Analysis of Differences Between Initial and Three Different-Day Blood Pressure Measurements and Associated Influencing Factors in Self-Reported Non-Hypertensive Adults Aged 35-64 Years (Post-Print)

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Abstract

Background Currently, researchers have conducted comparative analyses between first-time blood pressure measurements and three measurements on non-consecutive days in self-reported non-hypertensive populations; however, few related studies have been carried out in the context of COVID-19 vaccination. Objective To investigate the blood pressure levels of COVID-19 vaccine recipients aged 35-64 years during the normalized prevention and control period of COVID-19 infection, analyze the differences between first-time blood pressure measurements and three measurements on non-consecutive days among suspected hypertension patients identified through initial screening, and explore the influencing factors of blood pressure classification fluctuations in suspected hypertension patients, aiming to provide reference and guidance for blood pressure measurement services prior to COVID-19 vaccination. Methods Using random sampling, a total of 2,814 residents aged 35-64 years with self-reported no history of hypertension who received COVID-19 vaccines at Qingling Street Community Health Service Center in Hongshan District, Wuhan City, Hubei Province from September 2021 were selected as hypertension screening subjects. Their blood pressure was measured, with results recorded as initial blood pressure values. Based on these initial values, suspected hypertension populations [systolic blood pressure $\geq$ 140 mmHg and/or diastolic blood pressure $\geq$ 90 mmHg (1 mmHg = 0.133 kPa)] were identified. Without antihypertensive medication use, standardized office blood pressure measurements were conducted on three non-consecutive days for suspected hypertension patients. Based on the three non-consecutive-day measurement results, the proportions of individuals with ideal blood pressure levels (systolic blood pressure $<$ 120 mmHg and diastolic blood pressure $<$ 80 mmHg), normal high-value levels (systolic blood pressure

120-139 mmHg and/or diastolic blood pressure 80-89 mmHg), and hypertension patients (systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg) were calculated. Hypertension diagnosis rates among suspected hypertension patients of different genders, age groups, and initial blood pressure classifications were compared. Univariate and multivariate ordinal multiclass Logistic regression analyses were employed to examine the influencing factors of blood pressure classification fluctuations in suspected hypertension patients (changes in classification based on three non-consecutive-day results compared to initial classification). Results Among the 2,814 hypertension screening subjects, suspected hypertension patients accounted for 36.67% (1,032/2,814). After three non-consecutive-day measurements, among the 1,032 suspected hypertension patients, 8.82% (91/1,032) exhibited ideal blood pressure levels, 14.34% (148/1,032) exhibited normal high-value levels, and 76.84% (793/1,032) were confirmed as hypertension patients [including 63.68% (505/793) with grade 1 hypertension, 26.48% (210/793) with grade 2 hypertension, and 9.84% (78/793) with grade 3 hypertension]. The hypertension diagnosis rate in females [80.68% (380/471)] was higher than in males [73.62% (413/561)], with a statistically significant difference (^{2} = 7.173, P = 0.007). The hypertension diagnosis rate demonstrated an upward trend with increasing initial blood pressure classification levels in suspected hypertension patients (^{2} trend = 23.443, P < 0.001). Univariate and multivariate ordinal multiclass Logistic regression analysis results indicated that gender, age, time period of initial blood pressure measurement, presence of psychological factors during initial measurement, and whether environmental noise during initial measurement was ≥ 40 dB were influencing factors of blood pressure classification fluctuations in suspected hypertension patients (P < 0.05). Conclusion Substantial differences exist between first-time blood pressure measurement results and three non-consecutive-day measurement results in suspected hypertension patients identified through initial screening. Community medical personnel should ensure a quiet environment and confirm good psychological status when providing blood pressure measurement services for residents prior to COVID-19 vaccination. Additionally, special attention should be paid to whether the blood pressure of males, the 55-64 age group, and individuals receiving measurement services at community health centers during 11:00-14:00 can truly reflect their actual blood pressure levels, to ensure measurement reliability and facilitate smooth vaccination operations.

Full Text

Differences Between First Blood Pressure Measurement and Three Non-Consecutive Day Measurements and Associated Factors in Self-Reported Non-Hypertensive Individuals Aged 35-64 Years

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Abstract

Background: Previous studies have compared first-time blood pressure measurements with three non-consecutive day measurements in populations without self-reported hypertension, but few have examined this issue in the context of COVID-19 vaccination.

Objective: To assess blood pressure levels among 35-64-year-old COVID-19 vaccine recipients during routine pandemic containment, analyze differences between first-time and three non-consecutive day measurements in individuals with suspected hypertension identified through initial screening, and explore factors influencing blood pressure classification fluctuations, thereby providing guidance for pre-vaccination blood pressure measurement protocols.

Methods: In September 2021, we randomly selected 2,814 residents aged 35-64 years with no self-reported hypertension history from individuals presenting for COVID-19 vaccination at Qingling Community Health Service Center in Hongshan District, Wuhan, Hubei Province. Blood pressure was measured prior to vaccination and recorded as the initial value. Residents with suspected hypertension (systolic blood pressure $ $140 mm Hg and/or diastolic blood pressure $ $90 mm Hg; $1 mmHg = 0.133 kPa$) underwent three standardized clinic blood pressure measurements on different days without antihyper
120/80 $mmHg$), $high-normal blood pressure$(120−139/80−89 $mmHg$), $and hypertension$($140/90 mm Hg). Hypertension diagnosis rates were compared across sex, age groups, and initial blood pressure levels. Factors influencing blood pressure classification fluctuations (changes between initial and three-day measurements) were analyzed using univariate and multivariate ordered logistic regression.

Results: Among 2,814 participants, 36.67% (1,032/2,814) were identified as having suspected hypertension. After three non-consecutive day measurements, 8.82% (91/1,032) had ideal blood pressure, 14.34% (148/1,032) had high-normal blood pressure, and 76.84% (793/1,032) were diagnosed with hypertension (Stage 1: 63.68% [505/793]; Stage 2: 26.48% [210/793]; Stage 3: 9.84% [78/793]). The hypertension diagnosis rate was significantly higher in females (80.68% [380/471]) than males (73.62% [413/561]; $^2 = 7.173$, P = 0.007). Diagnosis rates increased with higher initial blood pressure levels (^{2} trend = 23.443, P < 0.001). Multivariate analysis identified sex, age, time

period of initial measurement, psychological factors during measurement, and environmental noise $ $40 dB as significant factors influencing blood pressure classification fluctuations ($P < 0.05$).

Conclusion: Substantial differences exist between first-time and three-day blood pressure measurements in suspected hypertensive individuals. To ensure reliable measurements and successful vaccination campaigns, community health workers should maintain quiet environments, confirm stable psychological states, and pay particular attention to males, individuals aged 55-64 years, and those measured between 11:00-14:00 to verify that pre-vaccination blood pressure readings accurately reflect true blood pressure levels.

Keywords: Hypertension; Screening; COVID-19 vaccines; Vaccination; Community health services

Introduction

COVID-19 is an acute respiratory infectious disease caused by SARS-CoV-2. With limited effective treatments available, COVID-19 vaccination has become a critical strategy for pandemic control. Current vaccines include inactivated, mRNA, viral vector, protein subunit, attenuated live, and virus-like particle vaccines. During routine pandemic containment, Qingling Community Health Service Center in Wuhan's Hongshan District provided inactivated COVID-19 vaccination services to residents aged 18-70. To ensure vaccination safety, community health workers measured blood pressure before vaccination, deferring individuals with systolic blood pressure $ $160 mm Hg and/or diastolic blood pressure $ $100 mm Hg until their blood pressure decreased below these thresholds.

During pre-vaccination screening, health workers identified numerous suspected hypertensive individuals who had not previously reported hypertension. Most lacked regular blood pressure monitoring, had limited hypertension awareness, and exhibited poor health consciousness. Blood pressure is highly variable and influenced by multiple intrinsic and extrinsic factors, potentially causing pre-vaccination measurements to misrepresent true blood pressure levels. Overestimation could delay vaccination, increasing risks of severe COVID-19 outcomes, while underestimation might elevate adverse reaction risks post-vaccination. Given the importance of accurate pre-vaccination blood pressure assessment, this study examined 35-64-year-old vaccine recipients without self-reported hypertension, comparing initial and three-day measurements in suspected hypertensive individuals and analyzing factors influencing blood pressure classification fluctuations to inform vaccination protocols and community-based hypertension screening.

Methods

Study Population

Using random sampling, we selected 2,814 residents aged 35-64 years with no self-reported hypertension history from individuals presenting for COVID-19 vaccination at Qingling Community Health Service Center between September 2021 and [end date]. Exclusion criteria included: (1) prior antihypertensive medication use; (2) refusal to complete three-day measurements; or (3) self-initiated antihypertensive medication during the study period. Based on previous research indicating approximately 20% hypertension prevalence, we calculated a required sample size of 2,732 using the cross-sectional study formula $N = Z^2 /_2 \times P \times (1\text{-}P) / E^2$ ($\alpha = 0.05$, $Z /_2 = 1.96$, $P = 0.20$, $E = 0.015$). The study was approved by the Medical Ethics Committee of Tianyou Hospital Affiliated to Wuhan University of Science and Technology (Approval No.: 2021008001), and all participants provided informed consent.

Blood Pressure Measurement

Before measurement, we asked participants about coffee/alcohol consumption or vigorous activity within 30 minutes and confirmed emotional stability. Participants rested seated for 5-10 minutes with empty bladders.

Initial Measurement: Trained community health workers measured seated upper-arm blood pressure using an AAMI-standardized electronic sphygmomanometer (HEM-7136, Omron Healthcare) with the arm at heart level. Initial values were recorded and classified.

Three-Day Measurements: Suspected hypertensive individuals ($ $140/90 mm Hg) underwent three standardized clinic measurements on different days without antihypertensive medication, following the Chinese Blood Pressure Measurement Guidelines. Before formal measurement, bilateral upper-arm blood pressure was measured in seated position, and the arm with higher readings was used for subsequent measurements. Conditions were standardized: ambient temperature <30°C, environmental noise <40 dB, measurement period 8:00-11:00, and absence of psychological factors. Using the same electronic sphygmomanometer, two seated measurements were taken 1-2 minutes apart and averaged; if systolic or diastolic differences exceeded 5 mm Hg, a third measurement was taken and all three were averaged. The mean of three non-consecutive day measurements was calculated. For confirmed hypertensive patients, classification was based on the highest systolic and diastolic values, using the higher grade when they differed. For non-hypertensive individuals, classification was based on the lowest values if 1-2 measurements reached $ $140/90 mm Hg.

Diagnostic Criteria

(1) **Hypertension:** Blood pressure $ $140/90 mmHg on three non-consecutive measurements. (2) **Classification:** **Ideal (<

$120/80mmHg); High-normal(120-139/80-89mmHg); Stage1(140-159/90-99mmHg); Stage2(160-179/100-109mmHg); Stage3($ \$180/110$ mm Hg).

Statistical Analysis

Normally distributed continuous data are presented as mean ± standard deviation. Paired t-tests were used for within-group comparisons, and general linear models for between-group comparisons. Categorical data are expressed as frequencies and percentages, compared using ^{2} or trend ^{2} tests. General linear models assessed correlations between age and blood pressure. Univariate and multivariate ordered logistic regression analyzed factors influencing blood pressure classification fluctuations (changes between initial and three-day classifications). Statistical significance was set at $P < 0.05$.

Results

Participant Characteristics

Among 2,814 vaccine recipients, 1,266 (44.99%) were male and 1,548 (55.01%) female, with mean ages of 49.5 ± 8.3 and 50.2 ± 8.2 years, respectively. Mean systolic blood pressure was 128.53 ± 19.35 mm Hg and diastolic was 79.96 ± 10.60 mm Hg. Significant differences existed in mean blood pressure across sex and age groups ($P < 0.05$,). Systolic pressure correlated positively with age ($r = 0.416$, $P < 0.001$), while diastolic pressure correlated negatively ($r = -0.046$, $P = 0.015$).

Comparison of Initial and Three-Day Measurements

Among 2,814 participants, 36.67% (1,032/2,814) were suspected hypertensive. Mean systolic and diastolic pressures from three-day measurements were significantly lower than initial measurements ($P < 0.05$), consistent across sex and age groups (Tables 2-3 ,). Three-day systolic pressure correlated positively with age ($r = 0.563$, $P < 0.001$), while diastolic correlated negatively ($r = -0.104$, $P < 0.001$).

Blood Pressure Classification and Hypertension Diagnosis

After three-day measurements, 8.82% (91/1,032) of suspected hypertensive individuals had ideal blood pressure, 14.34% (148/1,032) had high-normal, and 76.84% (793/1,032) were diagnosed with hypertension (Stage 1: 63.68% [505/793]; Stage 2: 26.48% [210/793]; Stage 3: 9.84% [78/793]). The hypertension diagnosis rate was significantly higher in females (80.68% [380/471]) than males (73.62% [413/561]; $^2 = 7.173$, $P = 0.007$). Diagnosis rates increased with age: 71.17% (158/222) for ages 35-44, 78.33% (282/360) for 45-54, and 78.44% (353/450) for 55-64. Rates also increased with higher initial blood pressure

levels (^{2} trend = 23.443, P < 0.001). Among excluded individuals, those initially classified as Stage 1 hypertension comprised the largest proportion (75.31% [180/239]).

Factors Influencing Blood Pressure Classification Fluctuations

Univariate and multivariate ordered logistic regression identified sex, age, measurement time period (11:00-14:00 vs. 8:00-11:00), psychological factors during measurement, and environmental noise $ $40 dB as significant factors influencing blood pressure classification fluctuations (P < 0.05,).

Discussion

Previous studies have compared initial and three-day blood pressure measurements in self-reported non-hypertensive populations, but few have focused on COVID-19 vaccine recipients. This study provides novel insights by examining 35-64-year-old vaccine recipients without hypertension history, comparing measurement methods, and analyzing factors affecting classification fluctuations.

Key findings include: (1) Significant differences between initial and three-day measurements across sex and age groups; (2) Lower hypertension diagnosis rates in males than females among suspected hypertensive individuals; (3) Positive correlation between initial blood pressure levels and diagnosis rates; and (4) Among excluded individuals, most were initially classified as Stage 1 hypertension.

The higher diagnosis rate in females aligns with previous research. While Chinese hypertension surveillance data show higher male prevalence before age 55, rates equalize or reverse after age 55, likely due to decreased estrogen levels post-menopause. Estrogen protects cardiovascular function by promoting endothelial nitric oxide synthase activation and modulating the renin-angiotensin system; its decline increases cardiovascular risk. Given these sex-specific patterns, community screening should be tailored accordingly.

Ordered logistic regression revealed multiple factors influencing measurement fluctuations. Males often experience higher stress levels, which can artificially elevate readings. The 11:00-14:00 measurement period was associated with lower blood pressure compared to 8:00-11:00, possibly due to reduced morning sympathetic activity. Psychological factors significantly impacted measurements—vaccine safety concerns, waiting-related anxiety, and pandemic-related stress could all cause transient elevations. Environmental noise $ $40 dB also increased readings through sympathetic activation and irritability. Additionally, the 55-64 age group, often in a “health examination gap period” and potentially experiencing “rural-to-urban” transition with lower health literacy, showed greater susceptibility to anxiety-induced blood pressure elevations.

Therefore, community health workers should ensure quiet environments and stable psychological states during pre-vaccination screening, with particular attention to males, individuals aged 55-64, and those measured between 11:00-14:00. Community hypertension screening should target those in examination gap periods and employ multi-channel health education about home blood pressure monitoring (HBPM) to improve awareness and self-monitoring capabilities.

COVID-19 vaccination campaigns provide valuable opportunities to identify undiagnosed hypertension in communities. For suspected hypertensive individuals, health workers should provide education, referral recommendations, and suggest both standardized clinic monitoring and regular HBPM, with ambulatory blood pressure monitoring (ABPM) when necessary for definitive diagnosis.

This study has limitations. First, suspected hypertension was identified through a single measurement, potentially missing some cases. Second, blood pressure variability may have affected three-day measurement stability; 24-hour ABPM or HBPM could improve diagnostic accuracy. Third, the sample was limited to one region with a relatively small number of suspected hypertensive individuals. Nevertheless, findings provide valuable guidance for pre-vaccination blood pressure measurement and community hypertension management during pandemic containment.

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