

# Effectiveness of in-office blood pressure measurement by eye care practitioners in early detection and management of hypertension

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## Abstract

• **AIM:** To investigate the number of hypertensive patients, the optometrist is able to identify by routinely taking blood pressure (BP) measurements for patients in "at-risk" groups, and to sample patients' opinions regarding in-office BP measurement. Many of the optometrists in Saudi Arabia practice in optical stores. These stores are wide spread, easily accessible and seldom need appointments. The expanding role of the optometrist as a primary health care provider (PHCP) and the increasing global prevalence of hypertension, highlight the need for an integrated approach towards detecting and monitoring hypertension.

• **METHODS:** Automated BP measurements were made twice (during the same session) at five selected optometry practices using a validated BP monitor (Omron M6) to assess the number of patients with high BP (HBP) – in at-risk groups –visiting the eye clinic routinely. Prior to data collection, practitioners underwent a two-day training workshop by a cardiologist on hypertension and how to obtain accurate BP readings. A protocol for BP measurement was distributed and retained in all participating clinics. The general

attitude towards cardiovascular health of 480 patients aged 37.2 ( $\pm 12.4$ )y and their opinion towards in-office BP measurement was assessed using a self-administered questionnaire.

• **RESULTS:** A response rate of 83.6% was obtained for the survey. Ninety-three of the 443 patients (21.0%) tested for BP in this study had HBP. Of these, (62 subjects) 67.7% were unaware of their HBP status. Thirty of the 105 subjects (28.6%) who had previously been diagnosed with HBP, still had HBP at the time of this study, and only 22 (73.3%) of these patients were on medication. Also, only 25% of the diagnosed hypertensive patients owned a BP monitor.

• **CONCLUSION:** Taking BP measurements in optometry practices, we were able to identify one previously undiagnosed patient with HBP for every 8 adults tested. We also identified 30 of 105 previously diagnosed patients whose BP was poorly controlled, twenty-two of whom were on medication. The patients who participated in this study were positively disposed toward the routine measurement of BP by optometrists.

• **KEYWORDS:** hypertension; blood pressure; optometrist; public health; high blood pressure

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## INTRODUCTION

The diagnosis and management of chronic diseases such as diabetes and hypertension require a multidisciplinary approach to provide optimal patient care [1]. Such a team approach, when utilized in the care of patients with chronic conditions is associated with improved outcomes and greatly reduces the risk of complications [2-4]. Optometry is a primary care profession [5,6] and the optometrists in most developed countries have long been responsible for detecting not only ocular diseases but systemic diseases with ocular manifestations [7-11].

Systemic hypertension does not only seriously affect vision and the visual system, it is also a threat to life and it is the single most common cause of worldwide morbidity and mortality<sup>[9,12-14]</sup>. Systolic blood pressure (BP) and diastolic BP have been shown to be strong predictors of death due to cardiovascular disease (CVD)<sup>[15-19]</sup>. In the USA and northern Europe, CVD accounted for approximately 70 deaths per 10 000 person-years as compared to approximately 20 deaths per 10 000 person-years in Japan and Mediterranean Southern Europe<sup>[16]</sup>. Low- and middle-income countries are disproportionately affected and currently, hypertension deaths in Saudi Arabia account for more than 12% of total deaths (the 4<sup>th</sup> largest percentage in the world)<sup>[20,21]</sup>.

Diagnosis and treatment of systemic hypertension is not always clear cut as the BP level at which management is initiated may differ between patients, and the individual affected may remain asymptomatic for many years<sup>[22]</sup>. To aid management, the Joint National Committee on Prevention, Detection, Evaluation and Treatment of high BP (HBP)<sup>[17]</sup> has classified BP into groups, according to measures of systolic and diastolic BP. Despite these classifications and the availability of effective treatment modalities, blood pressure control rates are not satisfactory globally<sup>[23,24]</sup>. It has been shown that many who know they are hypertensive are not on treatment, and many of those on medication have blood pressures that are not fully controlled<sup>[25,26]</sup>. Therefore, to ensure early detection and treatment of hypertension, some authors<sup>[25-28]</sup> have suggested the need to develop HBP screening and education programs, aimed at improving the knowledge, attitudes, and behaviors of patients and health care practitioners.

The ocular manifestations of systemic hypertension involve the retinal, choroidal and optic nerve head vasculature<sup>[29-32]</sup>. Retinopathy associated with HBP is the second most common retinal vascular disease after diabetic retinopathy<sup>[12]</sup>, while the risk of developing glaucoma (the second leading cause of blindness, and the leading cause of irreversible blindness<sup>[33]</sup>) is thought to increase in the presence of both systemic hypertension and systemic hypotension<sup>[34,35]</sup>. Detection of these ocular changes require ophthalmoscopic examination, but, because cardiovascular compromise and other organ system damage may occur prior to the practitioner picking up these changes, evaluation of hypertension is incomplete without assessing the patients systemic BP<sup>[22]</sup>.

The need for routine BP measurement (for at-risk groups) in optometry clinics has long been identified<sup>[7-10,22,36-38]</sup>. In previous surveys<sup>[10,39]</sup>, optometrists have stated that patients would appreciate in-office measurement of BP, if it eventually became a routine practice, and that such practices would be effective in the identification of patients with HBP. New automated oscillation sphygmomanometers increase the

objectivity and repeatability of BP measurements<sup>[40,41]</sup>. Also BP measurements combined with ophthalmoscopic signs (such as narrowing of arterioles *etc.*) are a much stronger diagnostic sign of hypertensive retinopathy than ophthalmoscopy signs alone<sup>[22]</sup>. Therefore it would make sense to incorporate routine BP measurement (on at-risk groups of patients) into optometry practice. Daubs<sup>[42]</sup> projected that 1/14 undiagnosed hypertensive patients would be discovered if optometrists took up BP assessment routinely.

The purpose of this study was three-fold: 1) to measure BP of adult patients, in selected optometry practices in Riyadh, in order to assess their BP status; 2) to determine the level of knowledge of patients at-risk of (or diagnosed with) hypertensive disease concerning their BP status; 3) to evaluate the patients' opinion concerning in-office BP measurement by the optometrist.

## SUBJECTS AND METHODS

**Subjects** Approval for this study was obtained from the Research Ethics Committee of the College of Applied Medical Sciences, King Saud University and the study was performed in accordance with the Declaration of Helsinki. Informed consent was obtained from all participating patients, prior to enrolment, after the study protocol (and their rights as participating subjects) had been explained to them.

Subjects for the questionnaire study were recruited from adult patients visiting the optometry practices and a subset of the adult subjects who also agreed to participate in the BP study also had their BP assessed. Patients who were on systemic medications other than anti-hypertensive medications were excluded from participation in the actual BP measurement section. Participation of optometry practices was by invitation which was sent out by regular mail to registered optometry practices (popularly known as optical stores) in Riyadh. The optical stores selected were those licensed to conduct eye examinations as many others are allowed to sell optical aids but not licensed to undertake eye examinations. The practices that responded were requested to nominate an optometrist to participate in the training session. Thus, for each practice, only one location and one optometrist was selected and trained respectively, to participate. The study was conducted between August and December 2013.

**Questionnaire Study** The first part of this study adopted a similar protocol as was used by Osuagwu *et al*<sup>[39]</sup> and Hurcomb and Wolffsohn<sup>[10]</sup> with a few modifications to specifically address the purpose of this study. To refine and validate the survey, we conducted a two-stage empirical validation study consisting of a pretest with a panel of domain experts followed by a field test among all eligible prescribers at our institution and by ten randomly selected patients visiting different optometry practices. The

self-administered questionnaire was drafted simultaneously in both English and Arabic languages. The final questionnaire was sent out to patients visiting the participating optometry practices. A technician was responsible for distribution and collection of all completed surveys. The questionnaires were included in the analysis if they were completed by adult patients visiting the optometry practices and excluded if they had participated in the initial validation of this questionnaire.

**Blood Pressure Study Protocol** The second part of this study involved an in-office measurement of BP of patients in selected practices in Riyadh. The nominated optometrists were required to attend a two-day active training workshop by a cardiologist (Ahmed HK) on hypertension and the use, operation, and calibration of the automated oscillatory BP monitor, the Omron M6 Comfort (OMRON Healthcare Co., Ltd., Kyoto, Japan), used in this study. During the training sessions, to ensure accuracy of BP readings, the optometrists had to measure arm sizes of practice subjects to get a gauge of patient's arm sizes in relation to body size. The clinicians were asked to measure the arm size of a patient, during the data collection, if they thought it might exceed 42 cm or be less than 22 cm. The Omron M6 uses a long comfort cuff size designed to fit the arm circumferences (22-42 cm) of most subjects. The Omron M6 was selected for use in this study because, it is one of a few validated automated devices<sup>[43]</sup> and for its comfort cuff. Seven Omron M6 BP monitors were distributed to the participating Optometrists for the purpose of data collection.

The protocol for measuring BP followed that outlined in Parati *et al*<sup>[44]</sup>. First, the optometrist was required to inquire if patients: 1) have been diagnosed with hemi- or paraplegia? If hemiplegia, which side? 2) had exercised or taken in caffeine in any form within the hour preceding the measurement. Following this, in the measurement of BP, the protocol detailed in Table 2 had to be followed to the letter. The rooms in which the BP measurements were to be taken were inspected by one of the members of the research team and the BP protocol was required to be pasted up on the wall as a reminder to the participating optometrist.

**Blood Pressure Measurement Protocol** 1) The subject must sit upright in the measurement position (with his/her feet flat on the ground) in a quiet room for five minutes prior to the measurement, with no talking, movement or leg crossing<sup>[44]</sup>. 2) Always use the left arm for BP measurements, except if the subject has a history of paralysis affecting that arm. 3) Subject's arm must be in horizontal position for measurement and it must be at approximately the same level as the heart. 4) Based on the two earlier training sessions we had, if you are suspicious that the circumference of the subject's arm is either greater than 42 cm or smaller than 22 cm, measure the circumference of the arm with your soft (tailor's) tape and record the arm circumference with the BP

reading. 5) Wrap the cuff around the subject's upper arm, just above the highest visible depression of the antecubital space, with the inflation tube placed inferiorly, approximately in line with the middle finger of the open, upward-facing palm.

6) Take 2 sets of measurements were taken 2-3min apart.

Practitioners were advised to always record the arm used for BP measurement in all cases of hemi- or paraplegia and to exclude (from BP assessment) patients who had carried out strenuous activity or who had consumed tea, coffee and/or caffeinated drinks less than 1h before BP.

All these were done to limit the number of false positive referrals.

BP was measured with strict adherence to the protocol above.

In cases where the average systolic BP reading was  $\geq 140$  mm Hg or the diastolic BP  $\geq 90$  mm Hg, the patient was considered to have HBP<sup>[45,46]</sup> and was issued a referral letter to their respective GPs with: the BP reading; the time of measurement; the device and cuff size used; and the arm that was measured, all included in the referral report.

Based on the two earlier training sessions conducted, the optometrists were also required to measure the circumference of the arm with a soft (tailor's) tape that was supplied to them and record the arm circumference with the BP reading. This procedure was carried out only if the participating optometrist was suspicious that the circumference of the subject's arm was either greater than 42 cm or smaller than 22 cm. In order to limit examiner bias, the optometrist taking the BP measurement was blinded to the survey response of the patient in all cases where such patients took part in both studies.

All BP measurements were obtained between 16:00 p.m. and 22:00 p.m., since a marked surge in BP has been shown to occur in the morning, decreasing through the day to a trough level in the evening<sup>[47]</sup>. All data were transferred at the end of each day to a central collection center by email and stored on a personal computer.

**Statistical Analysis** All responses obtained from the survey were self reported and the results were entered into a Microsoft Excel spreadsheet, overlaid to eliminate data errors and corrected. Analysis was performed using the SPSS statistical software version 16.0 (SPSS Inc., Chicago, USA). The scoring system was performed in a similar manner to that used in a previous study for each numerical grade in the questionnaire<sup>[39]</sup>. Results obtained from the actual BP measurements were analyzed using descriptive statistics and frequency distribution graphs were also drawn.

## RESULTS

Of the eleven optometry practices in Riyadh that indicated their willingness to participate in this study only seven (63.6%) of the nominated optometrists attended the training sessions and were allowed to participate in the data collection for this study.

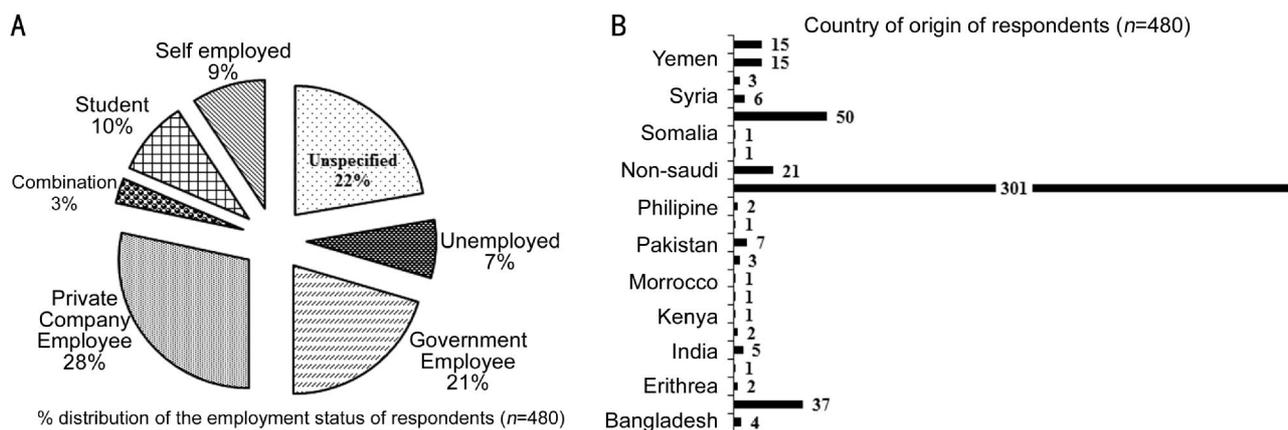


Figure 1 Demography of all patients (n=480) A: Nature of employment; B: Countries of origin.

Table 1 Patient Responses to questions on their opinion towards in-office blood pressure measurement n (%)

Questions asked	Responses obtained from 480 patients			
	Agree	Disagree	Neutral	No response
Appreciated by px	335 (69.8)	14 (2.9)	32 (6.7)	99 (20.6)
Unrelated to vision	185 (38.5)	103 (21.5)	91 (19.0)	101 (21.0)
Advances profession	275 (57.3)	31 (6.5)	71 (14.8)	103 (21.5)
Eliminates hospital time	307 (64.0)	15 (3.1)	54 (11.3)	104 (21.7)
Only on indication	154 (32.1)	122 (25.4)	92 (19.2)	112 (23.3)
For GPs only	122 (25.4)	126 (26.3)	122 (25.4)	110 (22.9)
For optometrist as well	259 (54.0)	28 (5.8)	80 (16.7)	113 (23.5)
Concurrent with change of Rxn	234 (48.8)	50 (10.4)	86 (17.9)	110 (22.9)
Takes extra px chair time	115 (24.0)	151 (31.5)	97 (20.2)	117 (24.4)
Should be performed routinely				
In optometry practice	206 (42.9)	50 (10.4)	115 (24.0)	109 (22.7)
Raises anxiety	103 (21.5)	200 (41.7)	67 (14.0)	110 (22.9)
GPs will frown at it	87 (18.1)	140 (29.2)	147 (30.6)	106 (22.1)

GP: General practitioner; Rxn: Prescription; px: Patient.

### Analysis of Survey Participants (n =480)

**Demographics of participants** Of the 574 eligible participants who visited the optometry practices during the study period, 480 (83.6%) agreed to participate in the survey. They include 411 males (85.6%), 64 females (13.3%) and 5 participants who did not specify their gender (1.0%). The average age ( $\pm$ SD) was 37.2 ( $\pm$ 12.4)y, with an age range between 19 and 90y. The remaining 94 declined because they could not spare their time. A hundred and eighty-nine of the participants were married (39.4%), 63 single (13.1%) and 223 did not specify their marital status (46.5%). The nature of employment and demographic data of the participants are depicted in Figure 1A and 1B, respectively.

**Opinions of patients concerning in-office measurement of BP by the optometrist** The responses of the patients regarding in-office measurement of blood pressure is shown in Table 1. From the table, about one-half of the participants were in favour of in-office BP measurement by the optometrist and 69.8% said such practice will be appreciated even as responses were split on whether it should be left for the GPs only.

### Analysis of responses to questions regarding patients' awareness of their health

Of the 438/480 (91.3%) participants who responded to this section of the survey, 114 (26.0%) stated they had been previously diagnosed with HBP. Of those previously diagnosed with HBP, 105/114 (92.1%) stated when they were diagnosed, with 69/114 (60.5%) having been diagnosed within the previous 2y, 22/114 (19.3%) within the previous 2-5y, 11/114 (9.7%) within the previous 5-10y, 3/114 (2.6%) more than 10y prior, and the rest [9/114 (7.9%)] did not respond.

Four hundred and thirty-eight patients responded to the questions enquiring on their attitude towards vascular health. Sixty-eight percent of these participants stated they had not been previously diagnosed with HBP. Among this group of participants, 13 (4.4%) had been previously diagnosed with low BP and thus were not included in this analysis. A breakdown of the responses is shown in Table 2.

Regarding their last BP check, 236/480 (49.2%) patients responded, among whom: one patient (0.4%) had checked his BP 2d before; 93 patients (39.4%) between 1-3mo earlier; 59 patients (25%) between 3-6mo earlier; 41 patients (17.4%)

**Table 2 Patient responses on their knowledge and attitude towards their vascular health** n (%)

Response on vascular health	Yes	No	Not sure	No response
Previous history of HBP (n=438)	114 (26.0)	298 (68.0)	18 (4.1)	8 (1.8)
On medications (n=438)	61 (13.9)	293 (66.9)	1 (0.2)	83 (18.9)
Forgets to take medications (n=114)	17 (14.9)	38 (33.3)	35 (30.7)	24 (21.1)
Knows the medications (n=114)	37 (32.5)	57 (50)	5 (4.4)	15 (13.2)
On more than one medication (n=114)	15 (13.2)	80 (70.2)	4 (3.5)	15 (13.2)
Owens a BP monitor (n=438)	43 (9.8)	328 (74.9)	0 (0)	67 (15.3)
Remembers last BP reading (n=438)	98 (22.4)	225 (59.4)	40 (9.1)	75 (17.1)

HBP: High blood pressure; BP: Blood pressure.

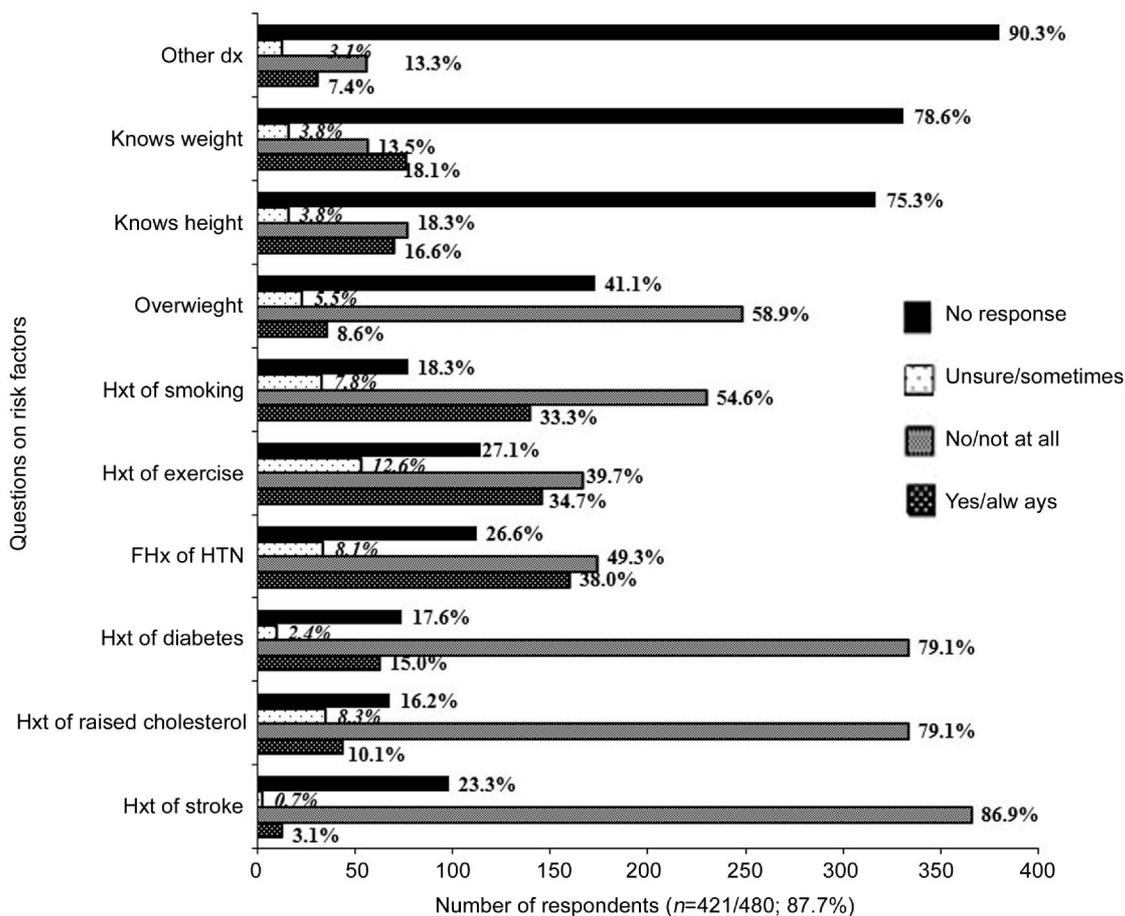


Figure 2 Percentage distribution of risk factors reported by survey patients.

between 6mo-1y earlier; 41 patients (17.4%) between 1-2y earlier; and one patient (0.4%) between 5-10y earlier.

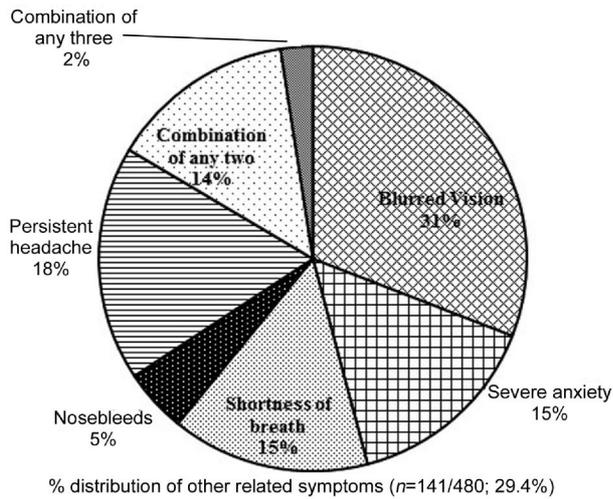
**Analysis of responses obtained regarding related risk factors** Four hundred and twenty-one responses were obtained (421/480; 87.7%), and a breakdown of the responses is depicted in Figure 2. About one-third of the participants reported a family history of hypertension and 15.0% had a history of diabetes.

Regarding related symptoms, a hundred and forty-one of 480 participants (29.4%) responded and thus were analyzed (Figure 3). Blurred vision was the predominant symptom followed by persistent headache while nosebleeds was the least experienced symptom.

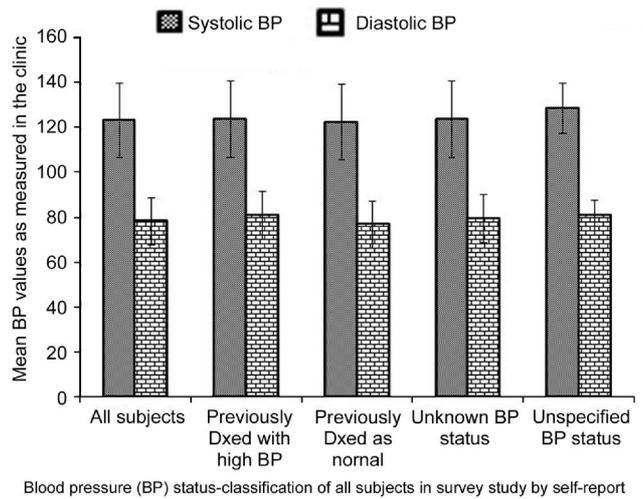
**Analysis Involving Only the Participants of Blood Pressure Measurement Study (n=443)**

**Study population** For the second part of this study, of the 480 participants in the survey, 460 (95.8%) also agreed to have their BPs measured for the second part of the study. Of this subset of participants, BP measurements obtained from only 443 patients (96.3%) were analyzed. The patient sample included 384 men (86.7%) and 59 women (13.3%), with a mean age (SD) of 37.3 (12.5)y (range, 19-90y). Of the other 17 patients (3.8%), five (29.4%) declined to have their BP readings taken after having initially consented. The other 12 (70.6%) had consumed caffeinated beverages or had carried out strenuous activity less than one hour prior to when the BP measurements were to have been made.

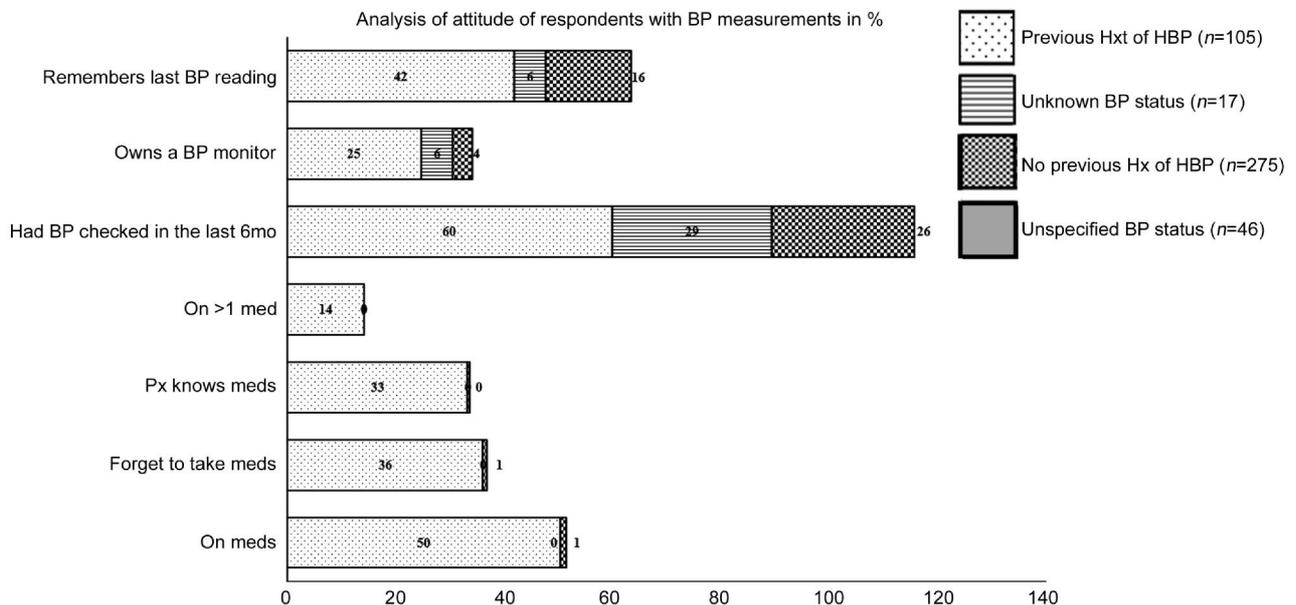
Analysis was performed by categorizing the participants into their self-reported BP status: previously diagnosed with HBP (n=105); previous diagnosed as normal (n=275); unknown



**Figure 3** Percentage distribution of other related symptoms reported by survey patients.



**Figure 4** Mean values and standard deviation of blood pressure measurements (mm Hg).



**Figure 5** The proportion of newly diagnosed high blood pressure patients and analysis of the patient attitude towards their cardiovascular health in percentages.

BP status ( $n=17$ ); and unspecified BP status ( $n=46$ ). The mean and standard deviation of the systolic and diastolic BP measurements for the four patient categories are shown in Figure 4. From the figure it can be deduced that for the 443 participants, the measured systolic and diastolic BP, respectively, ranged from, 84-192 mm Hg and 47-114 mm Hg. **Analysis of survey responses of blood pressure measurement participants ( $n=443$ )** The analyses of responses obtained from this sub-group (all aforementioned groups except the "unspecified BP status" group) of patients (on their attitude towards their cardiovascular health, and the number of patients from each group who had HBP at the time of this study) are depicted in Figure 5. None of the subjects with unspecified BP status responded to these questions. Further analysis revealed the following: of the previously diagnosed HBP patients, thirty out of 105 patients (28.6%) were positive for HBP. Of these 30 patients, twenty-two

(73.3%) were on medications, and eight (26.7%) were not, at the time of this study. Of those on medications, ten out of 22 (45.5%) were taking more than one medication. Concerning the remaining patients who showed normal BP readings at the time of this study, 44% (33/75) were on medications, 15.2% (5/33) of whom were on more than one medication. Fifteen of the 33 patients (45.5%) forgot to take their medications at least some of the time. Of the patients unsure of their BP status, four out of 17 (23.5%) showed HBP readings and none was on hypertensive medication at the time of study. Of the patients previously diagnosed as normal, fifty-one of 275 (18.5%) showed HBP readings, and only one patient (1/51; 2.0%) was on medication at the time of study. Of the unspecified BP status patients, eight out of 46 (17.4%) showed HBP readings and none of them responded to the questions on cardiovascular health.

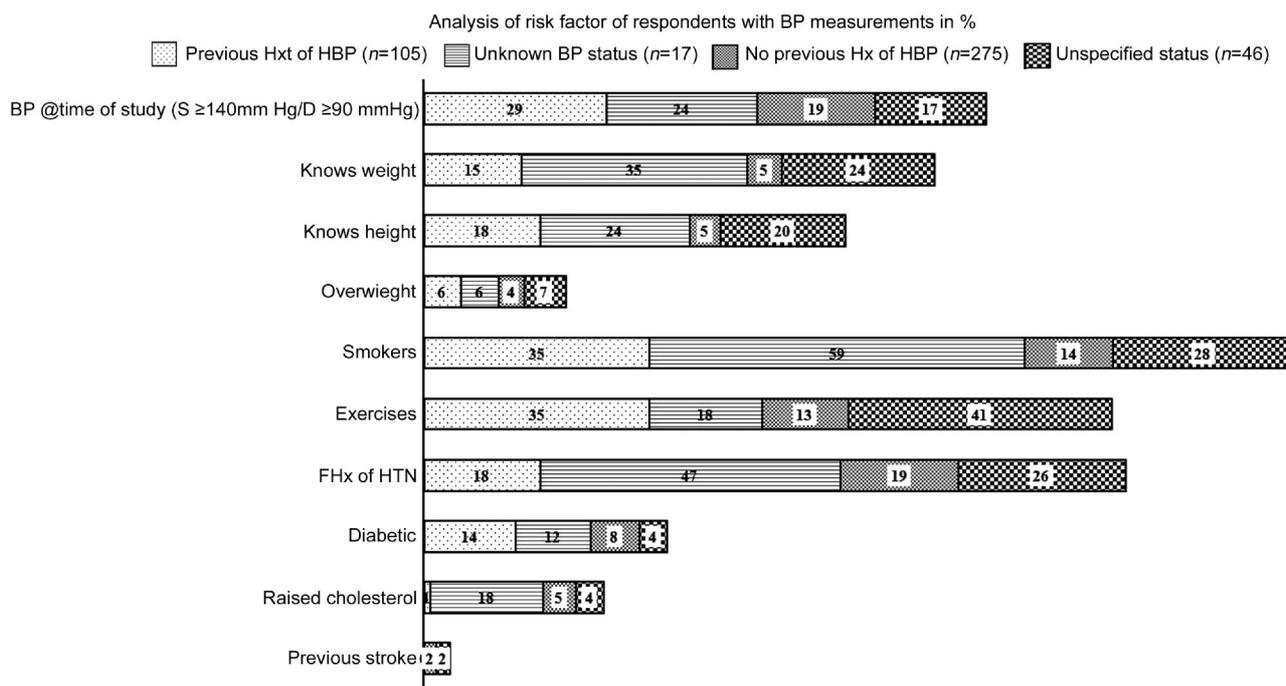


Figure 6 Percentage distribution of the risk factors reported by patients whose blood pressures were measured.

Overall, 93 of the 443 patients (21.0%) tested for BP in this study had HBP. At the time of this study 67.7% of 93 patients (or 14.2% of 443 patients whose BPs were measured in this study) were unaware of their HBP status. All participants who returned HBP measurements were referred to their respective physicians. The referral forms contained: the readings obtained; the arm measured; the device used; the cuff size; and the time of measurement.

**Analysis of related risk factors for blood pressure measurement participants only** The responses of patients concerning related risk factors are depicted in Figure 6. It shows that at the time of this study, a significant proportion of the previously diagnosed HBP (29%) and those who did not know their BP status (24%) actually had HBP.

**DISCUSSION**

This pilot study investigated how many HBP patients the optometrist would be able to identify if in-office BP measurement is incorporated into optometry practice. Unlike in the United States and some developed countries [10,22], measurement of BP is not currently part of the routine optometric examination in Saudi Arabia. This is because many of the ECPs in Saudi Arabia practice in optical stores which mainly sale optical aids with some that are also licensed to conduct eye examinations. Thus, this study was necessary mainly due to the rising prevalence of hypertension in the region [19-21,25,27]. Results from an earlier study showed that optometrists in the region were willing to make BP measurement a routine practice but needed more training in order to effectively and confidently do so [39]. Private optometry practices were chosen because in comparison to hospitals in the region, they are spread far and wide, much

more accessible and seldom require a pre-booked appointment.

**Sample, Location and Demography for All Participants**

The response rate obtained in the survey study was higher than that of previous studies [8,10,22,36,39], and even much higher in the BP study because we wanted to get as many of questionnaire fillers to have their BP taken, so we distributed the questionnaires only in the participating clinics at the time of exam. There was a preponderance of male subjects which is unsurprising as Saudi Arabia is a conservative, paternalistic country.

**Opinions of Patients on In-office Blood Pressure Measurement in Optometry Practices**

The patients were positively disposed toward optometrists taking BP measurements during routine eye checks, when necessary. This finding is consistent with those of a previous study [39]. That the patients also viewed such practice as not time consuming is understandable considering the ease with which patients could get their BP assessed if such practice is adopted routinely in optometry practices. This situation is in contradistinction to that in hospitals where patients in need of such simple checks spend so much time and are often moved from one station to the other due to the size of these facilities, and the multiservice functionality of hospitals [6].

**Attitude of Patients Concerning Their Blood Pressure Status**

This study showed that the vast majority of the patients (94.1%) visiting optometry practices in Saudi Arabia are aware of their BP status. A small number of participants (4.2%) had never been screened for hypertension and as such, were unaware of their BP status at the time of this study (Table 2). About one-half of the previously diagnosed HBP

patients were not on any medication despite 60.5% of them having been diagnosed as recently as 2y ago. Of the other half on medication, almost all were not compliant with their drug administration instructions. In addition, many (32.5%) of those previously diagnosed HBP did not know the antihypertensive medications they were taking. Notably, many of the participants shied away from questions inquiring of their awareness towards the medications they were using and if they forgot to take them. These findings are consistent with those of previous studies showing that most adults were aware of their hypertension status<sup>[48]</sup>, but that many hypertensive individuals do not care as much as they should about regulating their BPs despite being diagnosed with HBP<sup>[27,28,49]</sup>.

Another finding of this study was that, only 10% of patients owned a BP monitor (Table 2) despite the large number of participants (39.8%) in the BP measurement study being within the age bracket (40y and above) shown to exhibit a higher prevalence of hypertension in comparison to other age groups<sup>[48]</sup>. Interestingly, many of the previously diagnosed HBP patients did not have a BP monitor (Figure 5), neither did ninety-percent of the newly diagnosed HBP patients. The National Institute for Health and Care Excellence (NICE) guideline for hypertension management recommends patients to become more involved in the monitoring their hypertension by home BP monitoring (HBPM)<sup>[45]</sup>.

**Blood Pressure Measurement Study Findings** Comparing the responses of the patients concerning their BP status to the current BP measurement obtained during this study, it was observed that one in three patients (30/105; 28.6%) who stated they had been diagnosed with HBP actually had HBP (systolic  $\geq 140$  mm Hg and/or diastolic  $\geq 90$  mm Hg), at the time of this study.

Also, one in four participants (4/17; 23.5%) who stated that they were not sure of their BP status, one in five (51/275; 18.5%) who stated that they had not been diagnosed with HBP, and one in six (8/46; 17.4%) patients who did not specify their BP status, showed HBP readings (Figure 4). Adding together those subjects with HBP, measured in this study, who were not sure of their prior BP status and those who said they had been given the all-clear at an earlier examination (but excluding those subjects who had HBP but did not specify their initial BP status) there were 55 out of 443 subjects whose BP readings were high (even on a second BP measurement) but who were unaware of their BP status. That translates to one in eight subjects (12.4%).

With regard to the group of subjects who had previously been diagnosed with HBP ( $n=105$ ), thirty also had HBP in this study, some of whom (73.3%) were on medication (45.5% were on more than one medication). In contrast, of the other 75 subjects, 44% were on medication while only 6.7% were on more than one medication. These numbers suggest that the

hypertension in the group of 30 subjects was more difficult to bring under control and a case may be made for placing hypertensive patients on multiple drug therapy in a higher risk category, whose BP should be monitored as frequently as possible.

This is consistent with the recommendation made by Daubs<sup>[42]</sup> that optometrists could detect one undiagnosed hypertensive patient for every 14 adults tested if BP were measured routinely. With the reported global increase in the prevalence of hypertension<sup>[50-53]</sup>, and in line with previous reports on poor management of hypertension<sup>[54]</sup>, it is not surprising that we found one undiagnosed hypertensive patient for every 8 adults tested. Although children were excluded in this study, screening them for HBP in eye clinics was shown to be beneficial in early detection of HBP<sup>[8,54-56]</sup>.

The findings from this study support the potential role of the optometrist to contribute effectively to identification of the hypertensive patient. One advantage that may be specific to Saudi Arabia is that most optometry practices in the Kingdom place no charge for an eye examination. This makes them more accessible and adds to the advantage of being more geographically dispersed than hospitals, clinics, or GPs practices. This potentially expanded role for the optometrist could indeed significantly impact the detection of hypertension. If we also consider the people on single or multiple drug therapy whose BPs were still not under control and who might also be detected by such screening measures, the optometrist's potentially expanded role would be even more significant.

As a common draw back in survey studies, we could not expand the questions beyond the ones already asked. This was done to ensure high compliance. For example, we could have inquired about low BP, asked participants to specify which anti-hypertensive medications they were taking as well as dosage and duration of treatment. Even with the current length of the survey, many participants found it difficult to respond to many of the questions asked. Another drawback of this study was the lack of follow up. Repeat measurements on another day would have been important especially for those patients with initially high readings, but for the purpose of the study we preferred to refer such patients to GPs for proper recommendations and advice. We could not confirm how many of the referred participants actually were diagnosed with hypertension after visiting their GPs, or how many participants actually heeded our referral advice. The responses from the survey were also self-reported. Future studies should follow up these patients and also assess the burden such referrals would place on the work load of the GPs.

In conclusion, in-office BP measurement in optometry practice was able to detect one in 8 subjects (12.4%) with HBP who were previously unaware. Of those patients who

were aware of having HBP, BP was not always effectively controlled as 28.6% of these patients still showed HBP readings despite the fact that a majority of them (73%) were on medications. Also, only 25% of the previously diagnosed hypertensive patients owned a BP monitor. In general, most patients showed a positive attitude toward the routine measurement of BP in optometry practices.

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