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## Original research:

# Reliability, validity and sex differences in a quantitative gag reflex measurement method in children aged 5 – 12 years

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### Abstract

**Background:** The gag reflex is a normal, protective, physiological mechanism that occurs to prevent foreign objects and noxious material from entering the pharynx, larynx, and trachea. A proportion of the population has a profound and exaggerated reflex that can cause acute limitation of a patient's ability to accept dental treatment and a clinician's ability to provide it.

**Aim:** To evaluate the reliability, validity, and sex differences in a quantitative gag reflex measurement method in children, aged between 5 to 12 years.

**Methods:** 21 volunteers (10 female, 11 male) were included in the study. An examiner inserted a standard saliva ejector slowly down the participant's throat to determine the maximum tolerance of the gag reflex; the insertion depth was used as an index of the gag reflex. The reflex was measured by one examiner during two sessions (S1 and S3) and by a second examiner during one session (S2) under the same conditions. Heart rate (HR) was recorded during each session to test the method's validity. Data were analysed using the intraclass correlation coefficient (ICC), paired t-test, and two-way repeated-measures analysis of variance.

**Results:** The ICC of the gag reflex measurements was 0.92 between S1 and S2 and 0.93 between S1 and S3. The HR increased significantly after the maximum tolerance of the reflex in S1, S2, and S3.

**Conclusion:** The gag reflex assessment technique demonstrated remarkable inter- and intra-examiner reliability that remained unbiased based on gender, along with a notable autonomic response that is typical for this response.

**Keywords:** Gag reflex, dental impression technique, heart rate, sex differences, autonomic response

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## Introduction

The gag reflex is inherited and it progressively reverts during the child's first four years of life, as his/her oral utilities begin to develop, varying from the infantile ways of breathing and pulling to the more mature tasks of nasal breathing and swallowing.<sup>[1]</sup> Numerous dental procedures such as gaining maxillary and mandibular impressions, preparation of cavities, crowns, or root canal treatment for posterior teeth, and captivating intra-oral radiographs exclusively for the posterior teeth might cause extravagant gag reflexes.<sup>[2]</sup> Two main categories of gagging patients have been identified: namely the somatogenic group, where local and systemic disorders, anatomic factors, and iatrogenic causes are believed to operate; and the psychogenic group, where psychological factors based on classical and operant conditioning are believed to be causal.<sup>[1]</sup>

Effective management of gagging depends on the management of the reason and not only symptoms. Several strategies have been used to control the profound gag reflex and allow dental care. They include relaxation, distraction, and desensitization techniques; psychological and behavioral therapies; local anesthesia, conscious sedation, and general anesthesia techniques; and complementary medicine therapies such as hypnosis, acupuncture, and acupuncture.<sup>[3]</sup> These strategies have been variably successful, but it may be necessary to try multiple methods to find the appropriate technique for an individual. The currently available evidence regarding the effects of interventions to manage gagging is insufficient and well-reported trials are needed.<sup>[4]</sup> To consider an appropriate evidence-based strategy to control the gag reflex during dental procedures, a reliable method of gag reflex measurement must be established. Thus, the study has been conducted to evaluate the reliability, validity, and sex differences in a quantitative gag reflex measurement method in children, aged between 5 to 12 years.

## Methodology

Twenty-one volunteers (10 females, and 11 males) between the age ranges of 5 to 12 years participated in this study. All participants were healthy children with no medical history. The participants provided informed consent prior to participation. A conventional disposable saliva ejector with a heavy body addition silicone impression putty stopper was introduced into the participant's mouth at the maxillary central incisor and gently moved down the

throat along the palate to evaluate the gag response (Figure 1). By pressing a button that beeped, the participants informed the examiner when their maximum tolerance had been achieved. Using a digital caliper, the saliva ejector's insertion distance from the maxillary central incisor was measured. This distance served as a gag reflex index. The length of time the insertion took from the start to the maximum tolerance was also measured.

**Figure 1:** Gag reflex measurement process using standard saliva ejector with a stopper made of heavy body addition silicone impression putty. The insertion distance of the saliva ejector from the maxillary central incisor at the maximum tolerance was determined as an index of the gag reflex.



Measurements of the gag reflex were taken under identical settings by one examiner (A) in two separate sessions (S1 and S3) and by another examiner (B) in a single session (S2). A 5-minute rest period to decompress and remove the measurement's carry-over effect before and after each session was done. The time course of the study protocol was explained to the participants. (Table 1) When their maximum tolerance was reached, the subjects assessed how awful they felt. A visual analogue scale (VAS; 0-100 mm) with a range of 0 (not at all) to 100 (extremely strong) was used to collect the evaluations of unpleasantness.

## Physiological measurement

Each measuring session included the recording of the heart rate (HR), which serves as a physiological indicator of autonomic reactivity. A pulse transducer secured to the medial phalanges of the nondominant hand's thumb. The heart rate changes for each session were compared between the baseline, which was determined as the average value of a 30-second pre-stimulus time window, and the average value observed in a 10-second post-stimulus time window.<sup>[5]</sup>

### Self-reported questionnaires

A variety of self-reported questionnaires were employed to ascertain the impact of psychological variables on the gag reflex assessment. A gagging behavior questionnaire was utilised to evaluate the gagging behavior of the subjects. [6] Based on how each participant answered the question of how often they gag during dental procedures, they were divided into three groups. The frequency of gag reflex during dental treatment was lowest among those who said they "never" or "rarely" experienced it, moderate among those who said they "sometimes" or "frequently," and high among those who said they "almost always or always" experienced it. [6]

The State-Trait Anxiety Inventory-State (STAI-S) and STAI-Trait (STAI-T) were used to measure trait and state anxiety levels. [7] The twenty statements that make up the STAI-S and STAI-T assess the respondent's overall and current feelings. The dental fear survey (DFS), [8] which consists of 20 questions that address anxiety-inducing situations related to dental treatment, was used to gauge the degree of dental fear. The validity and reliability of the psychometric tests have already been confirmed. [9]

Before performing any analyses, the data set was tested for normality using the Shapiro-Wilk test (Shapiro-Wilk test for all conditions:  $P > 0.1$ ). The time of the insertion, the VAS rating, and the inter- and intra-examiner reliability of the gag reflex

assessment were evaluated using the intraclass correlation coefficient (ICC) and Pearson's correlation coefficient. To measure autonomic reactivity, the HR values before and after the gag reflex's maximum tolerance were compared using paired t-tests. P-values less than 0.05 were considered as significant. The variations in sample characteristics between the sexes were evaluated using a Student t-test and a Fisher's exact test. IBM SPSS Statistics for Windows, version 21.0, was used for all analyses.

### Results

#### Reliability

The mean values of the gag reflex measurements, the duration of the insertion, and VAS ratings of each session (Table 2). The ICC of the gag reflex measurement was 0.92 between S1 and S2, reflecting excellent inter-examiner reliability, and 0.93 between S1 and S3, reflecting excellent intra-examiner reliability. The ICCs of the duration of the insertion and the VAS rating were 0.72 and 0.81 between S1 and S2, respectively, and 0.87 and 0.82 between S1 and S3, respectively. The correlation coefficient of the gag reflex measurements was 0.82 ( $P < 0.001$ ) between S1 and S2, and 0.87 ( $P < 0.001$ ) between S1 and S3, reflecting excellent inter- and intra-examiner reliability. The correlation coefficients of the duration of the insertion and the VAS rating were 0.56 ( $P = 0.008$ ) and 0.67 ( $P = 0.001$ ) between S1 and S2, respectively, and 0.80 ( $P < 0.001$ ) and 0.69 ( $P = 0.001$ ) between S1 and S3, respectively.

**Table 1: Time course of the study protocol.**

Rest 1	Session 1 (S1)	Rest 2	Session 2 (S2)	Rest 3	Session 3 (S3)
	Gag reflex measurement by 'A'		Gag reflex measurement by 'B'		Gag reflex measurement by 'A'
5 min	2 min	5 min	2 min	5 min	2 min

**Table 2: Mean values of the gag reflex measurement, duration of insertion, and visual analogue scale (VAS) rating of each session**

Session	Gag reflex measurement (mm)	Duration of insertion (s)	VAS rating (mm)
S1	52.2 ± 4.9	4.2 ± 1.6	53.2 ± 18.7
S2	53.2 ± 4.1	5.1 ± 1.3	61.1 ± 18.9
S3	53.2 ± 5.9	5.6 ± 1.3	60.3 ± 19.7

VAS= visual analogue scale.

### Autonomic reactivity

The mean value of the HR at rest and after each session of gag reflex measurement are presented

in table 3. The HR significantly increased after the maximum tolerance of the gag reflex in S1, S2, and S3 (all,  $P < 0.001$ )

**Table 3:** Mean values of the heart rate (HR) at rest and after measurement of the gag reflex in each session

	HR (bpm)		HR (bpm)	P-value
Rest 1	64.8 ± 8.4	S1	74.8 ± 8.4	<0.001
Rest 2	65.8 ± 8.2	S2	73.6 ± 11.0	<0.001
Rest 3	65.7 ± 9.4	S3	74.0 ± 10.6	<0.001

**HR= heart rate.**

### Sex-related differences

Table 4 displays the mean age, STAI-S, STAI-T, DFS scores, and the number of participants who reported gagging at least once during dental care. No

significant differences in age, STAI-S, STAI-T, DFS scores, or distribution of the minimal/moderate frequency of gagging during dental care were observed between the sexes.

**Table 4: Sample characteristics of female and male participants**

Details	Female (n = 10)	Male (n = 11)	P – value
Age (y)	8 ± 3.4	8 ± 4.2	0.31
STAI-S score	38.5 ± 7.2	39.0 ± 9.2	0.89
STAI-T score	42.2 ± 8.2	46.7 ± 10.9	0.30
DFS score	33.0 ± 14.5	28.6 ± 7.8	0.40
Minimal/moderate frequency of gagging (n)	10/0	10/1	1.00

**STAI-S=State-Trait Anxiety Inventory-State; and STAI-T= STAI-S=State-Trait Anxiety Inventory-Trait; DFS=dental fear survey.**

### Discussion

Overt gagging can be disturbing for both the patient and the clinician. [10] Regardless of the major progress in dentistry in terms of controlling dental pain and managing children's behavior in the dental setting, gagging still occurs during and/or after dental procedures. [11] A wide multiplicity of management strategies has been defined and these should be tailored to suit the necessities of individual patients. The gagging difficulties require an imagined attitude using individualized, flexible treatment resolutions by a knowledgeable dental team. [12] In the present study, there was no discernible gender difference, and there was great inter- and intra-examiner reliability. The validity was further supported by the observation of notable internal physiological changes during the measurement. Patients differ greatly in their ability to tolerate intraoral stimulation and in how sensitive their oral cavity is. The base of the tongue, palate, uvula, posterior pharyngeal wall, and palatoglossal and

palatopharyngeal folds are the five intraoral regions that are referred to a "trigger zones." One of the trigger zones in the posterior portion of the oral cavity is where the gag reflex is typically initiated. [1]

Consequently, obtaining maxillary dental impressions was the most challenging dental trigger known to produce gag reflex; most patients had trouble with this treatment.

According to Heuvel et al. [13] an instrument to measure dental gagging should include the use of different materials and the intensity, duration, and location of the stimulus applied. In the present study, we used a standard saliva ejector as a trigger stimulus for certain parts of the palate and measured the distance of the saliva ejector from the maxillary central incisor and the duration of the insertion. As these two parameters were correlated, they could be suitable for the assessment of an intervention to control the gag reflex

While taking maxillary impressions. Barenboim et al.,<sup>[14]</sup> conducted a pilot study of the efficacy of granisetron, a selective inhibitor of type 3 serotonergic receptors, in gagging patients. They assessed patients' gagging levels by measuring the swab insertion depth from the upper central incisors to the posterior portion of the oral cavity. However, they used a 130-mm bacteriology transport swab, as well as did not show the reliability or validity of their method.

The gag reflex measuring method was found to have excellent inter and intra-examiner reliability in the present study, suggesting that examiners can assess the gag reflex with consistent precision. The current study used a VAS to confirm whether the participants had similar unpleasant experiences when their maximum tolerance had been reached during different measurement sessions excellent intra- and inter-examiner reliability was demonstrated by the VAS ratings. The remarkable repeatability of the procedure is also indicated by the results. The gag reflex measurement and the VAS rating in each session, however, did not significantly correlate. These results suggest that there is a discrepancy between the subjective evaluation and the objective measurement value.

However, there is some controversy regarding differences in gag reflex between the sexes. Using an intraoral examination, Saita et al.,<sup>[15]</sup> categorised patients into five groups based on their gag reaction. The STAI and dental anxiety scale scores did not significantly differ among the grades, but the gagging severity score of male patients was found to be significantly greater than that of female patients. According to van Houtem et al.,<sup>[16]</sup> there was a strong correlation found between dental anxiety and female sex and the patients' self-reports of gagging. Variations in the population and participant count may be the cause of the discrepancy in our results. More participants in our study reported having less dental anxiety and gagging in the clinic less frequently.

To assess the validity of the method, the present study recorded the HR as a physiological index of autonomic reactivity. According to Homma et al.,<sup>[17]</sup> mental stress stimulates the medial region of the amygdala, the lateral part of the hippocampus, and the inferior frontal gyrus; the

Mental sweating response follows 5–6 seconds later. While the HR baseline in every session remained constant over the course of the investigation. As a result, we examined the HR for the pre-and post-stimulus time windows in three pairs. According to the findings of the present study, the HR considerably increased following each session's gag reflex maximum tolerance. Sweating, dizziness, increased salivation, and lacrimation can all be symptoms of gagging. Therefore, the autonomic reactivity following the gag reflex's maximum tolerance attained during measurement indicates the method's validity. The purpose of the study was to determine each participant's maximum gag reflex tolerance while the anterior and posterior facial pillars and soft palate were selectively stimulated. Still, more research is required because we were unable to find the measurement to differentiate between patients with varying levels of gag reflex. Analysis based on gag reflex severity might be possible with a larger sample that included more individuals with a severe gag reflex.

### Conclusion

The current gag reflex assessment technique demonstrated remarkable inter- and intra-examiner reliability that remained unbiased based on gender, along with a notable autonomic response that is typical for this response. One may assess the impact of an intervention on an individual using the assessment technique we utilised in our study. The results of this study could aid in quantifying future research and creating new gagging treatment approaches.

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