		Male	8 965 927 (7 219 776, 10 931 862)	2 936.96 (2 414.04, 3 521.44)	7 978 742 (5 846 558, 10 169 063)	950.19 (693.28, 1 205.24)	−65.473 (−66.706, −64.241) [*]
	Age	30–49 yr.	538 461 (417 611, 670 812)	196.87 (153.28, 248.80)	188 325 (130 017, 251 103)	41.75 (28.82, 55.66)	−0.567 (−0.582, −0.553) [*]
		50–69 yr.	4 543 798 (3 572 701, 4 605 343)	3 003.40 (2 358.35, 3 707.76)	2 387 417 (1 678 785, 3 168 952)	629.39 (441.55, 835.43)	−20.315 (−20.777, −19.852) [*]
		≥70 yr.	5 690 728 (4 489 088, 6 100 556)	17 697.13 (13 961.64, 21 658.66)	6 018 748 (4 720 523, 7 126 569)	5 907.61 (4 358.86, 7 564.05)	−195.848 (−200.445, −191.251) [*]
YLDs	Sex	Both	649 167 (467 704, 848 868)	78.70 (56.63, 102.21)	1 336 793 (981 768, 1 699 656)	63.38 (46.17, 80.72)	−0.529 (−0.546, −0.513) [*]
		Female	161 481 (108 265, 225 258)	40.92 (27.33, 56.84)	292 060 (185 935, 411 953)	26.59 (16.78, 37.64)	−0.475 (−0.485, −0.465) [*]
		Male	487 686 (356 135, 633 333)	119.22 (87.99, 153.02)	1 044 733 (790 150, 1 323 658)	103.59 (78.07, 130.03)	−0.570 (−0.606, −0.533) [*]
	Age	30–49 yr.	109 909 (67 151, 160 667)	38.62 (24.00, 56.14)	118 657 (75 741, 171 723)	26.93 (16.92, 38.78)	−0.068 (−0.069, −0.066) [*]
		50–69 yr.	321 911 (231 620, 428 426)	211.69 (152.34, 281.79)	601 793 (426 253, 795 436)	158.51 (112.69, 209.45)	−1.273 (−1.309, −1.237) [*]
		≥70 yr.	216 341 (150 529, 286 936)	594.60 (410.56, 794.39)	623 363 (431 367, 840 140)	529.42 (369.55, 708.63)	−4.358 (−4.491, −4.225) [*]
DALYs	Sex	Both	11 435 165 (9 276 282, 13 748 860)	1 650.17 (1 330.25, 1 969.26)	10 320 279 (7 806 610, 12 875 089)	522.34 (394.50, 653.32)	−37.973 (−38.783, −37.162) [*]
		Female	1 981 552 (1 326 924, 2 702 501)	590.52 (397.30, 809.88)	1 296 804 (841 586, 1 923 625)	122.07 (78.04, 180.94)	−15.278 (−15.560, −14.997) [*]
		Male	9 453 613 (7 684 711, 11 416 672)	3 056.19 (2 518.64, 3 651.98)	9 023 475 (6 708 953, 11 292 486)	1 053.77 (780.98, 1 311.39)	−66.037 (−67.282, −64.792) [*]
	Age	30–49 yr.	548 369 (501 210, 817 251)	235.48 (182.35, 295.99)	308 981 (217 846, 302 695)	68.68 (48.33, 89.71)	−0.633 (−0.648, −0.618) [*]
		50–69 yr.	4 455 709 (3 846 023, 4 986 154)	3 215.09 (2 541.39, 3 954.14)	2 989 210 (2 225 944, 3 829 101)	787.90 (586.06, 1 009.55)	−21.583 (−22.065, −21.102) [*]
		≥70 yr.	5 915 088 (4 618 617, 6 978 360)	18 291.73 (14 432.70, 22 392.32)	7 024 656 (5 244 471, 8 142 033)	6 437.03 (4 830.41, 8 106.82)	−199.480 (−204.239, −194.722) [*]

ASR: age-standardized rate; AAPC: average annual percentage change; UI: uncertainty interval; YLLs: years of life lost; YLDs: years lived with disability; DALYs: disability-adjusted life years. ^{*} $P < 0.05$.

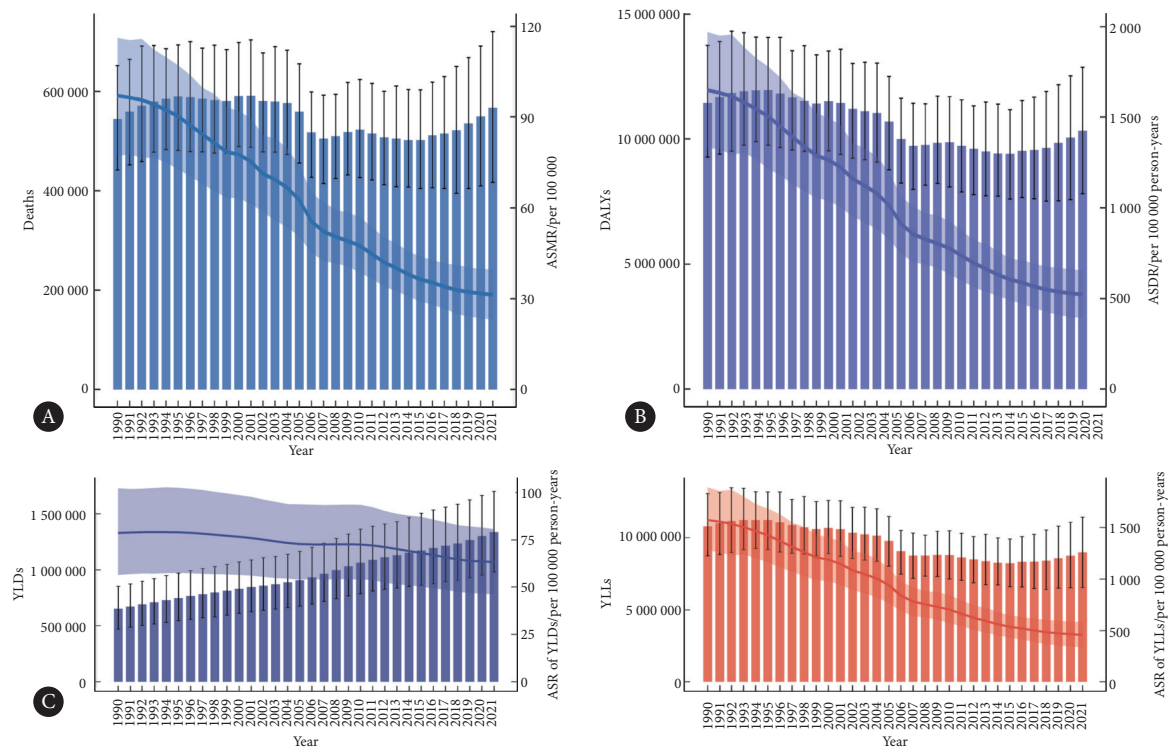


图 1 1990–2021年中国吸烟所致CRD的负担变化趋势

Fig 1 Trends in the burden of smoking-attributable CRD in China, 1990–2021

ASMR: age-standardized mortality rate; YLLs: years of life lost; YLDs: years lived with disability; DALYs: disability-adjusted life years; ASDR: age-standardized disability-adjusted life years rate; ASR: age-standardized rate. A, Number of deaths and ASMR; B, DALYs and ASDR; C, YLLs and YLDs, age-standardized YLLs rates and age-standardized YLDs rates. Bar graphs show the number of cases; line graphs show age-standardized rates; shading indicates 95% uncertainty intervals.

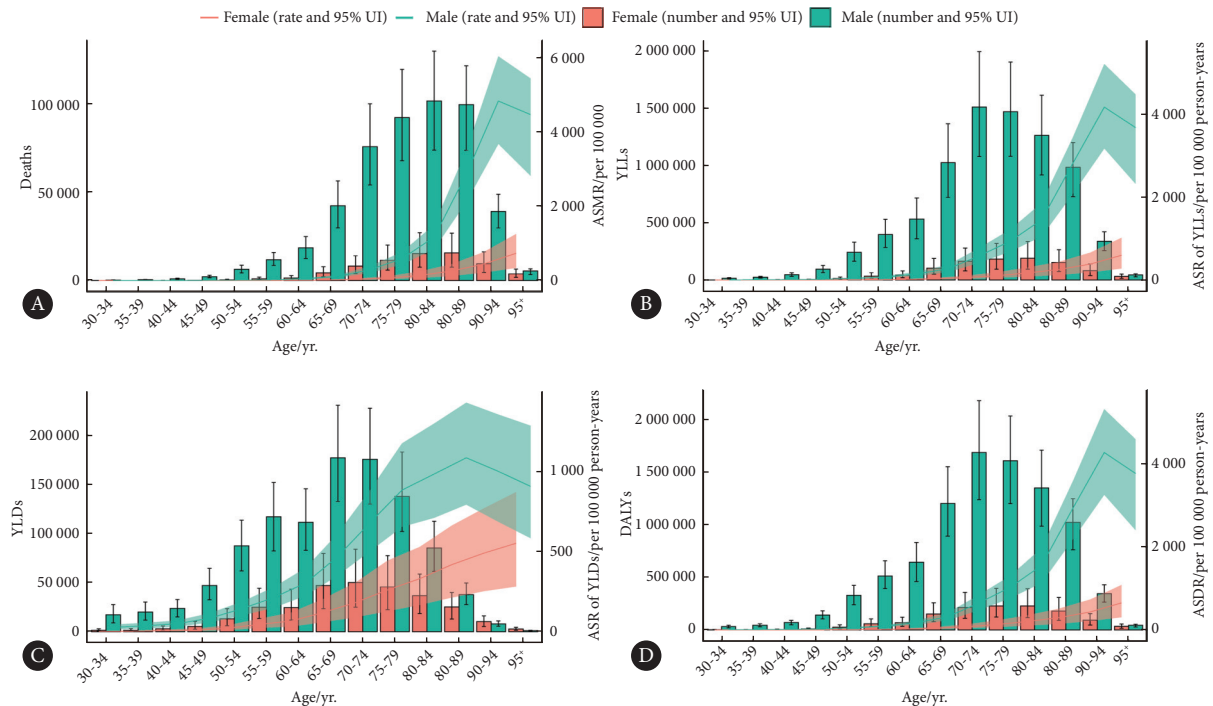


图 2 2021年中国不同年龄与性别人群吸烟所致CRD负担

Fig 2 Burden of CRD attributable to smoking among different age and gender groups in China, 2021

ASMR: age-standardized mortality rate; YLLs: years of life lost; YLDs: years lived with disability; DALYs: disability-adjusted life years; ASDR: age-standardized disability-adjusted life years rate. A, Number of deaths and ASMR; B, YLLs and age-standardized YLLs rates; C, YLDs and age-standardized YLDs rates; D, DALYs and ASDR. Bar graphs show the number of cases; line graphs show age-standardized rates; shading indicates 95% uncertainty intervals.

趋势, 30~49岁人群的负担相对较低, 50~69岁时显著增加, 70岁及以上年龄段达到最高, 尤以男性最为明显。具体来看, 随着年龄增长, 死亡人数、YLLs、YLDs及DALYs均持续上升, 提示中老年人群面临更高的CRD健康风险。

2.4 中国、日本、欧盟、美国与全球吸烟所致CRD负担比较

结果见图3。1990–2021年, 全球吸烟所致CRD的ASMR与ASDR总体呈下降趋势。中国的ASMR和ASDR在同期显著高于美国、日本、欧盟和全球平均水平, 美国则表现出一定波动。尽管如此, 中国与发达国家之间的疾病负担差距正逐步缩小, 其中日本在1990–2021年的ASMR与ASDR水平均处于最低位。

2021年, 中国吸烟所致CRD的ASMR与ASDR仍处于

全球较高水平(附图1A和1C), 但其ASMR与ASDR的AAPC在1990–2021年间下降幅度最大, 显示出显著的改善趋势(附图1B和1D)。附图进一步展示了全球吸烟所致CRD负担的空间异质性: 白俄罗斯及部分东欧国家的ASMR处于较高分位区间(6.281/10万人~7.63/10万人); 新加坡与北欧国家(如芬兰、挪威)负担水平较低(<2.99/10万人), 且年均下降幅度明显; 南美部分国家(如秘鲁、玻利维亚、委内瑞拉)在ASDR方面负担突出, 个别国家超过1000/10万人年。附图1见网络资源附件。

2.5 2022–2035年中国吸烟所致CRD负担预测

结果见图4。基于BAPC模型预测, 未来十余年中国吸烟所致CRD的ASMR和ASDR将持续下降, AAPC分别

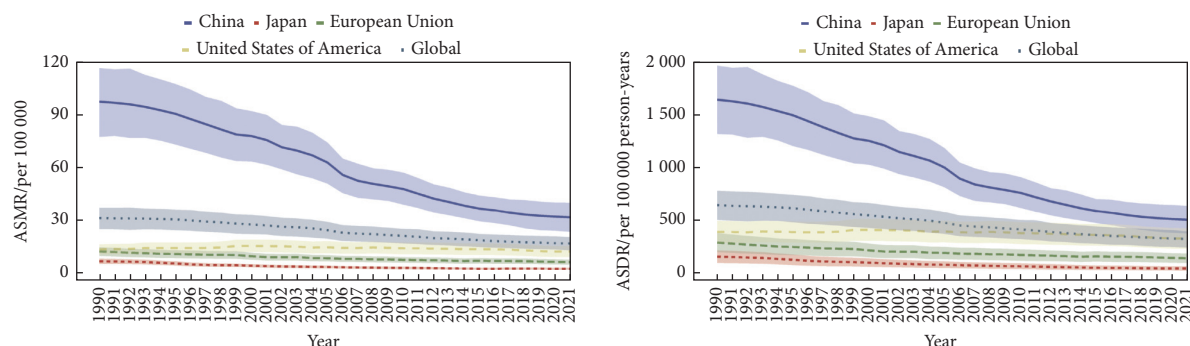


图3 1990–2021年中国、日本、欧盟、美国与全球吸烟所致CRD的ASMR变化趋势

Fig 3 Trends in smoking-attributable CRD ASMR in China, Japan, the EU, the US, and globally, 1990–2021

ASMR: age-standardized mortality rate; ASDR: age-standardized disability-adjusted life years rate.

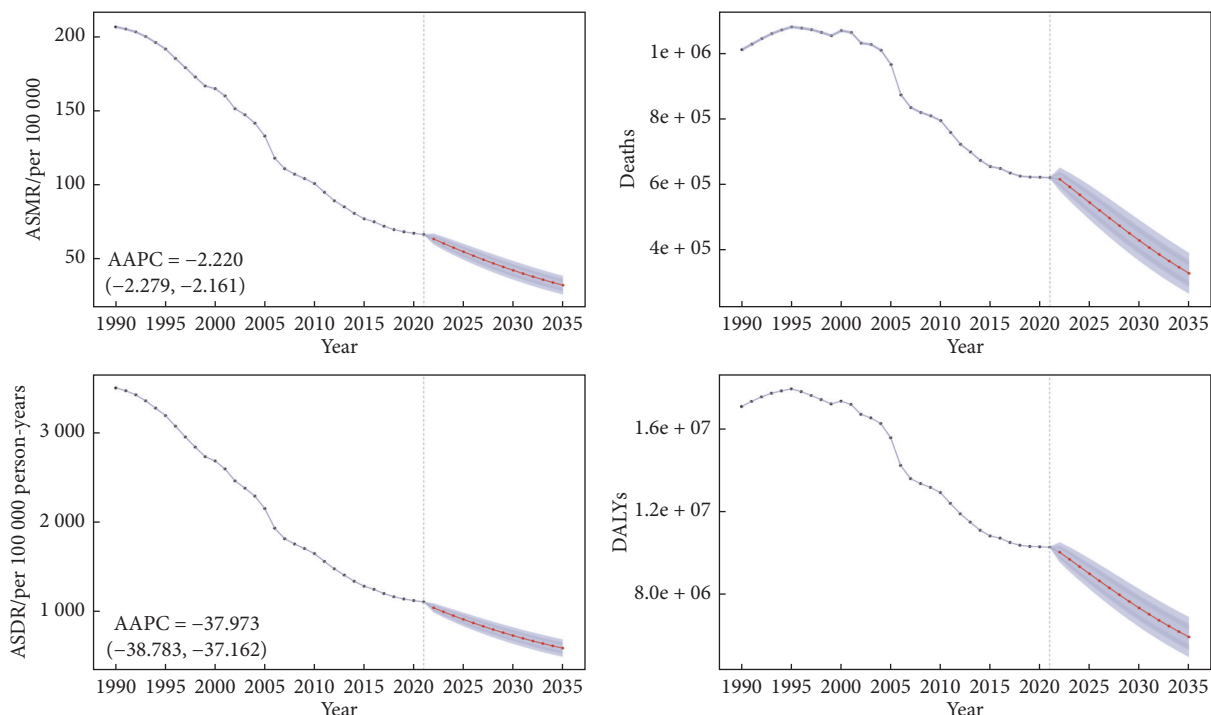


图4 1990–2035年中国吸烟所致CRD的ASMR与ASDR时间趋势及预测结果

Fig 4 Temporal trends and projections of ASMR and ASDR for smoking-attributable CRD in China, 1990–2035

ASMR: age-standardized mortality rate; DALYs: disability-adjusted life years; ASDR: age-standardized disability-adjusted life years rate.

为 $-2.220(95\%CI: -2.279, -2.161)$ 和 $-37.973(95\%CI: -38.783, -37.162)$ 。到2035年,CRD的死亡人数与DALYs总量预计较2021年进一步减少。

3 讨论

吸烟所致的CRD是一个由多种行为和环境因素共同驱动的复杂公共卫生问题,不仅对患者造成长期的身心负担,还带来了巨大的社会和经济压力^[3, 14]。本研究发现,1990–2021年,中国因吸烟导致的CRD的死亡人数、DALYs、YLLs和YLDs的ASR均呈现显著下降趋势,尤其是ASDR和ASMR的降幅在全球范围内处于领先水平。这一变化与全球平均水平形成鲜明对比,提示我国在控烟政策实施与慢性病管理方面取得了积极成效。

与此相对,全球范围内吸烟所致CRD的负担仍处于较高水平,低收入和中等收入国家的形势尤为严峻^[15]。我国之所以能实现显著的负担下降,得益于近二十年来在控烟与慢性病防控方面持续推进的多项公共卫生政策。例如,公共场所全面禁烟、烟草广告限制、提高烟草税、加强烟盒警示图文比例以及开展健康教育等措施有效减少了烟草使用率,控制了CRD的新增风险^[16–17]。《中国防治慢性病中长期规划(2017–2025年)》特别强调全生命周期健康管理、“三早”(早发现、早诊断、早治疗)策略及多部门协同机制,“健康中国行动”进一步推动了以控烟为核心的健康促进政策落地实施^[18–19]。这些干预的系统性与持续性在全球范围内具有一定的代表性,也为其他资源有限国家提供了可借鉴的控烟路径。

值得注意的是,“吸烟”在本研究中指终生曾经吸烟。大规模前瞻队列表明,戒烟5~15年后CRD死亡风险可下降30%~50%,提示老年期亦可获益^[20]。然而,由于肺功能不可逆损伤多在 ≥ 40 岁累积,控烟策略更应前移:①延迟首支烟年龄;②在30~50岁实现“黄金期”戒烟;③为 ≥ 60 岁戒烟者加强肺康复与肺癌筛查^[21–22]。尽管中国吸烟所致CRD的ASMR和YLDs率持续下降,但死亡人数和YLDs的绝对值仍呈上升趋势。这一现象主要归因于人口老龄化与人口基数增长的共同影响。一方面,老年人口持续增加,扩大了CRD的易感人群;另一方面,医疗服务水平提升和慢性病管理能力增强延长了患者寿命,从而增加了YLDs的累积。因此,即便风险水平下降,CRD带来的绝对疾病负担仍不可忽视^[23]。

从全球视角来看,以白俄罗斯等东欧国家和玻利维亚等南美安第斯地区国家为代表的吸烟所致CRD的ASMR($>55/10$ 万)和ASDR($>1\ 100/10$ 万人年)仍处于全球前十的高位区间,而新加坡及北欧国家(如芬兰、挪威)相

关指标均低于3/10万(人年)且近三十年降幅平稳,负担水平显著较低。这些国家在健康生活方式倡导、医疗资源配置和慢性病管理方面的综合干预措施,对我国控烟政策优化具有借鉴价值。未来应继续推动健康教育、加强公共卫生基础设施、完善慢性病管理策略,综合施策以降低吸烟相关疾病的健康影响。

在性别差异方面,本研究发现,男性在各年龄段的死亡人数、YLLs、YLDs、DALYs及其ASR均显著高于女性。这一差异可能由多重因素驱动,包括生物学差异(如气道结构、免疫反应)^[24],以及行为因素,尤其是我国男性吸烟率高达58.7%,而女性吸烟率显著较低^[25–26]。此外,社会经济地位亦在其中发挥作用,经济条件较差者往往医疗保障不足,导致CRD早期无法有效干预,从而加重疾病负担^[27]。因此,需制定性别敏感型控烟政策。世界卫生组织已提出将性别因素纳入烟草控制政策和干预基础设施设计之中,以实现更公平和有效的控烟效果^[28]。

在年龄层面,本研究显示中老年人群在吸烟所致CRD各项指标中负担最重。老年人机体功能衰退、免疫力下降,增加了吸烟对呼吸系统的损伤风险。同时,该人群往往合并多种慢性病,如高血压、糖尿病等,吸烟会加剧这些共病的进展,进而加重CRD的临床表现^[29–30]。因此,针对中老年人群的精准识别、健康管理和控烟干预应成为未来公共卫生重点工作方向之一。

随着中国人口结构的持续演变,特别是人口老龄化加剧和出生率下降,未来70岁及以上人群在吸烟所致CRD中的负担占比预计将进一步上升。本研究强调,应加强对老年人群的精准干预,以有效缓解其CRD健康负担。然而,老年人戒烟行为的干预难度相对较高。美国一项研究表明,传统控烟手段(如禁烟立法、提高烟草税)对老年人效果有限^[31]。一项纳入42项随机对照试验的系统评价表明,随访咨询联合戒烟药物的干预策略,在中老年吸烟者中取得的戒烟效果不亚于甚至优于年轻吸烟者^[32]。发展基于人群特征的戒烟计划,结合医生主动干预,有望改善老年人控烟效果。

根据本研究的预测结果,未来十余年中国吸烟所致CRD的ASMR和ASDR将持续下降,提示我国在强化控烟政策与健康促进方面已取得初步成效。尽管如此,考虑到庞大的人口基数与老龄化加速的现实挑战,仍需持续推进综合性干预策略,包括加强健康教育、优化医疗服务体系、推动多部门协同,以实现可持续的CRD负担控制目标。

相较于既往研究,本研究基于GBD 2021最新版数据,结合BAPC模型开展趋势预测,从人群与时段层面系统描绘了中国吸烟所致CRD负担的时空演变特征,突出了重

点人群特征, 为优化我国控烟与慢性病防控政策提供了循证支持。尽管GBD通过终生曾经吸烟调整了死因误分, 并使用多风险分摊控制重叠暴露, 但残余混杂与多病因共存仍可能导致归因误差, 应谨慎解读。本研究亦存在以下局限: 首先, 尽管GBD数据库在全球疾病负担评估中具有广泛应用, 但其数据主要依赖模型估算, 可能无法完全反映部分国家和地区, 尤其是特定人群的实际流行特征; 其次, 本研究所采用的吸烟暴露定义尚未纳入新型烟草制品(如无烟烟草、电子烟、加热不燃烧产品等), 而此类产品近年来使用率持续上升, 可能对CRD流行趋势产生新的影响; 最后, 本研究未能深入探讨区域间社会经济、医疗资源或控烟政策差异对疾病负担的具体作用, 可能限制了结论的外推性。综上所述, 中国在吸烟所致CRD防控方面已取得阶段性进展, 但在老龄化背景下, 疾病负担仍不容忽视。未来应加强针对性策略研究, 关注性别、年龄和社会经济差异, 探索个体行为、环境暴露与健康结果之间的复杂关联。同时, 应持续完善对新型烟草制品的监测与评估, 推动控烟政策与健康教育的动态优化。中国的防控经验也可为其他发展中国家提供有益借鉴, 特别是在烟草控制与公共卫生治理方面。

* * *

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参 考 文 献

[1] SUN Y, ZHANG M, OU Z, *et al.* Indoor microbiome, microbial and plant metabolites, chemical compounds, and asthma symptoms in junior high school students: a multicentre association study in Malaysia. *Eur Resp J*,

- 2022, 60(5): 2200260. doi: [10.1183/13993003.00260-2022](https://doi.org/10.1183/13993003.00260-2022).
- [2] 中国老年医学学会呼吸病学分会慢性阻塞性肺疾病学组. 中国老年慢性阻塞性肺疾病临床诊治实践指南. *中华结核和呼吸杂志*, 2020, 43(2): 100–119. doi: [10.3760/cma.j.issn.1001-0939.2020.02.007](https://doi.org/10.3760/cma.j.issn.1001-0939.2020.02.007).
- Chronic Obstructive Pulmonary Disease Group of Respiratory Branch of Chinese Geriatric Society. Clinical practice guideline for diagnosis and management of chronic obstructive pulmonary disease in elderly patients. *Chin J Tuberc Respir Dis*, 2020, 43(2): 100–119. doi: [10.3760/cma.j.issn.1001-0939.2020.02.007](https://doi.org/10.3760/cma.j.issn.1001-0939.2020.02.007).
- [3] LABAKI W W, HAN M K. Chronic respiratory diseases: a global view. *Lancet Respir Med*, 2020, 8(6): 531–533. doi: [10.1016/S2213-2600\(20\)30157-0](https://doi.org/10.1016/S2213-2600(20)30157-0).
- [4] 老年慢性呼吸系统疾病人群流感疫苗和肺炎球菌疫苗预防接种专家共识意见专家委员会, 中华医学会老年医学分会呼吸病学组. 老年慢性呼吸系统疾病人群流感疫苗和肺炎球菌疫苗预防接种专家共识(2024). *中华老年医学杂志*, 2024, 43(10): 1223–1235. doi: [10.3760/cma.j.issn.0254-9026.2024.10.001](https://doi.org/10.3760/cma.j.issn.0254-9026.2024.10.001).
- Expert Committee of Consensus Opinion on Influenza Vaccine and Pneumococcal Vaccine Vaccination for Elderly People with Chronic Respiratory Diseases, Respiratory Group of Chinese Geriatrics Society. Expert consensus on influenza vaccine and pneumococcal vaccination in elderly people with chronic respiratory diseases(2024). *Chin J Geriatr*, 2024, 43(10): 1223–1235. doi: [10.3760/cma.j.issn.0254-9026.2024.10.001](https://doi.org/10.3760/cma.j.issn.0254-9026.2024.10.001).
- [5] HSU Y E, CHEN S C, GENG J H, *et al.* Obesity-related indices are associated with longitudinal changes in lung function: a large Taiwanese population follow-up study. *Nutrients*, 2021, 13(11): 4055. doi: [10.3390/nu13114055](https://doi.org/10.3390/nu13114055).
- [6] KVILLEM P, FELTMANN K, ELGÁN T H, *et al.* Evaluation of the implementation of a 25-year outdoor school ground smoking ban: a qualitative interview study with implications for prevention practise. *Front Public Health*, 2021, 9: 628748. doi: [10.3389/fpubh.2021.628748](https://doi.org/10.3389/fpubh.2021.628748).
- [7] MOHAMMADI E, AMINORROAYA A, FATTAHI N, *et al.* Epidemiologic pattern of cancers in Iran: current knowledge and future perspective. *J Diabetes Metab Disord*, 2020, 20(1): 825–829. doi: [10.1007/s40200-020-00654-6](https://doi.org/10.1007/s40200-020-00654-6).
- [8] ZHU Y S, SUN Z S, ZHENG J X, *et al.* Prevalence and attributable health burdens of vector-borne parasitic infectious diseases of poverty, 1990–2021: findings from the Global Burden of Disease Study 2021. *Infect Dis Poverty*, 2024, 13(1): 96. doi: [10.1186/s40249-024-01260-x](https://doi.org/10.1186/s40249-024-01260-x).
- [9] SORIANO J B, KENDRICK P J, PAULSON K R, *et al.* Prevalence and attributable health burden of chronic respiratory diseases, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet Respir Med*, 2020, 8(6): 585–596. doi: [10.1016/S2213-2600\(20\)30105-3](https://doi.org/10.1016/S2213-2600(20)30105-3).
- [10] ZHENG J, ZHANG D, ZHANG S, *et al.* Global burden of malaria and neglected tropical diseases in children and adolescents, 1990–2019: a population-based, cross-sectional study. *J R Soc Med*, 2025, 118(3): 82–96. doi: [10.1177/01410768251321572](https://doi.org/10.1177/01410768251321572).
- [11] FERRARI A J, SANTOMAURO D F, AALI A, *et al.* Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet*, 2024, 403(10440): 2133–2161. doi: [10.1016/S0140-6736\(24\)00757-8](https://doi.org/10.1016/S0140-6736(24)00757-8).
- [12] LI Z, YANG L, CHEN H, *et al.* Global, regional and national burden of autism spectrum disorder from 1990 to 2019: results from the Global Burden of Disease Study 2019. *Epidemiol Psychiatr Sci*, 2022, 31: e33. doi: [10.1017/S2045796022000178](https://doi.org/10.1017/S2045796022000178).
- [13] HUANG J, LI H, YAN H, *et al.* The comparative burden of brain and central nervous system cancers from 1990 to 2019 between China and the United States and predicting the future burden. *Front Public Health*, 2022, 10: 1018836. doi: [10.3389/fpubh.2022.1018836](https://doi.org/10.3389/fpubh.2022.1018836).
- [14] AREIA M, DIAS L P, MATOS P, *et al.* Public involvement in chronic respiratory diseases research: a qualitative study of patients', carers' and citizens' perspectives: Health Expectations. *Health Expect*, 2024, 27(1): 1–10. doi: [10.1111/hex.13917](https://doi.org/10.1111/hex.13917).

- [15] WANG Z, LIN J, LIANG L, *et al.* Global, regional, and national burden of chronic obstructive pulmonary disease and its attributable risk factors from 1990 to 2021: an analysis for the Global Burden of Disease Study 2021. *Respir Res*, 2025, 26(1): 2. doi: [10.1186/s12931-024-03051-2](https://doi.org/10.1186/s12931-024-03051-2).
- [16] CHAN K H, WRIGHT N, XIAO D, *et al.* Tobacco smoking and risks of more than 470 diseases in China: a prospective cohort study. *Lancet Public Health*, 2022, 7(12): e1014-e1026. doi: [10.1016/S2468-2667\(22\)00227-4](https://doi.org/10.1016/S2468-2667(22)00227-4).
- [17] CHU M, LIU Z, FANG X, *et al.* Effects of a smoke-free policy in Xi'an, China: impact on hospital admissions for acute ischemic heart disease and stroke. *Front Public Health*, 2022, 10: 898461. doi: [10.3389/fpubh.2022.898461](https://doi.org/10.3389/fpubh.2022.898461).
- [18] 健康中国行动推进委员会. 健康中国行动(2019—2030年): 总体要求、重大行动及主要指标. *中国循环杂志*, 2019, 34(9): 846-858. doi: [10.3969/j.issn.1000-3614.2019.09.003](https://doi.org/10.3969/j.issn.1000-3614.2019.09.003).
- [19] 王一然, 王奇金. 慢性病防治的重点和难点: 《中国防治慢性病中长期规划(2017—2025年)》解读. *第二军医大学学报*, 2017, 38(7): 828-831. doi: [10.16781/j.0258-879x.2017.07.0828](https://doi.org/10.16781/j.0258-879x.2017.07.0828).
WANG Y R, WANG Q J. Key points and difficulties in prevention and treatment of chronic disease- interpretation of Guidelines for Prevention and Treatment of Chronic Diseases in China (2017—2025). *Academic Journal of Second Military Medical University*, 2017, 38(7): 828-831. doi: [10.16781/j.0258-879x.2017.07.0828](https://doi.org/10.16781/j.0258-879x.2017.07.0828).
- [20] THOMSON B, ISLAMI F. Association of smoking cessation and cardiovascular, cancer, and respiratory mortality. *JAMA Intern Med*, 2024, 184(1): 110-112. doi: [10.1001/jamainternmed.2023.6419](https://doi.org/10.1001/jamainternmed.2023.6419).
- [21] GARCIA-AYMERICH J, De Las HERAS M, CARSIN A E, *et al.* General population-based lung function trajectories over the life course: an accelerated cohort study. *Lancet Respir Med*, 2025, 13(7): 611-622. doi: [10.1016/S2213-2600\(25\)00043-8](https://doi.org/10.1016/S2213-2600(25)00043-8).
- [22] WU J, MENG W, MA Y, *et al.* Early smoking lead to worse prognosis of COPD patients: a real world study. *Respir Res*, 2024, 25(1): 140. doi: [10.1186/s12931-024-02760-y](https://doi.org/10.1186/s12931-024-02760-y).
- [23] SU B, GUO S, ZHENG X. Transitions in chronic disease mortality in China: evidence and implications. *China CDC Weekly*, 2023, 5(50): 1131-1134. doi: [10.46234/ccdcw2023.211](https://doi.org/10.46234/ccdcw2023.211).
- [24] XIAO D, CHEN Z, WU S, *et al.* Prevalence and risk factors of small airway dysfunction, and association with smoking, in China: findings from a national cross-sectional study. *Lancet Respir Med*, 2020, 8(11): 1081-1093. doi: [10.1016/s2213-2600\(20\)30155-7](https://doi.org/10.1016/s2213-2600(20)30155-7).
- [25] QUAN Z, YAN G, WANG Z, *et al.* Current status and preventive strategies of chronic obstructive pulmonary disease in China: a literature review. *J Thorac Dis*, 2021, 13(6): 3865-3877. doi: [10.21037/jtd-20-2051](https://doi.org/10.21037/jtd-20-2051).
- [26] WEN G, MENG J, PENG P, *et al.* Prevalence of chronic obstructive pulmonary disease and its associated risk factors in Yunnan Province, China: a population based cross-sectional study. *Int J Chron Obstruct Pulmon Dis*, 2024, 19: 1531-1545. doi: [10.2147/copd.s459267](https://doi.org/10.2147/copd.s459267).
- [27] DU M, ZHU L, LIU M, *et al.* Mutual associations of healthy behaviours and socioeconomic status with respiratory diseases mortality: a large prospective cohort study. *Nutrients*, 2023, 15(8): 1872. doi: [10.3390/nu15081872](https://doi.org/10.3390/nu15081872).
- [28] PIETERSMA C S, MULDER A G M G J, SABANOVIC A, *et al.* The impact of maternal smoking on embryonic morphological development: the Rotterdam Periconception Cohort. *Hum Reprod*, 2022, 37(4): 696-707. doi: [10.1093/humrep/deac018](https://doi.org/10.1093/humrep/deac018).
- [29] CHEN X, ZHOU C W, FU Y Y, *et al.* Global, regional, and national burden of chronic respiratory diseases and associated risk factors, 1990–2019: results from the Global Burden of Disease Study 2019. *Front Med*, 2023, 10: 1066804. doi: [10.3389/fmed.2023.1066804](https://doi.org/10.3389/fmed.2023.1066804).
- [30] WANG C, JIANG H, ZHU Y, *et al.* Association of the time to first cigarette and the prevalence of chronic respiratory diseases in Chinese elderly population. *J Epidemiol*, 2022, 32(9): 415-422. doi: [10.2188/jea.je20200502](https://doi.org/10.2188/jea.je20200502).
- [31] KALOUSOVÁ L. Tobacco control policy and smoking among older Americans: an analysis of a nationally-representative longitudinal sample (1992–2014). *Prev Med*, 2020, 137: 106127. doi: [10.1016/j.ypmed.2020.106127](https://doi.org/10.1016/j.ypmed.2020.106127).
- [32] JOHNSON A L, AVILA J C, CHRISTENSEN L, *et al.* Smoking cessation treatment efficacy and impact on health outcomes among middle-aged and older adults: a scoping review. *Nicotine Tob Res*, 2025: ntaf122. doi: [10.1093/ntr/ntaf122](https://doi.org/10.1093/ntr/ntaf122).

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