International Journal of Research in Medical Sciences
Singh S et al. Int J Res Med Sci. 2019 Jun;7(6):2168-2176
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20192493

Original Research Article

Ambulatory blood pressure pattern in overweight and obese subjects: a prospective, cross-sectional study

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Received: 23 March 2019
Accepted: 03 May 2019

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ABSTRACT

Background: Obesity is widely described as a leading cause of morbidity and mortality and is a known risk factor of many cardiovascular and non-cardiovascular diseases including hypertension. The aim of this study was to analyze the pattern of ambulatory blood pressure in overweight and obese subjects.

Methods: This was a prospective, cross-sectional study performed over a period of 1 year in 95 subjects attending the Department of Medicine of tertiary care teaching institute. Anthropometric measures such as weight, height, body mass index (BMI), and waist circumference (WC) were recorded. Ambulatory blood pressure monitoring over a period of 24-hrs was performed in each individual and values were recorded. Comparison between normal subjects and overweight and/or obese subjects was done in terms of various ambulatory BP parameters.

Results: Based on BMI, significantly higher proportion of females were obese (p-value = 0.020), as compared to males. Based on both BMI and WC, significant proportion of overweight and obese subjects had higher 24-hr SBP (p-value < 0.001) and 24-hr DBP (p-value = 0.001); higher day-time SBP (p-value < 0.001); higher night-time SBP (p-value < 0.001); and widening of 24-hr pulse pressure (> 50 mmHg) (p-value < 0.001) as compared to normal subjects. However, among various abnormal ABPM parameters, majority of the parameters revealed more incidence of BP abnormalities with increased BMI than with increased WC. Thus, BMI appeared to be a better anthropometric parameter than WC.

Conclusions: The findings of the present study confirm that obesity in apparently non-hypertensive subjects leads to rise in both SBP and DBP. Moreover, it is the systolic part of ABPM which probably predicts the cardiovascular morbidity in overweight and obese subjects.

Keywords: ABPM, Ambulatory, Blood pressure, Blood pressure monitoring, Obesity, Overweight

INTRODUCTION

Globally, there has been a substantial increase in prevalence of both overweight and obesity.[1] Since 1975, global prevalence of obesity has increased three times.[2] According to WHO, in 2016, 13% of adults were obese and 39% were overweight.[2] Obesity is modifiable risk factor of hypertension.[3,4] and various studies have frequently recognized higher BMI as predisposing factor of hypertension and new-onset hypertension.[5-7] In 2015, global prevalence of hypertension in adults was estimated to be approximately 30 - 45%.[3] Recent findings suggest 36% to 47% of obese patients are affected by hypertension, as compared to 20% individuals with normal BMI.[5]

A circadian rhythm exists in normotensive individuals which is characterized by higher day-time and lower night-time BP. This rhythm has night-time decline in BP known as dipping and rise during early morning.[8] Ambulatory blood pressure monitoring (ABPM) is non-invasive method of repeated BP measurements and it furnishes mean BP readings over a defined period.[3] Contrary to office BP monitoring, it provides mean BP over range of evaluation period and distinctly during normal daily life and sleep.[4] It is crucial in diagnosing white-coat and masked hypertension; assessing 24 hours variability in BP, and nocturnal dipping patterns; and in evaluating efficacy of antihypertensive agents.[9]

Although relationship between overweight and/or obesity and elevated BP has been proven for a long time, aim of present study was to determine pattern of ambulatory BP in overweight and/or obese subjects, based on body mass index (BMI) and waist circumference (WC), in terms of parameters derived from 24 hour ABPM including mean 24-hour, day-time and night-time systolic and diastolic BP; mean pulse pressure; and dipping and non-dipping status.[5-7]

METHODS

This was a prospective, cross-sectional study performed over period of 1 year in 95 subjects attending Department of Medicine, King George's Medical University, Lucknow, Uttar Pradesh, India. The study included adult subjects of either gender, aged 20-60 years, having BMI of >25 to <40 Kg/m^2. While, study excluded patients aged >60 years; with history of hypertension and receiving antihypertensive drugs; on lipid lowering agent; on medications that increases BP such as amphetamines, cocaine, corticosteroids, erythropoietin, tricyclic antidepressants, antimigraine medication like sumatriptan, estrogens (including Birth control pills), long term intake of cough/cold medication like ephedrine and pseudoephedrine, tranylcypromine; with history of endocrine disorders such as acromegaly, Cushing's syndrome, thyroid disorders, type-2 DM; pregnant and lactating women; having clinical neurological disease with autonomic dysfunction; with obstructive sleep apnea, excluded by clinical criteria like excessive snoring, excessive day-time sleep and fatigue with significant level of night sleep disturbance, headache, nocturia, frequent heart burn; and morbid obesity (BMI >40 Kg/m^2).

Anthropometry: Anthropometric tools used were calibrated mechanical weighing machine, stretch resistant measuring tape, and stadiometer. Weight was measured to nearest 0.1 kg with subjects lightly clothed and without footwear; height was measured to nearest 0.5 cm with subjects standing still without shoes; BMI (Kg/m^2) was estimated. Based on BMI, the subjects were divided into three categories: normal (18.5-24.9 Kg/m^2), overweight (25-29.9 Kg/m^2), and obese class (BMI ≥30 Kg/m^2).[2]

Waist circumference (WC, to nearest centimetre) was measured at the midpoint between lower margin of last palpable rib and top of the iliac crest in mid-axillary line, at end of several consecutive breaths, with subjects standing and measuring tape at level parallel to the floor. Based on WC, subjects were considered as obese, if WC was >94 cm (men) and >80 cm (women).[10]

Ambulatory blood pressure monitoring (ABPM)

Procedure and precautions explained to the subjects

Ambulatory BP measurements were recorded using CONTEC 06 C oscillometric device. Subjects were educated about fact that device will automatically inflate the cuff and measure BP periodically over a period of 24 hours. They were aware of need to book, so as to have monitor fitted and they cannot get device wet.

They were told to attend clinic after bathing and wear a shirt or top with loose sleeves that can best accommodate the cuff and a firm waistband was used to support the monitor. They were advised to continue with their normal daily activities, preferably including a workday rather than a rest day. They were explained that when cuff starts to inflate, they should stop moving and talking, keep arm still, extended and relaxed, and breathe normally. Furthermore, they were advised to avoid activities (such as vigorous exercise) that may interfere with performance of the device.

Precautions taken by medical personal

The correct cuff size is essential and in obese subjects, a conical shaped cuff was used. Different cuff sizes used in present study varied according to body structure of the subject i.e., 12 x 18 cm, 12 x 26 cm, and 12 x 40 cm for lean adults, normal adults, and adults with large arm, respectively.

Circadian parameters

The mean day-time SBP and DBP values were estimated using BP values obtained from 6 am to 10 pm, mean night-time SBP and DBP values were estimated using BP values from 10 pm to 6 am, and finally night-time dipping (ND) was calculated as: [(day-time mean SBP-night-time mean SBP)/day-time mean SBP] × 100.11 On basis of ND, circadian BP patterns were divided into three types: the dipper (a positive day-night ratio between 10% and 20%); the non-dipper (ratio of less than 10%), and the inverse dipper (a negative day-night ratio).[12]

What did the results mean?

- 24-hour mean BP <115/75 mmHg (hypertension threshold 130/80mmHg)

- Day-time BP <120/80 mmHg (hypertension threshold 135/85 mmHg)
- Night-time BP <105/65 mmHg (hypertension threshold 120/75 mmHg).

Ambulatory BP values above 'normal' and below thresholds for hypertension were considered as 'high normal'. BP was measured in both arms and if SBP difference was found to be <10 mmHg, the non-dominant arm was used. If SBP difference was >10 mmHg, arm with higher BP was used. If there were contraindications to measuring BP in one arm (e.g. fistula or previous axillary clearance), monitor was fitted on another arm.

To ensure validity of ABPM device, at least three readings were recorded simultaneously, using calibrated sphygmomanometer connected to ABPM device with help of Y connector. If the average readings for ABPM device and sphygmomanometer were found not to be differing by >5 mmHg, then ABPM device was used. ABPM device was programmed to take readings at set intervals i.e., every 15 minutes during day-time and every 30 minutes during night-time.

Statistical analysis

Data are collected and entered in Microsoft Excel Sheet 2010 and analysed using SPSS version 19.0 (IBM SPSS Inc., Chicago, IL, USA). Data was interpreted as mean±standard deviation, if normally distributed or as percentage otherwise. Continuous variables in patient groups were compared by analysis of variance. Categorical variables were compared by chi-square test. A p-value of less than 0.05 was accepted as statistically significant.

RESULTS

Demographic parameters and distribution of subjects according to BMI and WC are depicted in Table 1. Based on BMI and WC as criteria, 75 (78.9%) and 69 (72.6%) subjects, respectively were either overweight or obese. Though mean age showed incremental trend with increasing BMI and WC, but association between mean age and BMI (p-value = 0.361), and mean age and WC (p-value = 0.600) was not significant statistically. According to BMI and not WC, significantly higher proportion of females were obese (p-value = 0.020), as compared to males.

Table 1: Demographic parameters and distribution of subjects according to BMI and WC.

Groups	Characteristics		
	According to BMI		
	Age (years) (mean±SD)	**Gender (%)**	
		Female (%)	Male (%)
Group I (Normal) (n=20)	37.80±9.28	10 (50)	10 (50)
Group II (Over-weight) (n=50)	38.48±10.86	21 (42)	29 (58)
Group III (Obese) (n=25)	41.72±10.37	19 (76)	6 (24)
p-value	0.361*	0.020#	
	According to WC		
Group A (Normal) (n=26)	38.27±8.85	10 (38.5)	16 (61.5)
Group B (Obese) (n=69)	39.54±11.00	40 (58.0)	29 (42.0)
p-value	0.600*	0.090#	

Data expressed as absolute numbers, percentages, and Mean±SD; p-value <0.05 was considered as statistically significant; * - ANOVA; # - chi-square test; BMI-body mass index; WC-waist circumference

Comparison of biochemical parameters among study subjects is depicted in Table 2. Considering BMI as criteria, mean RBS and lipid levels (TC, TG, HDL-C, LDL-C) were significantly higher in overweight and obese groups as compared to those with normal BMI (p-value < 0.05). However, considering WC as criteria, only TC and LDL-C levels were found to be significantly higher in obese subjects as compared to normal subjects.

Systolic ambulatory BP pattern: Association of BMI and WC with systolic ambulatory BP pattern is depicted in Table 3. With BMI as criteria, proportion of patients with high/high normal 24 hr SBP, High/High normal day-time SBP, high/high normal night-time SBP were observed to be increasing with increase in BMI. Proportion of dippers were found to be decreasing with increasing BMI, while proportion of inverse dippers, those with positive day systolic load, and those with positive night systolic load revealed an incremental trend with increase in BMI. Similarly, circadian variability was found to be decreasing with increase in BMI. All these associations of ambulatory SBP with BMI were found to be statistically significant (p-value < 0.05).

Similarly, with WC as criteria, proportion of subjects with high/high normal 24 hr SBP, high/high normal day-time SBP, high/high normal night-time SBP, inverse dippers, and positive night systolic load was significantly higher in Group B as compared to Group A (p-value <0.05). Although, proportion of subjects with positive day systolic load and absence of circadian variation in SBP were higher in Group B as compared to Group A, but difference between two groups was not statistically significant (p-value >0.05).

Table 2: Comparison of biochemical parameters among study subjects.

Groups	Biochemical characteristics				
	According to BMI				
	RBS (mg/dl)	**TC (mg/dl)**	**TG (mg/dl)**	**HDL-C (mg/dl)**	**LDL-C (mg/dl)**
Group I (Normal) (n=20)	101.60±15.29	136.95±13.60	115.85±13.34	44.05±7.63	66.40±6.14
Group II (Over-weight) (n=50)	112.88±12.96	141.56±23.56	121.66±24.27	44.64±8.47	72.82±19.10
Group III (Obese) (n=25)	106.00±13.41	160.00±23.06	135.12±25.60	51.24±13.42	91.76±18.98
*p-value	0.005	0.001	0.014	0.015	<0.001
	According to WC				
Group A (Normal) (n=26)	105.08±15.50	137.19±14.51	117.73 ± 13.53	45.50±8.55	66.19±7.09
Group B (Obese) (n=69)	110.06±13.60	148.55±25.23	126.33 ± 26.20	46.54±10.81	80.32±21.27
*p-value	0.129	0.033	0.115	0.661	0.001

Data expressed as mean ± SD; p-value < 0.05 was considered as statistically significant; * - ANOVA; BMI-Body Mass Index; WC-Waist circumference; RBS-Random blood sugar; TC-Total cholesterol; TG-Triglycerides; HDL-C-High density lipoprotein cholesterol; LDL-C -Low density lipoprotein cholesterol

Table 3: Association of BMI and waist circumference with Systolic Ambulatory BP Pattern.

Pattern	According to BMI				According to WC		
	Group I (Normal BMI)(n=20)	**Group II (Overweight) (n=50)**	**Group III (Obese) (n=25)**	**p-value#**	**Group A (Normal) (n=26)**	**Group B (Over-weight) (n=69)**	**p-value#**
SBP 24 hr							
High	0	11	8	< 0.001	2	17	< 0.001
High Normal	4	26	14		6	38	
Normal	16	13	3		18	14	
Day SBP							
High	0	8	7	< 0.001	2	13	< 0.001
High Normal	2	28	14		4	40	
Normal	18	14	4		20	16	
Night SBP							
High	0	16	18	< 0.001	1	33	< 0.001
High Normal	10	21	4		13	22	
Normal	10	13	3		12	14	
Systolic Dipping							
Dipper	11	21	3	0.007	14	21	< 0.001
Non-Dippers /Inv. Dippers	9	29	22		12	48	
Day Systolic Load							
Negative	20	43	18	0.031	24	57	0.234
Positive	0	7	7		2	12	
Night Systolic Load							
Negative	20	36	7	< 0.001	25	38	< 0.001
Positive	0	14	18		1	31	
Circadian variation SBP							
Absent	10	31	21	0.046	13	49	0.055
Present	10	19	4		13	20	

Data expressed as absolute numbers; p-value <0.05 was considered as statistically significant; # - Chi-square test; BMI-Body Mass Index; WC-Waist circumference; SBP-Systolic blood pressure

Diastolic ambulatory BP pattern: Association of BMI and WC with diastolic ambulatory BP pattern is depicted in Table 4. With BMI as criteria, DBP had statistically significant association with increasing BMI for high/high normal 24 hr DBP, diastolic dipping, night diastolic load and circadian variation in DBP (p-value < 0.05). Whereas, there was no significant association (p-value 0.05) between DBP and increasing BMI for day-time DBP, night-time DBP and day diastolic load.

Table 4: Association of BMI and waist circumference with diastolic Ambulatory BP pattern.

Pattern	According to BMI				According to WC		
	Group I (Normal BMI) (n=20)	Group II (Overweigh) (n=50)	Group III (Obese) (n=25)	p-value#	Group A (Normal) (n=26)	Group B (Overweight) (n=69)	p-value#
DBP 24 hr							
High	0	11	3	0.001	3	11	0.001
High Normal	0	15	10		0	25	
Normal	20	24	12		23	33	
Day DBP							
High	0	10	3	0.055	3	10	0.161
High Normal	0	4	4		0	8	
Normal	20	36	18		23	51	
Night DBP							
High	0	11	8	0.084	0	19	0.011
High Normal	9	21	10		13	27	
Normal	11	18	7		13	23	
Diastolic Dipping							
Dipper	14	28	7	0.013	18	31	0.035
Non-Dippers / Inv.Dippers	6	22	18		8	38	
Day Diastolic Load							
Negative	20	43	24	0.106	23	64	0.502
Positive	0	7	1		3	5	
Night Diastolic Load							
Negative	20	47	19	0.011	26	60	0.053
Positive	0	3	6		0	9	
Circadian variation in DBP							
Absent	6	22	18	0.013	6	40	0.002
Present	14	28	7		20	29	

Data expressed as absolute numbers; p-value <0.05 was considered as statistically significant; # - Chi-square test; BMI-Body Mass Index; WC-Waist circumference; DBP-Diastolic blood pressure

Table 5. Association of BMI and WC with pulse pressure.

Groups	Pulse pressure	
	≤ 50 mmHg	**> 50 mmHg**
	Association of BMI	
Group I (Normal) (n=20)	20	0
Group II (Over-weight) (n=50)	35	15
Group III (Obese) (n=25)	11	14
p-value#	< 0.001	
	Association of waist circumference	
Group A (Normal) (n=26)	25	1
Group B (Obese) (n=69)	41	28
p-value#	< 0.001	

Data expressed as absolute numbers; p-value <0.05 was considered as statistically significant; # - Chi-square test; BMI-Body Mass Index; WC – Waist circumference

Similarly, with WC as criteria, proportion of subjects with high/high normal 24hr DBP, high/high normal night-time DBP, absence of diastolic dipping and absence of diastolic circadian variation were higher in Group B as compared to Group A and difference between them was statistically significant (p-value<0.05). Whereas, proportion of subjects with high/high normal day-time DBP, negative day diastolic load and positive night diastolic load was higher in Group B as compared to Group A but difference between them was not found to be statistically significant (p-value >0.05).

Pulse pressure: Association of BMI and WC with pulse pressure is depicted in Table 5. With both BMI and WC as criteria, the proportion of subjects with pulse pressure of >50 mmHg increased significantly with increase in both BMI and WC (p-value <0.001).

Finally, percentage of subjects (according to BMI and WC) with abnormal ABPM variables are depicted in Table 6.

Table 6. Percentage of subjects according to BMI and WC with abnormal ABPM variables.

Variables	% of subjects with increased BMI increased BMI>25	% of subjects with increased WC
HN/H 24-hr SBP	78.6	79.7
HN/H Day SBP	76	70.6
HN/H Night SBP	78.6	73.3
HN/H 24-hr DBP	65	48
HN/H Day DBP	28	24
HN/H Night DBP	66.6	66.6
Sys Day load	18.6	17.3
Sys Night load	42.6	41.3
Dias Day load	10.6	7.2
Dias Night load	12.	12
Sys Non-dippers and Inverse dippers	68	64
Dias Non-dippers and Inverse dippers	53.3	55
Loss of systolic circadian variability	69.8	65.3
Loss of diastolic circadian variability	53.3	53.3
Pulse pressure	38.6	40.5

Data expressed as percentages; BMI-Body Mass Index; WC-Waist circumference; HN-High Normal; H-High; SBP-Systolic blood pressure; DBP-Diastolic blood pressure; Sys-Systolic; Dias-Diastolic

DISCUSSION

As per WHO, abnormal or excessive accumulation of fat that might result in impaired health is termed as overweight and obesity.[2] BMI represents total body fat, whereas WC represents central body fat.[13] Increased body weight is associated with adverse effects on the physiological body functions and thus, is implicated in various chronic disorders such as osteoarthritis, cardiovascular diseases, type 2 DM, respiratory disease, cancers, and premature mortality.[1,2,14-16]

As compared to office BP monitoring, ABPM is better predictor of hypertension-mediated organ damage (HMOD).[17] Moreover, closer relationship has been demonstrated between 24 h mean ambulatory BP and morbid or fatal events, and it is more sensitive risk predictor of CV outcomes than office BP.[17,18-20] Understanding of ABPM depends on parameters such as mean day-time, night-time and 24-hour BP measurements, and evaluation of diary information and timing of drug treatment.[9]

In present study, majority of over-weight and/or obese subjects were female (Table 1). This finding is consistent with findings of global epidemiological studies that reported higher prevalence of over-weight or obesity in females.[1,2,21] In present study, mean age of over-weight and/or obese subjects was in range of 38-41 years, while as per epidemiological studies, prevalence obesity in adults peaks at 50-65 years.[1,21] In present study, increased BMI was associated with significantly increased mean RBS and lipid levels (p-value <0.05). However, increased WC resulted in significant increase in only TC and LDL-C levels (p-value <0.05) (Table 2). It has been cited in literature that obesity results in significantly increased plasma TC, TG, LDL-C, and RBS; and decreased HDL-C.[22,23] And this further leads to increased cardiovascular risk.[24]

In present study, based on BMI, there was significant increase in 24-hr SBP and DBP; day-time and night-time SBP; and systolic and diastolic dipping among over-weight and obese subjects as compared to normal subjects (p-value <0.05) (Table 3 and 4). Whereas, based on WC, obese subjects had significant increase in 24-hr SBP and DBP; day-time and night-time SBP; night-time DBP; and systolic and diastolic dipping as compared to normal subjects (p-value < 0.05) (Table 3 and 4). It was also observed that with increase in obesity, SBP and DBP increases both during day and night, but more during night and this was better demonstrated in terms of increase in BMI, than in terms of increase in WC (Table 6). Similar to present study, Kang et al, reported significant increase in both day-time and night-time SBP and DBP in patients with central obesity.[25] Kotsis et al, reported significant increase in 24 hr SBP, and both day-time SBP and DBP, but no significant increase in 24 hr DBP in obese individuals as compared to individuals with normal weight.[26]

In present study, based on BMI, prevalence of systolic and diastolic non-dipper and/or inverse dippers in obese subjects was 68% and 53.3%, respectively (Table 6). While, based on WC, prevalence of systolic and diastolic non-dipper and/or inverse dippers in obese subjects was 64% and 55%, respectively (Table 6). Moreover, based on both BMI and WC, there was a significant increase in non-dippers and/or inverse dippers for both SBP and DBP. It was also noted that dipping pattern was better explained with BMI but prevalence was better interpreted with WC. Similar to present study, Araujo et al, reported significant increase in non-dippers and reverse dippers in over-weight and/or obese individuals.[27] Furthermore, a strong association has been proven between non-dipper/reverse dipping BP pattern and an increased incidence of fatal and non-fatal cardiovascular events.[27] In present study, non-dipping was more frequently seen among subjects with than without obesity and associated more with BMI than WC.

In present study, based on BMI, both negative day and night systolic load, and negative night diastolic load was significantly higher in overweight and obese subjects (Table 3 and 4). It was systolic load which first started to increase as BMI increased >25 Kg/m^2. Thus, present study demonstrates that as BMI increases, both systolic and diastolic load increases, which was more at night. However, based on WC, only negative night systolic load was significantly higher in obese subjects (Table 3 and 4). Thus, the present study demonstrates that as compared to day, night systolic BP load increases with BMI and WC, but these values increases more in individuals whose BMI was >30 Kg/m^2. We could not find studies comparing systolic and diastolic load in obese adult subjects, but similar studies in pediatric and adolescent subjects revealed that as BMI increases, both systolic and diastolic load also increases, but in a study by Renda R there was a significant increase in only day and night diastolic load.[28]

In present study, as BMI increases, there was a significant increase in subjects with absent circadian variation in both SBP and DBP. However, as WC increased, there was a significant increase in subjects with absent circadian variation in only DBP. Gupta et al. reported that risk of CVD and early death increases with abnormalities in circadian BP variability. Furthermore, they concluded that abnormal circadian BP variability helps in early and easy recognition of increased CVD in asymptomatic normal-weight, overweight and/or obese adults.[12]

In present study, the proportion of subjects with pulse pressure (PP) of >50 mmHg increased significantly with increase in both BMI and WC. Moreover, it was observed that as BMI increases, systolic inverse dipping increases, but diastolic inverse dipping decreases i.e., pulse pressure rises. Similarly, Kang AS et al, and Kotsis V et al, reported that obese patients had significantly wider PP than non-obese patients.[25,29] Kotsis et al, concluded that both increased BMI and day-time PP are critical predictors of left ventricular enlargement and thus, 24-h ABP may be advantageous in obese patients, even when they do not suffer from hypertension.[29]

Various studies have reported that both BMI and WC are predictor of CVD risk, but which among them is a better predictor, still remains a matter of debate; with some reporting that both are equi-effective, 30-32 few reporting that BMI is better, while others reporting WC to be a better predictor of CVD risk.[33-36] It can be observed from present study that among various abnormal ABPM parameters, only three parameters with abnormal values i.e., 24-hr SBP, diastolic non-dippers and inverse dippers, and pulse pressure revealed more incidence with increased WC than with increased BMI (Table 6). Moreover, as a screening tool for hypertension in overweight subjects, BMI was preferred, as it covered more subjects for screening, as there were subjects with BMI >25 Kg/m^2 and had less WC (as per obesity criteria). Thus, if WC is used as criteria, then some subjects would be excluded despite having BMI >25 Kg/m^2. Hence, it can be inferred that BMI is better anthropometric parameter than WC.

Limitations of study included cross-sectional study design; small sample size; lack of follow-up data; lack of information on other risk factors, like alcohol, smoking, diabetes, dyslipidemia, high salt diet; and unequal distribution of overweight and obese subjects.

CONCLUSION

The present study confirms that obesity in apparently non-hypertensive subjects leads to rise in both SBP and DBP. The findings of study have significant epidemiological and clinical association, conveying that healthy subjects who are overweight are also susceptible to rise in BP. Furthermore, overweight and obesity results in abnormalities in circadian variation of BP and also affects nocturnal dipping pattern of both SBP and DBP. Finally, it is the systolic part of ABPM which probably predicts cardiovascular morbidity in overweight and obese subjects

ACKNOWLEDGEMENTS

Authors would like to thank Dr. V. S. Sharma, MD for his editing support.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by Institutional Ethics Committee of King George's Medical University, Lucknow, Uttar-Pradesh, India

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Cite this article as: Singh S, Lohakare AC. Ambulatory blood pressure pattern in overweight and obese subjects: a prospective, cross-sectional study. Int J Res Med Sci 2019;7:2168-76.