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Original Research Article

Study of Sleep Apnea Risk in Obese patients

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Abstract:

Background: Obesity is an important modifiable risk factor for obstructive sleep apnea (OSA), which frequently remains undiagnosed. Early screening may help identify obese patients who require confirmatory evaluation.
Objective: To assess OSA risk among obese patients and examine its association with demographic, clinical and anthropometric characteristics.
Materials and Methods: This hospital-based cross-sectional observational study included 100 adults with BMI ≥30 kg/m² attending a tertiary-care hospital. Participants were recruited consecutively and assessed using the STOP-Bang questionnaire. Scores of 0–2, 3–4 and 5–8 indicated low, intermediate and high risk, respectively. Chi-square and independent-samples *t*-tests were applied, with $p<0.05$ considered statistically significant.
Results: The participants' mean age was 49.7±10.949.7\pm10.9 years and mean BMI was 34.9±4.034.9\pm4.0 kg/m². Overall, 68% had increased OSA risk, including 38% at intermediate risk and 30% at high risk. Habitual snoring was reported by 61%, daytime tiredness by 55% and observed apnea by 28%. Increased risk was significantly associated with male sex ($p=0.003$), age >50 years ($p<0.001$), obesity class ($p=0.001$), hypertension ($p<0.001$), diabetes mellitus ($p=0.016$) and neck circumference >40 cm ($p<0.001$). Patients at increased risk had significantly higher mean age, BMI, neck circumference and waist circumference.
Conclusion: A substantial proportion of obese patients were at increased risk of OSA. Routine STOP-Bang screening may facilitate early identification and referral of high-risk patients for polysomnographic confirmation.

Keywords: Obesity; Obstructive Sleep Apnea; STOP-Bang Questionnaire; Neck Circumference; Hypertension; Risk Assessment.

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Introduction

Obesity is a major and rapidly increasing public-health problem associated with several metabolic, cardiovascular and respiratory complications. One important but frequently under-recognized complication of obesity is obstructive sleep apnea (OSA). OSA is a sleep-related breathing disorder characterized by recurrent partial or complete collapse of the upper airway during sleep. These episodes produce reduction or cessation of airflow, intermittent oxygen desaturation, repeated arousals and fragmentation of normal sleep architecture [1]. Its common clinical manifestations include loud habitual snoring, witnessed pauses in breathing, nocturnal choking or gasping, morning headache, unrefreshing sleep, excessive daytime sleepiness, impaired concentration and reduced work performance.

OSA is common in the general adult population, although its prevalence varies according to age, sex, obesity, ethnicity and the diagnostic criteria used. A systematic review reported that the prevalence of OSA defined by an apnea–hypopnea index (AHI) of at least five events per hour ranged from 9% to 38% in adults. Its prevalence was higher among men, older individuals and persons with a higher body mass index (BMI) [2]. In India, a recent systematic review and meta-analysis reported a pooled OSA prevalence of approximately 11% among adults, while moderate-to-severe OSA was present in approximately 5%. The prevalence was higher among men than women, indicating that OSA constitutes an important public-health burden in the country [3].

Obesity is one of the strongest modifiable risk factors for OSA. Accumulation of adipose tissue around the neck and pharyngeal region narrows the upper airway and increases its tendency to collapse during sleep. Central and abdominal obesity also reduce lung volume and the traction exerted by the lungs on the upper airway, further increasing pharyngeal collapsibility. In addition, obesity may impair upper-airway neuromuscular control and contribute to abnormalities in respiratory regulation. Consequently, increasing BMI, neck circumference and waist circumference are associated with a greater likelihood and severity of OSA [4]. Obesity and OSA may also have a bidirectional relationship. While excess body weight predisposes individuals to OSA, sleep fragmentation and insufficient restorative sleep may promote fatigue, reduced physical activity, altered appetite regulation and further weight gain.

The repeated episodes of upper-airway obstruction in OSA result in intermittent hypoxia, sympathetic nervous-system activation, oxidative stress, inflammation and changes in intrathoracic pressure. If left unrecognized or untreated, OSA may adversely affect multiple organ systems. It has been associated with systemic hypertension, insulin resistance, type 2 diabetes mellitus, dyslipidaemia, cardiac arrhythmias, coronary artery disease, heart failure and stroke [1,5]. OSA-related daytime sleepiness may also impair memory, concentration and psychomotor performance, thereby increasing the risk of occupational injuries and road-traffic accidents. These consequences are particularly important among obese patients, who may already have several coexisting cardiometabolic risk factors.

Despite its clinical importance, OSA frequently remains undiagnosed because snoring and daytime tiredness may be ignored or regarded as ordinary consequences of obesity or lifestyle. Overnight polysomnography is the standard investigation for establishing the diagnosis and determining the severity of OSA. Severity is commonly assessed using the AHI, which represents the average number of apnoea and hypopnoea episodes occurring per hour of sleep. However, polysomnography is relatively expensive, time-consuming and not universally available. Therefore, simple clinical screening instruments are useful for identifying individuals who require further diagnostic evaluation.

The STOP-Bang questionnaire is a widely used screening instrument that assesses eight factors: snoring, tiredness, observed apnoea, high blood pressure, BMI, age, neck circumference and gender. It is brief, inexpensive and easy to administer in outpatient and hospital settings. A score of three or more has high sensitivity for identifying individuals at risk of moderate-to-severe OSA, although a screening result alone cannot confirm the diagnosis [6]. Because BMI and neck circumference are included in the questionnaire, it is particularly suitable for evaluating sleep-apnea risk in obese patients.

Early identification of obese individuals at risk of sleep apnea provides an opportunity for timely counselling, weight-management interventions, diagnostic testing and appropriate treatment. It may consequently reduce cardiometabolic complications, improve daytime functioning and enhance quality of life. Therefore, the present study, titled "Study of Sleep Apnea Risk in Obese Patients," was undertaken to estimate the proportion of obese patients at risk of OSA and to examine its association with relevant demographic, anthropometric and clinical characteristics.

Materials and Method

Study Design and Setting: A hospital-based, cross-sectional observational study was conducted in the Department of General Medicine at Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, Telangana, over a period of 12 months. The study was undertaken to assess the risk of obstructive sleep apnea (OSA) among obese adult patients attending the outpatient department or admitted to the hospital.

Study Population: Adult patients aged 18 years or older with obesity were considered eligible. Obesity was defined as a body mass index (BMI) of ≥30 kg/m², calculated by dividing weight in kilograms by the square of height in metres.

Participants were enrolled after obtaining written informed consent.

Inclusion Criteria

- Patients aged 18 years or older.
- Patients with BMI ≥30 kg/m².
- Patients willing to participate and provide informed consent.
- Patients able to understand and respond to the study questionnaire.

Exclusion Criteria

- Previously diagnosed cases of obstructive or central sleep apnea receiving treatment.
- Patients currently using continuous positive airway pressure therapy.
- Pregnant women.
- Patients with severe cardiorespiratory illness requiring emergency treatment.
- Patients with craniofacial abnormalities or recent upper-airway surgery.
- Patients with severe psychiatric or neurological disorders affecting their ability to respond.
- Patients receiving sedatives or hypnotic drugs on a long-term basis.
- Patients who refused to provide consent.

Sample Size: The sample size was calculated using the formula for estimating a single population proportion:

$$n = \frac{Z_{\alpha/2}PQ}{ME^2}$$

where:

- n = required sample size
- $Z\alpha/2$ = 1.96 at a 95% confidence level
- p = expected prevalence of OSA risk among obese patients (33.5%)
- ME = Marginal Error (10%)

The sample size was calculated using the prevalence reported by Singh et al.[7], who found that 33.5% of obese individuals were at high risk of obstructive sleep apnea. Considering a 95% confidence level, 10% absolute precision and an expected prevalence of 33.5%, the minimum sample size calculated using the formula was 86. After adjusting for a 10% non-response or incomplete-data rate, the required sample size was 96. Therefore, a total of 100 obese patients were included in the study.

Sampling Technique: Eligible patients were recruited using consecutive sampling until the required sample size was achieved. Each participant was evaluated using a predesigned case-record form.

Data Collection Procedure: After enrolment, demographic and clinical information was collected through personal interviews and examination. The information included age, sex, occupation, smoking status, alcohol consumption, duration of obesity, physical activity, known hypertension, diabetes mellitus, cardiovascular disease and current medications.

Participants were questioned regarding common symptoms of OSA, including habitual snoring, witnessed episodes of cessation of breathing during sleep, nocturnal choking or gasping, unrefreshing sleep, morning headache, excessive daytime sleepiness and difficulty concentrating.

Anthropometric and Clinical Measurements: Height was measured without footwear using a stadiometer and recorded to the nearest 0.1 cm. Weight was measured in light clothing using a calibrated weighing scale and recorded to the nearest 0.1 kg. BMI was subsequently calculated.

Neck circumference was measured at the level of the cricothyroid membrane using a non-stretchable measuring tape. Waist circumference was measured midway between the lower border of the last palpable rib and the upper border of the iliac crest. Blood pressure was measured in the sitting position after at least five minutes of rest using a standard sphygmomanometer. Two readings were obtained, and their average was used for analysis.

Assessment of sleep-apnea risk: The risk of OSA was assessed using the STOP-Bang questionnaire, which consists of eight items:

- **S** – loud snoring
- **T** – daytime tiredness
- **O** – observed apnea
- **P** – high blood pressure
- **B** – BMI >35 kg/m²
- **A** – age >50 years
- **N** – neck circumference >40 cm
- **G** – male gender

Each positive response was assigned one point, giving a total score ranging from 0 to 8. Participants were classified as:

- **Low Risk:** STOP-Bang score 0–2.
- **Intermediate Risk:** STOP-Bang score 3–4.
- **High Risk:** STOP-Bang score 5–8.

For overall analysis, participants with a score of ≥3 were considered at increased risk of OSA. The STOP-Bang questionnaire was used only as a screening instrument and not as a confirmatory diagnostic test. Participants identified as being at high risk were advised to undergo further clinical evaluation and polysomnography where appropriate.

Ethical Considerations: The study protocol was approved by the Institutional Ethics Committee before commencement. Written informed consent was obtained from every participant. Confidentiality of personal and medical information was maintained throughout the study. Participation was voluntary, and participants were permitted to withdraw at any stage without affecting their medical care.

Statistical Analysis: The collected data were entered into Microsoft Excel and analysed using SPSS version 25. Continuous variables were presented as mean and standard deviation or median and interquartile range, as appropriate. Categorical variables were expressed as frequencies and percentages. The chi-square test or Fisher's exact test was used to assess associations between categorical variables. The independent-samples t-test or Mann–Whitney U test was used for continuous variables. Multivariable logistic regression was performed to identify independent predictors of increased OSA risk. A p-value of less than 0.05 was considered statistically significant.

Observation and Results

A total of 100 obese patients were included in the study. Their mean age was 49.7±10.9 years. The mean BMI was 34.9±4.0kg/m². According to the STOP-Bang questionnaire, 68% of the patients had an increased risk of obstructive sleep apnea, including 38% at intermediate risk and 30% at high risk.

Table 1: Demographic and clinical characteristics of participants

Characteristic	Frequency/Mean	Percentage/SD
Age, years	49.7	±10.9
Male	56	56.00%
Female	44	44.00%
BMI, kg/m²	34.9	±4.0
Neck circumference, cm	40.9	±3.7
Waist circumference, cm	108.8	±10.8
Class I obesity: BMI 30.0–34.9 kg/m²	58	58.00%
Class II obesity: BMI 35.0–39.9 kg/m²	28	28.00%
Class III obesity: BMI ≥40 kg/m²	14	14.00%
Hypertension	44	44.00%
Diabetes mellitus	32	32.00%
Current smoking	20	20.00%
Alcohol consumption	24	24.00%

Most participants belonged to Class I obesity, followed by Class II and Class III obesity. Hypertension was present in 44% and diabetes mellitus in 32% of participants.

Table 2: Distribution of individual STOP-Bang components

STOP-Bang component	Yes, n (%)	No, n (%)
Loud habitual snoring	61 (61.0%)	39 (39.0%)
Daytime tiredness	55 (55.0%)	45 (45.0%)
Observed episodes of apnea	28 (28.0%)	72 (72.0%)
High blood pressure	44 (44.0%)	56 (56.0%)
BMI >35 kg/m²	42 (42.0%)	58 (58.0%)
Age >50 years	42 (42.0%)	58 (58.0%)
Neck circumference >40 cm	39 (39.0%)	61 (61.0%)
Male sex	56 (56.0%)	44 (44.0%)

Loud habitual snoring was the most frequently reported STOP-Bang component, observed in 61% of participants. It was followed by male sex, daytime tiredness and hypertension. Observed apnea was reported in 28% of patients.

Table 3: Distribution according to STOP-Bang risk category

Risk Category	STOP-Bang score	Frequency	Percentage
Low risk	0–2	32	32.00%
Intermediate risk	3–4	38	38.00%
High risk	5–8	30	30.00%
Total		100	100.00%

Thirty-two percent of participants were classified as having a low risk of OSA. Intermediate and high risk were observed in 38% and 30%, respectively. Thus, 68% of the obese patients had an increased risk of OSA, defined as a STOP-Bang score of three or more.

Table 4: Association between participant characteristics and increased OSA risk

Characteristic	Total	Increased risk, n (%)	Low risk, n (%)	Chi-square	p-value
Sex					
Male	56	45 (80.4%)	11 (19.6%)	8.931	0.003
Female	44	23 (52.3%)	21 (47.7%)		
Age group					
>50 years	42	37 (88.1%)	5 (11.9%)	13.438	<0.001
≤50 years	58	31 (53.4%)	27 (46.6%)		
Obesity class					
Class I	58	31 (53.4%)	27 (46.6%)	13.657	0.001
Class II	28	24 (85.7%)	4 (14.3%)		
Class III	14	13 (92.9%)	1 (7.1%)		
Hypertension					

Present	44	39 (88.6%)	5 (11.4%)	15.377	<0.001
Absent	56	29 (51.8%)	27 (48.2%)		
Diabetes mellitus					
Present	32	27 (84.4%)	5 (15.6%)	5.799	0.016
Absent	68	41 (60.3%)	27 (39.7%)		
Neck circumference					
>40 cm	39	37 (94.9%)	2 (5.1%)	21.216	<0.001
≤40 cm	61	31 (50.8%)	30 (49.2%)		
Current smoking					
Yes	20	16 (80.0%)	4 (20.0%)	1.654	0.198
No	80	52 (65.0%)	28 (35.0%)		
Alcohol consumption					
Yes	24	19 (79.2%)	5 (20.8%)	1.81	0.179
No	76	49 (64.5%)	27 (35.5%)		

Increased OSA risk was significantly more common among male participants than female participants (80.4% versus 52.3%; p=0.003). Participants older than 50 years also had a significantly higher risk than younger participants (88.1% versus 53.4%; p<0.001).
OSA risk increased progressively with the severity of obesity. Increased risk was observed in 53.4% of participants with Class I obesity, 85.7% with Class II obesity and 92.9% with Class III obesity (p=0.001). Hypertension, diabetes mellitus and neck circumference greater than 40 cm were also significantly associated with increased OSA risk. Smoking and alcohol consumption did not show statistically significant associations.

Table 5: Comparison of anthropometric variables according to OSA risk

Variable	**Mean ± SD**		**t-value**	**p-value**
	Increased risk (n=68),	**Low risk (n=32)**		
Age, years	52.8 ± 10.2	43.1 ± 9.4	4.683	<0.001
BMI, kg/m²	36.0 ± 4.2	32.7 ± 2.3	5.064	<0.001
Neck circumference, cm	42.3 ± 3.1	37.8 ± 2.6	7.579	<0.001
Waist circumference, cm	112.4 ± 10.5	101.2 ± 8.3	5.765	<0.001

Participants with increased OSA risk had significantly higher mean age, BMI, neck circumference and waist circumference than those classified as low risk.

Discussion

The present study assessed the risk of obstructive sleep apnea among 100 obese patients using the STOP-Bang questionnaire. The mean age of the participants was 49.7±10. years, and the mean BMI was 34.9±4.0 kg/m². Overall, 68% of the participants had an increased risk of OSA, comprising 38% with intermediate risk and 30% with high risk. These findings indicate that a substantial proportion of obese patients may have clinically important but unrecognized sleep-disordered breathing and may benefit from further diagnostic evaluation.

The proportion of patients with high OSA risk in the present study was comparable to that reported by Singh et al., who found that 33.5% of obese participants in a semi-urban Indian population had a high likelihood of OSA based on the Berlin Questionnaire [7]. Similarly, Choudhury et al. reported that 25% of adults surveyed in a rural community of Odisha had a high likelihood of OSA [8]. Mathiyalagen et al., in a study conducted among patients attending a non-communicable disease clinic in Puducherry, found that 25.8% were at high risk of OSA [9]. The slightly higher proportion of high-risk patients in the present study may be explained by the inclusion of only obese individuals, whereas the comparison studies included more heterogeneous community or clinic populations.

When intermediate- and high-risk categories were combined, 68% of the present participants had a STOP-Bang score of at least three. This proportion was considerably higher than the 23% reported by Dubey et al. among male driving-licence applicants in Lucknow using the same STOP-Bang cut-off [10]. The difference was expected because the present study specifically included obese patients, while the study by Dubey et al. included a broader occupational population. Because obesity is a major component of OSA risk, selection of an exclusively obese population increases the probability that participants will satisfy multiple STOP-Bang criteria.

The risk estimated by a screening questionnaire should not be interpreted as the prevalence of confirmed OSA. Indian studies using polysomnography have generally reported lower prevalence estimates. Udwadia et al. reported sleep-disordered breathing in 19.5% and obstructive sleep apnea–hypopnea syndrome in 7.5% of middle-aged urban Indian men [11]. BMI, neck girth and diabetes mellitus were the principal covariates of sleep-disordered breathing in their study. Reddy et al. reported an estimated population prevalence of 9.3% for OSA and 2.8% for symptomatic OSA syndrome among middle-aged adults in Delhi [12]. More recently, Dixit et al. identified polysomnography-confirmed OSA–hypopnea syndrome in 15.15% of obese patients attending a tertiary care centre in Maharashtra [13]. These estimates cannot be directly compared with the present 68% screening positivity because STOP-Bang is designed to identify patients who require further investigation and is not a confirmatory diagnostic test.

Loud habitual snoring was the most common symptom in the present study, reported by 61% of participants, followed by daytime tiredness in 55% and witnessed apnea in 28%. Snoring is produced by vibration of soft tissues in a partially narrowed upper airway and is one of the most recognizable clinical indicators of OSA. Udwadia et al. observed that snoring, nocturnal choking, unrefreshing sleep, recurrent awakening, daytime hypersomnolence and fatigue were significantly associated with OSA–hypopnea syndrome [11]. The high frequency of snoring and tiredness observed in the present study therefore supports the clinical value of routinely asking obese patients about nocturnal and daytime symptoms.

Male participants had a significantly higher frequency of increased OSA risk than female participants, at 80.4% compared with 52.3% (p=0.003p=0.003). This finding was consistent with the study by Reddy et al., in which male sex was independently associated with OSA, with an adjusted odds ratio of 3.8 [12]. In the present study, sex was also a direct component of the STOP-Bang score; consequently, the magnitude of its association with the derived risk category should be interpreted cautiously. Nevertheless, the finding agrees with Indian epidemiological evidence showing a greater OSA burden among men.

Age was another important factor. Increased OSA risk was observed in 88.1% of participants older than 50 years, compared with 53.4% of younger participants ($p<0.001$). The mean age of the increased-risk group was also significantly higher than that of the low-risk group. Dubey et al. reported that STOP-Bang-defined OSA risk increased from 6.7% among participants younger than 35 years to 73% among those older than 45 years [10]. These findings suggest that increasing age, together with obesity-related anatomical changes, identifies a subgroup that should receive particular attention during clinical screening.

A clear relationship was observed between the severity of obesity and OSA risk. Increased risk was present in 53.4% of participants with Class I obesity, 85.7% with Class II obesity and 92.9% with Class III obesity (p=0.001). The increased-risk group also had a significantly higher mean BMI than the low-risk group (36.0±4.2 versus 32.7±2.3 kg/m²; $p<0.001$). Reddy et al. similarly found that BMI ≥25 kg/m² and abdominal obesity were independently associated with OSA [12]. Ghosh et al., in a South Indian community-based study, also found that increased BMI and neck circumference were significantly associated with OSA and concluded that obesity was a strong predictor of the disorder [14].

Neck circumference showed one of the strongest associations in the present study. Among patients with a neck circumference greater than 40 cm, 94.9% had an increased risk of OSA, compared with 50.8% of those with a neck circumference of 40 cm or less ($p<0.001$). Mean neck circumference was also significantly greater in the increased-risk group (42.3±3.1 versus 37.8±2.6 cm). These findings were consistent with the observations of Udwadia et al. and Ghosh et al., both of whom identified neck circumference as an important anthropometric correlate of OSA [11,12]. Increased fat deposition around the neck can narrow the pharyngeal airway and increase its tendency to collapse during sleep.

Waist circumference was significantly greater among participants with increased OSA risk than among low-risk participants (112.4±10.5 versus 101.2±8.3cm; $p<0.001$). This finding supports the role of central obesity in OSA risk. Reddy et al. reported that abdominal obesity was independently associated with OSA in middle-aged urban Indians [12]. Central obesity may reduce functional residual capacity and diminish the stabilizing traction exerted by the lungs on the upper airway, thereby increasing upper-airway collapsibility.

Hypertension was present in 44% of participants, and 88.6% of hypertensive patients had increased OSA risk, compared with 51.8% of non-hypertensive patients ($p<0.001$). Choudhury et al. identified hypertension as an independent risk factor for a high likelihood of OSA in rural Odisha [8]. Singh et al. also found that 62.4% of patients in the high-risk OSA group had hypertension [13]. However, hypertension is directly included in the STOP-Bang score; therefore, the observed association partly reflects the construction of the screening questionnaire and should not be interpreted as an independent causal effect.

Diabetes mellitus was present in 32% of participants. Increased OSA risk was significantly more frequent among diabetic than non-diabetic patients (84.4% versus 60.3%; p=0.016. This finding was supported by the study of Udwadia et al., in which diabetes mellitus was identified as one of the principal covariates of sleep-disordered breathing [11]. Obesity, diabetes and OSA frequently coexist and may contribute jointly to insulin resistance, sympathetic activation and cardiometabolic risk. Screening for sleep apnea may therefore be particularly valuable among obese patients who also have diabetes or hypertension.

Smoking and alcohol consumption were not significantly associated with increased OSA risk in the present study. In contrast, Choudhury et al. identified regular alcohol consumption as an independent risk factor for a high likelihood of OSA [8]. This difference may be related to the relatively small number of smokers and alcohol users in the present sample, variation in the frequency or quantity of exposure, under-reporting, or differences between hospital-based and community populations. Larger studies with detailed exposure assessment may be required to clarify these relationships.

The present findings have practical clinical implications. Simple assessment of snoring, daytime tiredness, witnessed apnea, blood pressure, age, BMI, neck circumference and sex can help identify obese patients who require further investigation. Nevertheless, STOP-Bang indicates risk and cannot establish an OSA diagnosis or determine its physiological severity. Patients classified as high risk, particularly those with severe obesity, large neck circumference, hypertension or diabetes, should be considered for comprehensive sleep evaluation and polysomnography.

The principal limitations were the cross-sectional design, relatively small hospital-based sample and reliance on a screening questionnaire without polysomnographic confirmation. Furthermore, several variables found to be associated with OSA risk including age, sex, BMI, hypertension and neck circumference are components of the STOP-Bang score itself. Their statistical association with the resulting risk category is therefore partly inherent or circular and should be interpreted descriptively. Despite these limitations, the findings demonstrate a substantial burden of possible OSA among obese patients and support the use of routine clinical screening in this high-risk population.

Conclusion

The study found that a considerable proportion of obese patients were at increased risk of obstructive sleep apnea, with 38% classified as intermediate risk and 30% as high risk. Increased OSA risk was significantly associated with male sex, older age, higher obesity class, larger neck and waist circumferences, hypertension and diabetes mellitus. These findings emphasize the importance of routine OSA screening among obese patients using a simple tool such as the STOP-Bang questionnaire. Patients identified as high risk should undergo further clinical evaluation and polysomnography for diagnostic confirmation and timely management.

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Conflict of Interest: None

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