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Comparison of acromio-axillo-suprasternal notch index with thyromental height test to predict difficult visualization of larynx

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ABSTRACT

Background: Securing and maintaining a patent airway for the conduct of general anesthesia are a major concern for an anesthesiologist. Unanticipated difficult intubation in anesthetized patients is the main cause of morbidity or mortality. Several predictors are proposed to anticipate difficult tracheal intubation, but no predictor is found to be 100% accurate. Acromio-axillo-suprasternal notch index (AASI) is a recent addition to the list of predictors. **Aims and Objectives:** The current study compared the usefulness of AASI and thyromental height test (TMHT) as predictors of difficult visualization of larynx (DVL). **Materials and Methods:** Following approval by the Institutional Ethics Committee and CTRI registration, written informed consent was taken. The study was conducted on 300 patients aged 18–65 years belonging to American Society of Anesthesiologists' physical status I and II, with modified Mallampati (MMP) Scores of 1 and 2, over a period of 6 months. Preoperatively all patient's airway was evaluated using AASI and TMHT. The DVL during direct laryngoscopy was noted as assessed by Cormack and Lehane grading. We compared the sensitivity and specificity for DVL with regard to AASI and TMHT. **Results:** The incidence of unanticipated DVL was 14%. The sensitivity, specificity, positive predictive value, and negative predictive value of AASI were 86.4%, 38.1%, 89.6%, and 31.4%, respectively, and for TMHT, they were 94.6%, 4.8%, 85.9%, and 12.5%, respectively. Pearson correlation coefficient was $r = -0.068$ ($P=0.243$) when AASI was compared with TMHT. **Conclusion:** AASI was found to be less sensitive when compared to TMHT and there was statistically no significant correlation between the two parameters to predict the DVL.

Key words: Acromio-axillo-suprasternal notch index; Thyromental height test; Modified Mallampati score; Laryngoscopy; Cormack and Lehane grading

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INTRODUCTION

Maintaining a patent airway following induction of general anesthesia is the most imperative concern for an anesthesiologist. Unanticipated difficult intubation, especially when associated with difficult or lack of ventilation in anesthetized patients, is still the main cause of morbidity or mortality.[1]

Unanticipated difficult visualization of larynx during laryngoscopy leading to failure of endotracheal intubation may result in serious complications such as hypoxic brain damage or death. Pre-operative prediction of difficult laryngoscopy thus plays a paramount role in airway management as proper planning and strategies may decrease the morbidity or mortality.[2]

The search for an optimum predictor of difficult visualization larynx is a dynamic area of research. Over the years many different predictors have been proposed and are being used, but the sensitivity and specificity are limited.[3]

Of all the anesthetic deaths, approximately 30–40% are attributed to an inability to manage a difficult airway.

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Several preoperative clinical airway assessment tests, such as modified Mallampati (MMP) score, upper lip bite test (ULBT), thyromental distance (TMD), thyromental height test (TMHT), sternomental distance (SMD), neck circumference (NC), and ratio of height to TMD (RHTMD) have been used either alone and/or in various combinations for predicting difficult airway. However, no single test or combination of tests has been validated as the best predictor of difficult airway.[3]

Conventional tests for prediction of difficult airway which are commonly used in daily practice such as MMP, TMHT, TMD, SMD, and NC use simple anatomical landmarks. These bedside screening tests, even though they are quite simple, require patient's cooperation for the correct assessment of the tests. For example, MMP test performed in a sitting position is a standard method of airway assessment and predicts difficult airway, but sometimes it is not possible to make the patients sit upright for airway evaluation like patients with hemodynamic instability, prolapsed discs, cervical trauma, unconscious patients, and uncooperative patients for emergency surgeries.

There is a paucity of literature regarding airway assessment in supine patients and the applicability of Mallampati classification in supine patients in such situation is doubtful.

The study of acromio-axillo-suprasternal notch index (AASI) is a relatively new, easy-to-perform, and convenient bedside test that can be performed in supine position for predicting difficult airway in patients undergoing general aneasthesia.[4]

There is a need for a test, which is quick and easy to perform, highly sensitive (so that the majority of difficult cases can be identified), and highly specific (so that false positive rate will be low when the test is used routinely). Any test devised should be easy to perform and interpret at the bedside. Panjiar p et al., validated the use of TMHT and observed that the new test had a better predictive value than MMT, TMD, and SMD.[5] The TMHT is an easy-to-do and non-invasive test done in supine position. The test is based on the height between the anterior border of the mentum and the thyroid cartilage, while the patient lies supine with the mouth closed.

Thus, we propose to compare these two novel parameters AASI and TMHT in terms of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) in predicting the difficult visualization of larynx during endotracheal intubation in patients undergoing general anesthesia.

The primary objective of the study was to compare the usefulness of AASI and TMHT for predicting the difficult visualization of larynx (DVL) during endotracheal intubation in patients undergoing general anesthesia as assessed by Cormack and Lehane (CL) grading. The secondary objectives were to correlate AASI with MMP score, SMD, TMD, and NC.

Aims and objectives

The primary objective of the study was to compare the usefulness of AASI and TMHT for predicting the DVL during endotracheal intubation in patients undergoing general anaesthesia as assessed by CL grading. The secondary objectives were to correlate AASI with MMP score, SMD, TMD and NC.

MATERIALS AND METHODS

A prospective comparative observational study was conducted on adult patients scheduled to undergo elective surgery requiring endotracheal intubation under general anesthesia at Medical College Hospital during the study period June 2023–November 2023.

Inclusion criteria

(i) Patients posted for elective surgeries requiring endotracheal intubation under general anesthesia. (ii) Patient aged between 18 and 65 years, (iii) Patients belonging to American Society of Anesthesiologists' physical status (ASA PS) I and II.

Patients with body mass index >30 kg/m^2, obstetric patients, patients with upper airway deformities, anatomical abnormality and limitation of TMJ and atlantoaxial joint, oral and maxillofacial tumors, history of head, neck, and thoracic surgery were excluded from the study.

After obtaining approval from the Institutional Ethics Committee (IEC number – EC 322, Dated – 14/3/2023), CTRI registration was done (CTRI/2023/05/053104). Written informed consent was taken from all the eligible patients who were enrolled in this prospective comparative observational single-center study.

On the day of surgery in the pre-operative room, after taking written informed consent, below airway parameters were measured in all the enrolled patients:
Tests done in Supine position – AASI and TMHT

1. AASI was measured with the patients lying in supine position and the upper limbs resting by the side of the body. Using a ruler, a vertical line drawn from the top of the acromion process to the superior border of the axilla at the pectoralis muscle (line A). Then a second line drawn perpendicular to line A from the suprasternal notch (line B). The portion of line A that lies above the intersection by line B on line A will be termed as line C. AASI is calculated

by dividing the length of line C by that of line A (AASI = C/A). AASI value of >0.49 is considered as a good predictor for DVL.[1]

2. TMHT: The height between the anterior border of the thyroid cartilage (on the thyroid notch just between the two thyroid lamine) and the anterior border of the mentum (on the mental protuberance of the mandible) will be measured, with the patient comfortably lying supine using a pillow with mouth closed. This height was measured with a digital depth gauge (INSIZE® Electronic Depth Gage, INSIZE). A measurement of <50 mm is considered to be a good predictor of DVL.

Tests done in a sitting position are – MMP, TMD, SMD, and NC.

3. MMP: Mallampati classification with the patient in the sitting position, mouth maximally opened, and tongue protruded, while the observer looking from the patient's eye level inspected the pharyngeal structures with a pen torch, without the patient phonating. Class I and II are classified as easy visualization of larynx (EVL), whereas Class III and IV are classified as DVL.
4. TMD: It was measured as a straight distance between the thyroid notch and the lower border of mental prominence, with the head fully extended and the mouth closed, using a rigid ruler. A measurement of ≤6.5 cm is considered to be a good predictor of DVL.
5. SMD: It was measured as a straight distance between the superior border of the manubrium sterni and the lower border of mental prominence, with the head in full extension and the mouth closed, using a rigid ruler. An SMD ≤13.5 cm is known to be associated with DVL.
6. NC: Circumference of the neck measured using a measuring tape, at the level of thyroid cartilage. NC of >40 cm is considered to be a good predictor of DVL.

During endotracheal intubation, the best laryngoscopy view was noted and graded according to the CL grading system. Grade I: Full glottis view, Grade IIa: Glottis partly visible, anterior commissure not visualized, Grade IIb: Arytenoids or posterior part of the vocal cord just visible, Grade III: Only epiglottis is visible, Grade IV: No epiglottis visualized. CL Grades I and IIa are considered as EVL and CL Grades IIb, III, and IV as DVL.

"Difficult Intubation" is defined as the placement of the endotracheal tube by using conventional laryngoscopy that required >2 attempts lasted >10 min, or required alternate methods to intubate. The "time taken for intubation" was defined as the time point from initiation of the first direct laryngoscopy attempt to confirmation of successful endotracheal intubation by continuous waveform capnography. The study subjects were advised about the fasting guidelines. On the day of surgery, after confirming the duration of preoperative fasting, in the preoperative room, all enrolled patients underwent the above tests. Thereafter, the patients were shifted to the operation theatre, and standard monitors were connected. After adequate pre-oxygenation, general anesthesia was induced with injection propofol 2 mg/kg IV, injection midazolam 0.05 mg/kg IV, injection fentanyl 2 mcg/kg IV, and injection succinylcholine 2 mg/kg IV. After 60 s of mask ventilation, the same experienced investigator (with ≥2 years of experience) performed the laryngoscopy using Macintosh blade of appropriate size (3 or 4) in the sniffing position. The glottic view obtained on the first attempt of direct laryngoscopy without any external laryngeal maneuvers was graded according to the CL classification.

All laryngoscopies were performed by the same anesthesiologist who was not involved in pre-operative airway examination. In case of failed attempts at intubation, standard protocols were followed as per AIDAA unanticipated difficult intubation guidelines. The difficult airway cart including intubating stylet, McCoy blade, intubating laryngeal mask airway, video laryngoscope, fibreoptic bronchoscope and percutaneous cricothyroidotomy were kept ready at all times.

Sample size

Based on the significance level of 0.05, power at 80%, and a standard deviation of 10 from a previous study (Kamranmanesh et al.[1]) the sample size is computed as follows:

$$n = \frac{\left(Z_\alpha + Z_\beta\right)^2 \times \sigma^2}{d^2},$$

$$n = (1.96 + 0.84)^2 \times (10)^2/(1.75)^2\ n = 256.$$

By adding (10%) for unexpected loss to follow up, the rounded-off sample size was 300, where, n=Sample size, d=the size of the effect that is clinically worthwhile to detect, α=the probability of falsely rejecting the true null hypothesis=0.05, Z_α=1.96, β=the probability of failing to reject the true null hypothesis=0.80, Z_β=0.84.

RESULTS

Descriptive analysis was carried out by frequency and proportion for categorical variables. Continuous variables were presented as mean±SD for normally distributed random variable and median (IQR) for non-normal variable. The Chi-square test was used to test the statistical significance of cross-tabulation between categorical variables. For assessing the diagnostic accuracy for clinical parameters to predict CL grading, receiver operating characteristic (ROC) analysis was done. SPSS Version 21 was used for the data analysis.

Table 1 shows demographic characteristics of study population. The mean age of cases were 40 years with average BMI of 26.34 ± 3.91Kg/m^2 belonging to ASA class 1(53.7%) ASA 2(46.3%).

There was no statistically significant correlation between AASI and TMHT, MMP, SMD, TMD and NC. Correlation coefficient test of clinical parameters AASI v/s TMHT were presented in Table 2. The results found that AASI V/s TMHT are negatively correlated P=0.243, rest of the parameters were seen positive association but no significant correlation found with study objectives P>0.05 as presented in Table 3.

The Comparison of clinical parameters with CL Grading (N=300) for both EVL (n=258) & DVL (n=42) was hypothetically tested by 2x2 contingency table and chi-square analysis associated with (<0.49 and >=0.49), significant correlation was seen in grading and parameters p<0.01. In case of TMHT both parameters were found to be no significant corelation between both EVL and DVL. As per CL grading EVL was observed in 258 patients and DVL in 42 patients presented in Table 4.

The Comparison of clinical parameters with CL Grading (N=300) and AASI hypothetically tested in correlation with EVL (n=258) & DVL (n=42) tested under 2x2 contingency table and chi-square analysis. Both AASI (<0.49; AASI>=0.49) were found to be no significant corelation p=0.21 presented in Table 5.

Table 1: Descriptive analysis of demographic characteristics in the study population (n=300)

Variables	Summary
Age, Median (IQR)	40 (29.25, 50)
BMI, Mean±SD	26.34±3.91
Gender (%)	
Female	191 (63.7)
Male	109 (36.3)
ASA class (%)	
Class 1	161 (53.7)
Class 2	139 (46.3)

BMI: Body mass index, ASA: American Society of Anesthesiologists

Table 2: IQR ‑ AASI versus TMHT

AASI – Median (IQR)	0.47 (0.45, 0.48)
TMHT – Median (IQR)	58.81 (55.52, 62.15)
CL grading (%)	
EVL	258 (86.0)
DVL	42 (14.0)

AASI: Acromio‑axillo‑suprasternal notch index, TMHT: thyromental height test, EVL: Easy visualization of larynx, DVL: Difficult visualization of larynx, CL: Cormack and Lehane

Sensitivity, specificity, PPV, NPV & AUC of AASI, TMHT and other parameters are presented in Table 6. Table 7 depicts AASI as a better predictor of CL grading as compared to TMHT. Graph 1 (AUC value) depicts that AASI has good sensitivity of 86.4% and specificity of 38.1% in comparison with TMHT which has 94.6% sensitivity and 4.8% specificity and Graph 2 ROC curve shows comparison of AASI and TMHT with other airway parameters in predicting CL grading.

DISCUSSION

The search for an optimum predictor of difficult tracheal intubation is a dynamic area of research. Over the years many different predictors have been proposed, but none reaches

Table 3: Correlation coefficient test of clinical parameters AASI versus TMHT

Variables	Correlation	P‑value
AASI versus TMHT	−0.068	0.243
AASI versus MMP	0.016	0.784
AASI versus SMD	0.034	0.555
AASI versus TMD	0.072	0.211
AASI versus NC	0.069	0.236

AASI: Acromio‑axillo‑suprasternal notch index, TMHT: Thyromental height test, MMP: Modified Mallampati, SMD: Sternomental distance, TMD: Thyromental distance, NC: Neck circumference

Table 4: Comparison of AASI and TMHT with CL Grading (n=300)

Parameters	CL grading		P‑value
	EVL (n=258) (%)	DVL (n=42) (%)	
AASI			
<0.49	223 (86.4)	26 (61.9)	<0.001
≥0.49	35 (13.6)	16 (38.1)	
TMHT			
≥50	244 (94.6)	40 (95.2)	1.000
<50	14 (5.4)	2 (4.8)	

AASI: Acromio‑axillo‑suprasternal notch index, TMHT: thyromental height test, EVL: Easy visualization of larynx, DVL: Difficult visualization of larynx, CL: Cormack and Lehane

Table 5: Comparison of AASI with TMHT (n=300)

Parameters	CL grading		P‑value
	EVL (%)	DVL (%)	
AASI<0.49 (Easy)			
TMHT			
<50 (n=12) (D)	10 (4.5)	2 (7.7)	0.363
≥50 (n=237) (E)	213 (95.5)	24 (92.3)	
AASI≥0.49 (Difficult)			
TMHT			
<50 (n=4) (D)	4 (11.4)	0 (0)	0.210
≥50 (n=47) (E)	31 (88.6)	16 (100.0)	

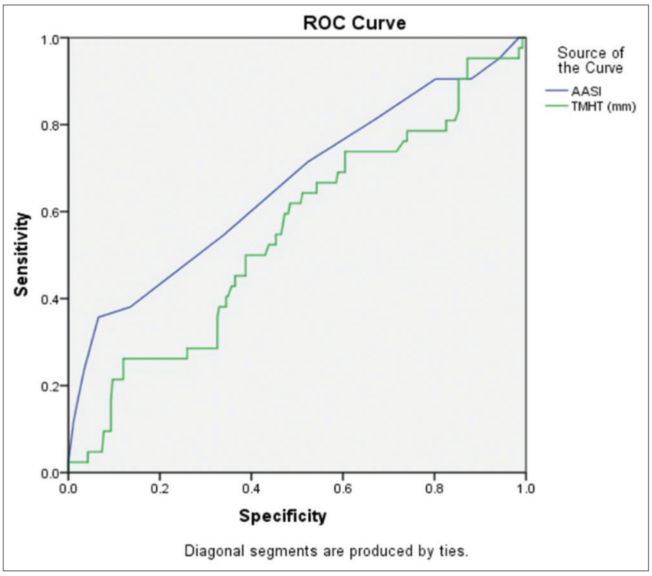
AASI: Acromio‑axillo‑suprasternal notch index, TMHT: thyromental height test, EVL: Easy visualization of larynx, DVL: Difficult visualization of larynx, CL: Cormack and Lehane

Table 6: Diagnostic accuracy test of clinical parameters in predicting DVL (n=336)						
Parameters	**Cut-off point**	**AUC (95% CI)**	**Sensitivity (95% CI)**	**Specificity (95% CI)**	**PPV (95% CI)**	**NPV (95% CI)**
Clinical parameters						
AASI	<0.49	79.7 (74.7–84.1)	86.4 (81.6–90.4)	38.1 (23.6–54.4)	89.6 (87.1–91.6)	31.4 (21.8–42.8)
TMHT	≥50	82.0 (77.2–86.2)	94.6 (91.1–97.0)	4.8 (0.6–16.2)	85.9 (85.0–86.8)	12.5 (3.3–37.7)
MMP	Grade 1 and 2	86.7 (82.3–90.3)	98.8 (96.6–99.8)	11.9 (3.9–25.6)	87.3 (86.0–88.5)	62.5 (29.3–87.04)
SMD	>13.5	74.3 (69.0–79.2)	83.3 (78.2–87.7)	19.1 (8.6–34.1)	86.4 (84.4–88.1)	15.7 (8.6–26.9)
TMD	>6.5	73.7 (68.3–78.6)	82.6 (77.4–86.8)	19.1 (8.6–34.1)	86.2 (84.3–88.0)	15.1 (8.3–25.9)
NC	<40	81.3 (76.5–85.6)	91.5 (87.4–94.6)	19.1 (8.6–34.1)	87.4 (85.6–88.9)	26.7 (14.8–43.3)

AASI: Acromio-axillo-suprasternal notch index, TMHT: thyromental height test, MMP: Modified Mallampati, SMD: Sternomental distance, TMD: Thyromental distance, NC: Neck circumference, PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under the curve

Table 7: AUC value of AASI and TMHT				
Test result variable (s)	**Area±SE**	**Asymptotic Sig.**	**Asymptotic 95% confidence interval**	
			Lower	**Upper**
AASI	0.661±0.50	0.001	0.563	0.579
TMHT (mm)	0.550±0049	0.294	0.455	0.646
MMP	0.613±0.047	0.019	0.521	0.705
SMD (cm)	0.548±0.051	0.322	0.448	0.647
TMD (cm)	0.535±0.52	0.473	0.432	0.637
NC (cm)	0.624±0.048	0.010	0.531	0.718

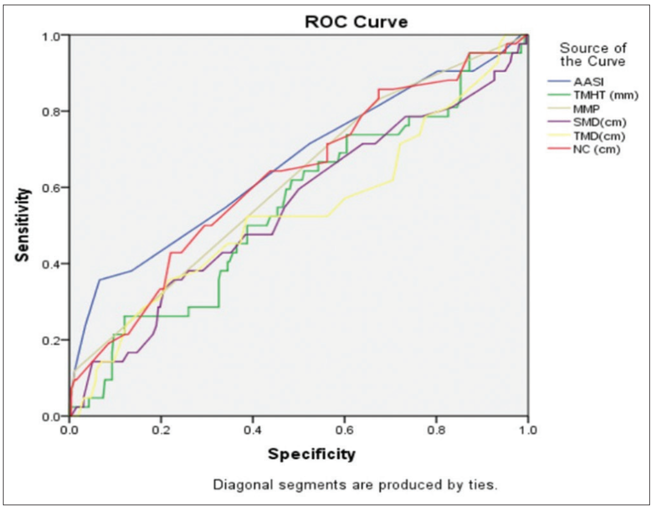
AASI: Acromio-axillo-suprasternal notch index, TMHT: thyromental height test, MMP: Modified Mallampati, SMD: Sternomental distance, TMD: Thyromental distance, NC: Neck circumference, AUC: Area under the curve



Graph 1: ROC curve for AASI & TMHI for predicting CL grading

the sensitivity and specificity that a practicing anesthesiologist desires. To minimize the risk of complications associated with a difficult airway, the screening test should be easy to perform and should have high sensitivity, specificity, high PPVs, and low false-positive value.

Many conventional tests which are measured routinely in day-to-day practice like MMP, TMD, SMD require patients to be in sitting position & cooperative. In patients such as those with hemodynamic instability, prolapsed discs,



Graph 2: ROC curve for AASI & other clinical parameters for predicting CL grading

cervical trauma, unconscious patients and uncooperative patients for emergency surgeries, it is not possible to make the patients sit upright for airway evaluation. Hence, we need new airway assessment parameters like AASI & TMHT which are useful tools in these challenging situations to predict difficult airway.[10] There is a paucity of literature when comparing AASI & TMHT, hence we conducted studies to compare these two novel airway tests for their usefulness to predict difficult airway.

Previous studies compared AASI with MMP score and concluded that AASI had higher sensitivity, positive predictive value, negative predictive value and accuracy compared to MMP in predicting DVL,[1,2,3,6,11] and area under the curve for AASI was higher than that of MMP,[1,6] when AASI was compared with ULBT & RHTMD, it was found that AASI had better sensitivity, specificity and positive predictive value than ULBT & RHTMD to predict difficult airway.[2,6] A study conducted on a large sample size of 716 obstetric patients found that the area under the curve (AUC) of the ROC was highest for AASI when compared with MMP, RHTMD, ULBT, HMDR, NC/TMD ratio, further concluded that AASI had the highest specificity, positive likelihood ratio, positive predictive value, negative predictive value and AUC in comparison with the other tests in predicting DVL.[6] In a prospective observational study found that AASI with cut off value >0.49 has higher sensitivity and positive predictive value and is better in predicting difficult airway in supine patients as compared to MMT.[12]

Other studies found that TMHT had higher sensitivity, specificity, PPV and NPV, compared to modified Mallampati score in predicting DVL,[5,7-9,13] it was found to be more accurate than MMP, TMD, and SMD to predict DVL.[7] A prospective observational study conducted by Piotr Palcynski et al concluded that patients with difficult intubation had a significant lower thyromental height (46 mm vs 54 mm) and other test parameters such as TMD, SMD and MMP did not differ significantly between the normal and difficult intubation groups.[8]

In a study on 550 patients, Panjiar P and others observed that TMHT was the best predictive test for difficult laryngoscopy with highest sensitivity, PPV, NPV, and odds ratio when compared with others such as RHTMD, MMT, SMD, TMD.[5] Rao and others also observed that TMHT was the most sensitive and accurate test in predicting difficult laryngoscopy when compared against MMP score, inter-incisor gap (IIG), TMD, NC, and neck extension. Further they observed that TMD had the least sensitivity and PPV.[9]

In our study of 300 patients with predicted easy visualisation of the glottis, AASI was found to be a better predictor of DVL as measured by CL Grading when compared to TMHT.

Limitations of the study

Study involves ASA1 and two patients so further studies involving obese and ASA3 and 4 patients with higher sample size needs to be evaluated to establish AASI and TMHT as predictors of difficult airway.

CONCLUSION

AASI (≥0.5) is a clear indicator of DVL with direct laryngoscopy. The present study concludes that AASI had higher predictive values (sensitivity, specificity, PPV, and NPV) and a lower false negative rate than other parameters to predict DVL.

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Authors' Contribution:
NCV- Implementation of study protocol, data analysis, concept, design, definition of intellectual content, editing, manuscript review and submission of article; **MKKS-** Literature survey, prepared the first draft of the manuscript, data collection, data analysis, statistical analysis; **DBG-** Data collection, preparation of figures, manuscript preparation; **SK-** Co-ordination and manuscript revision; **HSS-** Statistical analysis, manuscript revision.

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