

· 论 著 ·

苏州市中小學生非同日3时点血压测量结果

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摘要: **目的** 分析江苏省苏州市中小學生非同日3时点血压测量结果, 为儿童青少年高血压综合防治提供依据。**方法** 于2020年9—12月采用分层整群抽样方法抽取苏州市7~17岁中小學生进行问卷调查, 测量非同日3时点血压、身高和体重, 并依据WS/T 610—2018《7岁~18岁儿童青少年血压偏高筛查界值》分析3个时点的血压偏高检出率及其影响因素。**结果** 共调查中小學生3 713人, 其中男生1 924人, 占51.82%; 女生1 789人, 占48.18%。非同日3时点血压偏高率为13.63%、5.36%和3.37%, 3时点测量血压均偏高(高血压)检出率为3.37%。12~17岁學生3时点血压偏高率(16.90%、8.40%、5.26%)均高于7~<12岁學生(9.65%、1.67%、1.07%, $P<0.05$)。第1时点血压偏高率男生高于女生(15.23%和11.91%, $P<0.05$), 后2个时点男生和女生血压偏高率差异均无统计学意义($P>0.05$)。肥胖(27.62%、11.51%、7.06%)和超重學生(17.45%、6.95%、4.85%)血压偏高率均高于体重正常學生(9.44%、3.54%、2.15%); 除第3时点外, 肥胖學生血压偏高率均高于超重學生($P<0.017$)。**结论** 苏州市中小學生非同日3时点高血压检出率为3.37%, 非同日3时点测量可降低儿童青少年高血压测量结果的假阳性, 减少高血压误诊。

关键词: 高血压; 中小學生; 多次测量; 假阳性

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Prevalence of hypertension based on three separate visits among primary and middle school students in Suzhou City

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Abstract: Objective To investigate the prevalence of hypertension among primary and middle school students living in Suzhou City, Jiangsu Province, so as to provide insights into comprehensive hypertension control among children and adolescents. **Methods** Primary and middle school students at ages of 7 to 17 years were recruited for a questionnaire survey in Suzhou City using the stratified cluster random sampling method from September to December, 2020, and the height and body weight were measured. Blood pressure was measured at three separate clinic visits according to the national criteria *Reference of Screening for Elevated Blood Pressure among Children and Adolescents Aged 7-18 Years* (WS/T 610-2018), and the detection of elevated blood pressure was estimated at three separate visits. In addition, factors affecting elevated blood pressure were identified. **Results** A total of 3 713 students were enrolled, including 1 924 boys (51.82%) and 1 789 girls (48.18%). The detection of elevated blood pressure was 13.63%, 5.36%, and 3.37% at three separate visits, respectively, and the prevalence of hypertension (elevated blood pressure at all three visits) was

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3.37%。The detection rates of elevated blood pressure were all higher at three visits (16.90%, 8.40%, and 5.26%) among students at ages of 12 to 17 years than among students at ages of 7 to 11 years (9.65%, 1.67%, and 1.07%, $P < 0.05$). The detection of elevated blood pressure was significantly higher in boys (15.23%) than in girls (11.91%) at the first visit ($P < 0.05$), while no significant differences were seen at the second or third visit ($P > 0.05$). In addition, higher detection rates of elevated blood pressure were seen in obese (27.62%, 11.51%, and 7.06%) and overweight students (17.45%, 6.95%, and 4.85%) than in students with normal weight (9.44%, 3.54%, and 2.15%) at all three visits, and greater detection rates of elevated blood pressure were found in obese students than in overweight students at the first and second visits ($P < 0.017$). **Conclusions** The prevalence of hypertension was 3.37% based on three separate visits among primary and middle school students in Suzhou City. Measurement of blood pressure at three separate visits within different days is effective to reduce the false positive rate of hypertension and decrease misdiagnosis among children and adolescents.

Keywords: hypertension; primary and middle school students; multiple measurements; false positive

中国健康与营养调查显示, 7~17岁学生血压偏高检出率从1991年的5.7%上升至2015年的12.8%^[1]。儿童期高血压可导致心血管系统靶器官的早期损伤, 持续的儿童期高血压可增加成年期高血压的风险^[2-3]。儿童期高血压的规范监测和早期干预, 对成年以后心血管疾病防控具有重要意义^[4]。

美国儿科学会^[5]和我国2018年发布的行业标准^[6]均推荐儿童青少年高血压的判定应基于非同日3次及以上测量结果, 且每次间隔不少于2周。既往研究表明, 血压偏高检出率在同日3时点呈下降趋势, 约75%~80%首次测量血压偏高的个体经过2次不同时点的复测后血压显示正常^[5, 7], 提示血压存在一过性升高现象, 单一时点测量容易出现血压偏高的假阳性。因此, 本研究采用非同日3时点测量方法, 了解江苏省苏州市中小学生高血压检出情况, 为儿童青少年高血压综合防治提供参考。

1 对象与方法

1.1 对象 本研究按照“2020年全国学生常见病和健康影响因素监测”项目要求, 于2020年9—12月选择苏州市7~17岁中小学生为调查对象。排除患有重要脏器疾病、身体残疾、生理发育异常及其他严重代谢性疾病者。该研究通过苏州市疾病预防控制中心伦理委员会审查(SZJK2020-XW001)。调查学生及其家长均知情同意。

1.2 方法

1.2.1 样本量估算 样本量估算公式如下:

$$N = u_{\alpha/2}^2 \times \pi (1 - \pi) / \delta^2$$

式中: α 表示检验水准, 为0.05; $u_{\alpha/2}$ 为1.96; π 表示总体率, 参考全球平均流行水平, 儿童青少年高血压检出率为4.0%^[7]; δ 表示容许误差, 为0.006 4。考虑无效应答10%, 估算调查样本量为

4 002 人。

1.2.2 抽样方法 采用分层整群抽样方法, 抽取苏州市2个县(市、区), 在每个县(市、区)抽取2个街道(乡镇), 在每个街道(乡镇)抽取小学、初中和高中各1所, 每个年级随机选择2~3个班学生。

1.2.3 身高和体重测量 脱去鞋帽后直立, 脚跟并拢, 足跟、骶骨部及两肩胛间与立柱相接触, 成“三点一线”站立姿势, 测量身高和体重, 计算体质指数(BMI)。依据WS/T 586—2018《学龄儿童青少年超重与肥胖筛查》, BMI大于或等于同性别、年龄的超重/肥胖界值点判定为超重/肥胖^[8]。考虑身高对血压的影响^[9], 学生身高按照第50百分位数(P_{50})分组^[6]。

1.2.4 血压测量与评价 依据WS/T 610—2018《7岁~18岁儿童青少年血压偏高筛查界值》^[6]测量与评价。血压测量采用欧姆龙HBP-1300电子血压计, 测量前需与水银血压计比对, 校验至允许范围内。使用合适的袖带, 要求受检者取坐位, 至少休息15 min, 血压计与受检者心脏、右臂袖带处于同一水平, 测量2次, 若差值超过10 mm Hg(1 mm Hg=0.133 kPa), 进行第3次测量, 取血压值接近的2次测量平均值作为该时点血压水平^[6, 10]。本研究采用的非同日3时点测量法, 是对第1时点血压偏高者, 间隔2周后进行第2时点测量, 第2时点血压仍偏高者, 再间隔2周后进行第3时点测量。单时点收缩压和(或)舒张压大于或等于同性别、年龄、身高血压的 P_{95} 判定为单时点血压偏高。非同日3时点测量血压均偏高判定为高血压。另外, 根据收缩压或舒张压界值定义收缩压型或舒张压型血压偏高。

1.3 统计分析 采用R 3.2.2软件整理数据并统计分析。定性资料采用相对数描述, 不同年龄、性别、BMI组间血压偏高率比较采用 χ^2 检验, 两两比较采

用 Bonferroni 法。以 $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 基本情况 调查 7~17 岁中小學生 3 713 人。其中男生 1 924 人，占 51.82%；女生 1 789 人，占 48.18%。年龄为 (12.00 ± 3.14) 岁。检出超重 619 人，占 16.67%；肥胖 583 人，占 15.70%。第 1 时点检出血压偏高 506 人，血压偏高率为 13.63%；第 2 时点测量 505 人（失访 1 人），检出血压偏高 199 人，血压偏高率为 5.36%；第 3 时点测量 198 人（失访 1 人），检出血压偏高 125 人，血压偏高率为 3.37%。见表 1。

2.2 不同学生血压偏高情况比较 12~17 岁学生 3 时点血压偏高率均高于 7~<12 岁学生 ($P < 0.05$)。男生第 1 时点血压偏高率高于女生 ($P < 0.05$)，但不同性别学生第 2 和第 3 时点血压偏高率差异均无统计学意义 ($P > 0.05$)。不同身高学生 3 时点血压偏高率比较，差异均无统计学意义 ($P > 0.05$)。体重正常、超重和肥胖学生 3 时点血压偏高率差异均有统计学意义 ($P < 0.05$)；肥胖和超重学生血压偏高率均高于体重正常学生；除第 3 时点外 ($\chi^2 = 0.105$, $P = 0.105$)，肥胖学生血压偏高率均高于超重学生 ($P < 0.017$)。见表 2。

3 讨论

采用非同日 3 时点测量法调查苏州市中小學生高血压情况，高血压检出率为 3.37%，低于全球平均水平 (4.0%)^[7]，低于济南市 (4.9%)^[11] 和重庆市 (6.0%)^[12]，高于北京市 (3.1%)^[13]。这可能与不同地区儿童青少年行为习惯及膳食模式等因素不同有关。

苏州市中小學生 3 时点血压偏高率分别为 13.63%、5.36% 和 3.37%。CHIOLERO 等^[14] 调查 6 873 名瑞士儿童青少年 3 时点血压偏高率分别为 11.4%、3.8% 和 2.2%，高血压检出率为 2.2%。俞自强等^[15] 对山东淄博市 1 243 名 8~13 岁儿童多时点血压测量发现，第 1 时点血压偏高率为 11.8%，第 2、3 时点分别下降至 6.8% 和 4.0%。SUN 等^[16] 系统综述了 179 561 名儿童青少年多时点血压数据发现，3 时点血压偏高率分别为 12.1% (95%CI: 10.1%~14.0%)、5.6% (95%CI: 4.3%~7.0%) 和 2.7% (95%CI: 2.1%~3.3%)。以上研究提示单次测量血压偏高可能是假阳性结果，因此，儿童青少年高血压的判定建议采用非同日 3 时点测量。

既往大部分研究均基于单时点血压测量探讨高血

表 1 血压测量不同时点中小學生的基本情况 [n (%)]

Table 1 General information of primary and middle school students in different days of blood pressure measurements [n (%)]

| 项目 Item | 第 1 时点 First visit (n=3 713) | 第 2 时点 Second visit (n=505) | 第 3 时点 Third visit (n=198) |
|---|------------------------------------|-----------------------------------|----------------------------------|
| 年龄/岁 Age/Year | | | |
| 7~ | 1 678 (45.19) | 161 (31.88) | 28 (14.14) |
| 12~17 | 2 035 (54.81) | 344 (68.12) | 170 (85.86) |
| 性别 Gender | | | |
| 男 Male | 1 924 (51.82) | 292 (57.82) | 114 (57.58) |
| 女 Female | 1 789 (48.18) | 213 (42.18) | 84 (42.42) |
| 身高分组 Height group | | | |
| <P ₅₀ | 1 115 (30.03) | 139 (27.52) | 57 (28.79) |
| ≥P ₅₀ | 2 598 (69.97) | 366 (72.48) | 141 (71.21) |
| BMI | | | |
| 体重正常 Normal weight | 2 511 (67.63) | 237 (46.93) | 89 (44.95) |
| 超重 Overweight | 619 (16.67) | 108 (21.39) | 43 (21.72) |
| 肥胖 Obesity | 583 (15.70) | 160 (31.68) | 66 (33.33) |
| 血压 Blood pressure | | | |
| 血压偏高 Elevated blood pressure | 506 (13.63) | 199 (5.36) | 125 (3.37) |
| 高收缩压型 Elevated systolic blood pressure | 428 (11.53) | 159 (4.28) | 104 (2.80) |
| 高舒张压型 Elevated diastolic blood pressure | 171 (4.61) | 106 (2.86) | 80 (2.16) |

注：3 时点血压偏高检出率基数均为总调查人数。Note: The denominators were the total number of participants when calculated the rate of elevated blood pressure in three visits.

压与超重肥胖的关系^[17-18]。全国学生体质健康状况调查 (1985—2014 年) 结果显示，随着儿童超重肥胖率的快速上升，单时点血压偏高率比由 1995 的 6.3% 升高至 2014 年的 19.2%^[17]。羊柳等^[19] 基于山东淄博市儿童探讨肥胖与 3 时点血压关联，发现随着血压测量次数增加，相较于正常儿童，混合型肥胖与血压偏高的关联强度逐渐增加。本研究也证实了任何测量时点超重和肥胖均是血压偏高的危险因素，但并未发现随着血压测量次数增加，超重、肥胖与血压的关联效应增强，还需更多研究证实。

本研究还发现，12~17 岁学生血压偏高率高于 7~<12 岁学生，且 7~<12 岁学生血压偏高率在第 2、3 时点下降明显，提示血压重复测量对低年龄组意义更大，也提示高年龄组学生的高血压检出率高，应作为重点管理人群，与羊柳等^[19] 报道一致。另

表2 中小學生血压偏高率比较

Table 2 Comparison of prevalence rates of elevated blood pressure among primary and middle school students

| 项目 Item | 第1时点 First visit | | | 第2时点 Second visit | | | 第3时点 Third visit | | |
|-------------------|------------------------------|------------|--------|------------------------------|------------|--------|------------------------------|------------|--------|
| | 血压偏高 Elevated blood pressure | χ^2 值 | P值 | 血压偏高 Elevated blood pressure | χ^2 值 | P值 | 血压偏高 Elevated blood pressure | χ^2 值 | P值 |
| | [n (%)] | | | [n (%)] | | | [n (%)] | | |
| 年龄/岁 Age/Year | | 41.066 | <0.001 | | 82.226 | <0.001 | | 49.519 | <0.001 |
| 7~ | 162 (9.65) | | | 28 (1.67) | | | 18 (1.07) | | |
| 12~17 | 344 (16.90) | | | 171 (8.40) | | | 107 (5.26) | | |
| 性别 Gender | | 8.695 | 0.003 | | 3.003 | 0.083 | | 1.286 | 0.257 |
| 男 Male | 293 (15.23) | | | 115 (5.98) | | | 71 (3.69) | | |
| 女 Female | 213 (11.91) | | | 84 (4.70) | | | 54 (3.02) | | |
| 身高分组 Height group | | 1.826 | 0.177 | | 0.192 | 0.661 | | 0.239 | 0.625 |
| <P ₅₀ | 139 (12.47) | | | 57 (5.11) | | | 40 (3.59) | | |
| ≥P ₅₀ | 367 (14.13) | | | 142 (5.47) | | | 85 (3.27) | | |
| BMI | | 142.025 | <0.001 | | 62.613 | <0.001 | | 39.666 | <0.001 |
| 正常 Normal weight | 237 (9.44) | | | 89 (3.54) | | | 54 (2.15) | | |
| 超重 Overweight | 108 (17.45) ^a | | | 43 (6.95) ^a | | | 30 (4.85) ^a | | |
| 肥胖 Obesity | 161 (27.62) ^{ab} | | | 67 (11.51) ^{ab} | | | 41 (7.06) ^a | | |

注：a表示与正常组比较 $P < 0.017$ ；b表示与超重组比较 $P < 0.017$ 。Note: a, $P < 0.017$, compared with normal weight group; b, $P < 0.017$, compared with overweight group.

外，本研究仅在第1时点发现男、女生血压偏高率存在明显差异，既往研究也有类似报道^[19-20]。

本研究基于3次血压测量值，并未对学生降血压药服用情况进行调查，但考虑相关指南中对儿童原发性高血压的治疗均以运动、饮食等生活方式改善为主，对高血压检出率的影响较小^[5]。高血压的影响因素分析中未涉及饮食、行为等，应在以后研究中进一步探索。学校、基层医疗机构宜对学生常规体检和监测中发现的首诊血压偏高个体进行多时点测量，降低假阳性比例，减少家长和儿童不必要的心理恐慌以及医院资源的浪费。同时，应加强儿童青少年体重控制干预，降低高血压发病率。

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