Table 1: Participant characteristics overall and stratified by study.

|  | | **Study** | |
| --- | --- | --- | --- |
| **Characteristic\*** | **Overall (N = 1079)** | **CARDIA (N = 458)** | **JHS (N = 621)** |
| Age, years | 57.1 (8.57) | 54.7 (3.70) | 58.8 (10.5) |
| Male, % | 32.0 | 37.8 | 27.7 |
| Black, % | 81.0 | 55.2 | 100 |
| Education, % |  |  |  |
| College graduate | 62.3 | 61.1 | 63.2 |
| High School graduate/GED | 10.5 | 0.00 | 18.2 |
| Less than High School | 27.2 | 38.9 | 18.5 |
| Current smoker, %† | 10.8 | 12.9 | 9.25 |
| Diabetes, %‡ | 22.3 | 17.7 | 25.6 |
| Albuminuria, % | 8.06 | 6.99 | 9.09 |
| Left ventricular mass indexed to BSA, g/m2 | 77.5 (21.1) | 78.8 (20.2) | 76.7 (21.7) |
| Left ventricular hypertrophy, % | 9.78 | 8.59 | 10.6 |
| Sleep duration, hours | 8.00 (1.47) | 7.62 (1.43) | 8.29 (1.44) |
| Nocturnal hypertension, %§ | 46.9 | 36.7 | 54.4 |
| Antihypertensive medication use, % | 53.3 | 43.5 | 60.6 |
| Blood pressure, mm Hg | | | |
| Asleep systolic | 116 (15.6) | 111 (15.1) | 120 (14.7) |
| Asleep diastolic | 67.2 (8.95) | 66.3 (8.59) | 67.8 (9.16) |
| Clinic systolic | 124 (16.2) | 119 (15.1) | 128 (16.0) |
| Clinic diastolic | 73.8 (9.25) | 72.9 (9.86) | 74.5 (8.71) |
| \*Table values are mean (standard deviation) and percent for continuous and categorical variables, respectively. | | | |
| †Smoking status was defined as self-reporting cigarette use within the past year. | | | |
| ‡Diabetes was defined as fasting (8+ hours) glucose of at least 126 mg/dL or current use of anti-diabetes medication. | | | |
| §Nocturnal hypertension was defined as asleep systolic/diastolic blood pressure ≥120/70 mm Hg. | | | |
|  | | | |
| Missing counts (%): albuminuria: 148 (14%); left ventricular mass and hypertrophy: 57 (5.3%); antihypertensive medication use: 8 (0.74%); Smoking status: 6 (0.56%); diabetes: 2 (0.19%); education: 1 (0.09%) | | | |
| BSA = body surface area; CARDIA = Coronary Artery Risk Development in Young Adults; GED = General Educational Development; JHS = Jackson Heart Study | | | |

Table 2: summary of 12 blood pressure sampling variations that obtained the highest overall chance-corrected agreement (i.e., Kappa statistic) with ambulatory blood pressure monitoring throughout sleep.

| **BP sampling variations\*** | **CARDIA** | | | **JHS** | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Kappa statistic†** | **Mean absolute error** | | **Kappa statistic†** | **Mean absolute error** | |
| **Systolic BP** | **Diastolic BP** | **Systolic BP** | **Diastolic BP** |
| *2 concentrated BP measurements* | | | | | | |
| starting at 4 hours after midnight | 0.72 (0.65, 0.79) | 5.47 (5.05, 5.86) | 4.65 (4.33, 4.99) | 0.71 (0.65, 0.76) | 5.19 (4.89, 5.54) | 4.48 (4.19, 4.76) |
| starting at 2 hours after falling asleep | 0.72 (0.65, 0.79) | 5.42 (5.00, 5.93) | 4.44 (4.10, 4.81) | 0.72 (0.66, 0.77) | 5.58 (5.25, 5.92) | 4.59 (4.31, 4.89) |
| *2 distributed BP measurements* | | | | | | |
| at 1 and 3 hours after midnight | 0.78 (0.72, 0.84) | 4.72 (4.35, 5.06) | 3.74 (3.45, 4.10) | 0.70 (0.65, 0.76) | 4.97 (4.69, 5.29) | 4.10 (3.84, 4.36) |
| at 1 and 5 hours after falling asleep | 0.79 (0.73, 0.85) | 4.53 (4.20, 4.91) | 3.56 (3.28, 3.86) | 0.75 (0.69, 0.80) | 4.76 (4.50, 5.04) | 3.98 (3.75, 4.22) |
| *3 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.75 (0.68, 0.81) | 4.77 (4.39, 5.16) | 3.96 (3.65, 4.28) | 0.72 (0.66, 0.77) | 4.95 (4.61, 5.28) | 4.15 (3.89, 4.45) |
| starting at 1 hours after falling asleep | 0.77 (0.71, 0.83) | 4.78 (4.42, 5.14) | 3.87 (3.60, 4.17) | 0.73 (0.68, 0.78) | 5.65 (5.27, 5.99) | 4.55 (4.27, 4.86) |
| *3 distributed BP measurements* | | | | | | |
| at 1, 3 and 5 hours after midnight | 0.81 (0.76, 0.87) | 3.54 (3.28, 3.82) | 2.81 (2.58, 3.05) | 0.76 (0.71, 0.81) | 3.72 (3.51, 3.95) | 3.00 (2.80, 3.20) |
| at 1, 2 and 4 hours after falling asleep | 0.83 (0.78, 0.89) | 4.00 (3.75, 4.30) | 3.07 (2.86, 3.31) | 0.80 (0.75, 0.84) | 4.01 (3.77, 4.25) | 3.48 (3.29, 3.70) |
| *4 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.80 (0.74, 0.86) | 4.08 (3.81, 4.40) | 3.39 (3.14, 3.68) | 0.74 (0.69, 0.79) | 4.46 (4.18, 4.73) | 3.84 (3.61, 4.10) |
| starting at 2 hours after falling asleep | 0.79 (0.73, 0.85) | 4.00 (3.68, 4.33) | 3.18 (2.91, 3.44) | 0.75 (0.70, 0.81) | 4.40 (4.09, 4.69) | 3.72 (3.48, 3.98) |
| *4 distributed BP measurements* | | | | | | |
| at 1, 2, 4 and 5 hours after midnight | 0.85 (0.81, 0.90) | 3.15 (2.93, 3.39) | 2.60 (2.39, 2.84) | 0.78 (0.73, 0.83) | 3.17 (2.97, 3.37) | 2.63 (2.46, 2.78) |
| at 1, 2, 4 and 5 hours after falling asleep | 0.84 (0.79, 0.89) | 3.09 (2.87, 3.33) | 2.48 (2.30, 2.66) | 0.83 (0.79, 0.88) | 3.12 (2.94, 3.32) | 2.79 (2.62, 2.97) |
| BP = blood pressure; CARDIA = Coronary Artery Risk Development in Young Adults; JHS = Jackson Heart Study | | | | | | |
| \*Blood pressure sampling variations were compared to other variations that measure blood pressure the same number of times (i.e., 2, 3, or 4) using the same strategy (i.e., concentrated or distributed) and the same time reference (i.e., midnight or onset of sleep). Each of these 12 comparison groups had one variation with the highest overall Kappa statistic, and those variations are presented here. | | | | | | |
| †Kappa statistics measure the chance-corrected agreement in classification of nocturnal hypertension between ambulatory blood pressure monitoring throughout sleep and a blood pressure sampling variation. | | | | | | |

Table 3: Concordance statistics for prediction of left-ventricular hypertrophy and albuminuria using the 12 blood pressure sampling strategies that obtained the highest overall chance-corrected agreement with ambulatory blood pressure monitoring throughout sleep.

|  | | | **CARDIA** | | **JHS** | |
| --- | --- | --- | --- | --- | --- | --- |
| **Blood pressure sampling variant\*** | **Overall C-statistic†‡** | **P-value for difference§** | **Left-ventricular hypertrophy** | **Albuminuria** | **Left-ventricular hypertrophy** | **Albuminuria** |
| Measuring BP throughout sleep | 0.746 (0.709, 0.784) | 1 (Ref) | 0.708 (0.622, 0.793) | 0.833 (0.768, 0.897) | 0.717 (0.650, 0.783) | 0.728 (0.643, 0.813) |
| Foregoing BP measurement | 0.710 (0.671, 0.750) | 0.006 | 0.664 (0.578, 0.750) | 0.813 (0.741, 0.885) | 0.695 (0.625, 0.765) | 0.662 (0.571, 0.753) |
| *2 concentrated BP measurements* | | | | | | |
| starting at 4 hours after midnight | 0.742 (0.704, 0.779) | 0.52 | 0.700 (0.615, 0.786) | 0.834 (0.772, 0.896) | 0.716 (0.650, 0.782) | 0.716 (0.629, 0.804) |
| starting at 2 hours after falling asleep | 0.748 (0.709, 0.786) | 0.82 | 0.703 (0.615, 0.790) | 0.826 (0.751, 0.902) | 0.708 (0.639, 0.777) | 0.753 (0.676, 0.831) |
| *2 distributed BP measurements* | | | | | | |
| at 1 and 3 hours after midnight | 0.749 (0.711, 0.788) | 0.53 | 0.722 (0.635, 0.809) | 0.836 (0.770, 0.901) | 0.712 (0.642, 0.782) | 0.733 (0.649, 0.817) |
| at 1 and 5 hours after falling asleep | 0.738 (0.699, 0.776) | 0.10 | 0.711 (0.632, 0.791) | 0.821 (0.751, 0.891) | 0.709 (0.639, 0.778) | 0.718 (0.633, 0.804) |
| *3 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.744 (0.706, 0.782) | 0.65 | 0.716 (0.632, 0.801) | 0.829 (0.759, 0.898) | 0.712 (0.643, 0.781) | 0.725 (0.644, 0.807) |
| starting at 1 hours after falling asleep | 0.742 (0.703, 0.780) | 0.44 | 0.697 (0.610, 0.784) | 0.832 (0.762, 0.903) | 0.704 (0.634, 0.773) | 0.726 (0.642, 0.811) |
| *3 distributed BP measurements* | | | | | | |
| at 1, 3 and 5 hours after midnight | 0.744 (0.706, 0.782) | 0.55 | 0.706 (0.621, 0.791) | 0.835 (0.771, 0.899) | 0.713 (0.645, 0.781) | 0.721 (0.633, 0.808) |
| at 1, 2 and 4 hours after falling asleep | 0.744 (0.705, 0.782) | 0.63 | 0.694 (0.610, 0.779) | 0.834 (0.766, 0.901) | 0.704 (0.634, 0.774) | 0.742 (0.659, 0.825) |
| *4 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.748 (0.709, 0.786) | 0.77 | 0.724 (0.636, 0.811) | 0.835 (0.768, 0.902) | 0.712 (0.643, 0.781) | 0.730 (0.648, 0.811) |
| starting at 2 hours after falling asleep | 0.745 (0.707, 0.783) | 0.82 | 0.704 (0.618, 0.789) | 0.834 (0.766, 0.903) | 0.709 (0.641, 0.777) | 0.735 (0.654, 0.817) |
| *4 distributed BP measurements* | | | | | | |
| at 1, 2, 4 and 5 hours after midnight | 0.742 (0.704, 0.780) | 0.43 | 0.692 (0.610, 0.774) | 0.838 (0.775, 0.901) | 0.715 (0.648, 0.782) | 0.716 (0.630, 0.802) |
| at 1, 2, 4 and 5 hours after falling asleep | 0.744 (0.706, 0.783) | 0.67 | 0.704 (0.621, 0.788) | 0.829 (0.761, 0.897) | 0.709 (0.640, 0.778) | 0.741 (0.658, 0.824) |
| BP = blood pressure; CARDIA = Coronary Artery Risk Development in Young Adults; JHS = Jackson Heart Study | | | | | | |
| \*Blood pressure sampling variations were compared to other variations that measure blood pressure the same number of times (i.e., 2, 3, or 4) using the same strategy (i.e., concentrated or distributed) and the same time reference (i.e., midnight or onset of sleep). Each of these 12 comparison groups had one variation with the highest overall Kappa statistic, and those variations are presented here. | | | | | | |
| †Overall concordance was defined as the concordance statistic resulting from concatenating predicted probabilities and observed status across the two cohorts and two outcome variables. | | | | | | |
| ‡All concordance statistics obtained from blood pressure sampling variations were compared to the concordance statistic obtained when blood pressure was measured throughout sleep. | | | | | | |
| §P-values were obtained using DeLong's test for correlated concordance statistics. | | | | | | |

Table 4: Prevalence ratios (95% confidence intervals) for the association between mean systolic blood pressure during sleep and clinical outcomes using the 12 blood pressure sampling strategies that obtained the highest overall chance-corrected agreement (i.e., Kappa statistic) with measuring blood pressure throughout sleep.

|  | **CARDIA** | | **JHS** | |
| --- | --- | --- | --- | --- |
| **Blood pressure sampling variant\*** | **Left-ventricular hypertrophy** | **Albuminuria** | **Left-ventricular hypertrophy** | **Albuminuria** |
| Measuring BP throughout sleep | 1.44 (1.13, 1.83) | 1.08 (0.76, 1.53) | 1.14 (0.88, 1.48) | 1.38 (1.10, 1.73) |
| *2 concentrated BP measurements* | | | | |
| starting at 4 hours after midnight | 1.41 (1.13, 1.75) | 1.10 (0.81, 1.50) | 1.20 (0.96, 1.49) | 1.34 (1.08, 1.67) |
| starting at 2 hours after falling asleep | 1.31 (1.07, 1.60) | 1.24 (1.01, 1.52) | 1.10 (0.86, 1.42) | 1.57 (1.30, 1.90) |
| *2 distributed BP measurements* | | | | |
| at 1 and 3 hours after midnight | 1.57 (1.24, 1.99) | 1.17 (0.91, 1.50) | 1.14 (0.90, 1.43) | 1.40 (1.15, 1.70) |
| at 1 and 5 hours after falling asleep | 1.42 (1.13, 1.78) | 1.17 (0.86, 1.59) | 1.19 (0.96, 1.49) | 1.38 (1.12, 1.70) |
| *3 concentrated BP measurements* | | | | |
| starting at 1 hours after midnight | 1.39 (1.12, 1.72) | 1.04 (0.82, 1.32) | 1.10 (0.87, 1.38) | 1.33 (1.10, 1.59) |
| starting at 1 hours after falling asleep | 1.33 (1.06, 1.67) | 1.08 (0.83, 1.41) | 1.15 (0.91, 1.45) | 1.35 (1.08, 1.68) |
| *3 distributed BP measurements* | | | | |
| at 1, 3 and 5 hours after midnight | 1.46 (1.15, 1.86) | 1.07 (0.80, 1.44) | 1.14 (0.90, 1.44) | 1.35 (1.11, 1.66) |
| at 1, 2 and 4 hours after falling asleep | 1.35 (1.04, 1.74) | 1.14 (0.86, 1.53) | 1.18 (0.92, 1.51) | 1.48 (1.19, 1.83) |
| *4 concentrated BP measurements* | | | | |
| starting at 1 hours after midnight | 1.45 (1.15, 1.82) | 1.04 (0.80, 1.36) | 1.15 (0.91, 1.46) | 1.36 (1.12, 1.65) |
| starting at 2 hours after falling asleep | 1.33 (1.07, 1.65) | 1.11 (0.86, 1.44) | 1.07 (0.82, 1.39) | 1.47 (1.20, 1.80) |
| *4 distributed BP measurements* | | | | |
| at 1, 2, 4 and 5 hours after midnight | 1.30 (1.01, 1.67) | 0.93 (0.69, 1.25) | 1.19 (0.95, 1.50) | 1.33 (1.08, 1.63) |
| at 1, 2, 4 and 5 hours after falling asleep | 1.42 (1.10, 1.83) | 1.15 (0.84, 1.57) | 1.18 (0.93, 1.51) | 1.51 (1.22, 1.86) |
| CARDIA = Coronary Artery Risk Development in Young Adults; JHS = Jackson Heart Study | | | | |
| Prevalence ratios are adjusted for participant age, sex, diabetes status, smoking status, antihypertensive medication use and sleep duration | | | | |
| Prevalence ratios correspond to 10 mm Hg higher systolic blood pressure | | | | |
| \*Blood pressure sampling variations were compared to other variations that measure blood pressure the same number of times (i.e., 2, 3, or 4) using the same strategy (i.e., concentrated or distributed) and the same time reference (i.e., midnight or onset of sleep). Each of these 12 comparison groups had one variation with the highest overall Kappa statistic, and those variations are presented here. | | | | |

Figure 1: Illustration of blood pressure sampling variantsfollowing a concentrated and distributed sampling strategy.



Figure 2: Summary of Kappa statistics for the 6 blood pressure sampling variants with highest overall Kappa statistics among those that measured time in hours since midnight.



Panels on the diagonal show the Kappa statistic values for participants in the Jackson Heart Study (upper left) and Coronary Artery Risk Development in Young Adults study (bottom right). Panels on the off-diagonal show bootstrapped differences in the Kappa statistics presented on the corresponding diagonal tiles.
Confidence intervals were estimated using bootstrap resampling with bias correction and acceleration. Each interval was based on the aggregate of 10,000 bootstrap replicates.

**SUPPLEMENT**

Table S1: Participant inclusion cascade.

| **Inclusion criteria** | **CARDIA participants** | **JHS participants** |
| --- | --- | --- |
| All study participants | 5,115 | 5,306 |
| Participants who underwent 24-hour ABPM. | 831 | 1,146 |
| Participants with ≥5 asleep blood pressure measurements. | 788 | 941 |
| Participants who were asleep for all measurements between 1am and 5am. | 645 | 854 |
| Participants with at least 1 blood pressure measurement within 30 minutes of all sampling times | 458 | 621 |
| ABPM = ambulatory blood pressure monitoring; CARDIA = Coronary Artery Risk Development in Young Adults; JHS = Jackson Heart Study | | |

Table S2: Summary of all 74 blood pressure sampling variations that were evaluated in the current study.

| **BP sampling variations** | **CARDIA** | | | **JHS** | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Kappa statistic\*** | **Mean absolute error** | | **Kappa statistic\*** | **Mean absolute error** | |
| **Systolic BP** | **Diastolic BP** | **Systolic BP** | **Diastolic BP** |
| *2 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.72 (0.65, 0.78) | 5.94 (5.49, 6.40) | 4.79 (4.39, 5.20) | 0.68 (0.62, 0.74) | 5.74 (5.40, 6.14) | 4.63 (4.33, 4.96) |
| starting at 2 hours after midnight | 0.72 (0.65, 0.78) | 5.05 (4.68, 5.44) | 4.24 (3.95, 4.59) | 0.66 (0.61, 0.72) | 5.60 (5.26, 5.95) | 4.66 (4.37, 4.97) |
| starting at 3 hours after midnight | 0.71 (0.65, 0.78) | 5.01 (4.62, 5.42) | 4.50 (4.17, 4.85) | 0.68 (0.63, 0.74) | 5.61 (5.25, 5.96) | 4.71 (4.44, 5.00) |
| starting at 4 hours after midnight | 0.72 (0.65, 0.79) | 5.47 (5.05, 5.86) | 4.65 (4.33, 4.99) | 0.71 (0.65, 0.76) | 5.19 (4.89, 5.54) | 4.48 (4.19, 4.76) |
| starting at 1 hours after falling asleep | 0.73 (0.67, 0.80) | 5.48 (5.07, 5.84) | 4.60 (4.24, 4.94) | 0.66 (0.60, 0.72) | 6.45 (6.06, 6.82) | 5.30 (4.96, 5.63) |
| starting at 2 hours after falling asleep | 0.72 (0.65, 0.79) | 5.42 (5.00, 5.93) | 4.44 (4.10, 4.81) | 0.72 (0.66, 0.77) | 5.58 (5.25, 5.92) | 4.59 (4.31, 4.89) |
| starting at 3 hours after falling asleep | 0.74 (0.67, 0.80) | 5.20 (4.81, 5.62) | 4.27 (3.95, 4.61) | 0.67 (0.62, 0.73) | 5.35 (5.02, 5.69) | 4.74 (4.45, 5.04) |
| starting at 4 hours after falling asleep | 0.73 (0.67, 0.80) | 5.00 (4.62, 5.37) | 4.40 (4.10, 4.74) | 0.69 (0.64, 0.75) | 5.47 (5.14, 5.81) | 4.56 (4.29, 4.85) |
| *2 distributed BP measurements* | | | | | | |
| at 1 and 2 hours after midnight | 0.74 (0.67, 0.80) | 5.05 (4.67, 5.44) | 4.19 (3.86, 4.55) | 0.73 (0.67, 0.78) | 5.00 (4.67, 5.35) | 4.38 (4.13, 4.66) |
| at 1 and 3 hours after midnight | 0.78 (0.72, 0.84) | 4.72 (4.35, 5.06) | 3.74 (3.45, 4.10) | 0.70 (0.65, 0.76) | 4.97 (4.69, 5.29) | 4.10 (3.84, 4.36) |
| at 1 and 4 hours after midnight | 0.72 (0.65, 0.78) | 4.73 (4.39, 5.10) | 3.98 (3.65, 4.34) | 0.71 (0.65, 0.76) | 4.26 (4.00, 4.55) | 3.75 (3.51, 4.01) |
| at 1 and 5 hours after midnight | 0.72 (0.66, 0.79) | 4.72 (4.38, 5.07) | 3.76 (3.46, 4.10) | 0.72 (0.67, 0.78) | 4.43 (4.18, 4.71) | 3.67 (3.44, 3.91) |
| at 2 and 3 hours after midnight | 0.69 (0.62, 0.76) | 4.75 (4.36, 5.11) | 3.98 (3.66, 4.31) | 0.68 (0.62, 0.74) | 5.16 (4.86, 5.46) | 4.19 (3.93, 4.46) |
| at 2 and 4 hours after midnight | 0.72 (0.65, 0.79) | 4.88 (4.54, 5.24) | 3.96 (3.67, 4.26) | 0.72 (0.67, 0.78) | 4.72 (4.40, 5.03) | 3.96 (3.72, 4.20) |
| at 2 and 5 hours after midnight | 0.76 (0.70, 0.82) | 4.45 (4.14, 4.80) | 3.58 (3.29, 3.97) | 0.69 (0.63, 0.75) | 4.86 (4.58, 5.18) | 3.87 (3.62, 4.10) |
| at 3 and 4 hours after midnight | 0.74 (0.67, 0.80) | 4.79 (4.46, 5.14) | 3.95 (3.62, 4.27) | 0.70 (0.64, 0.76) | 4.80 (4.52, 5.10) | 3.97 (3.73, 4.21) |
| at 3 and 5 hours after midnight | 0.70 (0.63, 0.77) | 4.58 (4.23, 4.94) | 3.83 (3.54, 4.13) | 0.70 (0.64, 0.75) | 4.89 (4.59, 5.18) | 3.86 (3.62, 4.13) |
| at 4 and 5 hours after midnight | 0.72 (0.66, 0.79) | 5.05 (4.67, 5.48) | 4.11 (3.78, 4.48) | 0.69 (0.63, 0.75) | 5.00 (4.68, 5.29) | 4.00 (3.75, 4.24) |
| at 1 and 2 hours after falling asleep | 0.76 (0.70, 0.82) | 5.40 (5.01, 5.83) | 4.23 (3.93, 4.58) | 0.71 (0.65, 0.77) | 5.29 (4.97, 5.61) | 4.52 (4.26, 4.79) |
| at 1 and 3 hours after falling asleep | 0.76 (0.69, 0.82) | 4.87 (4.53, 5.20) | 3.92 (3.64, 4.18) | 0.69 (0.64, 0.75) | 5.19 (4.87, 5.52) | 4.43 (4.16, 4.71) |
| at 1 and 4 hours after falling asleep | 0.77 (0.71, 0.83) | 4.80 (4.48, 5.14) | 3.85 (3.57, 4.15) | 0.74 (0.69, 0.79) | 4.66 (4.39, 4.97) | 4.04 (3.79, 4.30) |
| at 1 and 5 hours after falling asleep | 0.79 (0.73, 0.85) | 4.53 (4.20, 4.91) | 3.56 (3.28, 3.86) | 0.75 (0.69, 0.80) | 4.76 (4.50, 5.04) | 3.98 (3.75, 4.22) |
| at 2 and 3 hours after falling asleep | 0.68 (0.61, 0.75) | 5.13 (4.73, 5.53) | 4.12 (3.79, 4.44) | 0.71 (0.65, 0.76) | 5.09 (4.78, 5.42) | 4.34 (4.06, 4.62) |
| at 2 and 4 hours after falling asleep | 0.78 (0.72, 0.84) | 4.66 (4.30, 5.01) | 3.64 (3.35, 3.97) | 0.75 (0.70, 0.80) | 4.73 (4.46, 5.02) | 4.09 (3.82, 4.34) |
| at 2 and 5 hours after falling asleep | 0.75 (0.68, 0.81) | 4.52 (4.21, 4.85) | 3.80 (3.51, 4.12) | 0.76 (0.71, 0.81) | 4.47 (4.20, 4.74) | 3.80 (3.56, 4.03) |
| at 3 and 4 hours after falling asleep | 0.75 (0.69, 0.81) | 4.99 (4.68, 5.37) | 3.98 (3.66, 4.26) | 0.73 (0.68, 0.79) | 4.84 (4.54, 5.17) | 4.03 (3.78, 4.29) |
| at 3 and 5 hours after falling asleep | 0.71 (0.64, 0.77) | 4.76 (4.42, 5.07) | 3.80 (3.53, 4.06) | 0.74 (0.68, 0.79) | 4.75 (4.46, 5.05) | 3.78 (3.55, 4.03) |
| at 4 and 5 hours after falling asleep | 0.72 (0.65, 0.78) | 5.04 (4.69, 5.41) | 4.10 (3.80, 4.44) | 0.74 (0.69, 0.79) | 4.80 (4.53, 5.09) | 4.23 (3.98, 4.47) |
| *3 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.75 (0.68, 0.81) | 4.77 (4.39, 5.16) | 3.96 (3.65, 4.28) | 0.72 (0.66, 0.77) | 4.95 (4.61, 5.28) | 4.15 (3.89, 4.45) |
| starting at 2 hours after midnight | 0.72 (0.65, 0.79) | 4.27 (3.97, 4.60) | 3.57 (3.30, 3.86) | 0.69 (0.64, 0.75) | 5.03 (4.72, 5.35) | 4.18 (3.93, 4.47) |
| starting at 3 hours after midnight | 0.72 (0.65, 0.78) | 4.34 (4.03, 4.64) | 3.76 (3.48, 4.06) | 0.69 (0.63, 0.74) | 4.89 (4.59, 5.20) | 4.19 (3.93, 4.42) |
| starting at 4 hours after midnight | 0.76 (0.70, 0.82) | 4.61 (4.25, 4.98) | 3.85 (3.59, 4.16) | 0.69 (0.63, 0.74) | 4.74 (4.46, 5.03) | 3.91 (3.67, 4.17) |
| starting at 1 hours after falling asleep | 0.77 (0.71, 0.83) | 4.78 (4.42, 5.14) | 3.87 (3.60, 4.17) | 0.73 (0.68, 0.78) | 5.65 (5.27, 5.99) | 4.55 (4.27, 4.86) |
| starting at 2 hours after falling asleep | 0.73 (0.67, 0.80) | 4.66 (4.28, 5.03) | 3.72 (3.43, 4.01) | 0.75 (0.70, 0.80) | 4.86 (4.55, 5.16) | 4.13 (3.84, 4.38) |
| starting at 3 hours after falling asleep | 0.78 (0.72, 0.84) | 4.57 (4.25, 4.90) | 3.73 (3.46, 4.00) | 0.69 (0.64, 0.75) | 4.69 (4.40, 4.98) | 4.14 (3.87, 4.40) |
| starting at 4 hours after falling asleep | 0.76 (0.70, 0.82) | 4.34 (4.03, 4.68) | 3.69 (3.42, 3.97) | 0.73 (0.67, 0.78) | 4.70 (4.42, 5.00) | 4.17 (3.92, 4.45) |
| *3 distributed BP measurements* | | | | | | |
| at 1, 2 and 3 hours after midnight | 0.81 (0.75, 0.86) | 3.86 (3.57, 4.19) | 3.11 (2.81, 3.36) | 0.74 (0.69, 0.79) | 4.23 (3.98, 4.50) | 3.53 (3.31, 3.75) |
| at 1, 2 and 4 hours after midnight | 0.80 (0.74, 0.86) | 3.92 (3.62, 4.22) | 3.24 (2.98, 3.49) | 0.77 (0.72, 0.82) | 3.74 (3.51, 3.98) | 3.27 (3.07, 3.48) |
| at 1, 2 and 5 hours after midnight | 0.79 (0.74, 0.85) | 3.64 (3.39, 3.91) | 3.00 (2.77, 3.28) | 0.75 (0.70, 0.81) | 3.81 (3.59, 4.06) | 3.13 (2.94, 3.31) |
| at 1, 3 and 4 hours after midnight | 0.80 (0.75, 0.86) | 3.63 (3.35, 3.91) | 3.00 (2.77, 3.26) | 0.75 (0.70, 0.81) | 3.67 (3.44, 3.89) | 3.12 (2.94, 3.35) |
| at 1, 3 and 5 hours after midnight | 0.81 (0.76, 0.87) | 3.54 (3.28, 3.82) | 2.81 (2.58, 3.05) | 0.76 (0.71, 0.81) | 3.72 (3.51, 3.95) | 3.00 (2.80, 3.20) |
| at 1, 4 and 5 hours after midnight | 0.78 (0.72, 0.84) | 3.74 (3.48, 4.02) | 3.05 (2.81, 3.33) | 0.78 (0.73, 0.83) | 3.56 (3.36, 3.75) | 2.87 (2.70, 3.05) |
| at 2, 3 and 4 hours after midnight | 0.80 (0.74, 0.86) | 3.93 (3.65, 4.20) | 3.21 (2.96, 3.47) | 0.75 (0.69, 0.80) | 4.07 (3.84, 4.35) | 3.30 (3.11, 3.53) |
| at 2, 3 and 5 hours after midnight | 0.78 (0.72, 0.84) | 3.59 (3.32, 3.87) | 2.93 (2.68, 3.22) | 0.74 (0.69, 0.79) | 4.13 (3.88, 4.38) | 3.16 (2.98, 3.36) |
| at 2, 4 and 5 hours after midnight | 0.76 (0.70, 0.82) | 3.88 (3.60, 4.16) | 3.13 (2.87, 3.42) | 0.74 (0.69, 0.79) | 4.01 (3.75, 4.28) | 3.16 (2.98, 3.36) |
| at 3, 4 and 5 hours after midnight | 0.76 (0.70, 0.83) | 3.90 (3.62, 4.23) | 3.19 (2.93, 3.44) | 0.75 (0.70, 0.81) | 4.04 (3.80, 4.29) | 3.19 (3.00, 3.39) |
| at 1, 2 and 3 hours after falling asleep | 0.78 (0.73, 0.84) | 4.33 (4.03, 4.67) | 3.35 (3.12, 3.62) | 0.75 (0.70, 0.80) | 4.48 (4.20, 4.74) | 3.76 (3.54, 3.99) |
| at 1, 2 and 4 hours after falling asleep | 0.83 (0.78, 0.89) | 4.00 (3.75, 4.30) | 3.07 (2.86, 3.31) | 0.80 (0.75, 0.84) | 4.01 (3.77, 4.25) | 3.48 (3.29, 3.70) |
| at 1, 2 and 5 hours after falling asleep | 0.82 (0.76, 0.87) | 3.80 (3.52, 4.08) | 2.96 (2.73, 3.20) | 0.78 (0.73, 0.83) | 3.77 (3.53, 4.01) | 3.20 (3.01, 3.41) |
| at 1, 3 and 4 hours after falling asleep | 0.81 (0.75, 0.86) | 3.86 (3.59, 4.15) | 3.12 (2.90, 3.34) | 0.77 (0.72, 0.82) | 3.97 (3.71, 4.24) | 3.36 (3.15, 3.58) |
| at 1, 3 and 5 hours after falling asleep | 0.78 (0.72, 0.84) | 3.56 (3.30, 3.81) | 2.79 (2.59, 3.01) | 0.78 (0.73, 0.83) | 3.90 (3.66, 4.11) | 3.22 (3.03, 3.41) |
| at 1, 4 and 5 hours after falling asleep | 0.80 (0.75, 0.86) | 3.68 (3.43, 3.94) | 3.00 (2.76, 3.22) | 0.80 (0.76, 0.85) | 3.61 (3.40, 3.83) | 3.24 (3.06, 3.45) |
| at 2, 3 and 4 hours after falling asleep | 0.81 (0.76, 0.87) | 4.07 (3.79, 4.37) | 3.15 (2.89, 3.40) | 0.80 (0.76, 0.85) | 4.13 (3.88, 4.39) | 3.48 (3.27, 3.70) |
| at 2, 3 and 5 hours after falling asleep | 0.76 (0.70, 0.83) | 3.77 (3.50, 4.06) | 3.02 (2.79, 3.27) | 0.79 (0.75, 0.84) | 3.85 (3.61, 4.08) | 3.21 (3.03, 3.41) |
| at 2, 4 and 5 hours after falling asleep | 0.78 (0.72, 0.84) | 3.62 (3.35, 3.88) | 3.04 (2.82, 3.27) | 0.81 (0.76, 0.85) | 3.68 (3.47, 3.89) | 3.24 (3.05, 3.44) |
| at 3, 4 and 5 hours after falling asleep | 0.78 (0.72, 0.84) | 3.96 (3.67, 4.28) | 3.12 (2.88, 3.39) | 0.77 (0.72, 0.82) | 3.94 (3.71, 4.19) | 3.27 (3.09, 3.46) |
| *4 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.80 (0.74, 0.86) | 4.08 (3.81, 4.40) | 3.39 (3.14, 3.68) | 0.74 (0.69, 0.79) | 4.46 (4.18, 4.73) | 3.84 (3.61, 4.10) |
| starting at 2 hours after midnight | 0.77 (0.70, 0.83) | 3.73 (3.47, 4.02) | 3.04 (2.81, 3.27) | 0.73 (0.67, 0.78) | 4.53 (4.26, 4.82) | 3.67 (3.42, 3.92) |
| starting at 3 hours after midnight | 0.74 (0.68, 0.81) | 3.83 (3.53, 4.13) | 3.33 (3.09, 3.58) | 0.73 (0.68, 0.78) | 4.37 (4.09, 4.64) | 3.68 (3.46, 3.92) |
| starting at 4 hours after midnight | 0.76 (0.70, 0.83) | 4.28 (3.95, 4.61) | 3.49 (3.23, 3.75) | 0.67 (0.62, 0.73) | 4.55 (4.25, 4.84) | 3.56 (3.33, 3.79) |
| starting at 1 hours after falling asleep | 0.78 (0.72, 0.84) | 4.16 (3.86, 4.45) | 3.32 (3.08, 3.56) | 0.76 (0.71, 0.81) | 4.89 (4.60, 5.23) | 4.01 (3.75, 4.26) |
| starting at 2 hours after falling asleep | 0.79 (0.73, 0.85) | 4.00 (3.68, 4.33) | 3.18 (2.91, 3.44) | 0.75 (0.70, 0.81) | 4.40 (4.09, 4.69) | 3.72 (3.48, 3.98) |
| starting at 3 hours after falling asleep | 0.77 (0.71, 0.83) | 3.81 (3.54, 4.11) | 3.21 (2.99, 3.44) | 0.76 (0.71, 0.81) | 4.25 (3.99, 4.51) | 3.59 (3.38, 3.84) |
| starting at 4 hours after falling asleep | 0.78 (0.72, 0.84) | 3.88 (3.57, 4.19) | 3.28 (3.05, 3.51) | 0.72 (0.67, 0.78) | 4.30 (4.06, 4.55) | 3.73 (3.52, 3.97) |
| *4 distributed BP measurements* | | | | | | |
| at 1, 2, 3 and 4 hours after midnight | 0.84 (0.78, 0.89) | 3.30 (3.07, 3.52) | 2.65 (2.44, 2.85) | 0.78 (0.73, 0.83) | 3.45 (3.24, 3.67) | 2.90 (2.71, 3.08) |
| at 1, 2, 3 and 5 hours after midnight | 0.84 (0.78, 0.89) | 2.95 (2.73, 3.20) | 2.44 (2.24, 2.67) | 0.78 (0.73, 0.83) | 3.38 (3.17, 3.59) | 2.70 (2.53, 2.88) |
| at 1, 2, 4 and 5 hours after midnight | 0.85 (0.81, 0.90) | 3.15 (2.93, 3.39) | 2.60 (2.39, 2.84) | 0.78 (0.73, 0.83) | 3.17 (2.97, 3.37) | 2.63 (2.46, 2.78) |
| at 1, 3, 4 and 5 hours after midnight | 0.85 (0.80, 0.90) | 3.05 (2.83, 3.27) | 2.41 (2.22, 2.63) | 0.78 (0.73, 0.83) | 3.18 (3.00, 3.38) | 2.53 (2.37, 2.68) |
| at 2, 3, 4 and 5 hours after midnight | 0.79 (0.73, 0.85) | 3.27 (3.02, 3.52) | 2.65 (2.45, 2.89) | 0.78 (0.73, 0.83) | 3.50 (3.28, 3.72) | 2.75 (2.57, 2.93) |
| at 1, 2, 3 and 4 hours after falling asleep | 0.84 (0.79, 0.90) | 3.52 (3.27, 3.77) | 2.68 (2.48, 2.87) | 0.79 (0.74, 0.84) | 3.61 (3.38, 3.84) | 3.06 (2.88, 3.25) |
| at 1, 2, 3 and 5 hours after falling asleep | 0.83 (0.77, 0.88) | 3.20 (2.97, 3.43) | 2.49 (2.30, 2.70) | 0.81 (0.76, 0.86) | 3.42 (3.21, 3.63) | 2.82 (2.66, 3.00) |
| at 1, 2, 4 and 5 hours after falling asleep | 0.84 (0.79, 0.89) | 3.09 (2.87, 3.33) | 2.48 (2.30, 2.66) | 0.83 (0.79, 0.88) | 3.12 (2.94, 3.32) | 2.79 (2.62, 2.97) |
| at 1, 3, 4 and 5 hours after falling asleep | 0.83 (0.78, 0.88) | 3.12 (2.87, 3.35) | 2.48 (2.29, 2.68) | 0.82 (0.77, 0.86) | 3.26 (3.08, 3.46) | 2.73 (2.58, 2.90) |
| at 2, 3, 4 and 5 hours after falling asleep | 0.79 (0.73, 0.85) | 3.23 (2.98, 3.47) | 2.57 (2.37, 2.76) | 0.83 (0.78, 0.87) | 3.34 (3.11, 3.53) | 2.87 (2.70, 3.03) |
| BP = blood pressure; CARDIA = Coronary Artery Risk Development in Young Adults; JHS = Jackson Heart Study | | | | | | |
| \*Kappa statistics measure the chance-corrected agreement in classification of nocturnal hypertension between ambulatory blood pressure monitoring throughout sleep and a blood pressure sampling variation. | | | | | | |

Table S3: Concordance statistics for prediction of left-ventricular hypertrophy and albuminuria using 74 different blood pressure sampling strategies.

|  | | | **CARDIA** | | **JHS** | |
| --- | --- | --- | --- | --- | --- | --- |
| **Blood pressure sampling variant** | **Overall C-statistic\*†** | **P-value for difference§** | **Left-ventricular hypertrophy** | **Albuminuria** | **Left-ventricular hypertrophy** | **Albuminuria** |
| Measuring BP throughout sleep | 0.746 (0.709, 0.784) | 1 (Ref) | 0.708 (0.622, 0.793) | 0.833 (0.768, 0.897) | 0.717 (0.650, 0.783) | 0.728 (0.643, 0.813) |
| Foregoing BP measurement | 0.710 (0.671, 0.750) | 0.006 | 0.664 (0.578, 0.750) | 0.813 (0.741, 0.885) | 0.695 (0.625, 0.765) | 0.662 (0.571, 0.753) |
| *2 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.745 (0.706, 0.784) | 0.86 | 0.729 (0.638, 0.820) | 0.826 (0.755, 0.897) | 0.708 (0.638, 0.777) | 0.727 (0.646, 0.808) |
| starting at 2 hours after midnight | 0.747 (0.709, 0.784) | 0.94 | 0.699 (0.616, 0.782) | 0.839 (0.774, 0.904) | 0.721 (0.653, 0.788) | 0.725 (0.640, 0.809) |
| starting at 3 hours after midnight | 0.747 (0.710, 0.785) | 0.84 | 0.709 (0.626, 0.792) | 0.834 (0.771, 0.897) | 0.718 (0.650, 0.785) | 0.733 (0.646, 0.820) |
| starting at 4 hours after midnight | 0.742 (0.704, 0.779) | 0.52 | 0.700 (0.615, 0.786) | 0.834 (0.772, 0.896) | 0.716 (0.650, 0.782) | 0.716 (0.629, 0.804) |
| starting at 1 hours after falling asleep | 0.738 (0.699, 0.776) | 0.23 | 0.691 (0.604, 0.778) | 0.838 (0.771, 0.904) | 0.702 (0.632, 0.772) | 0.717 (0.630, 0.803) |
| starting at 2 hours after falling asleep | 0.748 (0.709, 0.786) | 0.82 | 0.703 (0.615, 0.790) | 0.826 (0.751, 0.902) | 0.708 (0.639, 0.777) | 0.753 (0.676, 0.831) |
| starting at 3 hours after falling asleep | 0.741 (0.704, 0.779) | 0.41 | 0.697 (0.613, 0.781) | 0.844 (0.782, 0.907) | 0.710 (0.642, 0.777) | 0.716 (0.630, 0.801) |
| starting at 4 hours after falling asleep | 0.739 (0.700, 0.777) | 0.18 | 0.685 (0.598, 0.772) | 0.819 (0.753, 0.886) | 0.713 (0.644, 0.782) | 0.735 (0.651, 0.819) |
| *2 distributed BP measurements* | | | | | | |
| at 1 and 2 hours after midnight | 0.741 (0.703, 0.780) | 0.42 | 0.701 (0.618, 0.784) | 0.829 (0.758, 0.901) | 0.710 (0.640, 0.779) | 0.726 (0.644, 0.807) |
| at 1 and 3 hours after midnight | 0.749 (0.711, 0.788) | 0.53 | 0.722 (0.635, 0.809) | 0.836 (0.770, 0.901) | 0.712 (0.642, 0.782) | 0.733 (0.649, 0.817) |
| at 1 and 4 hours after midnight | 0.744 (0.706, 0.782) | 0.72 | 0.699 (0.615, 0.784) | 0.838 (0.775, 0.902) | 0.718 (0.649, 0.787) | 0.719 (0.635, 0.803) |
| at 1 and 5 hours after midnight | 0.737 (0.698, 0.775) | 0.06 | 0.695 (0.610, 0.780) | 0.827 (0.759, 0.895) | 0.711 (0.643, 0.778) | 0.712 (0.625, 0.799) |
| at 2 and 3 hours after midnight | 0.745 (0.707, 0.782) | 0.80 | 0.697 (0.616, 0.777) | 0.834 (0.770, 0.898) | 0.714 (0.646, 0.782) | 0.730 (0.644, 0.815) |
| at 2 and 4 hours after midnight | 0.744 (0.707, 0.782) | 0.80 | 0.689 (0.602, 0.775) | 0.841 (0.777, 0.905) | 0.718 (0.651, 0.785) | 0.717 (0.633, 0.802) |
| at 2 and 5 hours after midnight | 0.737 (0.698, 0.775) | 0.16 | 0.685 (0.599, 0.770) | 0.831 (0.764, 0.898) | 0.711 (0.645, 0.777) | 0.708 (0.620, 0.797) |
| at 3 and 4 hours after midnight | 0.749 (0.712, 0.785) | 0.67 | 0.700 (0.618, 0.782) | 0.847 (0.791, 0.903) | 0.722 (0.656, 0.789) | 0.727 (0.639, 0.815) |
| at 3 and 5 hours after midnight | 0.742 (0.704, 0.780) | 0.36 | 0.694 (0.612, 0.776) | 0.837 (0.775, 0.899) | 0.712 (0.646, 0.778) | 0.717 (0.626, 0.808) |
| at 4 and 5 hours after midnight | 0.740 (0.703, 0.778) | 0.39 | 0.685 (0.602, 0.768) | 0.840 (0.779, 0.900) | 0.718 (0.653, 0.782) | 0.706 (0.616, 0.796) |
| at 1 and 2 hours after falling asleep | 0.740 (0.701, 0.779) | 0.38 | 0.698 (0.615, 0.782) | 0.826 (0.751, 0.901) | 0.702 (0.632, 0.772) | 0.733 (0.649, 0.817) |
| at 1 and 3 hours after falling asleep | 0.732 (0.693, 0.771) | 0.02 | 0.697 (0.616, 0.778) | 0.826 (0.757, 0.894) | 0.701 (0.632, 0.770) | 0.705 (0.616, 0.794) |
| at 1 and 4 hours after falling asleep | 0.739 (0.701, 0.777) | 0.21 | 0.688 (0.605, 0.771) | 0.834 (0.771, 0.897) | 0.706 (0.636, 0.776) | 0.730 (0.646, 0.815) |
| at 1 and 5 hours after falling asleep | 0.738 (0.699, 0.776) | 0.10 | 0.711 (0.632, 0.791) | 0.821 (0.751, 0.891) | 0.709 (0.639, 0.778) | 0.718 (0.633, 0.804) |
| at 2 and 3 hours after falling asleep | 0.741 (0.703, 0.780) | 0.42 | 0.701 (0.615, 0.786) | 0.829 (0.758, 0.901) | 0.702 (0.634, 0.770) | 0.732 (0.649, 0.815) |
| at 2 and 4 hours after falling asleep | 0.748 (0.710, 0.786) | 0.75 | 0.695 (0.608, 0.781) | 0.834 (0.767, 0.902) | 0.706 (0.638, 0.775) | 0.755 (0.675, 0.835) |
| at 2 and 5 hours after falling asleep | 0.748 (0.709, 0.786) | 0.82 | 0.714 (0.629, 0.799) | 0.821 (0.746, 0.895) | 0.713 (0.646, 0.781) | 0.745 (0.664, 0.826) |
| at 3 and 4 hours after falling asleep | 0.738 (0.700, 0.776) | 0.12 | 0.692 (0.607, 0.777) | 0.830 (0.767, 0.893) | 0.707 (0.638, 0.775) | 0.723 (0.636, 0.809) |
| at 3 and 5 hours after falling asleep | 0.739 (0.701, 0.777) | 0.18 | 0.716 (0.635, 0.797) | 0.819 (0.748, 0.889) | 0.714 (0.647, 0.781) | 0.718 (0.631, 0.805) |
| at 4 and 5 hours after falling asleep | 0.745 (0.707, 0.783) | 0.80 | 0.705 (0.621, 0.789) | 0.823 (0.756, 0.889) | 0.717 (0.649, 0.785) | 0.739 (0.655, 0.822) |
| *3 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.744 (0.706, 0.782) | 0.65 | 0.716 (0.632, 0.801) | 0.829 (0.759, 0.898) | 0.712 (0.643, 0.781) | 0.725 (0.644, 0.807) |
| starting at 2 hours after midnight | 0.748 (0.711, 0.786) | 0.68 | 0.709 (0.625, 0.793) | 0.840 (0.778, 0.902) | 0.718 (0.649, 0.787) | 0.726 (0.641, 0.811) |
| starting at 3 hours after midnight | 0.748 (0.711, 0.785) | 0.71 | 0.703 (0.621, 0.785) | 0.841 (0.782, 0.899) | 0.720 (0.653, 0.787) | 0.736 (0.651, 0.822) |
| starting at 4 hours after midnight | 0.738 (0.701, 0.776) | 0.24 | 0.693 (0.611, 0.776) | 0.835 (0.774, 0.897) | 0.716 (0.650, 0.781) | 0.709 (0.622, 0.796) |
| starting at 1 hours after falling asleep | 0.742 (0.703, 0.780) | 0.44 | 0.697 (0.610, 0.784) | 0.832 (0.762, 0.903) | 0.704 (0.634, 0.773) | 0.726 (0.642, 0.811) |
| starting at 2 hours after falling asleep | 0.745 (0.706, 0.784) | 0.83 | 0.703 (0.617, 0.790) | 0.827 (0.756, 0.899) | 0.709 (0.641, 0.778) | 0.743 (0.662, 0.823) |
| starting at 3 hours after falling asleep | 0.742 (0.705, 0.780) | 0.46 | 0.695 (0.612, 0.779) | 0.845 (0.786, 0.903) | 0.715 (0.648, 0.782) | 0.711 (0.626, 0.796) |
| starting at 4 hours after falling asleep | 0.743 (0.706, 0.781) | 0.55 | 0.703 (0.617, 0.789) | 0.819 (0.751, 0.887) | 0.714 (0.645, 0.782) | 0.741 (0.660, 0.823) |
| *3 distributed BP measurements* | | | | | | |
| at 1, 2 and 3 hours after midnight | 0.747 (0.709, 0.785) | 0.83 | 0.712 (0.628, 0.796) | 0.836 (0.770, 0.901) | 0.713 (0.644, 0.782) | 0.731 (0.648, 0.815) |
| at 1, 2 and 4 hours after midnight | 0.745 (0.707, 0.782) | 0.81 | 0.698 (0.616, 0.780) | 0.840 (0.776, 0.905) | 0.716 (0.648, 0.785) | 0.721 (0.637, 0.804) |
| at 1, 2 and 5 hours after midnight | 0.739 (0.701, 0.778) | 0.16 | 0.695 (0.613, 0.778) | 0.831 (0.763, 0.899) | 0.710 (0.643, 0.778) | 0.718 (0.633, 0.803) |
| at 1, 3 and 4 hours after midnight | 0.748 (0.711, 0.786) | 0.65 | 0.709 (0.625, 0.793) | 0.842 (0.783, 0.902) | 0.719 (0.650, 0.787) | 0.728 (0.643, 0.814) |
| at 1, 3 and 5 hours after midnight | 0.744 (0.706, 0.782) | 0.55 | 0.706 (0.621, 0.791) | 0.835 (0.771, 0.899) | 0.713 (0.645, 0.781) | 0.721 (0.633, 0.808) |
| at 1, 4 and 5 hours after midnight | 0.742 (0.704, 0.780) | 0.38 | 0.695 (0.613, 0.778) | 0.838 (0.776, 0.900) | 0.717 (0.650, 0.784) | 0.713 (0.626, 0.800) |
| at 2, 3 and 4 hours after midnight | 0.748 (0.711, 0.785) | 0.79 | 0.696 (0.615, 0.778) | 0.846 (0.787, 0.905) | 0.720 (0.652, 0.787) | 0.726 (0.640, 0.812) |
| at 2, 3 and 5 hours after midnight | 0.742 (0.704, 0.780) | 0.40 | 0.692 (0.611, 0.773) | 0.837 (0.774, 0.900) | 0.714 (0.647, 0.780) | 0.721 (0.633, 0.809) |
| at 2, 4 and 5 hours after midnight | 0.742 (0.704, 0.779) | 0.48 | 0.689 (0.604, 0.774) | 0.840 (0.778, 0.901) | 0.718 (0.652, 0.783) | 0.711 (0.623, 0.799) |
| at 3, 4 and 5 hours after midnight | 0.745 (0.707, 0.782) | 0.75 | 0.692 (0.610, 0.773) | 0.841 (0.784, 0.899) | 0.719 (0.653, 0.784) | 0.718 (0.629, 0.808) |
| at 1, 2 and 3 hours after falling asleep | 0.739 (0.700, 0.778) | 0.20 | 0.701 (0.617, 0.784) | 0.829 (0.757, 0.900) | 0.701 (0.631, 0.770) | 0.725 (0.639, 0.810) |
| at 1, 2 and 4 hours after falling asleep | 0.744 (0.705, 0.782) | 0.63 | 0.694 (0.610, 0.779) | 0.834 (0.766, 0.901) | 0.704 (0.634, 0.774) | 0.742 (0.659, 0.825) |
| at 1, 2 and 5 hours after falling asleep | 0.742 (0.704, 0.781) | 0.42 | 0.708 (0.626, 0.790) | 0.822 (0.750, 0.895) | 0.707 (0.637, 0.776) | 0.734 (0.651, 0.817) |
| at 1, 3 and 4 hours after falling asleep | 0.737 (0.699, 0.775) | 0.07 | 0.694 (0.612, 0.777) | 0.831 (0.767, 0.895) | 0.703 (0.633, 0.772) | 0.720 (0.633, 0.808) |
| at 1, 3 and 5 hours after falling asleep | 0.737 (0.698, 0.775) | 0.03 | 0.709 (0.628, 0.789) | 0.824 (0.755, 0.893) | 0.707 (0.638, 0.776) | 0.713 (0.626, 0.801) |
| at 1, 4 and 5 hours after falling asleep | 0.741 (0.703, 0.779) | 0.23 | 0.705 (0.623, 0.787) | 0.826 (0.761, 0.891) | 0.711 (0.642, 0.780) | 0.733 (0.649, 0.817) |
| at 2, 3 and 4 hours after falling asleep | 0.744 (0.706, 0.782) | 0.59 | 0.699 (0.613, 0.785) | 0.834 (0.768, 0.900) | 0.705 (0.637, 0.774) | 0.738 (0.655, 0.822) |
| at 2, 3 and 5 hours after falling asleep | 0.744 (0.705, 0.782) | 0.59 | 0.712 (0.627, 0.796) | 0.824 (0.752, 0.896) | 0.710 (0.642, 0.778) | 0.732 (0.649, 0.815) |
| at 2, 4 and 5 hours after falling asleep | 0.748 (0.710, 0.786) | 0.68 | 0.705 (0.619, 0.790) | 0.827 (0.759, 0.896) | 0.712 (0.644, 0.780) | 0.749 (0.668, 0.830) |
| at 3, 4 and 5 hours after falling asleep | 0.741 (0.703, 0.779) | 0.28 | 0.704 (0.621, 0.788) | 0.825 (0.759, 0.891) | 0.713 (0.645, 0.781) | 0.728 (0.642, 0.814) |
| *4 concentrated BP measurements* | | | | | | |
| starting at 1 hours after midnight | 0.748 (0.709, 0.786) | 0.77 | 0.724 (0.636, 0.811) | 0.835 (0.768, 0.902) | 0.712 (0.643, 0.781) | 0.730 (0.648, 0.811) |
| starting at 2 hours after midnight | 0.748 (0.710, 0.785) | 0.76 | 0.710 (0.626, 0.794) | 0.840 (0.779, 0.901) | 0.717 (0.648, 0.786) | 0.726 (0.640, 0.813) |
| starting at 3 hours after midnight | 0.749 (0.712, 0.786) | 0.57 | 0.710 (0.626, 0.794) | 0.839 (0.779, 0.898) | 0.723 (0.656, 0.789) | 0.732 (0.646, 0.819) |
| starting at 4 hours after midnight | 0.738 (0.700, 0.775) | 0.09 | 0.698 (0.615, 0.780) | 0.831 (0.768, 0.893) | 0.715 (0.651, 0.780) | 0.706 (0.617, 0.794) |
| starting at 1 hours after falling asleep | 0.743 (0.704, 0.781) | 0.55 | 0.696 (0.608, 0.784) | 0.831 (0.761, 0.902) | 0.703 (0.634, 0.773) | 0.734 (0.651, 0.817) |
| starting at 2 hours after falling asleep | 0.745 (0.707, 0.783) | 0.82 | 0.704 (0.618, 0.789) | 0.834 (0.766, 0.903) | 0.709 (0.641, 0.777) | 0.735 (0.654, 0.817) |
| starting at 3 hours after falling asleep | 0.741 (0.704, 0.779) | 0.26 | 0.695 (0.610, 0.780) | 0.832 (0.770, 0.895) | 0.715 (0.647, 0.784) | 0.723 (0.639, 0.807) |
| starting at 4 hours after falling asleep | 0.743 (0.706, 0.781) | 0.54 | 0.700 (0.616, 0.784) | 0.823 (0.757, 0.889) | 0.716 (0.648, 0.784) | 0.737 (0.654, 0.820) |
| *4 distributed BP measurements* | | | | | | |
| at 1, 2, 3 and 4 hours after midnight | 0.748 (0.710, 0.785) | 0.75 | 0.705 (0.623, 0.787) | 0.842 (0.781, 0.903) | 0.717 (0.648, 0.785) | 0.726 (0.641, 0.811) |
| at 1, 2, 3 and 5 hours after midnight | 0.743 (0.705, 0.782) | 0.51 | 0.700 (0.617, 0.784) | 0.835 (0.770, 0.900) | 0.712 (0.644, 0.779) | 0.723 (0.637, 0.810) |
| at 1, 2, 4 and 5 hours after midnight | 0.742 (0.704, 0.780) | 0.43 | 0.692 (0.610, 0.774) | 0.838 (0.775, 0.901) | 0.715 (0.648, 0.782) | 0.716 (0.630, 0.802) |
| at 1, 3, 4 and 5 hours after midnight | 0.745 (0.707, 0.783) | 0.77 | 0.701 (0.618, 0.783) | 0.841 (0.781, 0.901) | 0.718 (0.651, 0.785) | 0.720 (0.632, 0.807) |
| at 2, 3, 4 and 5 hours after midnight | 0.744 (0.707, 0.782) | 0.71 | 0.691 (0.610, 0.773) | 0.842 (0.783, 0.901) | 0.718 (0.652, 0.784) | 0.719 (0.631, 0.807) |
| at 1, 2, 3 and 4 hours after falling asleep | 0.741 (0.703, 0.780) | 0.30 | 0.698 (0.614, 0.782) | 0.834 (0.767, 0.900) | 0.703 (0.633, 0.772) | 0.732 (0.647, 0.817) |
| at 1, 2, 3 and 5 hours after falling asleep | 0.741 (0.702, 0.779) | 0.24 | 0.707 (0.624, 0.790) | 0.825 (0.754, 0.896) | 0.706 (0.638, 0.775) | 0.728 (0.644, 0.812) |
| at 1, 2, 4 and 5 hours after falling asleep | 0.744 (0.706, 0.783) | 0.67 | 0.704 (0.621, 0.788) | 0.829 (0.761, 0.897) | 0.709 (0.640, 0.778) | 0.741 (0.658, 0.824) |
| at 1, 3, 4 and 5 hours after falling asleep | 0.740 (0.702, 0.778) | 0.08 | 0.705 (0.623, 0.787) | 0.829 (0.763, 0.894) | 0.709 (0.640, 0.777) | 0.724 (0.638, 0.810) |
| at 2, 3, 4 and 5 hours after falling asleep | 0.745 (0.707, 0.783) | 0.68 | 0.705 (0.620, 0.790) | 0.829 (0.761, 0.896) | 0.711 (0.643, 0.779) | 0.739 (0.656, 0.822) |
| BP = blood pressure; CARDIA = Coronary Artery Risk Development in Young Adults; JHS = Jackson Heart Study | | | | | | |
| \*Overall concordance was defined as the concordance statistic resulting from concatenating predicted probabilities and observed status across the two cohorts and two outcome variables. | | | | | | |
| †All concordance statistics obtained from blood pressure sampling variations were compared to the concordance statistic obtained when blood pressure was measured throughout sleep. | | | | | | |
| §P-values were obtained using DeLong's test for correlated concordance statistics. | | | | | | |

Table S4: Prevalence ratios (95% confidence intervals) for the association between mean diastolic blood pressure during sleep and clinical outcomes using the 12 blood pressure sampling strategies that obtained the highest overall chance-corrected agreement (i.e., Kappa statistic) with measuring blood pressure throughout sleep.

|  | **CARDIA** | | **JHS** | |
| --- | --- | --- | --- | --- |
| **Blood pressure sampling variant\*** | **Left-ventricular hypertrophy** | **Albuminuria** | **Left-ventricular hypertrophy** | **Albuminuria** |
| Measuring BP throughout sleep | 0.75 (0.56, 0.99) | 1.25 (0.92, 1.71) | 1.08 (0.88, 1.32) | 1.08 (0.86, 1.35) |
| *2 concentrated BP measurements* | | | | |
| starting at 4 hours after midnight | 0.80 (0.65, 0.97) | 1.18 (0.90, 1.56) | 1.01 (0.84, 1.21) | 0.98 (0.80, 1.20) |
| starting at 2 hours after falling asleep | 0.86 (0.71, 1.05) | 1.05 (0.90, 1.22) | 1.03 (0.86, 1.24) | 0.91 (0.75, 1.11) |
| *2 distributed BP measurements* | | | | |
| at 1 and 3 hours after midnight | 0.69 (0.55, 0.85) | 1.11 (0.91, 1.36) | 1.04 (0.88, 1.24) | 1.00 (0.83, 1.21) |
| at 1 and 5 hours after falling asleep | 0.73 (0.58, 0.92) | 1.04 (0.81, 1.35) | 0.96 (0.82, 1.14) | 1.01 (0.84, 1.22) |
| *3 concentrated BP measurements* | | | | |
| starting at 1 hours after midnight | 0.80 (0.64, 0.99) | 1.17 (1.00, 1.36) | 1.07 (0.90, 1.28) | 1.06 (0.88, 1.27) |
| starting at 1 hours after falling asleep | 0.80 (0.63, 1.00) | 1.19 (1.01, 1.40) | 0.97 (0.82, 1.14) | 1.03 (0.84, 1.26) |
| *3 distributed BP measurements* | | | | |
| at 1, 3 and 5 hours after midnight | 0.75 (0.59, 0.96) | 1.23 (0.94, 1.61) | 1.05 (0.87, 1.25) | 1.04 (0.86, 1.26) |
| at 1, 2 and 4 hours after falling asleep | 0.83 (0.63, 1.08) | 1.18 (0.95, 1.48) | 0.95 (0.80, 1.15) | 1.00 (0.81, 1.24) |
| *4 concentrated BP measurements* | | | | |
| starting at 1 hours after midnight | 0.76 (0.60, 0.96) | 1.21 (1.01, 1.46) | 1.03 (0.86, 1.24) | 1.04 (0.86, 1.26) |
| starting at 2 hours after falling asleep | 0.85 (0.67, 1.08) | 1.21 (0.98, 1.49) | 1.08 (0.90, 1.30) | 0.95 (0.77, 1.18) |
| *4 distributed BP measurements* | | | | |
| at 1, 2, 4 and 5 hours after midnight | 0.88 (0.67, 1.16) | 1.41 (1.08, 1.83) | 1.02 (0.84, 1.23) | 1.06 (0.86, 1.31) |
| at 1, 2, 4 and 5 hours after falling asleep | 0.76 (0.58, 0.99) | 1.16 (0.89, 1.51) | 0.98 (0.81, 1.19) | 0.99 (0.80, 1.23) |
| CARDIA = Coronary Artery Risk Development in Young Adults; JHS = Jackson Heart Study | | | | |
| Prevalence ratios are adjusted for participant age, sex, diabetes status, smoking status, antihypertensive medication use and sleep duration | | | | |
| Prevalence ratios correspond to 10 mm Hg higher diastolic blood pressure | | | | |
| \*Blood pressure sampling variations were compared to other variations that measure blood pressure the same number of times (i.e., 2, 3, or 4) using the same strategy (i.e., concentrated or distributed) and the same time reference (i.e., midnight or onset of sleep). Each of these 12 comparison groups had one variation with the highest overall Kappa statistic, and those variations are presented here. | | | | |

Figure S1: Summary of Kappa statistics for the 6 blood pressure sampling variants with highest overall Kappa statistics among those that measured time in hours since falling asleep



Panels on the diagonal show the Kappa statistic values for participants in the Jackson Heart Study (upper left) and Coronary Artery Risk Development in Young Adults study (bottom right). Panels on the off-diagonal show bootstrapped differences in the Kappa statistics presented on the corresponding diagonal tiles.
Confidence intervals were estimated using bootstrap resampling with bias correction and acceleration. Each interval was based on the aggregate of 10,000 bootstrap replicates.