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Normal Values of Blood Pressure Self-Measurement in View of the 1999 World Health Organization-International Society of Hypertension Guidelines

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New guidelines for the management of hypertension have been published in 1999 by the World Health Organization (WHO) and the International Society of Hypertension (ISH). The WHO/ISH Committee has adopted in principle the definition and classification of hypertension provided by the JNC VI (1997). The new classification defines a blood pressure of 120/80 mm Hg as optimal and of 130/85 mm Hg as the limit between normal and high-normal blood pressure. It is unclear which self-measured home blood pressure values correspond to these office blood pressure limits.

In this study we reevaluated data from our Dübendorf study to determine self-measured blood pressure values corresponding to optimal and normal office blood pressure using the percentiles of the (office and home) blood pressure distributions of 503 individuals (age, 20 to 90 years; mean age, 46.5 years; 265 men, 238 women). Self-measured blood pressure values corresponding to office values of 130/85 mm Hg and 120/80 mm Hg were 124.1/79.9 mm Hg and 114.3/75.1 mm Hg. Thus, we propose 125/80 mm Hg as a home blood pressure corresponding to an office blood pressure of 130/85 mm Hg (WHO 1999: normal) and 115/75 mm Hg corresponding to 120/80 mm Hg (optimal). Am J Hypertens 2000;13:940–943 © 2000 American Journal of Hypertension, Ltd.

KEY WORDS: **World Health Organization, International Society of Hypertension, guidelines, self-measured blood pressure.**

Self-measurement provides valuable information on the long-term control of blood pressure[1–3] and increases the reproducibility and precision of blood pressure measurement.[4] However, definitions for high blood pressure are generally based on casual, office blood pressure values. Until recently, most of the epidemiologic and pharmacologic studies have used only casual blood pressure measurement. Various influences that limit the accuracy and validity of casual (office) blood pressure measurement are well documented.[5] One of the problems of blood pressure self-measurement is that there is no universally agreed-upon upper limit of normal self-measured home blood pressure. Several studies have adressed this problem in the past. In the population-based Dübendorf study[6] we have proposed 133/86 mm Hg as the upper limit of normal self-measured blood pressure, corresponding to the 140/90 mm Hg cutoff limit for casual blood pressure using

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percentiles of the distributions of self-measured and casual blood pressure. Other groups have obtained similar data to our original Dübendorf study concerning the normal values of self-measurement, indicating that using percentiles for determination of normative values might be an appropriate method.[7] We agree with the statement in the JNC VI 1997 publication that self-measured blood pressure "values of 135/85 mm Hg or greater should be considered elevated," provided that 140/90 mm Hg is the definition of hypertension using office blood pressure.[8] Therefore, most of the international societies of hypertension have until now used 135/85 mm Hg as the upper limit of normal for self-measured blood pressure.

In the contrast, the 1999 WHO/ISH guidelines propose 125/80 mm Hg as home blood pressure corresponding to an office blood pressure of 140/90 mm Hg.[9] We disagree with this proposal, which is in contrast with our original Dübendorf data and with the JNC VI recommendations. The difference might be explained by the fact that this proposal is based on a single study using only two measurements on the same day an ambulatory blood pressure recording was performed.[10] We believe that only the average of home blood pressures obtained in the morning and in the evening for at least 7 days (better would be 14 days) might serve as a reference value.

In the 1999 World Health Organization/International Society of Hypertension Guidelines, an office blood pressure less than 130/85 mm Hg is defined as normal (130 to 139/85 to 89 mm Hg = "high normal") and a blood pressure less than 120/80 mm Hg is defined as optimal with respect to cardiovascular risk.[9] It is unclear how these newly defined office limits can be compared to self-measured blood pressure values.

MATERIALS AND METHODS

In this analysis, we have attempted to determine the self-measured blood pressure values corresponding to these cutoff points of office blood pressure by using percentiles of the distributions of self-measured and casual blood pressure from our Dübendorf database. In the Dübendorf study, 503 individuals were studied (age, 20 to 90 years; mean age, 46.5 years; 265 men, 238 women). The subjects were not preselected according to their blood pressure levels. Only patients taking antihypertensive drugs were excluded.

Office blood pressure was measured twice in the sitting position after a rest of at least 5 min before and after a 2-week period of home blood pressure measurement. The patients were instructed on the technique of blood pressure self-measurement during the first visit. Oscillometric semiautomatic devices (OM 1, Boehringer Mannheim, Switzerland) were used both for office and home blood pressure determination. The subjects were instructed to measure blood pressure at home once in the morning and once in the evening over a period of 14 days. They were instructed to write down the measurements and to report them during their second office visit (a mean of 26.7 measurements was obtained). The means of the first and second visit (two measurements per visit) were compared with the means of self-measured home blood pressure by paired two sided t test and values are given as means ± standard deviation.

TABLE 1. PERCENTILES OF THE DISTRIBUTION OF OFFICE BLOOD PRESSURE AT 120/80 MM HG, 130/85 MM HG, AND 140/90 MM HG AND THE CORRESPONDING SELF-MEASURED BLOOD PRESSURE VALUES

	Office Blood Pressure (mm Hg)	Percentile	Self-Measured Blood Pressure (mm Hg)
Systolic	140	76.3	132.6
	130	57.7	124.1
	120	34.8	114.3
Diastolic	90	78.4	85.8
	85	67.0	79.9
	80	50.1	75.1

RESULTS

Mean office blood pressure (130.0 ± 16.5/82.1 ± 11.1 mm Hg) was significantly ($P < .01$) higher than mean self-measured blood pressure (123.1 ± 14.6/77.6 ± 10.7 mm Hg). There was no significant difference between the first and second visit. Mean office blood pressure was 129.8 ± 17.6/82.5 ± 12.2 mm Hg (first visit) and 130.2 ± 18.0/81.7 ± 11.9 mm Hg (second visit). However, the correlation coefficients between the values were lower than those for the comparison between morning and evening self-measured blood pressures. This difference indicates that there was less variation in self-measured blood pressure compared with office blood pressure.

The percentiles of an office blood pressure of 130/85 mm Hg and 120/80 mm Hg were determined and the self-measured blood pressure values at these percentiles were calculated. The results are shown in Table 1 and are compared with our original results (office values, 140/90 mm Hg).

Thus, the corresponding self-measured blood pressure to the recently defined upper limit of normality (130/85 mm Hg) was 124.1/79.9 mm Hg and optimal office blood pressure corresponds to a home blood pressure of 114.3/75.1 mm Hg.

DISCUSSION

The objective of identifying normal values is to define blood pressure values associated with an increased cardiovascular morbidity and mortality. The predictive value of blood pressure self-measurement seems to be superior to office blood pressure.[11]

In the present study, the self-measured blood pressure values were written down by the subjects. We have recently shown an observer bias in the individual patient reporting self-measured blood pressure values.[12] This bias can be reduced by using devices such as the Omron IC to record all measurements; it was not available at the time of the present study. However, we have also demonstrated that observer bias did not substantially affect group comparisons,[12] and we are confident that we have obtained valid data in the present study.

During the last decades, large and prospective studies in untreated subjects have contributed to the definition of normal office blood pressure values by showing that blood pressure values greater than 140/90 mm Hg are associated with increased cardiovascular morbidity and mortality. It will be very difficult to conduct such large studies investigating the prognostic significance of self-measured blood pressure in untreated subjects.

A more acceptable method is to determine the percentile of the distribution of office blood pressures at 140/90 mm Hg. The corresponding blood pressure level at the same percentile of the distribution of self-measured values might serve as a reference value for an upper limit of normality. Other methods have been used for the determination of normal home blood pressure values. Mean blood pressure ± one or two standard variations or the 95th percentile in normotensive subjects have been proposed as upper limits, although these values are arbitrary cutoff points. In addition, regression analysis has produced values similar to the results of the so-called "percentile-correspondence" method used in this analysis. We think that every method can be criticized for some reason, but our original data from Dübendorf are in very good accordance with reference values for home blood pressure based on the only prognostic study available.[11]

For the definition of normal values it is not sufficient to introduce the mean differences between self- and office measurement as a correcting factor, as the office-home difference increases with higher levels of blood pressure.[13] In addition to the comparison of office and home blood pressure, another important conclusion might be drawn from the data shown in Table 1. At an office blood pressure of 140/90 mm Hg, the percentiles for systolic and diastolic pressures are very similar (76.3% and 78.4%). However, using the lower blood pressure levels of 130/85 and 120/80 mm Hg the percentiles for the systolic blood pressure decrease more than those obtained for diastolic blood pressure. The optimal blood pressure corresponds to percentiles of 34.8% (distribution of systolic blood pressure) and 50.1% (distribution of diastolic blood pressure). Thus, the new cutoff values might be more ambitious with respect to the systolic blood pressure as compared to diastolic blood pressure.

In conclusion, if an upper limit of 130/85 mm Hg for the normal office blood pressure is accepted, as suggested by the guidelines of the WHO and ISH (1999), we propose, for practical reasons, 125/80 mm Hg as the corresponding self-measured blood pressure.

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