Original Article

Evaluation of nose shape as a Mendelian-inherited trait in the determination of parentage among Nigerians in Port Harcourt

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Abstract

Background: Nose shape might be environmentally influenced; however, there are evidences of it being inherited in simple Mendelian dominant-recessive patterns. In such instance, a nose can be broad or narrow with respect to its wideness in comparison to the intercanthal bridge. Therefore, this study was aimed at determining the inheritance pattern of nose shape in the bid to ascertain its usability in parentage determination. **Methods:** Three hundred and thirty-seven subjects from 101 families comprising 202 parents and 135 offspring were recruited for this study. The families were randomly selected from within Port Harcourt by a multistage sampling technique. Their nose shape were observed physically in the father, mother, and at least a child in each family and documented. The offspring traits were tabularized in patterns of parental combinations (when both parents' nose are broad, both parents' nose are narrow, and a combination of broad and narrow). SPSS IBM (r) version 20 was used to analyze the data. Descriptive statistics and test for association between sex and nose shape was carried out by Chi-square analysis and the conformance to Mendelian inheritance pattern was analyzed using Mendelian Chi-square gene distribution model. **Results:** Broad nose shape was more frequent with 298 (88.4%) when compared to narrow nose shape (11.6%). About 46.9% of males had broad nose against 41.5% for females. However, this distribution was not observed to follow any sexual preference ($\chi^2 = 0.141$, $P > 0.932$). The observed and expected outcome were tested for significance on the assumption that offspring outcome conforms to Mendelian simple dominant-recessive monohybrid cross; conformance was observed. **Conclusion:** The distribution of nose shape was observed to be genetically determined and follows Mendelian single gene dominant-recessive pattern with the allele for narrow nose dominant over the allele for broad nose. This result can be used for preliminary screening in parentage dispute. It can also be useful in forensic and genetic studies.

Key words: Mendelian pattern, Nigerians, nose shape, Port Harcourt, trait

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INTRODUCTION

Morphogenesis is the process that generates tissue organization and shape and is usually the downstream response to timing and patterning (Bard, 1990; Bard, 2008). Generic mechanisms acting upon living tissues are capable of giving rise to morphogenetic rearrangements of tissue (Bard, 1990; Newman and Comper, 1990) and these morphogenetic and patterning effects are the inevitable outcome of recognized physical properties of tissues (Newman and Comper, 1990). Formation of the nose is as a result of structural arrangement and patterning; this gives it its unique physical characteristic.

The nose is the prominent structure between the eyes that serves as the entrance to the respiratory tract and contains the olfactory organ. The shape of the nasal cavity is complex (Moore and Dailey, 2006; Moore, *et al*. 2010). The visible part of the human nose is the protruding soft tissue of the face that bears the nostril. The shape of the nose is determined by the ethmoid bone; as it forms the root of the nose separating it from the brain (Jacob, 2008) and the nasal septum, which consist mostly cartilage that separates the nostrils. A narrow nose is thin, high, and approximately as wide as (or smaller than) the width of the intercanthal bridge; does not flay out, whereas a broad nose is flat and wider than the intercanthal bridge. On average, the nose of males is larger than that of nose of females (Jean-Baptiste de Panafieu, 2007).

Genetic inheritance is the reception of genetic qualities by passing on genetic characteristics (traits) from parents to offspring. There are four extensively studied patterns in which these traits can be inherited. They include dominant-recessive, sex-linked, multifactorial, and mitochondrial inheritance (University of Vermont and Patterns of Inheritance, 2002; Ordu and Nwosu, 2015). Dominant-recessive inheritance involves two pairs of contrasting characters (allele) controlling one trait where one of the allele (recessive) is masked by another allele (dominant) when they occur together (University of Vermont and Patterns of Inheritance, 2002; Molly, *et al*. 2010; Ordu, *et al*. 2014). Sex-linked inheritance occurs when the gene that encodes for the trait is located on the sex chromosome (that is, the X and Y chromosomes). Multifactorial or polygenic inheritance is when the conditions are not caused by a single gene, but rather as a result of interplay between genetic factors and environmental factors. In mitochondrial inheritance, DNA located in the mitochondria transfers genetic materials to offspring, especially the mother's egg, thus only females can transmit the trait to offspring, and however, they pass it on to all their offspring (University of Vermont and Patterns of Inheritance, 2002; Louis, *et al*. 2012).

With respect to the intercanthal bridge, the apparent type of nose shape can be determined by observational method; this is different from the anthropometric determination of nasal shape type as defining extents may vary between individuals. With known genetic constitutions of the parents, the outcome of specific offspring ratios will be predictable (Adams, *et al*. 2012).

METHODS

A total of 357 subjects were recruited for this study. The sample comprised 101 families with 202 parents and 135 offspring. Only families that were complete (father, mother, and at least an offspring) were included in the study. Relying on the consent of the families and subjects, with the subject sitting upright, each subject was asked to face forward and the intercanthal distance (nasal bridge distance) was compared with the nasal width, subject who had nasal width equal to or less than the intercanthal distance was documented as narrow (narrow nose shape [nNS]) whereas subjects who had a wider nasal width was regarded as broad (broad nose shape [bNS]). Subjects with any form of surgical manipulation of any part on the nose were excluded from the study. Data obtained were grouped according to families. The inheritance patterns were represented as families in a tabular form with each family trait considered as a single group of traits. Four parental combinations were observed and the offspring grouped from this combination.

- When both parents expressed bNS
- When both parents expressed nNS
- When the father exhibited bNS and the mother nNS
- When the father exhibited nNS and the mother bNS.

The number of offspring, male and female offspring that expressed bNS or nNS when their parents exhibited the trait in the above combination pattern were recorded and presented in tables. These combinations were represented with Mendelian monohybrid crosses. The expected offspring outcome was calculated based on the assumption that they follow or conform to single gene dominant-recessive Mendelian fashion.

The observed outcomes were then tested against the expected significant difference using the Mendelian Chi-square at $P < 0.05$ considered significant and level of confidence set at 95%, which corresponds to a Chi-square value of 3.841.

RESULTS

The result in Table 1 indicates that the distribution of broad nose is more in the studied population than narrow nose. One hundred and fifty-eight of the males representing 46.9% had bNS as against 19 (5.6%) who had nNS while 140 of the females representing 41.5% have bNS as against 20 (5.9%) who have nNS. The total distribution of individuals with bNS is recorded as 298 (88.4%) as against 39 (11.6%) with nNS. There were more females with narrow nose (16.1%) than males (7.1%); but this observed difference in distribution was insignificant ($\chi^2 = 0.613$, $P > 0.05$) for the alleles [Table 2].

Table 3 shows the total number of offspring, male offspring, and female offspring that were observed when both parents had broad nose, narrow nose, or when either of the parents had broad or narrow nose and the other, the alternative allele. The expected frequencies calculated from the observed outcome on the assumption that either broad or narrow nose is the dominant allele with the observed parental combinations were also presented.

In Table 4, the tests for significance between the observed frequencies and expected frequencies for offspring number from the different parental combinations were calculated; on the assumption that each of the alternate alleles was dominant following Mendelian crosses. The nNS on the assumption that it was dominant showed no significant different in the observed frequencies when compared to the expected outcome; clarifies its conformance to Mendelian inheritance pattern and hence narrow nose can said to be dominant.

Table 1: Distribution of nose shape within the observed populations

	Nose shape		Total (%)
	Broad (bNS)	Narrow (nNS)	
Father			
Count (%)	92 (27.3)	9 (2.7)	169 (50)
Percentage within members	91.10	8.90	
Son			
Count (%)	65 (19.3)	3 (0.9)	
Percentage within members	95.60	4.40	
Total males (%)	157 (92.9)	12 (7.1)	
Mother			
Count (%)	88 (26.1)	13 (3.9)	168 (50)
Percentage within members	87.10	12.90	
Daughter			
Count (%)	53 (15.7)	14 (4.2)	
Percentage within members	79.10	20.90	
Total females (%)	141 (83.9)	27 (16.1)	
Total	298 (88.4)	39 (11.6)	337

bNS - Broad nose shape, nNS - Narrow nose shape

Table 2: Chi-square test of association of sex and nose shape

	Trait (Allele)	df	Calculated (χ^2)	Critical (χ^2)	*P* value calculated	Inference
Sex	Nose shape	1	0.256	3.841	0.613	No significant association

DISCUSSION

Nose shape showed variation in the percentage distribution of the two alleles within the studied population, with higher prevalence of bNS (88.4%) over nNS (11.6%). This is higher in distribution, but in line with the study by Lianbin *et al*. (2002) which they observed a wider nose frequency of an average of 67.58% for the Mongolian students.

In this study, females (16.1%) had narrower nose shape than males (7.1%) this is far lower and in contrast with the result of Lianbin *et al*. (2002) for the Mongolian population with 33.26% of males having nNS as against 31.69% of females. The variation observed between the populations does not signify alternate forms of the expression of the traits, but rather physical alteration as a result of inheritance. Jean-Baptiste de Panafieu (2007) research on evolution and documented that women have smaller noses than men because of the fact of not having increased secretion of testosterone in adolescence. From this study and that of Lianbin *et al*. (2002), no sex preference was observed in the distribution of nose shape although higher percentage of bNS in males with a reasonable percentage was also recorded for females.

The result using Chi-square to test the pattern of inheritance based on Mendelian fashion at 0.05 significant level showed that when narrow nose was assumed to be dominant, the observed ratio was highly insignificant when compared to expected ratios. This indicates that the inheritance pattern of nose shape follows a simple dominant-recessive pattern with the nNS dominant over bNS, but with higher frequency observed for bNS. This result is in line with the findings of Lianbin *et al.* (2002) as they stated that the recessive characteristics of nasal profile showed distinctly higher percentage of phenotype than their dominant characters. However, this study does not dispute the existence of variation in the nose size, but it emphasizes that the nose shape conforms to a dichotomous genetic model.

Little or no research has been carried out on the pattern of inheritance of the nose shape except for that of Lianbin *et al*. (2002) which they only documented that the nasal profile conforms to hereditary pattern with high frequency of recessive gene. However, the data in Table 4 agree to that assertion using the transmission pattern observed by Mendel on the assumption that the allele for nNS is dominant-designated (N) and for bNS is recessive-designated (n). Hence, an individual that expresses nNS may be homozygous-dominant (NN) or heterozygous-dominant (Nn) whereas the individual that expresses bNS will be homozygous-recessive (nn). Therefore, when both parents had nNS, the possible cross

Table 3: Number of offspring that had broad or narrow nose shape from different parental combination of nose shape

Parents nasal shape combinations	Total number of offspring (%)			Male offspring			Female offspring		
	Broad	Narrow	Total	Broad	Narrow	Total	Broad	Narrow	Total
Broad nose in both parents	106 (98)	2 (2)	108 (80)	58	0	58	48	2	50
Expected outcome (if broad nose is dominant)	79.5	26.5							
Expected outcome (if narrow nose is dominant)	0	106							
Narrow nose in both parents	0 (0)	4 (100)	4 (3)	0	2	2	0	2	2
Expected outcome (if broad nose is dominant)	4	0							
Expected outcome (if narrow nose is dominant)	1	3							
Broad in father and narrow in mother	9 (64)	5 (36)	14 (10)	6	1	7	3	4	7
Expected outcome (if broad nose is dominant)	10.5	3.5							
Expected outcome (if narrow nose is dominant)	3.5	10.5							
Narrow in father and broad in mother	3 (33)	6 (67)	9 (7)	1	0	1	2	6	8
Expected outcome (if broad nose is dominant)	2.25	6.75							
Expected outcome (if narrow nose is dominant)	6.75	2.25							
Total	118 (87)	17 (13)	135	65	3	68	53	14	67

Table 4: Mendelian Chi-square test for frequency of nasal shape pattern (expected to observed outcome)

Parents nasal shape combinations	If broad is dominant			If narrow is dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Broad nose in both parents	30.864	3.841	Significant	0.037	3.841	Insignificant*
Narrow nose in both parents	0.000	3.841	Insignificant	0.333	3.841	Insignificant*
Broad in father and narrow in mother	1.786	3.841	Insignificant	5786	3.841	Significant
Narrow in father and broad in mother	4.000	3.841	Significant	1.000	3.841	Insignificant*

*More insignificant distribution with lower *P* value observed indicating indifferent distribution from the expected outcome as proposed by Mendel

may be between two homozygous-dominants (Nn × Nn) resulting in an observed ratio of 4:0 of the offspring. There was an insignificant difference with the observed ratio of 4:0. This discrepancy would have been due to the different genetic composition of the parents, which may have been homozygous only. Now taking the broad nose (bNS) to be recessive, the only expected cross is between two homozygous recessive parents (nn × nn) giving rise to only nn offspring. The two offspring with nNS [Table 3] is a deviation, but the number is insignificant at $P < 0.05$ between the observed and expected ratio, hence broad nose is recessive in conformity with Mendelian cross. Therefore, suggesting that narrow nose is dominant while nose is recessive.

Environmental Influence on Nose Shape

This findings oppose the theories; attributing nose shape and size to climate, ethnic, and racial difference alone. The postulations of notable researchers; Thomas and Buxton (1923), Weiner (1954), Wolpoff (1968), Huston (1994), Franciscus and Long (1991), Noback *et al*. (2011), that in hot, humid conditions a low, broad nose serves to dissipate heat and as such influences the nasal shape may be speculative and not scientific; as it was noted by Lederman and Bartsch (2001) that nose shape and size were characteristics measured across human groups. The theory of environmental influence on the shape of the nose was always discussed in terms of measurements that set the white, male nose as a standard (Lederman and Bartsch 2001).

If the theories of environmental influence are total correct, it is expected that offspring from parents of Nigerian descent born in areas of very cold climate is expected to have narrower nose due to environmental influence; no such evidence has been documented. However, Caucasians who are delivered in the hottest humid part of Nigeria still retain their nose shape irrespective of the climate conditions. If nose shape is climatic and hormonal influenced postulated by Thomas and Buxton, 1923; Weiner, 1954 is without doubt consistent, it is expected that Nigerians from cold Northern environment such as Jos is expected to have narrower nose than those from the Niger delta; no such reports have been documented. In addition, the possibility of males having more broad nose than females may have been as a result of classification based on anthropometric variables; however, this study observed that the distribution of the different allelic combinations for nose shape was without sexual preference.

The results of this study emphasizes that nose shape is genetically determined and follows the Mendelian single gene dominant-recessive pattern. The pattern of inheritance of nose shape by the offspring proved to be determined first by the allele the individual inherits from the parents during meiosis, such that once an individual is born, he has a predetermined nose shape which cannot be change without surgery, therefore, the inheritance of the nose shape is more by chance or randomly inherited and not sex- or environmentally-linked.

CONCLUSION

Nose shape type is genetically determined and the pattern of inheritance follows the Mendelian single gene dominant-recessive pattern with the narrow nose being the dominant allele and the bNS being the recessive allele.

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Conflicts of Interest

There are no conflicts of interest.

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