Changing Relationship Among Office, Ambulatory, and Home Blood Pressure With Increasing Age
A Neglected Issue

George S. Stergiou, Angeliki Ntineri, Anastasios Kollias

In this issue, Conen et al reported data showing changing relationship between office blood pressure (OBP) and awake ambulatory BP (aABP) with increasing age. This observation is not new, but it is largely neglected and ignored and has major clinical implications.

OBP is known to increase with aging, leading to increasing hypertension prevalence. This applies to BP measurements in and out of the office (Figure). The problems start here because, as Conen et al confirmed, the range of BP rise with age is much higher (about double) for OBP than aABP. As a result, a practical problem emerges because the relationship between OBP and aABP is not the same across all the age groups.

There is convincing evidence that in children and adolescents the relationship among OBP, aABP, and home BP (HBP) is not the same as in the adults. A comparison of normalcy tables currently recommended for defining hypertension in children and adolescents showed that the corresponding percentiles are consistently lower for HBP than for aABP. Moreover, there is a trend for OBP to be lower than HBP and aABP in younger children, yet this difference is progressively eliminated with increasing age. The findings in regard to aABP might be attributed to high level of physical activity of the young individuals during the day (increases aABP), whereas the findings for HBP might be because of inability of the young children to remain still during repeated HBP measurements (increases HBP) (Table). The latter observation is not new, but it is largely neglected and ignored and has major clinical implications.

As long as it is known that in young subjects the relationship among OBP, aABP, and HBP is not the same as in the adults, the obvious question is at which age this relationship changes (probably a progressive change) and which factors interfere (Figure).

In 2011, Ishikawa et al published a meta-analysis of 34 studies (n=16148) investigating the relationship between office and out of office BP with increasing age (Figure). This analysis included untreated normotensives or hypertensives aged from 10 to >90 years with OBP and either aABP or HBP measurements. The conclusion was that systolic OBP increases with age more steeply than aABP and becomes higher than aABP after the age of 50 years. HBP was lower than OBP at all ages and also lower than aABP in younger subjects becoming similar in older ones.

In 2010, we reported data from 696 subjects aged 5 to 78 years, all of whom had OBP, aABP, and HBP measurements using the same protocol. The main conclusion was that (1) in children and adolescents aABP is higher than HBP and OBP and (2) in older subjects the aABP–HBP difference is eliminated and the aABP–OBP difference is progressively inverted. We recently expanded this data set and performed an updated analysis in 642 untreated subjects aged 5 to 78 years (unpublished data) and confirmed that (1) the crossing age point where aABP becomes higher than OBP is at 21 years and (2) HBP is lower than aABP in children, adolescents, and young adults up to the age of 40 years, and then tends to have similar values up to 60 years, and later on might be higher than aABP (Figure).

The key finding presented by Conen et al is that OBP is lower than aABP up to the age of 50 years, and this relation is reversed in older subjects (Figure). This change in the OBP-aABP relationship resulted in low prevalence of white-coat hypertension and high of masked hypertension in young people, and the reverse in old ones. Strengths of this analysis are that (1) it is based on random population studies, (2) included a large sample (n=9550), and (3) all were untreated for hypertension. Limitations are that (1) an incomplete picture of the age spectrum is provided because children and adolescents were not included, (2) there are no HBP data, (3) OBP was based on 2 readings on a single occasion, which is too little information for a measure known to be unstable and poorly reproducible, (4) OBP was obtained at the person’s home or at an examination center, whereas the diagnostic HBP threshold is not the same as for OBP; and (5) these findings are based on untreated population samples and may differ in subjects with elevated BP or treated for hypertension.

Common in the 3 studies comparing OBP with aABP is the age point of change after which their relationship is reversed with higher OBP than aABP. This is at 50 years in the data by Conen et al and Ishikawa et al compared with 21 years in...
Diagnostic disagreement is inevitable when using >1 BP measurement methods in clinical practice and getting around this problem is a challenge. Moreover, in the individual patient the OBP–aABP relationship is unpredictable. OBP is based on 2 to 3 measurements taken in an artificial setting, whereas aABP is based on 30 to 50 readings taken in the individual’s usual environment and activities. Therefore, it is not a surprise that ABP is a much stronger predictor of cardiovascular risk than OBP, and in case of diagnostic disagreement between them (white-coat or masked hypertension), the risk is dictated by ABP. For these reasons a straightforward approach would be to retain OBP for wide scale screening, but when ABP is available to base decisions exclusively on this method and ignore OBP. As for the diagnostic ABP threshold, indeed this has been derived from outcome studies in adults aged >50 years. In young people such studies are not feasible and distributional criteria have been used to define ABP thresholds in children and adolescents. Defining ABP normalcy through its relationship with preclinical organ damage (left ventricular mass) is a sensible approach for young subjects that needs to be addressed in future studies.

Disclosures

None.

References

Changing Relationship Among Office, Ambulatory, and Home Blood Pressure With Increasing Age  
A Neglected Issue  

George S. Stergiou, Angeliki Ntineri, Anastasios Kollias

The opinions expressed in this editorial are not necessarily those of the editors or of the American Heart Association.

From the Hypertension Center, Third University Department of Medicine, Sotiria Hospital, Athens, Greece.

Correspondence to George Stergiou, Hypertension Center, Third University Department of Medicine, Sotiria Hospital, 152 Mesogion Ave, Athens 11527, Greece. E-mail: g.stergi@med.uoa.gr (Hypertension. 2014;64:931-932.)
© 2014 American Heart Association, Inc.

Hypertension is available at http://hyper.ahajournals.org

DOI: 10.1161/HYPERTENSIONAHA.114.04076
Hypertension  December 2014

that ABP is a much stronger predictor of cardiovascular risk usual environment and activities. Therefore, it is not a surprise aABP is based on 30 to 50 readings taken in the individual's

on 2 to 3 measurements taken in an artificial setting, whereas

this problem is a challenge. Moreover, in the individual patient measurement methods in clinical practice and getting around

the white-coat phenomenon. In other

words, the greater increase in OBP than aABP with aging is

increased prevalence of the white-coat phenomenon. In other

the OBP–aABP relationship, because it is accompanied by

prevalence (elevated aABP), which was almost double across

be largely driven and explained by differences in hypertension

pressure. Constructed from data reported by Conen et al,1 Ishikawa et al,2 and Stergiou et al.3

Thus, >1 BP measurement methods in clinical practice and getting around

the white-coat phenomenon.

3. Stergiou GS, Rarra VC, Yiannes NG. Prevalence and predictors of

masked hypertension detected by home blood pressure monitoring in

children and adolescents: the Arsakeion School study. Am J Hypertens


4. Evangelou I, Roussias L. Changing relationship between clinic, home

and ambulatory blood pressure with increasing age. J Hypertens

2011;29(suppl 1):175.

5. Stergiou GS, Karpettas N, Panagiotakos DB, Vazeou A. Comparison of

office, ambulatory and home blood pressure with increasing age in children: the

Arsakeion School study. Am J Hypertens

2011;24:218–223.


7. Stergiou GS, Rarra VC, Yiannes NG. Prevalence and predictors of

masked hypertension detected by home blood pressure monitoring in children and adolescents: the Arsakeion School study. Am J Hypertens


Working Group on Blood Pressure Monitoring. European Society of


9. Stergiou GS, Parati G. Home blood pressure monitoring may make office


### Table 1: Changes in young and old subjects using different methods for measuring blood pressure

<table>
<thead>
<tr>
<th>Age</th>
<th>Impact Factors</th>
<th>Effect</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>Physical activity; work pressure ↑</td>
<td>Office BP ↑</td>
<td>Secondary prevention of hypertension</td>
</tr>
<tr>
<td>Senior</td>
<td>Physical activity; retirement ↓</td>
<td>Office BP ↓</td>
<td>Primary prevention of hypertension</td>
</tr>
</tbody>
</table>

**Figure.** Relationship between age and blood pressure

**Table.** Factors affecting blood pressure measured by different methods. Dotted horizontal line indicates

### Notes


