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Prevalence of and risk factors for postprandial hypotension in older Chinese men

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Abstract

Objective To assess the prevalence of and risk factors for postprandial hypotension (PPH) among old and very old Chinese men. **Methods** The study included 349 Chinese men aged 65 and older, grouped into two age categories: group 1 (old) included 163 men aged 65 to 80 years; group 2 (very old) included 186 men aged over 80 years. Blood pressure changes after meals were assessed every 15 min by ambulatory blood pressure monitoring. Symptoms after meal ingestion and after standing up and changes in the baseline condition relative to blood pressure changes were observed continuously. Additional baseline data included body mass index, medical history, and medication use. **Results** The prevalence of PPH was 59.3% overall and was significantly higher in group 2 than group 1 (63.4% *vs.* 54.6%, $P < 0.05$). In group 2, the prevalence of PPH after breakfast (33.8%) and lunch (32.1%) were higher than that after supper (20.9%), $P < 0.05$. Hypertension and age were significant risk factors for PPH (OR = 2.188, 95% CI: 1.134–4.223, $P = 0.02$; OR = 1.86, 95% CI: 1.112–3.11, $P = 0.018$, respectively). In contrast, acarbose use was protective against PPH (OR = 0.4, 95% CI: 0.189–0.847, $P = 0.017$). The decrease in blood pressure during PPH was 20–40 mmHg and the maximum was 90 mmHg. PPH usually occurred at 30–60 min after a meal and lasted 30–120 min. **Conclusions** These findings demonstrate that the prevalence of PPH in men aged over 80 years is significantly higher than those in men aged 65 to 80 years, and the blood pressure decline is also higher for men aged over 80 years. In addition, hypertension and age were main risk factors for PPH in the older men, which suggest that preventing and treating PPH is worthwhile.

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Keywords: Male; Postprandial hypotension; Prevalence; The elderly

1 Introduction

Postprandial hypotension (PPH) is a common but under-recognized problem among elderly individuals. It is an independent risk factor for general mortality, coronary disorders, and stroke.[1] PPH is defined as a decline in systolic blood pressure (SBP) greater than or equal to 20 mmHg, or the presence of a postprandial SBP less than or equal to 90 mmHg when the preprandial SBP is greater than or equal to 100 mmHg, within 2 h of eating a meal.[2] PPH may also be diagnosed in the absence of these postprandial blood pressure criteria when there are clinical symptoms such as dizziness, syncope, or falls.[2] Limited data are available regarding postprandial changes in diastolic blood pressure (DBP). Previous studies have reported PPH prevalence of approximately 25%–38% and as high as 67% in hospitalized patients.[3–6] PPH is probably multifactorial, due to an attenuated baroreflex, an attenuated reflex increase in sympathetic activity by activation of stretch receptors in the stomach (gastrovascular reflex),[7] sympathetic dysfunction (e.g., due to diabetes mellitus or Parkinson disease), inability to increase cardiac output due to heart failure, or a combination of these factors.[2] Thus, PPH is more likely to occur in older patients with extensive comorbidities. While the magnitude of the blood pressure decrease in older patients with PPH is not well-described.

This study's aims were to assess the prevalence of and risk factors for PPH, the onset, duration, and magnitude of postprandial blood pressure changes, and associated symptoms among Chinese men over age 80, compared with older men aged 65 to 80. We used 24 h ambulatory blood pressure monitoring (ABPM) to accurately diagnose PPH.

2 Methods

2.1 Patients

Older Chinese men were recruited from Wanshou Road

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Community, Beijing, China. Study inclusion criteria were male sex, age over 65 years, completion of 24 h of ABPM, and stable vital signs. Study exclusion criteria were problems with oral food ingestion, presence of orthostatic hypotension, syncope, or an electrolyte disorder, and inability to cooperate with 24 h of ABPM. Subjects were divided by age into two groups. Group 1 (old) included 163 men aged 65 to 80; group 2 (very old) included 186 men aged over 80. Subjects were subcategorized based on the presence or absence of hypertension.

2.2 Instrumentation and procedure

Subjects were given a standardized diet for three meals, consisting of the following calorie percentages: carbohydrates 50%–60%; protein 10%–15%; fat 20%–30%. Meals were given at 7:30, 11:30, and 17:30, and limited to less than 15 min. Blood pressure was continuously measured in the right upper arm with a Mobil-o-Graph® device (I.E.M., Stolberg, Germany) for 24 h. Subjects were advised to avoid intense activities while using the ambulatory equipment.

SBP and DBP were measured every 15 min, from 30 min before until 120 min after the start of a meal, while participants were seated. Baseline blood pressure was defined as the average the measurements between 30 min before and immediately at the start of the meal. PPH was defined as a meal-induced decline in SBP greater than or equal to 20 mmHg within 120 min after a meal compared with baseline SBP.[1] Postprandial symptoms, symptoms after standing up, and changes in the baseline condition relative to blood pressure changes were observed continuously by researchers.

Researchers also collected data on body mass index (BMI), medical history, and medication use. Participants underwent Doppler echocardiography with measurements of left ventricular end-systolic dimension (LVED) and left ventricular ejection fraction (LVEF) with a Philips HP5500 device, in order to find whether abnormal ejection fraction affect PPH occurrence.

2.3 Statistical analysis

Statistical analysis was performed with SPSS version 17.0 (SPSS Inc., Chicago, Illinois, USA). A *P* value less than 0.05 was defined as the significance level. Continuous measurement data were summarized as means ± SD unless otherwise indicated, and compared using one-way analysis of variance (ANOVA). Dichotomous variables were expressed as frequencies and compared using Chi-square tests. Correlation analysis was conducted with logistic regression.

3 Results

3.1 Patients' baseline characteristics

Overall, the study included 349 Chinese men with a mean age of 81.39 ± 7.94 years. Baseline values for age and BMI were significantly higher in group 2 than in group 1 ($P < 0.01$). Baseline SBP and DBP values in the two groups were comparable ($P > 0.05$). Patient characteristics are shown in Table 1.

Table 1. Baseline characteristics for the two groups.

Characteristics	Group 1 (*n* = 163)	Group 2 (*n* = 186)	*P*
Age, yrs	68.65 ± 7.67	86.49 ± 4.50	0.00
Body mass index, kg/m^2	28.47 ± 8.13	33.98 ± 7.4	0.00
SBP, mmHg	143 ± 22 (96–244)*	139 ± 26 (83–203)*	0.12
Diastolic blood pressure, mmHg	72 ± 10 (32–114)*	69 ± 12 (30–90)*	0.40

Baseline SBP and DBP were calculated as the average measurements of 30 min before and the start of the meal. Group 1 included the old men aged 65 to 80 years; Group 2 included the very old men aged over 80 years. *Data in the parentheses were the minimum and maximum values of SBP and DBP. DBP: diastolic blood pressure; SBP: systolic blood pressure.

3.2 Prevalence of PPH

In group 2, the prevalence of PPH after breakfast and lunch was significantly higher than after supper, while there was no difference in PPH prevalence between breakfast and lunch. Group 1 subjects did not display any between-meal differences in PPH prevalence. PPH prevalence data are shown in Table 2.

Overall, 207 of 349 subjects (59.3%) demonstrated PPH. The prevalence of PPH in group 2 was significantly higher than that in group 1. PPH more commonly occurred in subjects with hypertension compared with those without hypertension. Furthermore, subjects in group 2 with and without hypertension had higher prevalence of PPH than the respective hypertension categories in group 1 (Table 3).

Of the 207 subjects with PPH, 4.8% (*n* = 10) showed clinical symptoms, all concurrently with postprandial declines in SBP of 20 mmHg or more. Four (1.9%), five (2.4%), and

Table 2. The prevalence of PPH in the two groups after three meals.

Groups	No.	Breakfast	Lunch	Supper
Group1	163	48 (29.4)	47 (28.8)	35 (21.5)
Group2	186	70 (37.6)*	65 (34.9)*	40 (21.5)
Total	349	118 (33.8)*	112 (32.1)*	75 (21.5)

Data are presented as *n* (%). Group 1 included the old men aged 65 to 80 years; Group 2 included the very old men aged over 80 years. *$P < 0.05$, compared with supper. PPH: postprandial hypotension.

Table 3. Prevalence of PPH in the total group and subgroup.

Groups	Subgroups		Total
	Hypertension	Non-hypertension	
Group 1	73 (63.5)*	16 (33.3)	89 (54.6)
Group 2	102 (66.2)*	16 (50)#	118 (63.4)#
Total	175 (65.1)*	32 (40)	207 (59.3)

Data are presented as *n* (%). Group 1 included the old men aged 65 to 80 years; Group 2 included the very old men aged over 80 years. *$P < 0.01$, compared with the non-hypertension subgroup; #$P < 0.05$, compared with group 1. PPH: postprandial hypotension.

one (0.5%) cases had postprandial angina, postprandial dizziness and fatigue, and lethargy, respectively.

3.3 PPH characteristics

Among all 207 subjects with PPH, the SBP declined 15–30 min after a meal; the SBP decline of at least 20 mmHg occurred at 30–60 min. Maximal SBP decline occurred at 30–80 min after a meal. The postprandial SBP decline was 20–29 mmHg, 30–49 mmHg, and over 40 mmHg in 136 cases (65.7%), 49 cases (23.7%), and 22 cases (10.6%), respectively. Among 195 patients (94.2%) with PPH, the SBP decline lasted 30–120 min and returned to the preprandial SBP level within the duration. In 5 cases (2.4%), SBP returned to normal within 15 min. In 7 cases (3.4%), SBP did not normalize until the next meal.

3.4 Comparison of PPH characteristics in the two groups

There was no difference of the PPH prevalence in subjects in either group taking with different antihypertensive drugs. However, subjects in both group 1 and 2 who took diuretics had significantly higher PPH prevalence of PPH (The details regarding anti-hypertension medications were all putting in Table 4). The maximum decline of postprandial SBP in group 2 was significantly higher than in group 1 (90 mmHg *vs*. 70 mmHg), but maximum declines occurred at 30 min after breakfast in both groups. The decline of SBP after supper was higher in group 2 than in group 1 (Table 5).

Table 4. The details regarding anti-hypertension medications.

Anti-hypertension drugs	Total subjects, *n*	PPH occurrence, *n*
Benazepril	13	9
Enalapril	10	6
Captopril	16	10
Valsartan	51	31
Candesartan	24	8
Irbesartan	45	21
Losartan	11	5
Metoprolol tartrate	125	67
Nifedipine	195	100
Hydrochlorothiazide	13	10
Furosemide	20	15
Spirolactone	7	3

PPH: postprandial hypotension.

Table 5. Comparison of PPH characteristics in the two groups.

	Group 1	Group 2
Prevalence of PPH of different anti-hypertension drugs (%)▲		
ACEI	11/17 (64.7%)##	14 /22 (63.6%)##
ARB	30 /59 (50.8%)##	39/72 (54.2%)##
Beta-blockers	30/57 (52.6%)##	37 /68 (54.4%)##
Calcium channel blockers	42/85 (49.4%)##	58/110 (52.7%)##
Diuretics	3/4 (75.0%)	25/36 (69.4%)
Nitrates	38/60 (63.3%)##	68/128 (53.1%)##
Postprandial ΔSBP, mmHg (mean[SD])		
After breakfast	29.83 ± 12.46	30.82 ± 12.69
After lunch	28.56 ± 10.78	29.67 ± 8.54
After supper	29.85 ± 10.19	30.45 ± 9.81*
LVED, mm	49.49 ± 3.36	48.62 ± 3.32#
LVEF, %	62.32 ± 3.96	60.33 ± 4.78*

Group 1 included the old men aged 65 to 80 years, $n = 163$; Group 2 included the very old men aged over 80 years, $n = 186$. *$P < 0.01$, compared with group 1; #$P < 0.05$, ##$P < 0.01$, compared with subgroup of diuretics. ▲the number of subjects diagnosed PPH and non-PPH. ACEI: angiotensin converting enzyme inhibitors; ARB: angiotensin receptor blockers; LVED: left ventricular end-systolic dimension; LVEF: left ventricular ejection fraction; PPH: postprandial hypotension; SBP: systolic blood pressure.

LVED and LVEF were lower in group 2 than in group 1. Other variables were not different between the two groups (Table 5). The results means the change in SBP was not due to difference in ejection fraction.

3.5 Logistic regression analysis

Multivariate logistic regression was performed to assess the association of various risk factors and PPH. Variables such as age, coronary heart disease, anti-hypertension drugs, arcobose, hypertension, cerebrovascular disease, and diabetes mellitus are included in the logistic model.

Hypertension and age were significant risk factors for PPH (OR = 2.188, 95% CI: 1.134–4.223, $P = 0.02$; OR = 1.86, 95% CI: 1.112–3.11, $P = 0.018$, respectively). Acarbose use was protective against PPH (OR = 0.4, 95% CI: 0.189–0.847, $P = 0.017$), (Table 6).

4 Discussion

Pronounced decreases in SBP and syncope or falls are

Table 6. Association of risk factors and PPH.

	B	SE	Wald	df	Sig.	Exp (B)	95% CI for EXP(B)	
							Lower	Upper
Age	0.620	0.262	5.598	1	0.018	1.860	1.112	3.110
Cerebrovascular disease	0.100	0.295	0.115	1	0.734	1.105	0.620	1.971
Coronary heart disease	–0.217	0.289	0.563	1	0.453	0.805	0.457	1.418
Anti-hypertensive drug	–0.629	0.363	3.010	1	0.083	0.533	0.262	1.085
Acarbose	–0.916	0.383	5.733	1	0.017	0.400	0.189	0.847
Hypertension	0.783	0.335	5.446	1	0.020	2.188	1.134	4.223
Diabetes melitus	0.066	0.310	0.045	1	0.831	1.068	0.582	1.961
Constant	–0.486	0.736	0.436	1	0.509	0.615		

PPH: postprandial hypotension.

common symptoms in elderly people with PPH.[5,8] PPH is an independent risk factor for cardiovascular events, stroke, and death and an independent predictor of all-cause deaths in elderly people.[9] In the present study, we evaluated the characteristics of PPH in 349 Chinese men. These characteristics include the prevalence of and risk factors for PPH, the onset, duration, and magnitude of postprandial blood pressure changes, and associated symptoms.

Previous studies have pointed out that, compared with younger people, older people have a higher prevalence of PPH and can frequently experience adverse events such as cardiovascular and cerebrovascular ischemic symptoms.[2,10] We found that the prevalence of PPH was 59.3% in all 349 subjects and was significantly higher in men aged over 80 years than in men aged 65 to 80 years (63.4% *vs*. 54.6%), which confirmed the previous viewpoint. The actual decrease in blood pressure in episodes of PPH was 20–40 mmHg, with a maximum decline of 90 mmHg in men aged over 80 years, which was significantly higher than the maximum blood pressure decline of 70 mmHg in men aged 65 to 80 years. Potential explanations for this difference may include various medical comorbidities, use of polypharmacy, and physical dysfunction seen in men aged over 80 years. We observed a higher prevalence of PPH after breakfast than after the other two meals ($P < 0.05$), in agreement with previous research.[11] Men aged over 80 years often take anti-hypertension drugs in the morning, which may intensify baseline postprandial effects, causing a higher prevalence of PPH after breakfast. In our study, the prevalence of PPH in subjects with hypertension was higher than in those without hypertension ($P < 0.01$). Because hypertension impairs baroreflex sensitivity and limits diastolic ventricular filling, rendering the heart more dependent on ventricular preload, it increases the risk for PPH.[12,13]

The prevalence of PPH was higher after breakfast (33.8%) and lunch (32.1%) than after supper (20.9%). In the elderly participants, prolonged recumbency at night may cause nocturnal polyuria, reduced intraventricular volumes, and central hypovolemia, and, as a result, decrease cardiac output because the arterial baroreflex sensitivity is decreased and vasomotor and cardiac responses (increase in heart rate, stroke volume, and peripheral resistance) are reduced.[14,15] Therefore, PPH will be aggravated after breakfast by the pronounced insufficient increase in cardiac output.

Patients with PPH may present with syncope, falls, dizziness, weakness, angina pectoris, stroke, and other ischemic symptoms.[16] However, not all PPH patients showed typical symptoms.[8] Similarly, we observed that only 10 subjects diagnosed with PPH had cardiovascular and cerebrovascular ischemic symptoms. Men over age 80 years, who had cognitive dysfunction and became tolerant of PPH symptoms, complained of the clinical symptoms less frequently, leading to a reduced PPH detection rate and serious consequences. In order to avoid this phenomenon, we must pay close attention to very old men with PPH.

Logistic regression analyses revealed that age and hypertension were risk factors for PPH, while acarbose was a protective factor against PPH. Subjects with PPH who were taking acarbose had lower detection of PPH than those without acarbose, consistent with prior research.[17,18] This result was an unintended finding, suggesting that acarbose may be useful in preventing and treating very old patients with PPH in the future. Previous studies reported that PPH detection rate was not associated with the use of antihypertensive drugs,[10] which is consistent with our study's findings.

The pathogenesis of PPH is complicated and not yet fully understood.[5] It is related to hemodynamic changes, sympathetic decompensation, and humoral decompensation after a meal.[19–21] Meal ingestion has been demonstrated to induce splanchnic vasodilatation and a decrease in systemic vascular resistance, which may provoke a decrease in venous return and cause PPH.[13] For men over age 65, symptoms of PPH should be addressed because of the high

prevalence of PPH, extensive comorbidities, and complex risk factors. Key to treating PPH is preventing adverse events. Practitioners should use of medications appropriately. For older patients taking blood pressure medications, the peak time of antihypertensive effect may coincide with the PPH effect, leading to adverse consequences from hypotension. Strict control of eating conditions, such as drinking some water before a meal, eating less or shortening the mealtime, or having a proper rest after a meal, is also recommended. In addition, providers should pay more attention and monitor changes in postprandial blood pressure in very old men who may have fewer clinical symptoms in order to detect and prevent PPH.

The present study also has some limitations. Female subjects were not included because the very old participants from the Wanshou Road Community who met our inclusion criteria were mostly male. In addition, blood pressure was assessed only on one occasion; repeat measurements would be needed to identify whether the occurrence PPH was incidental. Future research will address these limitations.

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References

1 Lyzohub VH, Zaval's'ka TV, Stakhurs'ka LA, *et al*. Postprandial hypotension. *Lik Sprava* 2013: 42–48. [Article in Ukrainian]
2 Van Orshoven NP, Jansen PA, Oudejans I, *et al*. Postprandial hypotension in clinical geriatric patients and healthy elderly: prevalence related to patient selection and diagnostic criteria. *J Aging Res* 2010; 243752
3 Vloet LCM, Pel-Little RE, Jansen PAF, *et al*. High prevalence of postprandial and orthostatic hypotension among geriatric patients admitted to Dutch hospitals. *J Gerontol A Biol Sci Med Sci* 2005; 60: 1271–1277.
4 Le Couteur DG, Fisher AA, Davis MW, *et al*. Postprandial systolic blood pressure responses of older people in residential care: association with risk of falling. *Gerontology* 2003; 49: 260–264.
5 Puisieux F, Bulckaen H, Fauchais AL, *et al*. Ambulatory blood pressure monitoring and postprandial hypotension in elderly persons with falls or syncopes. *J Gerontol A Biol Sci Med Sci* 2000; 55: M535–M540.
6 Aronow WS, Ahn C. Postprandial hypotension in 499 elderly persons in a long-term health care facility. *J Am Geriatr Soc* 1994; 42: 930–932.
7 van Orshoven NP, Oey PL, van Schelven LJ, *et al*. Effect of gastric distension on cardiovascular parameters: gastrovascular reflex is attenuated in the elderly. *J Physiol* 2004; 555: 573–583.
8 Luciano GL, Brennan MJ, Rothberg MB. Postprandial hypotension. *Am J Med* 2010; 123: 281 e281–e286.
9 Fisher AA, Davis MW, Srikusalanukul W, *et al*. Postprandial hypotension predicts all-cause mortality in older, low-level care residents. *J Am Geriatr Soc* 2005; 53: 1313–1320.
10 Jian ZJ, Zhou BY. Efficacy and safety of acarbose in the treatment of elderly patients with postprandial hypotension. *Chin Med J (Engl)* 2008; 121: 2054–2059.
11 Wicklein S, Muhlberg W, Richter B, *et al*. Increased splanchnic arterial vascular resistance in oldest old patients - possible relevance for postprandial hypotension. *Z Gerontol Geriatr* 2007; 40: 37–42.
12 Jansen RW, Lipsitz LA. Postprandial hypotension: epidemiology, pathophysiology, and clinical management. *Ann Intern Med* 1995; 122: 286–295.
13 Lysogub VG, Bondarchuk OM, Altunina NV. Postprandial hemodynamic reactions of patients with ischemic heart diseases and chronic pancreatitis. *Lik Sprava* 2011: 64–70. [Article in Ukrainian]
14 Fisher AA, Davis MW, Le Couteur DG. The effect of meals at different mealtimes on blood pressure and symptoms in geriatric patients with postprandial hypotension. *J Gerontol A Biol Sci Med Sci* 2005; 60: 184–186.
15 Vloet LC, Smits R, Jansen RW. The effect of meals at different mealtimes on blood pressure and symptoms in geriatric patients with postprandial hypotension. *J Gerontol A Biol Sci Med Sci* 2003; 58: 1031–1035.
16 Tanakaya M, Takahashi N, Takeuchi K, *et al*. Postprandial hypotension due to a lack of sympathetic compensation in patients with diabetes mellitus. *Acta Medica Okayama* 2007; 61: 191–197.
17 Masuo K, Mikami H, Ogihara T, *et al*. Mechanisms mediating postprandial blood pressure reduction in young and elderly subjects. *Am J Hypertens* 1996; 9: 536–544.
18 Fisher AA, Davis MW, Le Couteur DG. The effect of meals at different mealtimes on blood pressure and symptoms in geriatric patients with postprandial hypotension. *J Gerontol A Biol Sci Med Sci* 2005; 60: 184–185.
19 Son JT, Lee E. Prevalence and risk factors of postprandial hypotension in Korean elderly people. *J Korean Acad Nurs* 2009; 39: 198–206.
20 Bateman BT, Hernandez-Diaz S, Huybrechts KF, *et al*. Outpatient calcium-channel blockers and the risk of postpartum haemorrhage: a cohort study. *BJOG* 2013; 120: 1668–1677.
21 Ong ACL, Myint PK, Potter JF. Pharmacological treatment of postprandial reductions in blood pressure: a systematic review. *J Am Geriatr Soc* 2014; 62: 649–661.