Research Article

Burstone's Norms for Orthognathic Surgery in Dogra Population

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ABSTRACT

Introduction: Burstone's analysis for orthognathic surgery, popularly known as COGS (Cephalometric for Orthognathic Surgery), is widely used for diagnosis and treatment planning of both orthognathic and orthodontic cases. Numerous studies have validated this analysis and determined values based on their ethnicities, demographic groups, population, and genders. This study aimed to determine the cephalometric norms in the Dogra ethnic population of Indo- Aryan origin, settled in the Jammu region, which is situated in the northern India.

Materials & Methods: The subjects selected for this study comprised 50 males and 50 females of Dogra origin. Lateral cephalograms of subjects with Class I skeletal base were taken in a standardized way and traced manually. All tracings were performed by the same operator and the intra-class correlation coefficient was determined to account for error. The values for all landmarks specified in Burstone's analysis were determined and compared with those of the Caucasian population. The collected data were tabulated in an Excel sheet and subjected to statistical analysis. Unpaired t-test was used to compare between both groups in relation to cephalometric parameters between Caucasian and Dogra males and females.

Results: Most of the parameters in COGS showed statistically significant differences between Dogra males and females. Similarly, when the Dogra population values were compared with those of Caucasians, many parameters were found to be statistically different.

Conclusion: The Dogra population exhibits statistically different skeletal and dental features compared to Caucasian norms.

KEYWORDS: Cephalometrics for Orthognathic Surgery (COGS), Dogra ethnicity, Ethnic norms.

INTRODUCTION

The concept of beauty and facial esthetics varies across different cultural backgrounds, ethnicities and populations. In orthodontics, various cephalometric analyses conducted on cephalograms aid in understanding the harmonious relationship of underlying facial structures, which plays a crucial role in orthodontic diagnosis and treatment planning. Since the advent of cephalometry by Broadbent, many cephalometric analyses in orthodontics have been developed for diagnosis and treatment planning. The first such analysis was introduced by Down, which was based on White American subjects within a specific age group.[1] Likewise, other widely used analyses include Steiner's,[2] Ricketts',[3] Mc Namnara[4] all of which were derived from cephalograms of Caucasian populations.

Burstone developed a specialized cephalometric appraisal system, called Cephalometrics for Orthognathic Surgery (COGS), [5,6] which was developed at the Indiana University. The COGS analysis was originally formulated for the cephalometric analysis of orthognathic surgery cases in individuals of Caucasian (White) origin, the COGS analysis effectively evaluates the horizontal and vertical positions of facial bones using constant reference lines that incorporate various linear and angular measurements.

The term "cephalometric norms" refers to the establishment of an individual's or a population's craniofacial morphology reference based on the average measurements. All the norms from aforementioned cephalometric analyses are derived exclusively from Caucasian population. However, numerous studies have demonstrated ethnic variation in craniofacial morphology, including skeletal, and dentoalveolar, and soft tissue components.[7-10] Additionally, studies have reported gender-based differences in cephalometric parameters.[11,12] The establishment of these norms for a particular ethnicity is important as it provides insight into the normal dentofacial pattern of that population, thereby enhancing treatment success and ensuring the establishment of optimal facial harmony in accordance with the prevalent norms in that ethnicity.

Several studies have established cephalometric norms for various ethnic groups, including the Japanese,[13] and the Srilankan Sinhalese population.[14] In India, cephalometric norms have been established for different regional populations, including the COGS norms for Rajasthan,[15] Eastern Uttar Pradesh,[16] Central india,[17] Karnataka[18] and South India[19]. However, these studies often include samples comprising a mix of ethnic backgrounds, which does not provide a standardized set of norms for a specific population to be treated orthodontically. To derive accurate and reliable cephalometric norms the sample should be based on population with same ethnic backgrounds which gives more reliable and standardized norms.

The Dogra population is an Indo-Aryan ethno-linguistic group that speaks the Dogri language. The total documented Dogra population is approximately 2.5 million according to the 2011 census[20] who primarily resides in the Jammu region of Jammu and Kashmir, as well as neighbouring areas of Punjab, Himachal Pradesh and northeastern Pakistan. Their ancestral homeland is called Duggar. While many Dogras in Jammu and Kashmir follow Hinduism, a sizable minority practices Islam, Christianity and Buddhism.[21-24]

Currently, there is no existing literature on the cephalometric norms for orthognathic surgery in the Dogra population. Establishing a new norm for this population can provide valuable reference data for orthodontists, that helps in the orthodontic diagnosis and treatment planning. Therefore, the aim of this study was to establish Burstones cephalometric norms for male and female Dogra population and compare these norms with those of the Caucasian populations.

MATERIAL & METHODS

This study was a longitudinal study and the sample included subjects of Dogri origin which were segregated from the patients reporting for orthodontic treatment to the Department of Orthodontics, Indira Gandhi Government Dental College & Hospital, Jammu. They were made to fill out a structured questionnaire designed to determine the ethnic background of the Dogri origin subjects. This study was approved by the Institutional Ethics Board (IEC/IGGDC/145). The study was completed over a duration of 1 year and 11 months from April 2021 to March 2023.

Keeping the power of the study at 95% with an alpha of 5%, the total sample size was 100, which included 50 males and 50 females. Inclusion criteria of the samples included 1) Age range between 19 to 24 years, 2) No facial or spinal abnormalities, 3) Standardized Lateral Cephalograms, 4) Both parents born in Jammu (Dogri speaking), 5) Healthy patients without any history of systemic diseases, and 6) Skeletal class I bases with ANB angle 0 to 4°, WITS appraisal (male -1 mm, female 0 mm)[25], Yen angle (117° – 123°)[26]

Similarly, the exclusion criteria included 1) Signs of systemic illness (metabolic disorders), 2) Undergoing any medical treatment that could affect facial morphology 3) Pregnancy 4) Patients suffering from disorders of bone, nutritional deficiencies and endocrinal disturbances 5) Skeletal Class II & III bases, 6) Craniofacial deformities like clefts 7) Any history of orthodontic treatment

Pre-treatment Lateral cephalogram of all the patients were obtained in a standardized position with teeth in centric occlusion and Frankfort plane parallel to the floor by the same trained operator using a cephalostat machine at 66 kV, 0.5 mA, and 18.7 s exposure time on 100% scale (Figure 1). Manual Tracing of all the cephalograms was done on acetate paper with a tracing pencil under optimal illumination.

Fig 1: Cephalogram: Tracing done on Dogra subjects having Class I skeletal base.

All the lateral cephalograms were traced using lead pencil and 0.003" thick acetate matte tracing paper under sufficient illumination. All the cephalograms were traced by a single operator and to assess intra-operator reliability, a lateral cephalogram was retraced again by the same operator over a gap of 3 days and the intra-class correlation coefficient (ICC) was 0.61 between the two sets of measurements showing good agreement.

COGS analysis by Burstone was done on all the lateral cephalograms and the values were tabulated in an Excel sheet for both Dogra males and females, and the norms were compared with the Caucasian population. All data were entered in Microsoft Office Excel 2010 and analysis of results was done using SPSS version 22 (IBM) software. Descriptive statistics such as mean and standard deviation were calculated for quantitative variables. The p-value was fixed at 0.05. Data normality was checked using Shapiro-Wilk test. A one-sample t-test was used to compare the cephalometric parameters between the Caucasian and Dogra populations. Unpaired t-test was used to compare cephalometric parameters between between Dogra males and Dogra females.

RESULTS

Mean and Standard deviation for different parameters values for Dogra and Caucasian male and female populations were calculated and compared.

Table 1: Comparison of cephalometric parameters between Dogra population and Caucasian population (males)

	Parameters	Caucasian Mean (SD)	Dogra Males Mean (SD)	Unpaired t test	p-value, Significance
Cranial Base	Posterior cranial base (Ar-PTM mm):	37.1 (2.8)	33.69 (1.72)	t = 5.67	p< 0.001**
	Anterior cranial base (PTM-N)mm:	52.8 (4.1)	45.76 (1.52)	t = 7.68	p<0.001**
Horizontal (Skeletal)	Facial convexity (N-A-Pg):	3.9 (6.4)	3.25 (0.21)	t = 0.87	p = 0.712
	Maxillary protrusion (N-A) mm:	0 (3.7)	-0.416 (1.16)	t = 0.42	p = 0.863
	Mandibular protrusion (N-B) mm:	-4.3 (6.7)	1.216 (0.24)	t = 5.612	p<0.001**
	Chin protrusion (N-Pg) mm:	-4.3 (8.5)	1.373(0.303)	t = 6.108	p<0.001**
Vertical (Skeletal and dental relation)	Upper anterior facial height (N-ANS) mm:	54.7 (3.2)	50.65 (1.04)	t = 3.21	P = 0.008*
	Lower anterior facial height (ANS-Gn) mm:	68.6 (3.8)	62.96 (1.45)	t = 6.51	p<0.001**
	Upper posterior facial height (PNS-N) mm:	53.9 (1.7)	50.92 (0.99)	t = 3.12	p = 0.008*
	Mandibular plane angle (MP-HP):	23 (5.9)	19.04 (1.54)	t = 4.27	p = 0.001*
	Upper anterior dental height (U1-NF) mm:	30.5 (2.1)	24.32 (2.76)	t = 7.21	p<0.001**
	Lower anterior dental height (L1-MP) mm:	26.2 (2)	21.59 (0.82)	t = 5.24	p<0.001**
	Upper posterior dental height (UM-NF (mm):	35.8 (2.6)	31.83 (0.68)	t = 4.37	p = 0.009*
	Lower posterior dental height (LM– MP) mm:	45 (2.1)	41.02 (0.85)	t = 4.86	p = 0.003*

Maxilla and mandible	Maxillary length (PNS-ANS) mm:	57.7 (2.5)	51.51 (0.51)	t = 6.81	p<0.001**
	Mandibular ramus length (Ar-Go) mm:	52 (4.2)	47.91 (0.58)	t = 4.89	p = 0.002*
	Mandibular body length (Go-Pg) mm:	83.7 (4.6)	74.06 (0.61)	t = 8.732	p<0.001**
	Chin depth (B-Pg) mm:	8.9 (1.7)	5.76 (0.34)	t = 3.812	p = 0.14*
	Gonial angle (Ar-Go-Gn):	119.1(6.6)	121.59(0.68)	t = 2.143	p = 0.027*
Dental Relationship	Occlusal plane angle (OP – Hp):	6.2 (5.1)	10.26 (0.65)	t = 4.318	p = 0.005*
	Upper incisor inclination (U1-NF):	111 (4.7)	110.56(0.96)	t = 1.08	p = 0.842
	Lower incisor inclination (L1-MP):	95.9 (5.2)	96.88 (0.91)	t = 1.533	p = 0.649
	Wits analysis (A-B/OP) mm	-1.1 (2)	2.31 (0.51)	t = 1.85	p = 0.412

*p< 0.05 - statistically significant **p< 0.001 – highly significant

Table 1 shows the comparison of Burstone's cephalometric parameters between male Dogra population and Caucasian population in males. All the parameters were statistically significant indicating a close resemblance of Dogra values with Caucasian population except for certain parameters which are: N-A-Pg (degrees) and N-A (mm) in horizontal skeletal and U1-NF (degrees), L1/Go-ME (degrees), A-B (mm) in the dental relationship.

Table 2: Comparison of cephalometric parameters between Dogra population and Caucasian population (females)

	Parameters	**Caucasian Mean (SD)**	**Dogra Females Mean (SD)**	**Unpaired t test**	**p-value**
Cranial Base	Posterior cranial base (Ar-PTM mm):	32.8 (1.9)	31.65 (0.91)	t = 1.76	p< 0.001**
	Anterior cranial base (PTM-N) mm:	50 (3)	43.14 (0.90)	t = 5.93	p<0.001**
Horizontal (Skeletal)	Facial convexity (N-A-Pg):	2.6 (5.1)	3.3 (0.26)	t = 2.18	p = 0.158
	Maxillary protrusion (N-A) mm:	-2 (3.7)	-0.078 (1.02)	t = 0.812	p = 0.481
	Mandibular protrusion (N-B) mm:	-6.9 (4.3)	0.209 (0.77)	t = 16.923	p<0.001**
	Chin protrusion (N-Pg) mm:	-6.5 (5.1)	0.46 (0.57)	t = 14.376	p<0.001**
Vertical (Skeletal and dental relation)	Upper anterior facial height (N-ANS) mm:	50.6 (2.4)	43.31 (1.69)	t = 6.532	P< 0.001**
	Lower anterior facial height (ANS-Gn) mm:	61.3 (3.3)	57.74 (1.21)	t = 4.912	p<0.001**
	Upper posterior facial height (PNS-N) mm:	50.6 (2.2)	47.11 (0.79)	t = 2.178	p = 0.091
	Mandibular plane angle (MP-HP):	24.2 (5)	21.93 (0.71)	t = 3.481	p =0.041*
	Upper anterior dental height (U1-NF) mm:	27.5 (1.7)	24.37 (0.82)	t = 2.387	p =0.381
	Lower anterior dental height (L1-MP) mm:	23 (1.3)	21.22 (6.05)	t = 1.832	p = 0.248
	Upper posterior dental height (UM-NF) mm:	32.1 (1.9)	29.65 (0.37)	t = 3.881	p = 0.093
	Lower posterior dental height (LM-MP) mm:	40.8 (1.8)	35.6 (0.99)	t = 5.012	p = 0.004*

Maxilla and mandible	Maxillary length (PNS-ANS) mm:	52.6 (3.5)	50.67 (0.77)	t = 2.381	p = 0.238
	Mandibular ramus length (Ar-Go) mm:	46.8 (2.5)	42.04 (0.72)	t = 4.281	p = 0.001*
	Mandibular body length (Go-Pg) mm:	74.3 (5.8)	71.58 (0.53)	t = 2.861	p = 0.034*
	Chin depth (B-Pg) mm:	7.2 (1.9)	4.84 (0.255)	t = 3.921	p = 0.003*
	Gonial angle (Ar-Go-Gn):	122 (6.9)	116.7 (1.28)	t = 3.438	p = 0.015*
Dental Relationship	Occlusal plane angle (OP – Hp):	7.1 (2.5)	7.02 (0.106)	t = 1.482	p = 0.351
	Upper incisor inclination (U1-NF):	112.5 (5.3)	113.0 (0.58)	t = 0.971	p = 0.628
	Lower incisor inclination (L1-MP):	95.5 (5.7)	101.71 (0.78)	t = 3.275	p = 0.047*
	Wits analysis (A-B/OP) mm	-0.4 (2.5)	3.13 (0.26)	t = 5.098	p<0.001**

*p< 0.05 - statistically significant **p< 0.001 – highly significant

Table 2 shows the comparison of The Burstone's cephalometric parameters between the female Dogra population and Caucasian population. All the parameters were statistically significant indicating resemblance of Dogra values with Caucasian population, except for certain parameters which are: N-A-Pg (degrees),N-A (mm) in horizontal skeletal, PNS-N (mm) in vertical skeletal, UI-NF (mm), U6-NF (mm), L6-MP (mm), in vertical dental, PNS-ANS (mm) in the maxilla-mandible, OP-HP (degrees), U1-NF (degrees) in dental relationship.

Table 3: Comparison of cephalometric parameters between Dogra male and female population respectively

	Parameters	Dogra Males Mean (SD)	Dogra Females Mean (SD)	Unpaired t test	p-value
Cranial Base	Posterior cranial base (Ar-PTM mm):	33.69 (1.72)	31.65 (0.91)	t = 0.982	p< 0.001**
	Anterior cranial base (PTM-N) mm:	45.76 (1.52)	43.14 (0.90)	t = 1.862	p<0.001**
Horizontal (Skeletal)	Facial convexity (N-A-Pg):	3.25 (0.21)	3.3 (0.26)	t = 0.743	p = 0.158
	Maxillary protrusion (N-A) mm:	-0.416(1.16)	-0.078 (1.02)	t = 0.381	p = 0.481
	Mandibular protrusion (N-B) mm:	1.216 (0.24)	0.209 (0.77)	t = 1.634	p<0.001**
	Chin protrusion (N-Pg) mm:	1.373(0.303)	0.46 (0.57)	t = 1.981	p = 0.098
Vertical (Skeletal and dental relation)	Upper anterior facial height (N-ANS) mm:	50.65 (1.04)	43.31 (1.69)	t = 6.057	p< 0.001**
	Lower anterior facial height (ANS-Gn) mm:	62.96 (1.45)	57.74 (1.21)	t = 4.912	p<0.001**
	Upper posterior facial height (PNS-N) mm:	50.92 (0.99)	47.11 (0.79)	t = 2.178	p = 0.091
	Mandibular plane angle (MP-HP):	19.04 (1.54)	21.93 (0.71)	t = 1.481	p = 0.132
	Upper anterior dental height (U1-NF) mm:	24.32 (2.76)	24.37 (0.82)	t = 0.276	p = 0.987
	Lower anterior dental height (L1-MP) mm:	21.59 (0.82)	21.22 (6.05)	t = 0.371	p=0.962
	Upper posterior dental height (UM-NF (mm):	31.83 (0.68)	29.65 (0.37)	t = 1.083	p = 0.301
	Lower posterior dental height (LM– MP) mm:	41.02 (0.85)	35.6 (0.99)	t = 5.012	p = 0.021*

Maxilla and mandible	Maxillary length (PNS-ANS) mm:	51.51 (0.51)	50.67 (0.77)	t = 0.582	p = 0.628
	Mandibular ramus length (Ar-Go) mm:	47.91 (0.58)	42.04 (0.72)	t = 5.812	p = 0.038*
	Mandibular body length (Go-Pg) mm:	74.06 (0.61)	71.58 (0.53)	t = 0.981	p = 0.331
	Chin depth (B-Pg) mm:	5.76 (0.34)	4.84 (0.255)	t = 1.102	p = 0.217
	Gonial angle (Ar-Go-Gn):	121.59(0.68)	116.7 (1.28)	t = 3.438	p = 0.035*
Dental Relationship	Occlusal plane angle (OP – Hp):	10.26 (0.65)	7.02 (0.106)	t = 3.109	p = 0.046*
	Upper incisor inclination (U1-NF):	110.56(0.96)	113.0 (0.58)	t = 2.198	p = 0.281
	Lower incisor inclination (L1-MP):	96.88 (0.91)	101.71 (0.78)	t = 3.067	p = 0.049*
	Wits analysis (A-B/OP) mm	2.31 (0.51)	3.13 (0.26)	t = 2.743	p = 0.079

*p< 0.05 - statistically significant **p< 0.001 – highly significant

Table 3 shows the comparison of Burstone's cephalometric parameters between male and female Dogra populations. All the parameters were statistically significant indicating close resemblance except for N-A-Pg(degrees), N-A(mm), N-Pg(mm) in horizontal skeletal, PNS-N(mm), MP-HP(degrees) in vertical skeletal, UI-NF(mm), U6-NF(mm), L6-MP(mm) in vertical dental, PNS-ANS, Go to Pg(mm), B- Pg(mm) in maxilla mandible, U1-NF(degrees) in dental relationship.

The female Dogra population have more parameters which have non-resemblance with the Caucasian population as compared to male Dogra population.

DISCUSSION

Cephalometric for Orthognathic surgery (COGS) analysis given by Burstone has been extensively used for research and in treatment planning for Orthognathic surgery. The original values of this analysis are based on the Caucasian population so they may not be applicable as a reference in the diagnosis and treatment planning of populations of other ethnic backgrounds. This study was aimed at deriving the ethnic-based norms which can provide standard values as compared to the population-based norms. This study determined the Burstone's norms of the Dogra population, which can be used as an aid in the diagnosis and treatment planning in Orthodontics for this ethnicity.

Both posterior cranial base (Ar-Ptm) and anterior cranial base (Ptm-N) were shorter in Dogra population as compared to Caucasians, which was also statistically significant which is suggestive of the mandible being proportionally located more posterior to maxilla in Dogra population than in Caucasians in both males and females. This finding is in alignment with the other Indian studies with Similar findings for males of Rajasthani,[15] Central India,[17] Karnataka[18] population. On the contrary, females of Rajasthani[15] and Karnataka[18] population had longer posterior cranial base than Caucasians. Comparing with international norms, Japanese women[13] have a similar cranial base length as Caucasian women and greater than Dogra women, but the pterygomaxillary fissure in them is located anteriorly, resulting in a shorter maxillary length. Jacobson[27] also reported about the anterior cranial base being smaller in Black Americans as compared to Caucasians. In Saudi population anterior cranial base was also found to be longer and posterior cranial base to be shorter.[28]

In horizontal skeletal parameters, facial convexity (N-A-Pg angle) and maxillary protrusion (N-A) were not statistically significant, though the values for maxillary protrusion (N-A) were higher in the female Dogra population. Facial convexity in males was less which can be attributed to the shorter length of anterior cranial base (PTM-N). The findings of facial convexity were similar to the North Indian population but showed less convexity than the Caucasian population[5] as well as the Rajasthani[15] and Central Indian[17] males. For females, a non- significant difference was noted between Rajasthani,[15] Karnataka[18] and Central India[17] populations when compared with Caucasians[5]. The results of the study conducted by Valiathan[29] support that the convexity of Indian facial profile is greater than in the Caucasians.

Apical base of the maxilla (N-A) in the Dogra male population was not positioned significantly anteriorly,

contrary to North Indians[16] and Caucasians,[5] suggesting an orthognathic maxilla in the Dogra population, and this is in alignment with the values of Central Indian males.[17] Dogra females showed a protrusive maxilla, which is contrary to findings observed for Rajasthani,[15] Karnataka population[18] and Central Indian females.[17] In Japanese population[13] the maxilla apical base was shorter than Caucasian in both sexes.

The apical base of the mandible (N-B) was placed significantly anteriorly in Dogra males and females than in the Caucasians, suggesting a more prognathic mandible. This is contrary to the North Indian[16] and Karnataka[18] population, where non-significant difference was seen on this parameter. Regarding the chin position (N-Pg), it was more anteriorly placed in male and female Dogra population as compared to Caucasians, but was seen more anteriorly placed in males.

The values of vertical skeletal parameters were all decreased in both male and female Dogra populations as compared to Caucasians, which was also statistically significant, except for the upper posterior facial height, which was not significant in the Dogra female population. This is in contrast with the results of the Karnataka female population, which had greater middle facial heights and is in alignment with the studies of males from Rajasthan,[15] Central India[17] and Karnataka,[18] which did not show a significant difference with Caucasians.[5]

The values of vertical dental heights in Dogra males and females were lower as compared to Caucasian population and all the parameters were statistically significant which is in alignment with the results of the North Indian population as well for maxilla-mandibular relationship, where all the values for Dogri males and Females were lower as compared to Caucasian population and were statistically significant except for PNS -ANS in females which was found to be statistically not significant. These results are in alignment with the results of North Indian population,[30] Central Indian[17] and Karnataka[18] population except for the ramus length and the mandibular body length in female group, which were larger as compared to Caucasians, as well as the Dogra, Central Indian[17] and Karnataka[18] females, which had significantly greater mandibular body length than Caucasian.

The values of dental relationship in male and female Dogra populations were greater as compared to the Caucasians, referring to the more protrusive dental relationships. In males, only one parameter was seen to be statistically significant, i.e., OP-HP, which is in alignment with the results of the North Indian population and in contrast with the results of Central Indian,[17] Rajasthani[15] and Karnataka[18] population showed statistically non-significant difference on comparison with Caucasians.[5] while as in Dogra females lower incisor inclination (L1-Mp) and wits analysis (A-B/OP) values were more than the Caucasian population and were statistically significant which is similar to results of females of Central India,[19] Karnataka[20] and Rajasthani[17] population had significantly more proclined incisors than their Caucasian5 counterparts.

Mandibular lower incisors were proclined in Dogra males and it was statistically non-significant like the North Indian males which showed similar results. Maxillary central incisor angulation between Dogra males and females showed no significant differences as compared to Caucasian population.[5] While as the values were quite higher in other Indian study populations like Rajasthani, North Indian.

This study was carried on Skeletal Class I males and females belonging to the Dogra ethnic origin and was first of its kind. In male Dogra population out of 23 parameters only 5 were statistically not significant, whereas in female Dogra population 9 parameters were not significant. The limitation of the study was that the dental relationship values could not be considered much reliable or ideal as the lateral cephalograms taken for analysis belonged to the patients who had dental malocclusion.So the skeletal parameters held more reliability in the present study. The results of this study are beneficial to clinicians for planning treatment regarding orthognathic correction in Dogra patients. Also the results are helpful in anthropological and forensic fields.

CONCLUSION

The results of this study unfold the ethnic differences in the cephalometric values of Burstone's analysis, also known as COGS analysis, when compared with the Dogra population, which should be taken into account while planning orthodontic and orthognathic treatment because of the significant differences in facial features between the Dogra population and the Caucasian population.

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CONFLICTS OF INTEREST:
There is no conflict of interest.

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