Randomised Controlled Trial

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Success rates of endotracheal intubation using the standard method versus the modified-ramped position

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Background: The sniffing position used in intubation has disadvantages, including suboptimal glottic view, respiratory problems, increased risk of aspiration, and pain. In this regard, we have proposed new conditions to facilitate intubation and tube placement in patients with a Mallampati score higher than 2, by introducing a new position called the modified rapid airway management positioner (RAMP) position. The authors compared various parameters to improve intubation conditions between these two positions.

Methods: This intervention is a randomized clinical trial study, with a random sampling method that divides the patients into two groups: a control group placed in the standard position (S) and an intervention group placed in the modified (M) RAMP position. An anesthesiologist performed intubation. In group (S), patients were placed in the supine position as usual, and a pillow with a height of 10 cm was placed under their heads. In group (M), the patients were placed in the supine position on a modified RAMP with a triangular shape, 15 cm in height, and 80 cm in length, at a 30° angle. The pillow had lengths of 20 and 80 cm.

Results: In the present study, 112 patients were investigated, consisting of 58 women (51.8%) and 54 men (48.2%). The intubation time in the intervention group using the modified RAMP roll technique was significantly shorter (51.25 s) compared to the control group using the standard method (88.39 s) ($P = 0.019$).

Conclusion: The results of the study showed that the modified RAMP roll improved the general conditions of intubation and led to a better view of the glottis in direct laryngoscopy. This is a very important aspect of intubation, and with a better view of the pharynx and glottis, the intubation procedure can be performed with higher quality, reducing the number of intubation attempts and the duration of the procedure.

Keywords: laryngoscopy, RAMP, Mallampati, pain, Intubation, sniffing position.

Introduction

Airway management in patients under general anaesthesia is a set of actions that lead to the creation of a safe and secure airway for ventilation[1]. Failure in airway management and hypoxia can lead to irreversible brain damage within minutes[2]. One of the airway interventions is endotracheal intubation, which, in case of improper placement, can result in adverse effects such as bradycardia, hypoxaemia, and even death reported in 4% of patients. Various complementary techniques are recommended to improve the safety characteristics of endotracheal intubation, including patient positioning to facilitate oxygen delivery and ventilation[3].

One of the standard positions commonly used in intubation is the sniff position[4]. In the sniff position, the patient lies flat, and a pillow or rolled-up blanket is placed under the head or neck to position the head with an elevation of 7 cm and neck flexed at 35° relative to the upper body. The head is extended to place the face at a 15° angle to the ceiling[5].

HIGHLIGHTS

- The sniffing position used in intubation has disadvantages, including suboptimal glottic view, respiratory problems, increased risk of aspiration, and pain.
- The results of the study showed that the use of the modified rapid airway management positioner roll improves the general conditions of intubation and leads to a better view of the glottis in direct laryngoscopy.
- This is a very important aspect of intubation, and with a better view of the pharynx and glottis, the intubation procedure.
- It can be performed with higher quality, reducing the number of intubation attempts and the duration of the procedure.

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If necessary, pillows or towels are added or removed under the head to align the external auditory meatus with the sternal notch[6]. One of the drawbacks of the sniffing position is its inadequacy in optimizing glottic visualization during direct laryngoscopy[7]. It is also poorly tolerated in morbidly obese patients with fat deposits behind the neck and shoulder belt, which may result in unsuccessful head extension. Examples of the sniff position for airway management are shown in the figure below[8].

The other standard position is the ramped position, where the bed is kept half-flat and the head is elevated up to 25°. The patient's face is parallel to the ceiling, the neck and trunk are at a 25° angle, and the legs are parallel to the ceiling. Pillows or towels are added or removed under the head to align the external auditory meatus with the sternal notch. Once the desired patient position is achieved, the entire bed is moved up or down to position the patient's mouth at an appropriate level for intubation[9]. This position can improve glottic view and facilitate intubation and ventilation. Achieving this position is crucial but creating the ramped position with pillows and cushions is difficult and time-consuming. Moreover, it heavily relies on the experience of the person providing the position, which can cause problems for the patient during surgery or even in the recovery period[10].

Therefore, it seems that finding a simple alternative method that can create conditions like the proposed standard conditions for laryngoscopy would be a suitable solution for intubating patients with higher difficulty. In this regard, we have introduced a new position called "modified rapid airway management positioner (RAMP)" for intubating these individuals[11].

In this strategy, a triangular-shaped pillow with a height of 15 cm, an angle of 30°, a length of 80 cm, and a 20-cm-long roll RAMP, named the modified RAMP, was designed by emergency medicine specialists, anesthesiologists, and a research team to position the patient based on the measurements of the oral axis, laryngeal axis, and pharyngeal axis[12]. Placing the modified RAMP under the patient's head, compared to the Ramped position method, positions the head in a more extended position, which seems to make intubation conditions easier, especially in obese patients with fat accumulation behind the neck and shoulder strap, patients with short necks, and difficult intubation conditions[13]. Additionally, this method requires much less time than the Ramped position method to position the patient. In this study, we aim to investigate the modified RAMP position for intubation in individuals with a Mallampati score of more than 2 and compare different parameters to improve intubation conditions between this position and the current standard conditions.

Materials and methods

This study is an interventional randomized clinical trial. A total of 112 patients who were candidates for non-emergency surgery and were undergoing general anaesthesia in the operating room of the (Baqiyatallah Hospital in Qom) and met the inclusion criteria but not the exclusion criteria were randomly assigned to the study.

After obtaining the ethics code and sampling permission from the Research and Technology Deputy of (Baqiyatallah Hospital in Qom), patients who were candidates for surgery under general anaesthesia in the operating room of the (Baqiyatallah Hospital in Qom) and met the inclusion criteria were approached and informed consent were obtained for their participation in the study.

Inclusion Criteria: Age between 15 and 80 years old, patients with mallampati score II–IV, and patients who were scheduled for non-emergency general anaesthesia had informed consent to participate in the study.

Exclusion criteria: Patients who aimed to undergo regional or spinal anaesthesia, patient dissatisfaction at any stage of the study, limitations for placement in the modified RAMP position, history of any disease that may cause instability of the cervical spine, patients with limited neck extension and flexion, patients with large neck masses.

By using random sampling these patients were divided into two groups: the control group, which used the standard position (S), and the intervention group, which used the modified (M) RAMP position. An anesthesiologist performed intubation, and the data were collected by a technician in the operating room who was unaware of the intervention and control groups in the study, using a checklist prepared by the researcher. In the control group (S), patients were positioned in the supine position as usual, and a pillow with a height of 10 cm was placed under the patient's head. In the intervention group (M), patients were positioned supine on a modified RAMP with a triangular shape, with a height of 15 cm and a length of 80 cm, at an angle of 30°, which had lengths of 20 and 80 cm.

Based on the provided checklist, an investigator recorded the patient's information including age, gender, history of diabetes, BMI, neck circumference, use of dentures, thyromental distance, Mallampati score, and Cormack–Lehane classification. Then, the parameters of blood pressure, heart rate, SPO2, respiratory rate, aspiration, intubation time, the number of successful intubation attempts, the use of auxiliary devices during intubation, and patient satisfaction were recorded.

Upon entering the operating room, airway evaluation was performed for patients including Mallampati score, Cormack–Lehane classification, thyromental distance, mouth opening, and neck extension. Before the operation, patients received isotonic IV fluid. Before the induction of anaesthesia, patients were randomly assigned to either the standard group or the modified rapid sequence induction group. Conventional monitors including an electrocardiogram, noninvasive blood pressure monitor, and pulse oximetry were used for evaluation and the patient's vital signs immediately before intubation were recorded in the checklist as pre-intubation vital signs. For induction of anaesthesia, 1–2 mg/kg propofol, 0.1 mg/kg cisatracurium, and 0.2 μg/kg sufentanil were used.

Also, a ventilation mask was performed using a face mask 3 min before induction, then intubation was done with tube number 7-7.5-8 by the same anesthesiologist and using a Macintosh laryngoscope for tube placement inside the trachea. The number of successful intubation attempts and the duration of intubation were recorded in the checklist. If auxiliary tools such as gum elastic bougie, classic laryngeal mask, intubating laryngeal mask airway, McCoy laryngoscope, fiberoptic laryngoscope, and tracheostomy cart were used during intubation, they were mentioned in the checklist.

The correct positioning of the endotracheal tube was confirmed by capnography, and immediately after intubation, the patient's

vital signs were recorded as post-intubation vital signs in the checklist. After 10 min, the patient was cautiously returned to the standard position. Then, 6–12 h after the procedure, the patient's satisfaction level was recorded based on pain and discomfort in the post-intubation area using the visual analog scale method. The patient was asked to express their pain on a scale of 0 (no pain) to 10 (unbearable pain). In the end, the control and experimental groups were compared in terms of the above criteria and variables.

In this study, the appropriate sample size in each group was estimated to be 56 patients based on the formula below and considering a type I error rate of 0.05, a test power of 0.80, and a Cormack Lehane grade equal to 40% and 17% in the intervention and control groups, respectively, based on previous studies[12]. Therefore, a total of 112 patients were included in the study.

Formula:

$$n = (Z\alpha/2 + Z\beta)^2 * (p1(1 - p1) + p2(1 - p2))/(p1 - p2)^2$$

Data collection method

In this study, the researcher collected data based on a checklist that includes age, sex, diabetes history, BMI, neck circumference, thyromental distance, Mallampati score, Cormack Lehane blood pressure, heart rate, SPO2, respiratory rate, aspiration, intubation time, number of successful intubation attempts, use of assistive devices during intubation, patient's dental injury after intubation, and patient satisfaction.

Data analysis: The data were analyzed using SPSS version 22 software. Independent *t*-test were used to analyze quantitative variables between groups and the χ^2 test were used for qualitative data. A significance level of less than 0.05 was considered.

The study was performed after the approval of the ethics committee of Baqiyatallah Hospital in Qom and the registration in Baqiyatallah Hospital in Qom. The work has been reported in line with the CONSORT criteria[14].

Results

In the present study, 112 patients were randomly assigned to two groups. 56 patients (50%) were in the intervention group and received intubation using the modified-ramped position, while the other 56 patients (50%) were in the control group and received intubation using the standard method.

Out of 56 cases in the intervention group, 37 individuals (66.1%) were female, and 19 individuals (33.9%) were male. In the control group, 21 individuals (37.5%) were female, and 35 individuals (62.5%) were male.

Out of 112 participants in the study, 14 cases (12.5%) had diabetes, 27 cases (24.1%) had hypertension, and 16 cases (14.3%) had obstructive sleep apnoea.

Fifty-five cases (49.1%) had a Mallampati score of II, 44 cases (39.3%) had a score of III, and 13 cases (11.6%) had a score of IV. It should be noted that only individuals with Mallampati scores II–IV were included in this study. It can be concluded that there is no significant difference between the case and control groups in terms of Mallampati score, which is a criterion for predicting the difficulty of intubation in the trachea ($P = 0.639$).

There was a significant difference between the case and control groups in terms of the Cormack–Lehane scale, which represented the glottic view during direct laryngoscopy. The intervention group, who underwent intubation using the modified-ramped position, had a lower Cormack–Lehane grade. Therefore, it can be concluded that using the modified-ramped position in intubation led to a better glottic view during direct laryngoscopy ($P = 0.009$) (Fig. 1).

Furthermore, 39 cases (34.8%) were classified as American Society of Anesthesiologists (ASA) I, 16 cases (14.3%) as ASA II, 47 cases (42%) as ASA III, and 10 cases (8.9%) as ASA IV. It should be noted that individuals with ASA scores higher than ASA IV were not predicted to be able to continue their lives without surgery and were usually in need of emergency surgery and were not included in this study. There was no significant difference in ASA scores, which was a subjective assessment of the overall health of patients, between the case and control groups ($P = 0.610$).

There was a significant difference between the case and control groups in terms of the number of attempts needed to successfully perform intubation. The intervention group, who underwent intubation using a modified RAMP position, required fewer attempts to successfully perform intubation compared to the group who underwent intubation using the standard method (0.023) (Fig. 2).

In terms of the occurrence of aspiration, none of the 56 cases in the intervention group developed aspiration, and no cases of aspiration were observed in the control group either. Therefore, the use of the modified RAMP position showed no effect on the occurrence of aspiration during patient intubation in this study.

In terms of the need for adjunctive devices during intubation, 4 cases (7.1%) in the intervention group required the use of adjunctive devices out of 56 intubations, while 14 cases (25%) in the control group required the use of adjunctive devices. Based on a *P* value less than 0.05, it can be concluded that the use of the modified RAMP position can reduce the need for adjunctive devices during intubation (Fig. 3).

The assessment of patient pain based on the visual analog scale, which was asked of patients 6–12 h after surgery, showed that the intervention group had an average pain score of 2.89 out of 10, while the control group had an average pain score of 4.46 out of 10. It can be concluded that the use of the modified RAMP position can reduce pain after intubation and result in greater satisfaction compared to the standard method (Table 1).

The use of the modified RAMP for intubation did not have any effect on the patient's blood pressure after intubation. However, there was a significant difference in terms of pulse rate, respiratory rate, and oxygen saturation percentage between the two groups of cases and controls (*P* value < 0.05). The result indicates that the use of the modified RAMP for intubation can reduce the pulse and respiratory rate and increased the oxygen saturation percentage after intubation in patients undergoing intubation with this method (Table 2).

There was a significant difference in the duration of intubation between the case and control groups, and the intervention group, which underwent intubation using the modified RAMP roll, required a shorter time for successful intubation compared to the intubation by the standard method in the control group ($P = 0.019$) (Table 3).

Discussion

Airway management in patients under anaesthesia is extremely important. One of the common interventions for this purpose is intubation. However, if the proper placement of the endotracheal tube fails, it can cause irreversible complications for the patient and in some cases, lead to the patient's death.

The study focuses on the efficacy of a novel position called "modified RAMP" in reducing intubation complications and improving patient outcomes. This position has not been

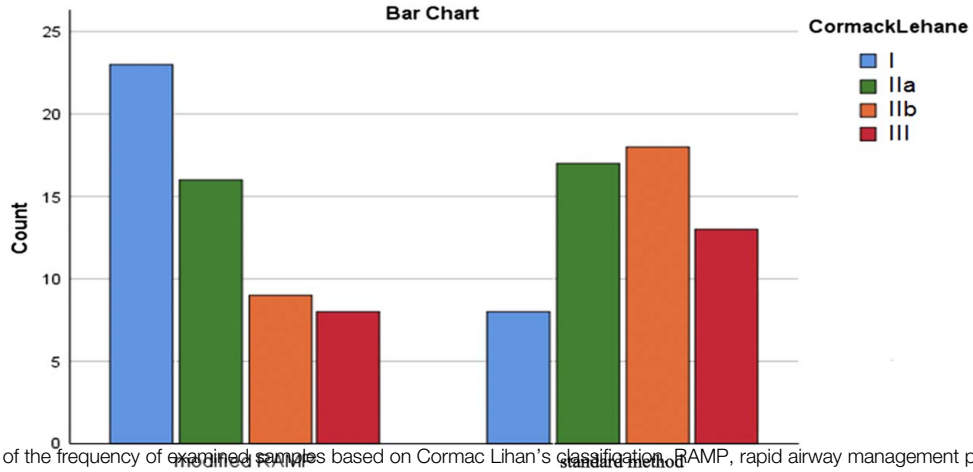

Figure 1. Distribution of the frequency of examined samples based on Cormac Lihan's classification. RAMP, rapid airway management positioner.

previously used or studied in similar research. The modified RAMP is a triangular pillow with specific dimensions, including a height of 15 cm, an angle of 30°, a length of 80 cm, and a length of 20 cm, which is positioned under the patient's head. Intubation is carried out within the modified RAMP, and the study assesses the effectiveness of this technique in improving intubation conditions.

In 2015, a study was conducted by Ju-Hwan Lee and colleagues comparing the success rate of endotracheal intubation between the Sniff position and Ramped position in patients with difficult airways. The result showed that successful endotracheal intubation and better glottic view were achieved in the R group compared to the S group ($P < 0.05$). It also demonstrated that anaesthesia specialists, who were trained and experienced, had a higher success rate of endotracheal intubation in the R group compared to less experienced assistants in the S group[15].

In 2020, a clinical trial was conducted by Mahzad Alimian and colleagues to compare two positions, RAMP and modified RAMP, during intubation using laryngoscopy. The results showed no significant differences between the two groups in terms of ventilation score, laryngoscopy grade, number of intubation attempts, duration of intubation, and the need for Backwards, Upwards, Rightwards, Pressure manoeuvres during intubation. Therefore, the new modified RAMP position can be easily accessible and cost-effective to use[16].

A clinical trial with a similar topic was conducted in 2017–2018 by Ahmed Hasanin and his colleagues. This study showed that the modified RAMP position provides better conditions for intubation, improves the glottic view, and eliminates the need for patient movement during the placement of laryngoscope, compared to the steep head-up position[17].

A randomized controlled pilot study in 2020 compared ramped position with a modified-ramped position during induction of anaesthesia in 60 obese female patients. The results showed that the modified-ramped position provided better intubating conditions, improved laryngeal view, and eliminated the need for repositioning during the insertion of the laryngoscope compared to ramped position[18].

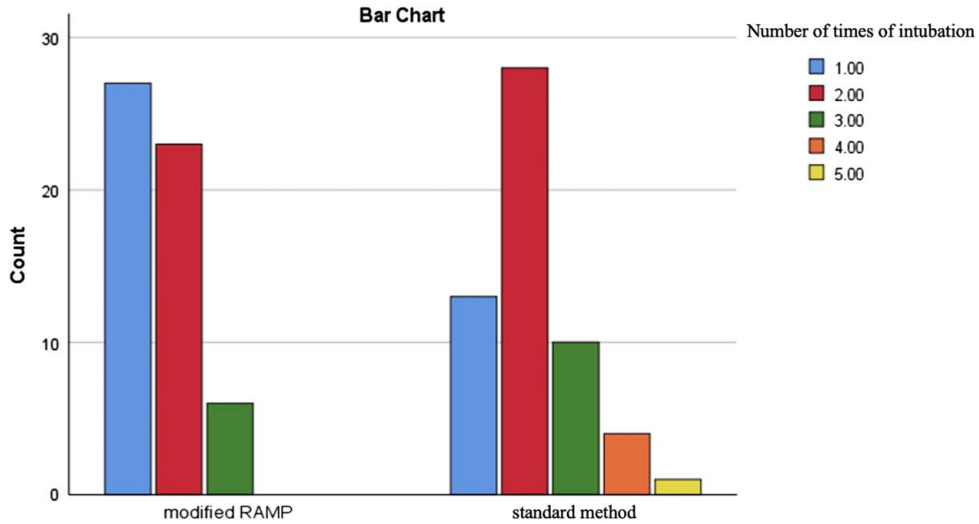

Figure 2. Distribution of the frequency of examined samples based on the number of required intubations. RAMP, rapid airway management positioner.

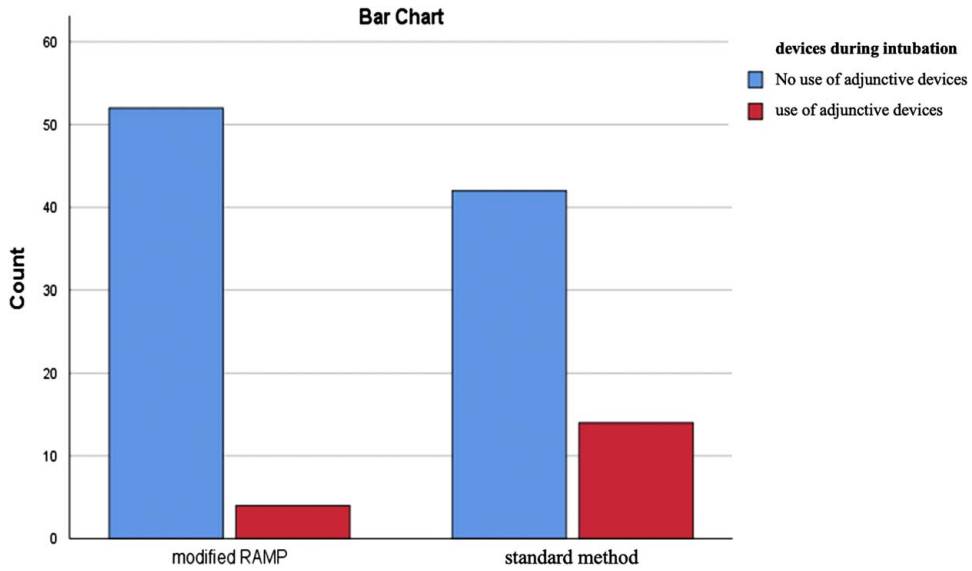

Figure 3. Distribution of the frequency of examined samples based on the need for adjunctive devices during intubation. RAMP, rapid airway management positioner.

Another study published in Anesth Pain Med journal in 2021 compared the standard RAMP position with the proposed low-cost and easily accessible modified RAMP position during laryngoscopic view during intubation of patients with morbid obesity. The results showed no significant differences between the two groups regarding ventilation score, laryngoscopy grade, number of intubation attempts, duration of intubation, and need for Backwards, Upwards, Rightwards, Pressure manoeuvres during intubation. Therefore, it concluded that the new modified RAMP position can be used with more ease and availability at less cost[16].

These studies suggest that a modified RAMP position may be an effective technique for reducing complications associated with endotracheal intubation and improving patient outcomes.

Conclusion

The results of the study showed that using the modified RAMP position for intubation improves the general conditions of intubation and provides a better view of the glottis in direct laryngoscopy. This is of great importance in intubation, and an anesthesiologist with a better view of the larynx and glottis can perform intubation with better quality, leading to a reduction in

Table 1

Pain assessment of the patients based on the visual analog scale.

		Number	Mean	SD	*P* value[a]
Pain assessment of the patient (0–10)	Intubation using modified RAMP	56	2.8929	1.41008	0.000
	Intubation using standard method	56	4.4643	1.67293	0.000

RAMP, rapid airway management positioner.
[a]*P* value for independent *t*-test.

Table 2

Assessment of vital signs after intubation in patients.

		Number	Mean	SD	*P* value[a]
SBP (mmHg)	Intubation using modified RAMP	56	121.3214	16.01035	0.990
	Intubation using standard method	56	121.3571	13.74763	
DBP (mmHg)	Intubation using modified RAMP	56	82.5357	8.42068	0.735
	Intubation using standard method	56	83.1250	9.90145	
HR (per min)	Intubation using modified RAMP	56	91.1786	8.38854	0.017
	Intubation using standard method	56	95.3214	9.67679	
RR (per min)	Intubation using modified RAMP	56	18.2143	1.39759	0.042
	Intubation using standard method	56	18.8750	1.95460	
O2 sat	Intubation using modified RAMP	56	97.3214	1.25201	0.018
	Intubation using standard method	56	96.4821	2.30408	

DBP, diastolic blood pressure; HR, heart rate; O2 sat, oxygen saturation; RAMP, rapid airway management positioner; RR, respiratory rate; SBP, systolic blood pressure.
[a]*P* value for independent *t*-test.

Table 3

Evaluation of intubation duration.

		Number	Mean	SD	*P* value[a]
Intubation duration	Intubation using modified RAMP	56	51.2500	18.44525	0.019
	Intubation using standard method	56	88.3929	115.15644	

RAMP, rapid airway management positioner.
[a]*P* value for independent *t*-test.

the number of intubation attempts and the duration of intubation. This was the conclusion reached in this study. On the other hand, this reduction in manipulation and intubation time can lead to a reduction in damage to the area. As the results showed, patients experience less pain after intubation and have higher satisfaction. Additionally, this study showed that the use of the modified RAMP position in intubation can have a positive effect on the quality of oxygen delivery to patients.

Ethics approval and consent to participate

This study is approved by Ethics Committee of Vice Chancellor for Research & Technology of the Qom University of Medical Sciences (MUQ)(IR.MUQ.REC.1401.010) and the study was performed after the registration in the International Iranian Clinical Trials Registration Center with IRCT number: IRCT20220511054817N1. All patients and control subjects signed the informed consent. This study was performed in accordance with the ethical standards of the Declaration of Helsinki (2013) and its subsequent amendments.

Consent

Informed consent was obtained from the patient for publication of this report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request".

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Author contribution

M.S. and R.T.: conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. S.R. and A.A.: designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript. S.L. and S.M.: coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.

Conflicts of interest disclosure

All authors clarify that they have no affiliations/involvements in any organization or entity in any financial interest or non-financial interest for the subject and material discussed in the article.

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Availability of data and materials

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