

## ORIGINAL RESEARCH

## Factors predicting blood pressure control in older Chinese immigrants to the United States of America

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**Abstract**

**Aim.** This paper is a report of a study of the extent to which demographic characteristics, medication-related factors, hypertension-related knowledge and medication adherence predict systolic and diastolic blood pressure.

**Background.** Little is known about predictors of hypertension control in Chinese elders.

**Methods.** A longitudinal study with a 3-month follow-up was conducted with 90 Chinese immigrants to the United States of America aged  $\geq 65$  years and recruited from 2006 to 2007. The independent variables were measured at baseline. Blood pressure was measured at 3 months. Multiple linear regression analysis was used to evaluate the independent effects of seven variables on change in blood pressure at 3 months.

**Results.** Participants ranged in age from 66 to 92 years (Mean 76.7, SD 6.6). The overall regression model for systolic blood pressure was statistically significant ( $R^2 = 0.32$ ,  $F = 4.37$ ,  $P < 0.01$ ). A higher number of prescribed oral medications ( $sr^2 = 0.06$ ,  $t = 2.42$ ,  $P = 0.02$ ) and lower medication adherence ( $sr^2 = 0.07$ ,  $t = -2.60$ ,  $P = 0.01$ ) were statistically significant determinants of an increased systolic blood pressure. The overall regression model for diastolic blood pressure was statistically significant ( $R^2 = 0.21$ ,  $F = 2.39$ ,  $P = 0.03$ ). Male gender ( $sr^2 = 0.06$ ,  $t = 2.26$ ,  $P = 0.03$ ) and lower medication adherence ( $sr^2 = 0.11$ ,  $t = -3.03$ ,  $P < 0.01$ ) were statistically significant determinants of an increased diastolic blood pressure.

**Conclusion.** A greater number of prescribed medications and lower adherence predicted higher level of systolic blood pressure. Male gender and lower adherence were significantly associated with higher level of diastolic blood pressure. These predictors should be considered when designing interventions to help Chinese elders achieve better hypertension management.

**Keywords:** blood pressure control, hypertension, immigrants, medication adherence, nursing, older Chinese

## Introduction

Hypertension (HTN) is defined as systolic blood pressure (BP)  $\geq 140$  mmHg and diastolic BP  $\geq 90$  mmHg (Joint National Committee 2003). HTN is known worldwide to be easily detected and usually manageable if an effective treatment regimen is undertaken (Joint National Committee 2003, Whitworth 2003). Whereas effective treatments for HTN have been documented in the literature and the benefits of preventing HTN related complications (e.g. stroke and heart attack) via these treatments are also reported (Kaplan 1993, Joint National Committee 1997), HTN remains uncontrolled in many developing and developed countries (Whitworth 2003). Unfortunately, reasons for uncontrolled HTN remain unclear in older people (Havas *et al.* 1996, Jamerson & DeQuattro 1996). Thus, it is very challenging for nurses to tailor interventions to target the most critical risk behaviours, such as poor adherence to antihypertensive medications or lack of knowledge about HTN management, to gain the most benefits of HTN treatment in the older population.

Some studies have been conducted to investigate issues related to HTN management (McKenney *et al.* 1992, He *et al.* 2002). However, the majority of participants in these studies were White and so these findings may not be generalizable to older Chinese people. The current study was designed to fill this gap by investigating predictors of poor HTN control in older Chinese immigrants in the United States of America (USA). This study is important for three reasons. First, very few tools are available to assess factors that influence blood pressure control, such as medication adherence and HTN-related knowledge, in Chinese elders. In this study we adopted instruments that were originally designed for Chinese individuals. Second, our findings may help establish a precise nursing care model (i.e. how much effort should be targeted at each predictor) to help Chinese elders achieve better BP control. Third, as Chinese elders share similar cultural backgrounds (e.g. Chinese medicine) and lifestyle (e.g. use of soy sauce in their cooking) worldwide (Taiwan Government Information Office 2001, Satia-Abouta *et al.* 2002), a prediction model for HTN management would not only be applicable in the USA, but also other Western countries and China itself.

### Older Chinese immigrants on antihypertensive medications

The number of Americans aged 65 years and older was 35 million in 2000 (U.S. Bureau of the Census 2000). This population has the lowest BP control rate in the USA (Hyman

& Pavlik 2001). Chinese immigrants constitute the largest proportion (25%) of Asian Americans and Pacific Islanders (10.9 million in year 1999) in the USA (U.S. Bureau of the Census 2000), and the most recent data show that age- and gender-adjusted prevalence rates of HTN are high in older Chinese immigrants to the USA: 33.5% for women and 29.7% for men (Choi *et al.* 1990). Although quite a few researchers have studied issues in HTN management in the general US population, very few (Hu *et al.* 1996a,b, Li *et al.* 2008b) have investigated HTN management in older Chinese immigrants. As Chinese immigrants' cultural health practices (e.g. Chinese medicine) and backgrounds (e.g. more soy sauce [sodium] intake in food) differ from the general Americans, the generalizability of studying findings from the general US population to older Chinese immigrants is difficult.

### Predictors of blood pressure

Medication-related factors (e.g. number of prescribed medications, frequency of medications taken daily) and knowledge (knowledge about antihypertensive medications) have been reported previously to be associated with HTN management in Chinese elders (Hu *et al.* 1996a, 1999). However, most research has investigated the association between these factors and antihypertensive medication adherence, with adherence treated as an outcome (Schechtman *et al.* 2002, Gregoire *et al.* 2006); none were found that examined how these medication and knowledge-related factors, along with medication adherence, are related to BP control. In addition, scarce evidence was found on the unique contribution of each predictor to HTN management (Hu *et al.* 1996a,b, Li *et al.* 2008b). Currently, nurses have inadequate data on which to base more targeted approaches to treatment (Materson 2004). Knowing the unique contribution of each predictor is especially important for the development of both culturally-sensitive and cost- and time-efficient approaches to care.

### Systolic blood pressure as primary outcome

In the study reported here, systolic blood pressure (SBP) was chosen as a primary outcome because it is more difficult to control than diastolic blood pressure (DBP) (Cushman *et al.* 2002), and is the most important predictor of the development of advanced, severe cardiovascular disease (e.g. stroke) in elders, compared to DBP, mean arterial pressure and pulse pressure (Stamler *et al.* 1993, Sesso *et al.* 2000, Benetos *et al.* 2002). In two studies (recruiting 4714 and 2407 older men), SBP and DBP were compared to see which measure had the strongest association with cardiovascular disease risk

(e.g. stroke and myocardial infarction) (Sesso *et al.* 2000, Benetos *et al.* 2002). The findings showed that SBP was a better predictor of cardiovascular diseases among these older participants than DBP (Sesso *et al.* 2000, Benetos *et al.* 2002). In addition, Australia researchers investigated 5092 Chinese men and found that SBP was the single best predictor of coronary heart disease when compared to DBP, mean arterial pressure and pulse pressure (Zhang *et al.* 2004). Given these findings, SBP was chosen as a primary end-point measure for our study.

**Theoretical framework**

The theoretical framework guiding this study was derived from: (1) The Health Belief Model (HBM) (Becker 1974); (2) literature on HTN-related issues; (3) the first author’s preliminary study findings; and (4) numerous years of clinical experience.

The HBM was originally proposed in early 1950s to describe health behavioural patterns related to disease prevention (Rosenstock 1974). The HBM was modified and tested in the first author’s preliminary studies (Li *et al.* 2005, 2006), and results supported the utility of the model for the proposed study of older Chinese immigrants (Li *et al.* 2008a). The HBM offers insight into the health outcomes of Chinese elders, showing how their background (e.g. immigrant status), HTN-related knowledge and clinical factors (e.g. number of prescribed oral medications) interact with their HTN management. Many of the concepts in the HBM were essential in guiding the development of our prediction model of SBP and DBP among older Chinese immigrants. This modified theoretical framework differs from the original

HBM in that it takes into consideration the cultural backgrounds of older Chinese immigrants, such as cultural beliefs about HTN and its management (Figure 1). In addition, this modified framework includes an adherence measure, which was specifically developed for Chinese individuals.

**The study**

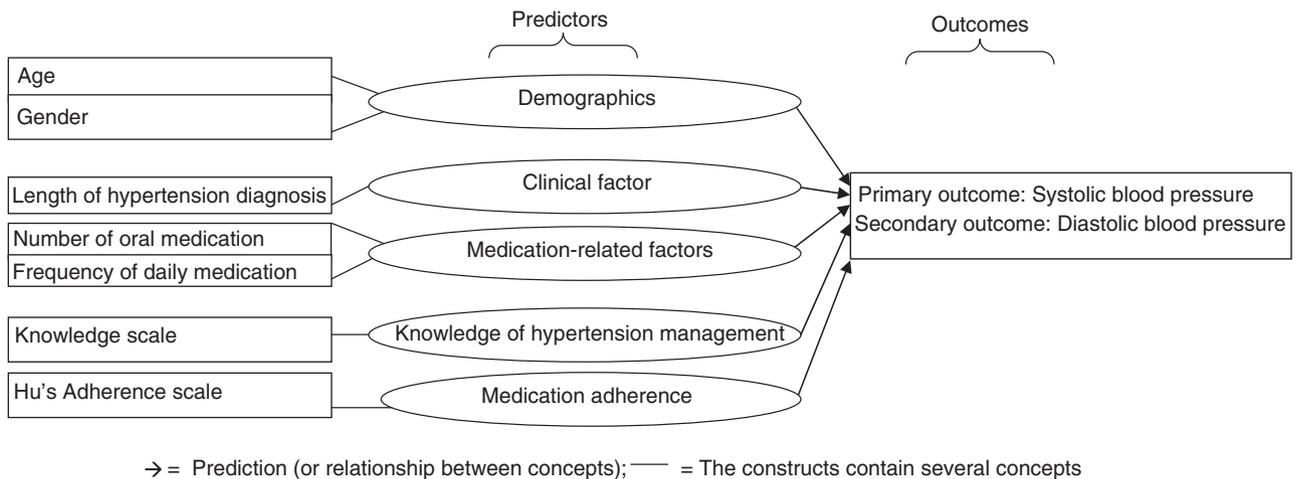
**Aims**

The primary aim of this study was to investigate the extent to which demographic characteristics, medication-related factors, HTN-related knowledge, and medication adherence predict SBP. In addition, because duration of HTN (a clinical factor) has been found to be associated with BP levels, it was also included in the predictive model.

The secondary aim was to investigate the extent to which demographic characteristics, medication-related factors, HTN-related knowledge, duration of HTN and medication adherence predict DBP. DBP was chosen as the secondary outcome is because it is the other important indicator of severe cardiovascular consequence (e.g. stroke) that is routinely measured to assess severity of HTN (Joint National Committee 2003).

**Design**

Ninety Chinese immigrants to the USA, aged ≥65 years, were recruited between June 2006 and May 2007. Assessments occurred at baseline and 3 months. Independent variables, including demographic characteristics, medication-related



**Figure 1** Theoretical framework.

factors, HTN-related knowledge and medication adherence, were obtained at the baseline. SBP and DBP were measured at baseline and 3 months.

### Setting

An Asian health clinic in the San Francisco Bay area was chosen as a recruitment site because it had provided services for a large number of Chinese immigrants for over 30 years. This clinic was located in an active China Town in a large city in California. Of 12,000 registered patients for whom this clinic provided services annually, about 64% were Chinese. Around 200 patients visited the clinic daily for health problems, 65% of whom were Chinese elders with HTN.

### Participants

#### *Inclusion criteria*

Older Chinese immigrants taking antihypertensive medications who were registered in the Asian health clinic were the target population for the study. This population was chosen because it has a high stroke death rate related to HTN (He *et al.* 1995). Patients were included if they: (1) were a Chinese immigrant 65 years and older; (2) had a diagnosis of HTN; (3) were taking antihypertensive medications at enrolment; and (4) were able to speak Mandarin Chinese. The exclusion criteria were being medically unstable (e.g. renal failure) and having concurrent psychiatric problems (e.g. schizophrenia).

#### *Power estimate*

Using nQuery Advisor (Elashoff 1999) for a multiple regression model that included seven covariates with a squared multiple correlation  $R^2$  of 0.31, a sample size of 90 was determined to have more than 80% power to detect an increase in  $R^2$  of 0.04 (at  $\alpha = 0.05$ ) with the inclusion of one additional covariate.

### Data collection

The study began in June 2006 and a convenience sample of 90 older Chinese immigrants was recruited. An initial visit was scheduled for those who agreed to participate. Written consent was obtained at the beginning of the initial visit. Participants were re-contacted at 3 months. They had a right to refuse to participate in the study at any time. Two methods were used to minimize dropout. First, a reminder phone call was made 2 days before each follow-up interview day. Second, participants were given \$20 in acknowledgement of their time commitment.

At the initial visit, participants' BP was checked twice by the research assistant. Afterwards, they were asked to complete a demographic questionnaire, along with questions on HTN-related knowledge, medication, clinical data, and medication adherence questionnaires. At the 3-month visit, BP was checked twice again. The first visit took about 30 minutes and the 3-month visit lasted about 20 minutes.

#### *Measurement of demographic characteristics*

The national guideline developed by Centers for Disease Control and Prevention (CDC) (Centers for Disease Control and Prevention 1998) was modified by adding immigrant status (duration of stay in the USA) as a component of the demographic characteristics collected. As age and gender were suggested in the literature to be associated with blood pressure management, these were included in the prediction model for BP control (Majernick *et al.* 2004, Nilsson *et al.* 2005, Morris *et al.* 2006).

#### *Measurement of predictors*

The selection of the predictors was based on the literature review, the first author's years of clinical practice with older Chinese immigrants, and multiple linear regressions using a backward stepwise elimination approach. All measures of predictors were collected at baseline and were self-reported, including medication-related, clinical, knowledge and adherence factors.

#### *Medication-related factors*

*Number of prescribed oral medications* was defined as all types of oral medication, including antihypertensive and non-antihypertensive medications, taken for more than a month on a regular basis and prescribed by healthcare providers.

*Frequency of prescribed oral medications per day* was defined as number of oral medications taken on a daily basis that were prescribed by healthcare providers. This included all antihypertensive and non-antihypertensive medications, but not over-the-counter medications, such as vitamin supplements.

#### *Clinical factor*

*Length of HTN diagnosis (years)* was defined as the total length of time since the participant was diagnosed or told by healthcare providers that they had HTN.

#### *Knowledge factor*

*HTN-related knowledge* was defined by three main categories, that is, knowledge about: (1) HTN (three items), (2) antihypertensive medications (six items) and (3) risk factors

(eight items). This 17-item scale was selected from Hu *et al.*'s study and was originally developed for a Taiwanese population (e.g. Mainland Chinese people who migrated to Taiwan) (Hu *et al.* 1996b). The response choices were 'true' (scored as 1), 'false' (scored as 0) and 'do not know' (scored as 0). As this questionnaire was developed particularly for Chinese people, cultural factors were taken into account. For example, one item was 'An individual's blood pressure is worsened by taking excessive sodium, such as soy sauce'. Chinese people have been known to use more sodium than Western people in their cooking (Cheng 2004). Eleven items were positively scored and six were negatively scored. Scores for the 17 items were summed for each participant (possible range: 0–17). A higher total score indicated better knowledge of HTN. The Kuder-Richardson 20 (KR-20), a measure of internal consistency reliability for instruments with dichotomous choices (Cortina 1993), was 0.96 in a study with 600 Chinese people with HTN in Taiwan (Hu *et al.* 1996b).

#### *Medication adherence*

The Medication Adherence Scale by Hu *et al.* (Hu *et al.* 1996b) was used to measure frequency, type and level of medication adherence. This 15-item scale was selected from Hu *et al.*'s (1996b) study. The response choices ranged from 1 (do it every day) to 5 (never do it). An example item was: 'You ever reduced dose of taking the pills by yourself for some reason'. Three items were positively scored and 12 were negatively scored question. Scores for the 15 items were summed for each participant (possible range: 15–75). A higher total score indicated better medication adherence. Cronbach's  $\alpha$  was 0.82 in a study with 600 Chinese people with HTN in Taiwan (Hu *et al.* 1996b). This instrument was different from other adherence scales in two ways that made it suitable for Chinese immigrants. First, it took a very detailed approach in asking whether participants ever reduced/or added dose/frequency or changed time of taking antihypertensive medications. This was appropriate for Chinese individuals because it could carefully assess different aspects of medication taking behaviours that were very often under-reported by Chinese people. Second, each item had five choices, which were appropriate for a Chinese population because many Chinese people prefer being offered multiple rather than dichotomous choices (Li *et al.* 2005).

#### *Outcome measurement*

Both SBP and DBP were measured using a mercury sphygmomanometer and applying standard procedures suggested by the US Joint National Committee (Joint National Committee 2003). BP was taken twice and the values for

SBP and DBP averaged. The rationale for obtaining an averaged BP was to reduce variability and increase accuracy. If the averaged BP was <140/90 mmHg (130/80 mmHg for participants with diabetes or chronic kidney disease), it was classified as BP control (Joint National Committee 2003). SBP and DBP as continuous variables were used in model testing, as this approach gave greater power to detect significant predictors than BP coded as a dichotomous variable.

#### **Ethical considerations**

Approval for the study was obtained from a university committee on human research. There were no physical risks to participants. They might have experienced boredom during the interviews, and were encouraged to address their negative feelings and discuss how to relieve these feelings. If these feelings continued, participants had a right to withdraw from the study.

#### **Data analysis**

SPSS version 12 (SPSS Inc., Chicago, IL, USA) was used for data entry, management and analysis. Descriptive statistics were used to screen data, such as for missing values and outliers. Missing data (either for a predictor or outcome) were removed from the analysis (i.e. when a prediction of the outcome was analyzed). Outliers were checked by the first author against raw data and if there was any mistake, it was corrected manually by the first author. Multiple linear regression analysis using a backward stepwise approach was used to evaluate the independent effects of seven baseline variables for their prediction of a reading (absolute value) of SBP and DBP at 3 months. An  $\alpha$  level of 0.05 was used in all the tests.

## **Results**

### **Participant demographics**

Originally, 125 participants were contacted, but 30 refused to participate and five lived too far from the study site and could not take part. This resulted in a response rate of 72%. Out of 90 who participated in the baseline visit, 78 completed the 3-month follow-up visit. Therefore, the attrition (lost to follow-up) rate at 3-month follow-up was 13%.

Table 1 shows the demographics. Participants ranged in age from 66 to 92 years (Mean 76.7, SD 6.6). Half were men (50.0%) and almost half had less than a high school education (43.3%). The majority was married (72.2%) and lived with family or close friends (82.2%). The median

annual household income was less than \$9999 (vs. median annual US household income: \$48,200 in 2006). The average length of time in the USA was 16.9 years (SD 7.3), with a range of 5–41 years. Only 2.2% reported being able to communicate in English with their healthcare providers. Less than 50% (47.8%) of total sample ( $n = 90$ ) had their HTN controlled at baseline.

**Predictors of change in systolic and diastolic blood pressure**

In order to assess possible colinearity among the independent variables, the bivariate association between all independent variables was evaluated. This showed that none of bivariate associations were above 0.50, which suggests that no statistically significant colinearity existed among the independent variables. The overall regression model for SBP was statistically significant ( $R^2 = 0.32, F = 4.37, d.f. = 7, 65, P < 0.01$ ). However, only the number of prescribed oral medications

and medication adherence were statistically significant determinants of SBP at 3 months when all other independent variables were held constant; higher number of prescribed oral medications ( $sr^2 = 0.06, t = 2.42, P = 0.02$ ) and lower medication adherence ( $sr^2 = 0.07, t = -2.60, P = 0.01$ ) were both statistically significantly associated with higher level of SBP (Table 2).

The overall regression model for DBP was statistically significant ( $R^2 = 0.21, F = 2.39, d.f. = 7, 65, P = 0.03$ ). However, only male gender and medication adherence were statistically significant determinants of DBP at 3 months when all other independent variables were held constant. Male gender ( $sr^2 = 0.06, t = 2.26, P = 0.03$ ) and lower medication adherence ( $sr^2 = 0.11, t = -3.03, P < 0.01$ ) were both statistically significantly associated with higher level of DBP (Table 3).

**Table 1** Demographic and clinical variables of older Chinese immigrants

Demographics, frequency (%)	Older Chinese immigrants ( $n = 90$ )
Hypertension control	43 (47.8)
Length of stay in the US (years), Mean $\pm$ SD	16.9 $\pm$ 7.3
Women	45 (50.0)
Education	
Less than high school	39 (43.3)
Marital status	
Married	65 (72.2)
Live with family or friends	74 (82.2)
Annual household income	
Less than \$9999	46 (51.1)
In which country were you born?	
China	75 (83.3)
Religion	
Buddhism or folk religion	22 (24.5)
Others	31 (34.4)
None	37 (41.1)
Prefer using English to communicate with healthcare provider	2 (2.2)
Cardiovascular risk factors	
Family history (being aware of)	13 (14.4)
Physical inactivity	11 (12.2)
Lipid abnormality	57 (63.3)
Type II diabetes	16 (17.8)
Obesity	4 (4.4)
Smoker	19 (21.1)
Target organ disease	
Heart disease	16 (17.8)
Stroke or transient ischemic attack	9 (10.0)

**Table 2** Multivariate linear regression of predictors for a higher absolute systolic blood pressure

Variables	B	sr <sup>2†</sup>	T	P value
Gender (male coded as 1)	3.51	0.01	1.02	0.31
Age (years)	0.39	0.02	1.39	0.17
Duration of hypertension	-0.08	<0.01	-0.59	0.56
Number of prescribed oral medications	1.83	0.06	2.42	0.02*
Frequency of prescribed oral medications per day	1.46	<0.01	0.93	0.36
Knowledge of hypertension management	0.90	0.04	1.55	0.12
Medication adherence	-0.92	0.07	-2.60	0.01*

\*Statistically significant.

†Percentage of total variance in systolic blood pressure can be explained by a predictor.

**Table 3** Multivariate linear regression of predictors for a higher absolute diastolic blood pressure

Variables	B	sr <sup>2†</sup>	T	P value
Gender (male coded as 1)	5.80	0.06	2.26	0.03*
Age (years)	-0.12	<0.01	-0.59	0.55
Duration of hypertension	-0.03	<0.01	-0.32	0.75
Number of prescribed oral medications	-0.01	<0.01	10.20	0.84
Frequency of prescribed oral medications per day	1.34	0.02	1.15	0.26
Knowledge of hypertension management	0.52	0.02	1.21	0.23
Medication adherence	-0.79	0.11	-3.03	<0.01*

\*Statistically significant.

†Percentage of total variance in diastolic blood pressure can be explained by a predictor.

## Discussion

### Study limitations

The findings of the study need to be considered in the context of its limitations. The retention rate was 87%, leaving 13% (12 participants) lost to follow-up. As the outcome (BP measurement) of the participants might be different from that of those lost to follow-up, the findings may not be generalized to the latter. Similarly, as missing data (either for a predictor or outcome variable) were excluded from the analysis, the findings may also not be generalized to those with missing data. As a majority of the participants who were lost to follow up had a transport issue, providing a reasonable transport service to the study site should be considered in the future study, a point discussed in further detail below.

In addition, the response rate in this older minority population was 72%, indicating that participation of older Chinese immigrants in the study was moderate. This was lower than the response rate of 87% in a cross-sectional study investigating issues related to medication use (not specifically related to antihypertensive medications) conducted with 92 older Chinese Canadians (Tjam & Hirdes 2001). The reason might be due to different health conditions in the two populations. As our participants were recruited from an outpatient clinic, while the Canadian researchers recruited theirs from a community, our participants might have had more chronic conditions and mobility issues. Moreover, the Canadian sample was comprised of more women (67% vs. 50% in our study). Women have been reported previously to have higher study participation rates than men (Ho 1991). Therefore, the higher participation rate in the Canadian sample might be due to the higher proportion of female participants. These observations suggest that different strategies may be needed when recruiting an older Chinese population from clinics rather than communities (e.g. church or day care center). For example, if a participant does not drive or it is very inconvenient to take public transportation (e.g. they do not speak English and so hesitate to use public transport), arrangement of transport will become a key factor in facilitating participation. Also, if an older Chinese population tends to have more male participants, a more dynamic approach and culturally-tailored recruitment techniques (e.g. holding a seminar in Chinese with the assistance of a gatekeeper) to explain the purpose and potential benefits of a study (Lin *et al.* 2005) might increase the chances of recruiting more men.

Twelve of our participants (13%) were lost to follow-up at 3 months. A relatively large epidemiological study investi-

gating health predictors of mortality in Hong Kong ( $n = 1054$  older Chinese) had a similar attrition rate (10%) at 24-month follow-up. As no data on attrition rate were provided for their shorter follow-up periods (e.g. 6 and 12 months), we could not directly compare our attrition rate to that of the Hong Kong study. However, because the current study, with a shorter follow-up time, had a similar attrition rate to the Hong Kong study, it could be concluded that the retention rate of the Hong Kong study was better than ours. Possible explanations are that the Hong Kong sample was healthier (community sample) than ours and/or that public transport was more convenient in Hong Kong. For future studies, especially in the rural area, other methods should be used to prevent loss to follow-up if transport is not arranged for participants, such as reasonable remuneration to reimburse transport costs and participation time.

### Prediction model

As for the prediction model for SBP, about a third of the total variance in SBP could be explained by a combination of our seven demographic characteristics, medication-related, clinical and knowledge factors, and medication adherence. Therefore, the significance of the prediction model we proposed is supported and deserves further investigation to validate its predictive potential. On the other hand, as around 70% of variance in SBP could not be explained by our model, the investigation of other factors, such as health insurance and use of traditional medicine therapy (e.g. Chinese herbs) (Hu *et al.* 1999, Li *et al.* 2008b), should be investigated in the future.

As for a unique contribution of each independent variable, older age was reported to be positively associated with poor BP management in the literature (Cushman *et al.* 2002, Nilsson *et al.* 2005). Although our study also showed that older age was associated with higher level of SBP, the finding was not statistically significant. Additional studies with larger samples may be needed to differentiate the impact of age (e.g. young-old vs. old-old) on blood pressure control.

Among the three clinical and medication-related factors, including length of HTN, number of prescribed oral medications and frequency of oral medications taken daily, only number of prescribed medications was statistically significantly associated with increased SBP. The more prescribed oral medications the participants took, the higher their SBP was at 3 months. However, the directionality between number of medication and SBP cannot be established because baseline BP was not controlled in our model (due to the limited sample size). We suggest that in future studies baseline BP is taken into account.

### What is already known about this topic

- Hypertension ( $\geq 140/90$  mmHg) is a major risk factor for many serious cardiovascular complications, such as stroke and heart attack.
- Hypertension is known worldwide to be easily detected and usually manageable if an effective treatment regimen is undertaken.
- While effective treatments for hypertension have been documented in the literature and the benefits of preventing hypertension-related complications (e.g. stroke and heart attack) via these treatments are also reported, hypertension remains uncontrolled in many developing and developed countries.

### What this paper adds

- Prediction models for both systolic and diastolic blood pressure control.
- A greater number of prescribed medications and lower adherence predicted higher level of systolic blood pressure, and male gender and lower adherence were statistically significantly associated with higher level of diastolic blood pressure.
- A specific prediction model for systolic blood pressure is important because many older individuals have isolated systolic hypertension, and the model may help identify more appropriate nursing care plans to help manage systolic blood pressure in older Chinese immigrants.

### Implications for practice and/or policy

- Any nursing care plan designed to achieve better blood pressure control in older Chinese individuals needs to use a culturally-appropriate approach that addresses number of medications prescribed as well as medication adherence, measured by a culturally-sensitive instrument.
- The prediction models for systolic and diastolic blood pressure can help clinical nurses or nurse researchers identify older Chinese immigrants who are at risk for poor blood pressure control and can help generate more effective hypertension management plans.

prescribed oral medications and adherence should be taken into consideration when designing an intervention for management of isolated systolic HTN in older Chinese people. As poor medication adherence is often overlooked in clinical settings (Miller 1997, Hill & Miller 2003), nursing care should be carefully planned to address adherence issues before another line of antihypertensive medication is added. Moreover, it has been reported that many Chinese elders tend to over-report their adherence in order to please healthcare providers. This makes assessment of poor adherence more challenging. We suggest that a culturally-sensitive measurement tool be used in both clinical settings and future research.

As the literature suggests that the number of oral medications prescribed is associated with medication adherence (Hu *et al.* 1996a), it is possible that there is a causal pathway from number of medications to adherence to SBP (i.e.  $\uparrow$ number of medications  $\rightarrow$   $\downarrow$ adherence  $\rightarrow$   $\uparrow$ SBP). However, such a causal pathway was rarely evaluated in previous research; most literature has either examined the association between number of medications and adherence (Hu *et al.* 1996a) or between adherence and BP (Morisky *et al.* 1986). Nevertheless, without this information, it is not possible to determine how much effort should be put into changing medication regimens to improve adherence or BP control vs. redirecting effort to other unclear and understudied aspects, such as the influence of cultural health practices in HTN management. Due to a limited sample size, we were unable to examine this relationship among these three factors. We suggest that in future studies the causal pathway be examined in older Chinese immigrants.

The prediction model of DBP indicated that male gender was statistically significantly associated with higher DBP. There are two potential explanations for this difference. First, changes that occur in the vascular system or activities differ between men and women (Barron *et al.* 2002). Second, men might adhere to their treatment regimen less stringently than women (Chung *et al.* 2006, Li *et al.* 2008b). In this case, it would be interesting for future researchers to look at how gender predicts BP levels according to medication adherence (i.e. interaction between gender and medication adherence on predicting BP).

It is interesting that male gender only predicted higher level of DBP but not SBP. This may be explained by van der Meer *et al.*'s (van der Meer *et al.* 2008) discussion of age-related decline in left ventricular diastolic function (i.e. stiffness of ventricular and vessel walls) with concomitantly better-retained systolic function. Therefore, for clinical nurses, it is important to understand this mechanism in order to be able to give male patients care. For example, as higher DBP may indicate poorer left ventricular diastolic function, a

Poor medication adherence was also a statistically significant predictor for higher SBP. Both number of oral medications and medication adherence accounted for 6–7% of the total variance in SBP. The implication is that both number of

therapeutic intervention may be achieved by giving patients a selective beta-blocking agent (e.g. atenolol) (if there is no contraindicated condition, such as heart failure) to improve relaxation of the heart (which in turn prolongs the diastolic phase of the heart). For nursing interventions, it is important to monitor patients' DBP on a regular basis. It may be questioned why female gender did not also predict higher level of DBP. This may be due to the fact that the hormonal status of women improves metabolism of lipids, which is a statistically significant contributor to decline in left ventricular diastolic function (van der Meer *et al.* 2008). Thus, female gender did not appear to be associated with change of DBP level.

Similar to SBP, the other statistically significant predictor for higher level of DBP was poor medication adherence. However, compared to SBP (7%), the adherence factor accounted for a higher portion of the total variance in DBP (11%). This also suggests that adherence is an important factor in the management of both SBP and DBP.

## Conclusion

As many Chinese elders have uncontrolled SBP or isolated systolic HTN, it is important to examine factors that are associated with higher level of SBP. Our prediction model indicates that there were at least two important predictors of SBP – number of prescribed oral medications and medication adherence. As for medication adherence, as many clinicians have a problem in assessing this factor, especially for elder Chinese immigrants who tend to over-report their medication adherence, a culturally-sensitive measure should be used to obtain the most accurate result. In terms of the clinical implications of our prediction model, this model can help clinical nurses or researchers to identify those at risk for uncontrolled SBP and what interventions may facilitate better SBP control. Although DBP is not the most important risk factor for Chinese elders, it is still important for clinicians to assess patients' DBP carefully, because higher DBP very often accompanies higher SBP, and higher DBP may indicate poorer diastolic function. As male gender and lower adherence were suggested by this study to be statistically significantly associated with higher level of DBP, which were consistent with observations of the first author with many years of clinical experience in Chinese communities, these predictors should be carefully assessed in clinical settings to help design an effective intervention for controlling DBP. In addition, because our study was the first to provide a specific prediction model for SBP and DBP among older Chinese immigrants, we suggested that it be replicated in other Chinese communities to generate more robust and general-

izable results. With further validation, these findings may also be applied to Chinese immigrants residing in other Western countries, such as England and Australia because older Chinese immigrants share similar cultural backgrounds and beliefs across countries. In the future, an international comparison study carried out with older Chinese immigrants across various countries should help to establish an effective HTN management model for this population worldwide.

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## Conflict of interest

No conflict of interest has been declared by the authors.

## Author contributions

WWL was responsible for the study conception and design. WWL performed the data collection. WWL & MIW performed the data analysis. WWL, MIW & ESF were responsible for the drafting of the manuscript. WWL, MIW & ESF made critical revisions to the paper for important intellectual content. WWL provided statistical expertise. WWL, MIW & ESF obtained funding. WWL provided administrative, technical or material support. WWL & MIW supervised the study. WWL provided other contributions.

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