

# 贵州省少数民族人群胆结石与心血管疾病的关联及肾小球滤过率的中介效应分析

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**摘要:**目的 探讨贵州省少数民族人群胆结石与心血管疾病的关联及肾小球滤过率在关联中的中介效应, 为减轻心血管疾病负担提供参考建议。方法 本研究基于“西南区域少数民族聚集地世居自然人群队列研究”数据库, 采用分层、多阶段整群抽样, 于 2018—2019 年在贵州省黔东南州、黔南州对 30 ~ 79 岁少数民族人群展开基线调查, 通过多因素 logistic 回归分析胆结石与心血管疾病的关联, 中介效应模型评估肾小球滤过率在关联中的中介效应。结果 贵州省少数民族人群心血管疾病检出率为 3.16%, 其中侗族、苗族、布依族检出率分别为 3.27%、3.07%、3.12%, 胆结石总检出率为 9.03%。Logistic 回归分析显示, 调整所有协变量后(模型 3), 在总人群[OR(95% CI): 1.633(1.269 ~ 2.102)]、侗族[OR(95% CI): 1.567(1.077 ~ 2.280)]、苗族[OR(95% CI): 1.679(1.055 ~ 2.673)]中, 胆结石与心血管疾病呈正相关。在布依族人群, 胆结石与心血管疾病之间不存在关联。亚组分析显示, 侗族 < 60 岁胆结石患者与心血管疾病呈正相关[OR(95% CI): 1.825(1.022 ~ 3.258)]、未患高脂血症的胆结石患者[OR(95% CI): 2.151(1.352 ~ 3.422)]、未患高血压的胆结石患者[OR(95% CI): 1.612(1.013 ~ 2.565)]与心血管疾病存在正相关。苗族 ≥ 60 岁[OR(95% CI): 1.878(1.038 ~ 3.397)]、男性[OR(95% CI): 1.546(1.212 ~ 5.586)]、BMI ≥ 24 [OR(95% CI): 1.972(1.160 ~ 3.354)]、有高血压的胆结石患者[OR(95% CI): 2.264(1.297 ~ 5.429)]与心血管疾病呈正相关。中介分析发现, 在总人群、侗族、苗族、布依族人群中, 肾小球滤过率在胆结石与心血管疾病之间的中介效应占比分别为 16.96%、12.08%、17.43%、14.52%。结论 贵州省侗族、苗族人群中胆结石与心血管疾病呈正相关, 尤其在苗族超重、高血压人群。在布依族人群中胆结石与心血管疾病之间不存在关联。肾小球滤过率在胆结石与心血管疾病之间存在部分中介效应。

**关键词:**心血管疾病; 胆结石; 中介分析; 关联; 亚组分析

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## Association between gallstones and cardiovascular diseases and the mediating effect of glomerular filtration rate in the minority population, Guizhou Province

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**Abstract: Objective** To explore the association between gallstones and CVD among ethnic minority populations in Guizhou Province, as well as the mediating effect of glomerular filtration rate (GFR) in this association, in order to provide reference suggestions for reducing the burden of CVD. **Methods** Based on the database of Cohort Study of Native Natural Population in Ethnic Minority Gathering Areas in Southwest China, stratified and multi-stage cluster sampling was used to conduct a baseline survey of ethnic minorities aged 30 - 79 years in Qiandongnan and Qiannan Prefectures of Guizhou Province from 2018 to 2019. Multivariate logistic regression was used to analyze the association between gallstones and CVD, and the mediating effect model was used to evaluate the mediating effect of glomerular filtration rate in the association. **Results** The detection rate of CVD in Guizhou minority population was 3.16%, among which the detection rates of Dong, Miao and Buyi were 3.27%, 3.07% and 3.12%, respectively. The total detection rate of gallstones was 9.03%. Logistic regression analysis showed that after adjusting for all the variables (model 3), the detection rates of CVD in the total population [OR(95% CI): 1.633(1.269 - 2.102)], the Dong [OR(95% CI): 1.567(1.077 - 2.280)], and Miao [OR(95% CI): 1.679

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(1.055 - 2.673)], gallstones were positively associated with CVD. No association between gallstones and CVD was found in the Buyi population. Subgroup analysis showed that Dong patients with gallstones <60 years old were positively correlated with CVD [OR(95% CI): 1.825(1.022 - 3.258)], gallstone patients without hyperlipidemia [OR(95% CI): 2.151(1.352 - 3.422)], gallstone patients without hypertension [OR(95% CI): 1.612(1.013 - 2.565)] were positively correlated with CVD. Miao ≥60 years old [OR(95% CI): 1.878(1.038 - 3.397)], male [OR(95% CI): 1.546(1.212 - 5.586)], BMI ≥24 [OR(95% CI): 1.972(1.160 - 3.354)], gallstone patients with hypertension [OR(95% CI): 2.264(1.297 - 5.429)] were positively correlated with CVD. Mediation analysis revealed that the glomerular filtration rate accounted for 16.96%, 12.08%, 17.43%, and 14.52% of the mediating effect between gallstones and CVD in the total population, Dong, Miao, and Buyi people, respectively. **Conclusion** Gallstones are positively correlated with CVD in the Dong and Miao populations in Guizhou Province, especially in the overweight and hypertension population of the Miao nationality. There is no association between gallstones and CVD in the Buyi population. Glomerular filtration rate has a partial mediating effect between gallstones and CVD.

**Keywords:** Cardiovascular disease; Gallstone; Mediation analysis; Association; Subgroup analysis

心血管疾病(Cardiovascular Disease, CVD)是导致全世界人口死亡的主要原因,约占全球所有死亡人数的三分之一<sup>[1]</sup>。在中国<sup>[2]</sup>,CVD患病率仍处于持续上升阶段,预估患病人数达3.3亿。目前,关于胆结石与CVD之间的关系仍然不明确<sup>[3]</sup>。胆结石的形成过程中伴随着动脉粥样硬化的发生,这可能会导致CVD的发生<sup>[4]</sup>。在韩国一项研究中<sup>[5]</sup>,在男性和女性中,胆结石与CVD风险均没有关联。肾小球滤过率已被证实与CVD之间存在关联<sup>[6-8]</sup>。而胆固醇水平升高会导致肾小球滤过率降低<sup>[9-10]</sup>,进而影响CVD的发生。因此,我们推测肾小球滤过率可能在胆结石与CVD关联中之间存在中介效应。

目前未见研究探讨肾小球滤过率在胆结石与CVD之间的中介作用。有必要在自然人群中进一步探讨二者之间的联系以及肾小球滤过率是否中介这一关联。贵州省是一个少数民族聚集的省份,其侗族、苗族、布依族有着独特的生活习惯和饮食文化。高血脂会增加CVD的患病风险<sup>[11]</sup>,而当地少数民族喜食的特色饮食已被证实具有一定的降血脂功效<sup>[12-13]</sup>。本研究旨在探讨贵州省少数民族人群胆结石与CVD之间的关系,为减轻CVD负担提供参考建议。

## 1 对象与方法

**1.1 研究对象** 本研究基于“西南区域少数民族聚集地世居自然人群队列研究”基线调查数据<sup>[14]</sup>,本研究采用分层、多阶段整群抽样方法,选择贵州省黔东南州、黔南州为调查现场,于2018—2019年对18 790名侗族苗族布依族常住居民进行调查,样本具有代表性。排除标准:CVD信息缺失者1 529人、肌酐数据缺失者259人、体力活动和身高体重等身体指标缺失者429人,共16 573人纳入分析。本研究通过四川大学医学伦理委员会(K2016038)和贵州医科大学附属

医院医学伦理委员会[2018(094)]批准。所有研究对象均自愿参加并签署知情同意书。

**1.2 研究内容与方法** (1)问卷调查:调查表采用“西南区域少数民族聚集地世居自然人群队列研究”基线问卷;(2)体格检查:测量身高和体重时,地面平坦坚固,身着轻衣并脱鞋,取两次平均值。使用电子血压计测量收缩压和舒张压,测量前休息5分钟,取3次平均值。(3)血标本采集和实验室检测:采集空腹静脉血,进行抗凝离心,-80℃超低温冰箱保存。采用全自动生化仪检测血脂、尿酸、肌酐等。

**1.3 研究变量定义** (1)吸烟:至今吸烟超过100支。(2)饮酒:过去半年中每周至少饮酒一次。(3)体力活动:计算与职业、交通出行、家务和休闲活动相关的代谢当量总和。(4)肾小球滤过率:基于中南大学湘雅三医院团队研发的“湘雅公式”计算<sup>[15]</sup>,单位为ml/min/1.73 m<sup>2</sup>。(5)体质指数(Body Mass Index, BMI):体重/身高<sup>2</sup>。(6)腰臀比(Waist Hip Ratio, WHR):腰围/臀围。(7)高血压:收缩压≥140 mmHg或舒张压≥90 mmHg,取基线调查时三次测量的平均值。

**1.4 诊断标准** 胆结石:由专业医生负责腹部超声检查和诊断确认,根据标准,当胆囊内有回声投射时,诊断为胆结石<sup>[16]</sup>。CVD:包括冠心病、脑卒中、心律失常三种亚型。以上CVD信息来源于调查对象自报,自报信息来源于乡/区或县级以上医院诊断结果,研究对象患有一种或一种以上被诊断为CVD,该定义得到验证<sup>[17]</sup>。

**1.5 统计学分析** 连续变量不服从正态分布采用中位数和四分位数间距 $M(P_{25}, P_{75})$ 表示,组间差异比较采用Mann-Whitney U检验。分类变量用频数(构成比)表示,组间差异采用卡方检验比较。Logistic回归模型分析胆结石与CVD之间的关系,以OR和95% CI评估风险大小。采用有向无环图来识别可能

的混杂因素, logistic 回归分析建立三个模型: 模型 1 未调整变量, 模型 2 调整年龄、性别和民族, 模型 3 调整教育程度、家庭收入、吸烟等混杂因素。R 软件 forestplot 包绘制森林图。基于 Baron 和 Kenny 准则, 采用 mediation 包进行中介分析, 得出总效应、直接效应和间接效应值及其 95% CI, 并计算中介效应占比 [ 中介效应占比 = ( 间接效应 / 总效应 ) × 100% ], bootstrap 法用于检测中介效应的显著性, 并随机抽样 1 000 次。统计分析软件采用 SPSS 25.0 和 R 4.3.2, 检验水准为双侧  $\alpha = 0.05$ 。

## 2 结果

### 2.1 研究对象的基线特征

本研究共纳入 16 573

人, 侗族 6 265 人 ( 37.80% ), 苗族 4 923 人 ( 29.70% ), 布依族 5 385 人 ( 32.50% )。CVD 患者检出 524 人, 检出率为 3.16%; 侗族、苗族、布依族检出率分别为 3.27% ( 205/6 265 )、3.07% ( 151/4 923 )、3.12% ( 168/5 385 ); 男性、女性检出率分别为 3.77% ( 212/5 613 )、2.85% ( 312/10 960 )。总人群胆结石检出率为 9.03%。与非 CVD 者相比, CVD 患者年龄偏大、女性占比多、教育程度偏低、家庭收入偏低、尿酸、BMI、WHR 和血糖偏高、体力活动和肾小球滤过率偏低。两组在饮酒、午休、高脂血症、高血压、牛/羊瘪、鱼腥草、紫血肉、红酸汤、胆结石方面差异具有统计学意义 ( $P < 0.05$ ), 详见表 1。

表 1 研究人群的基本特征

Table 1 Basic characteristics of the study population

| 变量                                 | 总人群 (n = 16 573)        | 非心血管疾病 (n = 16 049)     | 心血管疾病 (n = 524)         | P 值    |
|------------------------------------|-------------------------|-------------------------|-------------------------|--------|
| 年龄 (岁)                             | 51.71 (44.23, 60.54)    | 51.37 (44.04, 60.02)    | 60.99 (54.40, 68.55)    | <0.001 |
| 性别                                 |                         |                         |                         | 0.001  |
| 男性                                 | 5 613 (33.86)           | 5 401 (33.65)           | 212 (40.45)             |        |
| 女性                                 | 10 960 (66.14)          | 10 648 (66.35)          | 312 (59.55)             |        |
| 民族                                 |                         |                         |                         | 0.809  |
| 侗族                                 | 6 265 (37.80)           | 6 060 (37.75)           | 205 (39.12)             |        |
| 苗族                                 | 4 923 (29.70)           | 4 772 (29.73)           | 151 (28.81)             |        |
| 布依族                                | 5 385 (32.50)           | 5 217 (32.52)           | 168 (32.07)             |        |
| 教育程度                               |                         |                         |                         | 0.041  |
| 文盲                                 | 7 195 (43.41)           | 6 954 (43.32)           | 241 (45.99)             |        |
| 小学及初中                              | 6 295 (37.98)           | 6 105 (38.03)           | 190 (36.25)             |        |
| 高中及大专                              | 2 403 (14.50)           | 2 320 (14.45)           | 83 (15.83)              |        |
| 大学及以上                              | 680 (4.11)              | 670 (4.20)              | 10 (1.93)               |        |
| 家庭年收入 (元)                          |                         |                         |                         | 0.001  |
| < 12 000                           | 4 833 (29.16)           | 4 655 (29.00)           | 178 (33.96)             |        |
| 12 000 ~ 59 999                    | 8 364 (50.46)           | 8 145 (50.75)           | 219 (41.79)             |        |
| 60 000 ~ 199 999                   | 3 224 (19.45)           | 3 102 (19.32)           | 122 (23.28)             |        |
| ≥ 200 000                          | 152 (0.93)              | 147 (0.93)              | 5 (0.97)                |        |
| 尿酸 (mmol/L)                        | 316.00 (261.00, 383.00) | 315.00 (260.00, 381.00) | 348.50 (293.00, 430.00) | <0.001 |
| BMI (kg/m <sup>2</sup> )           | 24.11 (21.79, 26.48)    | 24.07 (21.77, 26.45)    | 24.93 (22.29, 27.13)    | <0.001 |
| WHR                                | 0.90 (0.85, 0.95)       | 0.90 (0.85, 0.95)       | 0.93 (0.88, 0.98)       | <0.001 |
| 体力活动 (METs - h/d)                  | 24.16 (13.07, 37.17)    | 24.45 (13.40, 37.46)    | 15.00 (6.15, 28.07)     | <0.001 |
| 肾小球滤过 (ml/min/1.73m <sup>2</sup> ) | 82.35 (75.90, 88.80)    | 82.55 (76.13, 88.96)    | 75.58 (69.88, 82.05)    | <0.001 |
| 血糖 (mmol/L)                        | 5.22 (4.91, 5.62)       | 5.22 (4.91, 5.61)       | 5.32 (5.01, 5.83)       | <0.001 |
| 吸烟                                 |                         |                         |                         | 0.862  |
| 否                                  | 13 266 (80.04)          | 12 845 (80.03)          | 421 (80.34)             |        |
| 是                                  | 3 307 (19.96)           | 3 204 (19.97)           | 103 (19.66)             |        |
| 饮酒                                 |                         |                         |                         | 0.005  |
| 否                                  | 13 770 (83.08)          | 13 311 (82.93)          | 459 (87.59)             |        |
| 是                                  | 2 803 (16.92)           | 2 738 (17.07)           | 65 (12.41)              |        |
| 午休                                 |                         |                         |                         | 0.019  |
| 否                                  | 8 550 (51.58)           | 8 306 (51.75)           | 244 (46.65)             |        |
| 是                                  | 8 023 (48.42)           | 7 743 (48.25)           | 280 (53.35)             |        |
| 高脂血症                               |                         |                         |                         | 0.002  |
| 否                                  | 11 644 (70.25)          | 11 308 (70.45)          | 336 (64.12)             |        |
| 是                                  | 4 929 (29.75)           | 4 741 (29.55)           | 188 (35.88)             |        |
| 高血压                                |                         |                         |                         | <0.001 |
| 否                                  | 11 899 (71.79)          | 11 600 (72.27)          | 299 (57.06)             |        |

(续表)

| 变量   | 总人群( <i>n</i> = 16 573) | 非心血管疾病( <i>n</i> = 16 049) | 心血管疾病( <i>n</i> = 524) | <i>P</i> 值 |
|------|-------------------------|----------------------------|------------------------|------------|
| 是    | 4 674(28.21)            | 4 449(27.73)               | 225(42.94)             | 0.002      |
| 否    | 9 136(55.12)            | 8 812(54.90)               | 324(61.83)             |            |
| 牛/羊瘪 | 7 437(44.88)            | 7 237(45.10)               | 200(38.17)             | 0.001      |
| 否    | 3 029(18.27)            | 2 903(18.08)               | 126(24.04)             |            |
| 鱼腥草  | 13 544(81.73)           | 13 146(81.92)              | 398(76.96)             | 0.001      |
| 否    | 10 276(62.00)           | 9 914(61.77)               | 362(69.08)             |            |
| 紫血肉  | 6 297(38.00)            | 6 135(38.23)               | 162(30.92)             | <0.001     |
| 否    | 5 354(32.30)            | 5 145(32.05)               | 209(39.88)             |            |
| 红酸汤  | 11 219(67.70)           | 10 904(67.95)              | 315(60.12)             | <0.001     |
| 否    | 15 077(90.97)           | 14 673(91.42)              | 440(83.96)             |            |
| 胆结石  | 1 496(9.03)             | 1 412(8.58)                | 84(16.04)              |            |

注:分类变量用 *n*(%) 表示,连续性变量用 *M*(*P*<sub>25</sub>,*P*<sub>75</sub>) 表示。

**2.2 胆结石与 CVD 的 logistic 回归分析** 未调整变量时,在总人群、侗族、苗族、布依族人群中,胆结石与 CVD 均存在正相关,其 *OR*(95% *CI*) 分别为 1.979(1.557 ~ 2.515)、1.805(1.262 ~ 2.581)、2.243(1.452 ~ 4.464)、2.025(1.239 ~ 3.310) (*P* < 0.05)。进一步调整所有变量后(模型 3),在总人群、

侗族、苗族人群中胆结石与 CVD 的差异具有统计学意义,其 *OR*(95% *CI*) 分别为 1.633(1.269 ~ 2.102)、1.567(1.077 ~ 2.280)、1.679(1.055 ~ 2.673) (*P* < 0.05)。在布依族人群中,胆结石与 CVD 之间不存在关联(*P* > 0.05),详见表 2。

表 2 胆结石与心血管疾病的 logistic 回归分析

Table 2 Logistic regression analysis of gallstones and cardiovascular disease

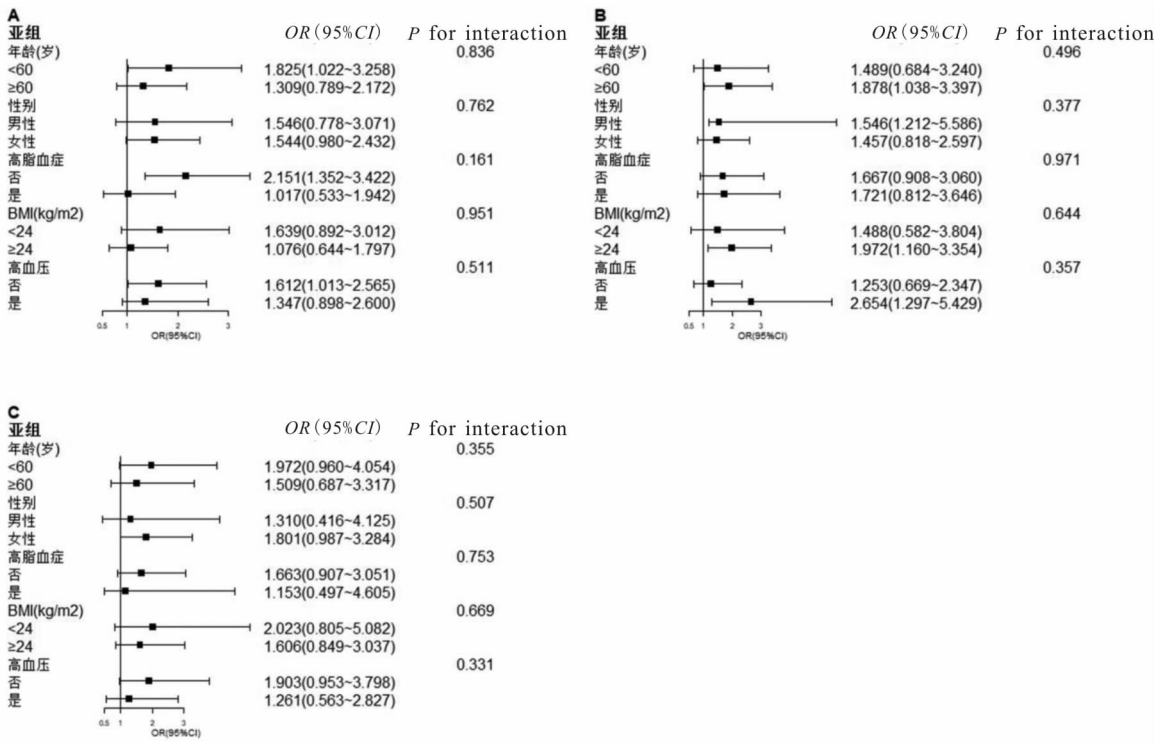
| 变量  | 模型 1                       |            | 模型 2                       |            | 模型 3                       |            |
|-----|----------------------------|------------|----------------------------|------------|----------------------------|------------|
|     | <i>OR</i> (95% <i>CI</i> ) | <i>P</i> 值 | <i>OR</i> (95% <i>CI</i> ) | <i>P</i> 值 | <i>OR</i> (95% <i>CI</i> ) | <i>P</i> 值 |
| 总人群 | 1.979(1.557 ~ 2.515)       | <0.001     | 1.872(1.465 ~ 2.391)       | <0.001     | 1.633(1.269 ~ 2.102)       | <0.001     |
| 侗族  | 1.805(1.262 ~ 2.581)       | 0.001      | 1.754(1.218 ~ 2.526)       | 0.003      | 1.567(1.077 ~ 2.280)       | 0.019      |
| 苗族  | 2.243(1.452 ~ 4.464)       | <0.001     | 2.163(1.384 ~ 3.381)       | 0.001      | 1.679(1.055 ~ 2.673)       | 0.029      |
| 布依族 | 2.025(1.239 ~ 3.310)       | 0.005      | 1.833(1.058 ~ 1.089)       | 0.018      | 1.633(0.968 ~ 2.754)       | 0.066      |

模型 1:未调整变量;模型 2:调整性别、年龄;模型 3:在模型 2 的基础上进一步纳入教育程度、家庭收入、尿酸、WHR、BMI、体力活动、肾小球滤过率、空腹血糖、饮酒、午休、高脂血症、高血压、牛/羊瘪、鱼腥草、紫血肉、红酸汤。

**2.3 亚组分析** 我们按年龄、性别、高脂血症、BMI 和高血压进行了亚组分析。侗族人群中,与未患胆结石者相比,年龄 < 60 岁的胆结石患者心血管疾病 *OR* 及 95% *CI* 为 1.825(1.022 ~ 3.258),未患高脂血症的胆结石患者心血管疾病 *OR* 及 95% *CI* 为 2.151(1.352 ~ 3.422),未患高血压的胆结石患者心血管疾病 *OR* 及 95% *CI* 为 1.612(1.013 ~ 2.565);苗族人群中,与未患胆结石者相比,年龄 ≥ 60 岁的胆结石患者心血管疾病 *OR* 及 95% *CI* 为 1.878(1.038 ~ 3.397),男性胆结石患者心血管疾病 *OR* 及 95% *CI* 为 1.546(1.212 ~ 5.586),BMI ≥ 24 的胆结石患者心血管疾病 *OR* 及 95% *CI* 为 1.972(1.160 ~ 3.354),有高血压的胆结石患者心血管疾病 *OR* 及 95% *CI* 为 2.264(1.297 ~ 5.429)。没有在布依族人群亚组中发现胆

结石与 CVD 之间的关联。在侗族、苗族和布依族人群中,胆结石与年龄、性别等分层变量对 CVD 不存在交互作用(*P* for interaction > 0.05),详见图 1。

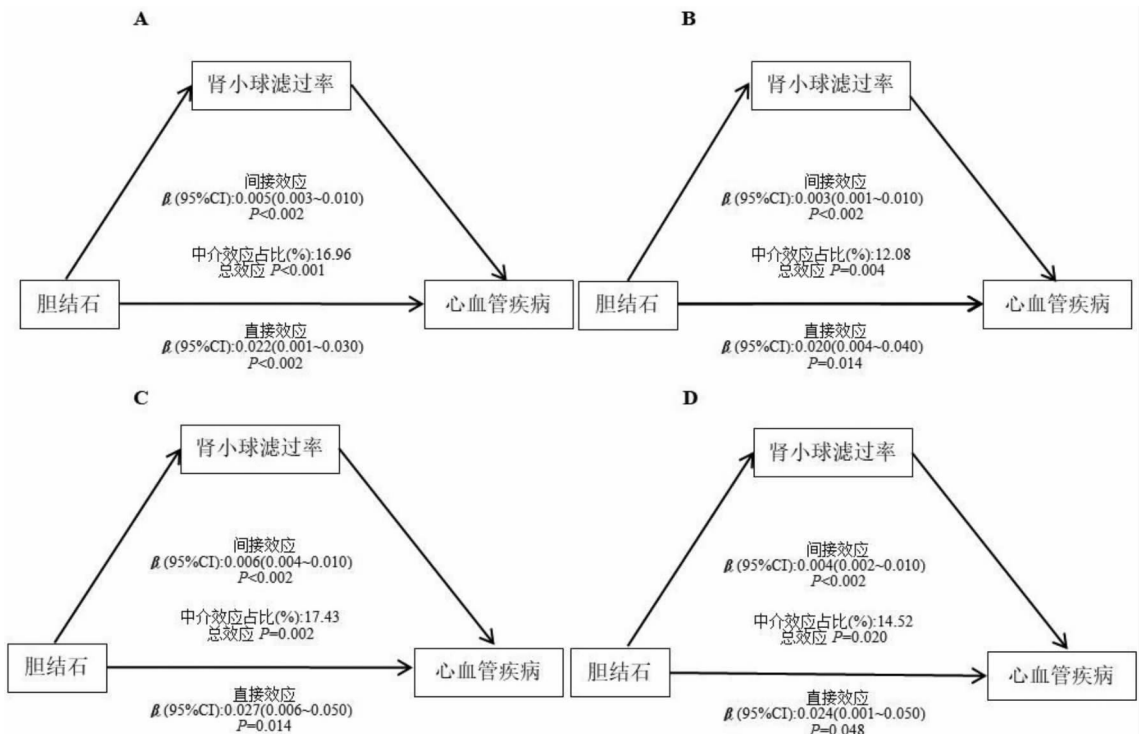
**2.4 肾小球滤过率在胆结石与心血管疾病之间的中介效应分析** 中介分析显示,总人群、侗族、苗族和布依族人群中肾小球滤过率对胆结石与 CVD 的中介效应均具有统计学意义,且为部分中介。间接效应 β 及其 95% *CI* 分别为 0.005(0.003 ~ 0.010, *P* < 0.002)、0.003(0.001 ~ 0.010, *P* < 0.002)、0.006(0.004 ~ 0.010, *P* < 0.002)、0.004(0.002 ~ 0.010, *P* < 0.002)。总人群、侗族、苗族、布依族人群中中介效应占比分别为 16.96%、12.08%、17.43%、14.52%。详见图 2。



注:A代表侗族,B代表苗族,C代表布依族。所有亚组均调整了除分层变量外的教育水平、家庭收入、尿酸、WHR、体力活动、肾小球滤过率、血糖、饮酒、午休、牛/羊瘪、鱼腥草、紫血肉、红酸汤。

图 1 亚组分析

Fig. 1 Subgroup analysis



注:A代表总人群,B代表侗族,C代表苗族,D代表布依族。

图 2 肾小球滤过率在胆结石与心血管疾病中的中介效应及路径模型

Fig. 2 The mediating effect and path model of glomerular filtration rate in gallstones and cardiovascular diseases

### 3 讨论

贵州省 30 ~ 79 岁少数民族人群 CVD 总检出率为 3.16%, 低于全国平均水平<sup>[18]</sup>。其中侗族检出率最高, 为 3.27%, 布依族为 3.07%、苗族为 3.12%。我们发现在侗族、苗族人群中, 胆结石与 CVD 呈正相关。侗族 < 60 岁、未患高血压、未患高血脂的胆结石患者, 苗族 ≥ 60 岁、苗族男性、苗族 BMI ≥ 24、苗族患高血压的胆结石患者与 CVD 呈正相关。肾小球滤过率在胆结石与 CVD 之间存在部分中介作用。

我们的结果显示胆结石与 CVD 呈正相关, 是 CVD 的危险因素, 与既往研究一致<sup>[19-21]</sup>。胆结石患者的胆汁酸和卵磷脂分泌下降而胆固醇分泌增多, 使得胆固醇合成能力增强, 附着于血管壁后造成血管狭窄, 从而增加 CVD 风险<sup>[22]</sup>。同时, 流行病学调查发现, 胆结石患者大多伴有肥胖、血脂异常及体力活动减少等情况, 这些都会增加 CVD 风险<sup>[23]</sup>。这与韩国结论不一致<sup>[5]</sup>, 可能是因为该研究对象为职业人群, 由于定期健康体检改变了职业人群的不良生活方式, 达到了一级预防效果<sup>[24]</sup>。亚组分析显示, 侗族人群中 < 60 岁胆结石患者 CVD 风险增加 1.825 倍。也有研究指出<sup>[25-26]</sup>, 较年轻的胆结石患者 CVD 风险更高, 与我们侗族人群结果相一致。此外, 在侗族中, 非高脂血症和高血压的胆结石人群与 CVD 呈正相关, 而患这两种病的胆结石人群却无关联, 可能是因为有这两种病的侗族人群改变了不良的生活习惯并定期体检就医。然而, 在苗族人群中年龄 ≥ 60 岁的胆结石患者 CVD 风险增加 1.878 倍, 可能是由于不同民族间文化、饮食和生活习惯差异所致。并且, 苗族男性胆结石患者 CVD 风险更大, 与 Fan 等人研究结果不一致<sup>[27]</sup>。有研究指出女性胆结石患者 CVD 风险高于男性, 可能是因为低高密度脂蛋白水平促进了胆结石与 CVD 的发展, 男性的总胆固醇水平峰值比女性晚, 绝经后妇女的高密度脂蛋白水平下降<sup>[28]</sup>。苗族中患高血压的胆结石人群 CVD 风险增加 2.264 倍, 可能是因为高血压作为 CVD 的独立危险因素<sup>[29]</sup>, 二者协同增加了 CVD 患病风险。

中介分析显示, 肾小球滤过率部分中介了胆结石与 CVD 之间的联系, 目前未见研究探讨肾小球滤过率在二者间的中介作用。胆固醇是胆结石形成的主要成分, 胆固醇含量增高会导致胆盐和卵磷脂的含量减少, 致使胆固醇相互聚集而沉淀析出, 从而产生胆结石<sup>[30-31]</sup>。而胆固醇升高会导致肾小球滤过率降低<sup>[9, 32]</sup>, 从而增加 CVD 的患病风险<sup>[33-35]</sup>。

我们建议胆结石患者应该健康饮食, 积极排石, 避免增加 CVD 患病风险。同时, 尤其是胆结石患者

应该定期检查肾功能, 控制肾小球滤过率在正常范围水平。另外, 应该积极锻炼, 保持健康体重。

本研究的局限性: 首先, 这是一项横断面研究, 无法进行因果推断。其次, 未考虑胆囊切除术对这种关联的影响, 需要进一步的研究去探讨。同时, 我们只纳入冠心病、脑卒中和心律失常三种亚型, 可能会对造成一定的偏移。本研究的优势, 基于西南区域少数民族聚集地世居自然人群队列研究数据, 所有数据由专业调查员收集, 在问卷调查、体格检查、生化指标提取过程中进行严格质控, 数据安全可靠。同时, 本研究基于大样本量数据, 分别在三个民族中探讨胆结石与 CVD 的关联, 后续随访可进一步证明二者之间的因果关系。

综上所述, 贵州省侗族、苗族人群中胆结石与 CVD 呈现正相关, 尤其是在苗族超重肥胖、高血压人群。肾小球滤过率在胆结石与 CVD 之间存在部分中介作用。建议人们重视胆结石带来的危害, 保持肾小球滤过率值在正常范围内, 定期体检, 保持健康体重, 从而减轻 CVD 负担。

**利益冲突声明** 本研究不存在任何利益冲突

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