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Nose anthropometric study on Indian Americans and its clinical applications

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Abstract
Objectives: The aim was to determine the normal average values of nose liner measurements and to determine any significant sex differences exists in Indian Americans.
Methods: The direct nose anthropometric measurements were carried out using digital caliper in 100 (men, women) Indian American students (18 to 30 years) of American University of Antigua (AUA), Antigua and compared between the sexes.
Results: Nose measurements showed higher value in men than women. Nasal height and width were higher in both sexes. This study results suggest that Indian Americans have broader nose and narrower mouth. Low coefficient of variations were found in nasal ratios, thus making them far more reliable.
Conclusion: Nose anthropometric data specific to Indian Americans will be useful if in case they need to undergo rhinoplasty and for establishing baseline data for cosmetic surgeons which can be used to correct structural defects treating Indian Americans.

Keywords: Nose; morphometry; nasal width; nasal index

Introduction

Anthropometric facial proportions and symmetry are considered determinants of beauty (Carvalho *et al.* 2012) [1]. The nose is a person's most determining feature of beauty because it is at the center of the face (Romo and Abraham, 2003) [2]. The part of the nose that protrudes forwards from the face is the external nose (Sinnatamby, 2006) [3]. The shape of the external nose is variable, and is determined by ethmoid bone and nasal septum, which consist mostly of cartilage and which separates the nostrils (Standring, 2008) [4].

The human nose can be found in many shapes and sizes and are affected by various factors including age, sex, ethnicity, socioeconomic status, environment and region (Heidari *et al.* 2009; Last, 1981) [5, 6]. The narrower noses are favored in cold and dry climates while broader noses in warmer, moister ones as a consequence of natural selection in human evolution (Hall and Hall, 1995) [7]. The shape of the nose is a signature indicating the ethnicity, race, age and sex (Leong and White, 2004) [8]. Nasal index is very useful in anthropology in distinguishing racial and ethnic differences (Franciscus and Long, 2001) [9].

In 2014, nearly 16 million cosmetic procedures were performed in the United States alone [10]. The number of cosmetic procedures performed in the United States has almost doubled since the start of the century. 92% of cosmetic procedures were performed on women in 2014 up from 88% in 2001 [11]. Nose reshaping **(**Rhinoplasty) is among the five most popular plastic surgery procedures performed in the United States, with more than 200,000 procedures performed in 2013 alone. According to the American Society of Plastic Surgeons**,** rhinoplasty is the second most popular cosmetic procedure in the country [12].

The increased use of cosmetic procedures crosses racial and ethnic lines in the U.S.A, with increases seen among African-Americans, Asian Americans and Hispanic Americans as well as Caucasian Americans. In Asia, cosmetic surgery has become more popular, and countries such as China and India have become Asia's biggest cosmetic surgery markets [13].

In the field of facial anthropometry, Farkas' has done the research extensively in many ethnic groups (Farkas *et al.*, 2005) [14]. Facial morphometry is well discussed in Caucasians (Farkas *et al.*, 2005) [14] and African Americans (Ofodile *et al.*, 1993) [15] but, only a limited number of studies exist for Asian Americans (Sim *et al.*, 2000) [16].

Results of the studies conducted in certain ethnic groups or regions may not be applicable to the populations elsewhere (Siddiqui and Shah, 1944) [17]. Therefore there is a need for systematic study for each ethnic groups or region.

There are very few anthropometric studies that have dealt with different migrant ethnic groups in the USA. Indian Americans are the second-fastest growing ethnic group in the United States of America (USA). Most of the studies on nose anthropometric measurements in the USA have been done in Caucasians and therefore may not be applicable for Indian Americans.

A few studies have been conducted on nose anthropometry in Indian populations within India (Jagadish Chandra *et al.*, 2012; Chhabra *et al.*, 2012; Anju Choudhary and Chowdhary, 2012; Patil *et al.*, 2011; Farkas *et al.*, 2005; Khanderkar *et al.*, 2005) [14, 18-23]. But, the available literature search shows a study performed by Husein *et al.* (2010) [24] dealing only with 100 Indian American Woman's face by using photographs. However, there are no reports available on the nose anthropometry in Indian American population.

Nose anthropometric data specific to Indian Americans will be useful if in case they need to undergo rhinoplasty. This study also seeks to expand scientific research on nose anthropometry for establishing baseline data for treating congenital or post-traumatic facial disfigurements of Indian Americans in the USA. Nasal index also exhibits sexual differences (Zhang *et al.*, 1990) [25] and it has become a useful tool in Forensic Science (Xu *et al.*, 2001) [26].

Hence, the aim of the present study was to determine the normal average values of nose liner measurements and ratios in Indian Americans, and if there are any significant differences exist in the measurements among the sexes.

Materials and Methods

1. Subjects

The study group consisted of 100 Indian American students of American University of Antigua (AUA), Antigua, with equal number of men and women. The age of the subjects ranged from 18-30 years. This study was approved by AUA ethics committee. The subjects with previous history of developmental and neurological defects of facial region, cosmetic treatment of nose and upper lip region, cranio-facial trauma, facial surgery and bi-racial ethnic origins were excluded in this study.

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The study was explained and the standard informed consent was obtained from the participants prior to the study. The anthropometric landmarks were identified on the subjects with careful inspection and then marked on the face with black liquid eye liner (Table1) (Figures 1 and 2).

2. Landmarks (nose) (Table1) (Figures 1 and 2)

Table 1: Anthropometric nose land marks

al	alare	most lateral point on the alar contour
n	nasion	the innermost point between forehead and nose
pn	pronasale	most protruded point of the nasal apex
sn	subnasale	midpoint at the union of the lower border
		of the nasal septum and the upper lip
en	endocanthion	internal commissura of the eye fissure
ls	labrale superioris	midpoint of the vermilion line of the upper lip
ch	cheilion	labial commissura

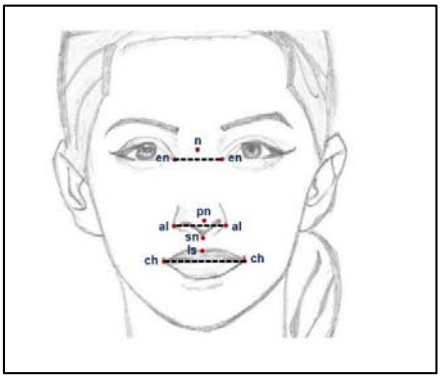

Fig 1: Photograph shows the nose anthropometric landmarks and nose linear measurements. n, nasion; pn, pronasale; sn, subnasale; ls, labrale superioris. Paired landmarkS: al, alare; en, endocanthion; ch, cheilion. Nose linear measurements: nasal width (al–al); Intercanthal width (en-en); Outer intercommisural (mouth) width (ch-ch).

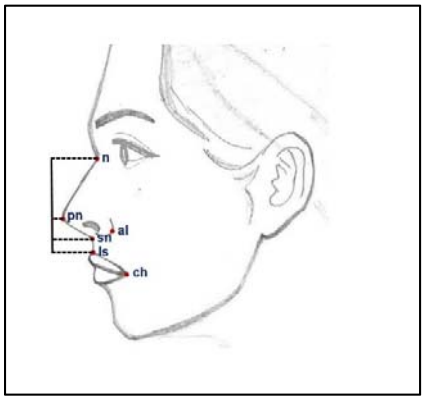

Fig 2: Photograph shows the anthropometric nose linear measurements. Height of the nose (n–sn); length of the nasal bridge (n–pn); philtrum length (sn–ls).

Midline landmarks: n, nasion; pn, pronasale; sn, subnasale; ls, labrale superioris.

Paired landmark: al, alare; en, endocanthion; ch, cheilion.

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3. Position of the subjects

Subjects were asked to sit in an upright relaxed position "natural and normal" erect posture of head and shoulders, with both arms hanging free beside the trunk for the linear measurements of the face (Farkas *et al.*, 2005) [14].

4. Direct Anthropometric measurements (Manual measurement) (Packiriswamy *et al.*, 2012) [27]

The following measurements were done up to 0.5 degree and 0.5 mm accuracy on the subjects with maximum care and comfort by using Neiko 01407A stainless steel digital caliper with extra-large LCD (liquid crystal display) screen and instant SAE-metric (Society of Automotive Engineers) conversion, New York, USA. Every measurement was obtained thrice by the same observer. A third reading was taken if the initial two measurements showed a large discrepancy, and the two closer readings were used (Figure 3).

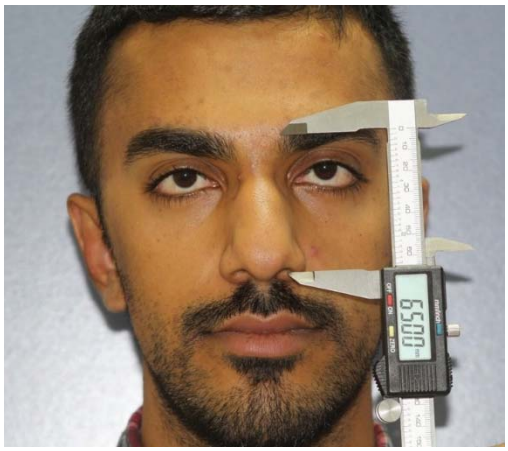

Fig 3: Photograph shows the sample nose linear Measurement using digital caliper.

4.1 Nose linear distances (unit: mm) (Figures 1 and 2)

nasal width (al–al); height of the nose (n–sn); length of the nasal bridge (n–pn); philtrum length (sn–ls); Intercanthal width (en-en); Outer intercommisural (mouth) width (ch-ch).

4.2 Nose ratios

4.2.1. Ratio of horizontal to horizontal measurements:

Intercanthal-nasal width index (en-en/al-al)
Nose-mouth width index (al-al/ch-ch)

4.2.2. Ratio of vertical to horizontal measurement:

Nasal index (al-al/n-sn)

5. Statistical analysis

Data was collected and analyzed in accordance with the current law about personal data and privacy. The statistical analysis was performed using "Graph pad instat" (Version 3.06, Graph pad Software Inc.), San Diego, CA. The nose linear distances were presented as mean and standard deviation (SD). The nose linear distances were compared between sexes by using "Independent t test". Values of $p < 0.05$ were considered as significant. Facial nose ratios were also calculated.

Results

The present study establishes the basal values for various parameters of the nose amongst Indian American students of American University of Antigua (AUA).

Descriptive statistics of the nose anthropometric measurements

The mean and standard deviation (SD) of nose linear anthropometric measurements of Indian Americans are shown in Table 2. The nose anthropometric measurements of Indian American men showed higher value when compared to women (Table 2).

On comparing height of the nose and length of the nasal bridge, it was found to be higher in the height of the nose in both sexes. The nasal width was higher when compared to intercanthal width in both sexes. The outer intercommisural width was higher when compared to nasal and intercanthal widths in both sexes.

Comparison of the nose anthropometric measurements by sex

The nose anthropometric measurements are compared between the sexes by using "independent t test". Nasal width, height of the nose, length of the nasal bridge, philtrum length, intercanthal width and outer intercommisural width in the Indian Americans showed statistically significant sexual difference (Table 2). These results support the findings that sexual dimorphism does exist within the Indian Americans. Nasal width is higher than the intercanthal width in both sexes.

Table 2: Showing various parameters of nose morphometry in Indian American men and women

SN	Parameter in millimeter	Men (n=100)	Women (n=100)	
		mean (SD)	mean (SD)	p Value
1	Height of the nose (n-sn)	51.82 (5.55)	48.84 (4.53)	<0.0001***
2	length of the nasal bridge (n-pn)	47.35 (4.37)	43.87 (3.98)	<0.0001***
3	Cutaneous height of upper lip (philtrum (sn–ls))	12.9 (2.54)	11.08 (2.61)	<0.0001***
4	Nasal width (al-al)	38.82 (3.10)	36.13 (2.58)	<0.0001***
5	Intercanthal width (en-en)	32.74 (3.75)	31.33 (3.09)	0.0040**
6	Outer intercommisural (mouth) width (ch-ch)	52.05 (3.81)	50.42 (4.61)	0.0069**

SN - serial number; SD - standard deviation; ***highly significant (p<0.0001); **Significant (p<0.001)

Horizontal to horizontal nose measurements ratio in the sexes

The mean, standard deviation and coefficient of variation of horizontal to horizontal nose measurements ratio of Indian Americans are shown in Table 3 and 4. We have a very high coefficient of variation of intercanthal-nasal width index when compared to nose-mouth width index in both sexes. But, the intercanthal-nasal width index and nose-mouth width index are quiet reliable with coefficient of variation in both sexes (Table 3 and 4).

Vertical to horizontal nose measurement ratio in the sexes

The mean, standard deviation and coefficient of variation of vertical to horizontal nose measurement ratio (nasal index) of Indian Americans is shown in Table 3 and 4. Indian American men have high coefficient of variation of nasal index when compared to Indian American women. But, the nasal index is quiet reliable with coefficient of variation in both sexes (Table 3 and 4).

Table 3: Ratios of the nose measurements in Indian American men (n=100)

SN	Index	Ratio	Mean	SD	Min	Max	CV
1	Intercanthal-nasal width index	(en-en/al-al)	0.85	0.11	0.66	1.06	13.27%
2	Nose-mouth width index	(al-al/ch-ch)	0.75	0.07	0.56	0.88	9.00%
3	Nasal index	(al-al/n-sn)	0.76	0.88	0.57	0.96	11.58%

SN - serial number; SD - standard deviation; CV - coefficiant of variation; Min - minimum; Max - maximum

Table 4: Ratios of the nose measurements in Indian American women (n=100)

SN	Index	Ratio	Mean	SD	Min	Max	CV
1	Intercanthal-nasal width index	(en-en/al-al)	0.87	0.09	0.65	1.12	11.31%
2	Nose-mouth width index	(al-al/ch-ch)	0.72	0.07	0.57	0.87	9.78%
3	Nasal index	(al-al/n-sn)	0.75	0.80	0.56	0.95	10.76%

SN - serial number; SD - standard deviation; CV - coefficiant of variation; Min - minimum; Max - maximum

Discussion

The slightest imbalance in a person's nose can make a distinct difference in their appearance. The published anthropometric data for racial groups is of little use in planning nasal surgery. Anthropometric measurements of the nose may help to answer important clinical questions in research on the effects of surgery on nasal and facial development (Doddi and Eccles, 2010) [28].

Comparison of the present study with other studies revealed variations and similarities in the nose measurement. The nose results were compared with the other available data for Indian, Indian American and North American Whites as given in Tables 5 and 6. In Table 5 we have compared men of the present study with men of previous studies and in Table 6 comparison of women of the present study with women of previous studies.

In the present study, the nose anthropometric measurements of Indian American men showed higher value when compared to Indian American women. On comparing height of the nose and length of the nasal bridge, it was found to be higher in the height of the nose in both sexes. The mean values of the height of nose was consistency with previous studies done on North American Whites (Farkas *et al*., 2005) [14] and Indians (Chhabra *et al*., 2012) [21] whereas the height of nose observed was higher in the studies conducted on Indians (Jagadish Chandra *et al*., 2012; Anju Choudhary and Chowdhary, 2012) [19, 20]. But, few studies conducted on Indians (Farkas *et al*., 2005; Patil *et al*., 2011) [14, 22] and Indian American Women (Husein *et al*., 2010) [24] showed lower value compared to present study.

The mean values of length of the nasal bridge was consistency with previous studies done on North American White women (Farkas *et al*., 2005) [14] and Indians (Chhabra *et al*., 2012) [21] whereas length of the nasal bridge observed was lower in the studies conducted on Indian (Patil *et al*., 2011) [22] and Indian American Women (Husein *et al*., 2010) [24].

The mean values of philtrum length observed was higher in the study conducted on Indians (Khanderkar *et al*., 2005) [23] compared to the present study. The mean values of the nasal width was consistency with previous studies done on Indians (Farkas *et al*., 2005; Jagadish Chandra *et al*., 2012; Anju Choudhary and Chowdhary, 2012; Chhabra *et al*., 2012; Patil *et al*., 2011) [14, 19, 22] and Indian American Women (Husein *et al*., 2010) [24] whereas the nasal width was lower in the studies conducted by Farkas *et al.* (2005) [14] and Khanderkar *et al.* (2005) [23] on Indians.

The mean values for all parameters of nose morphometry reported in the literature by different scientists vary in different populations. This could be due to several factors such as differences in age, number of subjects, gender of the subjects and geographical conditions, moreover the method adopted.

These results support the findings that sexual dimorphism does exist and showed the statistically significant difference between the sexes. Variations in the nose morphology arise through number of factors which include gender, race, dietary, climate, and environment where we live (Wankhede *et al*., 2012) [30]. Kunjur *et al.* (2006) [31] suggested that the aesthetic standards of a particular group may not suit other patients belonging to diverse racial and ethnic background.

It becomes clear from the available literature/data that the soft tissue relationship of Indian adults differs from the North American White standards or others and cannot be applied on each other. Therefore, these findings suggest that it will help to correct the inappropriateness of using other population data as different populations need different standards to carry out cosmetic surgery.

In this study, number of cases were more as compared to previous studies except the study conducted by Chhabra *et al.* (2012) [21]. We had taken all the parameters of nose region, but in previous studies not even a single study had taken all the parameters.

The studies done on Indians (Kalra *et al*. 2015; Patil *et al*. 2011) [18, 22] and Indian American women (Husein *et al*., 2010) [24] were based on photographic data. The results possibly due to difference in methodology. The present study has been done by direct measurements, which is more reliable. Significant difference was observed between men and women when compared to the present study; working on live material is found to be superior over photograph. No authentic published data on the Indian American population was available and the available data from the Indian population and Indian American women was significantly different. Hence the need for baseline data for such a big Indian Americans in USA though earlier published data on Indians and North American Whites have shown significant racial differences. The present study clinches on to the racial significant data apart from sex dimorphism.

The mean values of intercanthal, nasal and mouth widths were compared within and between Indian American sexes (Tables 3 and 4). Generally, nasal width and intercanthal width are almost equal. The mouth width is double the value of nasal or intercanthal width. The narrower noses are favored in cold and dry climates while broader noses in warmer, moister ones as a consequence of natural selection in human evolution (Hall and Hall, 1995) [7]. In the present study, nasal width is higher than the intercanthal width in both sexes. The mouth width is not equal to the double the value of nasal or intercanthal width. This study results suggest that Indian Americans have broader nose and narrower mouth. In cosmetic nose surgery, reducing the width of the nose, even by a small amount, can have a significant effect on how the nose fits in with the rest of the facial features. The shape differences in nasal anatomy between male and female are important thus, feminization of a male nose is an undesirable result.

The nose ratios were compared with the other available data for Indians, and North American Whites as given in Table 7. The intercanthal-nasal width index in Indian Americans were consistency with previous studies done on Indians (Kalra *et al*., 2015; Jagadish Chandra *et al*., 2012) [18, 19] and higher in North American Whites (Farkas *et al*., 1994) [27]. The nose-mouth width index in Indian American women was higher when compared to previous studies done on Indians (Kalra *et al*., 2015) [18] and North American Whites (Farkas *et al*., 1994) [27]. The nasal index in Indian Americans were consistency with Chhabra *et al.* (2012) [21] study and higher in Patil *et al.* (2011) [22] study on Indians. We have a low coefficient of variation of intercanthal-nasal width, nose-mouth width and nasal indexes, thus making them far more reliable. We had taken all the possible parameters of nose ratios in Indian Americans, but in previous studies not even a single study had taken all the parameters.

The climate, dietary, and environment are different in USA when compared to India. The Indian Americans born and bought up in USA environment are quite high. Parameters can be affected by all these factors. But this will not harm the study because our primary aim is to generate preliminary data and this

will provide useful information and will be helpful in further study.

Further research is very much required to lay down the standards of adoption for cosmetic surgery; however, these preliminary data will provide useful information.

All of these bear different proportions to each other in the two sexes, which may be useful for cosmetic surgeons. However, these represent average values and not the optimal ones that make the face attractive. One should not forget that every individual is a unique creature. Reconstructive surgeons may use these parameters, but at the same time must be familiar with the methods of objectively judging facial harmony and proportion. They need to know how to arrange linear distances, inclination and proportions of the area undergoing surgery while allowing some asymmetries.

Table 5: Compilation of nose measurements in Indian, Indian American and North American White Men (mm).

	Population	(n-sn)	(n-pn)	(sn-ls)	(al-al)	(en-en)	(ch-ch)
Present study	**Indian American**	**51.82**	**47.35**	**12.9**	**38.82**	**32.74**	**52.05**
Farkas *et al.* (2005) [14]	North American White	53			34.7	32.9	53.3
Farkas *et al.* (2005) [14]	Indian	47.2			37.9	34.1	51
Jagadish Chandra *et al.* (2012) [19]	Indian	56.82			37	33.16	50.14
Anju Choudhary and Chowdhary (2012) [20]	Indian	55.84			39.24		
Chhabra *et al.* (2012) [21]	Indian	51.32	46.55		39.48		
Khanderkar *et al.* (2005) [23]	Indian			16.2	32.3		53.5

Nasal width (al–al); height of the nose (n–sn); length of the nasal bridge (n–pn); philtrum length (sn–ls); Intercanthal width (en-en); Outer intercommisural (mouth) width (ch-ch).

Conclusion

The nose anthropometric measurements of Indian American men showed higher value when compared to women. These results support the findings that sexual dimorphism does exist and showed the statistically significant difference between the sexes. The height of the nose was found to be higher when compared to length of the nasal bridge in both sexes. Nasal width is higher than the intercanthal width in both sexes. This study results suggest that Indian Americans have broader nose and narrower mouth.

Facial asymmetries are very common in patients seeking rhinoplasty, and special attention should be paid to these aspects both for surgical planning and for counseling of patients. Rhinoplasty can also be used to correct structural defects, including those that cause breathing problems. The rhinoplasty surgeon must understand the common variations of nasal anatomy seen in various races of individuals

A successful outcome in rhinoplasty requires a thorough and accurate preoperative planning, and awareness of the morphological differences. Anthropometric analysis of nose is showing us a way to provide data which should contribute to satisfactory results of the cosmetic nasal surgery. The present study's nose anthropometric data can be used as a reference value for Indian Americans which can be made use of if they need to undergo rhinoplasty in the USA.

Table 6: Compilation of nose measurements in Indian, Indian American and North American White Women (mm).

	Population	(n-sn)	(n-pn)	(sn-ls)	(al-al)	(en-en)	(ch-ch)
Present study	**Indian American**	**48.84**	**43.87**	**11.08**	**36.13**	**31.33**	**50.42**
Farkas *et al.* (2005) [14]	North American White	48.9	44.7		31.4	31.6	49.8
Farkas *et al.* (2005) [14]	Indian	43.7			33.8	30.9	46.5
Jagadish Chandra *et al.* (2012) [19]	Indian	58.58			37.98	32.08	49.44
Anju Choudhary and Chowdhary (2012) [20]	Indian	56.42			38.42		
Chhabra *et al.* (2012) [21]	Indian	50.3	45.26		35.79		
Patil *et al.* (2011) [22]	Indian	43.26	37.27		35.6		
Khanderkar *et al.* (2005) [23]	Indian			14.2	30.5		47
Husein *et al.* (2010) [24]	Indian American	45.6	39.2		35.6	31.2	51.1

Nasal width (al–al); height of the nose (n–sn); length of the nasal bridge (n–pn); philtrum length (sn–ls); Intercanthal width (en-en); Outer intercommisural (mouth) width (ch-ch).

Table 7: Compilation of nose ratios in n various populations

	Population	(en-en/al-al)		(al-al/ch-ch)		(al-al/n-sn)	
		Men	Women	Men	Women	Men	Women
Present study	**Indian American**	**0.85**	**0.87**	**0.75**	**0.72**	**0.76**	**0.75**
Farkas *et al.* (2005) [14]	North American White					0.66	0.61
Kalra *et al.* (2015) [18]	Indian		0.86		0.69		0.62
Jagadish Chandra *et al.* (2012) [19]	Indian	0.90	0.85			0.65	0.65
Anju Choudhary and Chowdhary (2012) [20]	Indian					0.68	0.7
Chhabra *et al.* (2012) [21]	Indian					0.77	0.72
Patil *et al.* (2011) [22]	Indian						0.95
Farkas *et al.* (1994) [29]	North American White		1.01		0.63		0.64

Intercanthal-nasal width index (en-en/al-al); nose-mouth width index (al-al/ch-ch); nasal index (al-al/n-sn).

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Conflict of interest
There are no conflicts of interest to disclose.

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