SELECTED FACIAL MEASUREMENTS OF CHILDREN FOR OXYGEN-MASK DESIGN

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I. Introduction.

Current flight conditions and anticipated programs in commercial air travel have created a need to improve the functional efficiency of oxygen masks. A significant portion of this efficiency can be realized with improved designs and materials to assure proper oxygen delivery by adequate mask fit for all potential mask users, including infants and children.

Designing a universal oxygen mask is difficult but necessary when provision for a series of graded mask sizes is impractical or impossible. The extremes of variability found in facial dimensions, shape, and tissue characteristics of well-reported adult populations are amplified when all ages are considered.

Practical design criteria for oxygen masks must result from a complete descriptive and dimensional knowledge of the face. Numerous studies of the facial structures important to mask design have described representative adult populations as well as younger age groups. No previous study, however, includes measurements on infants or descriptions of certain face structures for all ages necessary to the development of a universal mask. The dimensional information also provides a reliable procedure for evaluating new mask configurations.

Eighteen measurements were taken on 978 subjects in selected age groups from 1 month through 17 years. The number of subjects in each group varied, but the sex distribution was reasonably constant. In the groups from 1 month through 4 years, no sex distinction was made; each group had 20 subjects. The subject distribution of all other age groups is as follows: 5 years—31; 6 years—91; 7 years—103; 8 years—93; 9 years—79; 10 years—67; 11 years—40; 12 years—18; 13 years—58; 14 years—45; 15 years—76; 16 years—90; 17 years—67. School-age subjects were selected from throughout the Oklahoma County School System. All preschool subjects (1 month to 5 years) were measured in their homes or in the Clinics of the University of Oklahoma Medical Center.

II. Procedure.

It was necessary to specify the facial areas that must be accommodated by a fitted mask. Nondeformable areas such as the upper portion of the nasal bridge present an entirely different design problem from that offered by the more elastic or pliable areas around the mouth and cheeks. Both tissue areas, however, must be accommodated by a single universal mask. Measurements that define structures associated with large amounts of soft tissue covering or with the muscles of expression can be quite variable. Normal facial expressions such as laughing, yawning, coughing, and sneezing change many baseline measurements taken under normal conditions. This realistic design problem makes necessary the definition and description of the ranges of variation of these measurements.

The standard facial measurements as reported in the literature present an overall sizing description of major face structures or areas and are based on specific, established, anatomical landmarks. Additional measurements on specific face structures and areas were considered essential to the design effort and were selected and standardized for use as practical design information. Only one standard anatomical landmark used as a measuring point has been modified for the convenience and practical use of this study. Point nasion is used here to indicate the midpoint of the nasal root depression, and does not necessarily, coincide with the fronto-nasal suture landmark.

The specific face area of concern for oxygen-mask design is the area surrounding and including the nose and mouth (oronasal area); therefore, a definition, description, and application of each measurement for design use relating to this and adjacent areas is considered. Only those measurements considered essential for direct appli-

cation in determining a mask configuration are discussed. Other measurements (of the head and face) are included in this series; they may not have immediate usefulness for the present needs but are included for future use in design problems requiring this information.

Measuring instruments used for this survey included a standard olive-tip spreading caliper with fitted flat acrylic tips, a standard sliding caliper and a special depth-height gage adapted for use with the sliding caliper. This gage was used to determine the relative heights of nose structure projecting from the adjacent face areas.

III. Description of Measurements.

The following measurements are identified by letters corresponding to those shown in Figures 1, 2, and 3. (All figures and tables are given in the appendix.)

A. *Head Length:* The greatest distance between the most anterior midline point on the forehead (glabella) and posterior projection of the back of the head (occipital area). (Figure 1 and Table 1).

B. *Head Breadth:* The greatest bilateral diameter of the head measured in a plane perpendicular to the anterior-posterior head plane. (Figure 2 and Table 2).

C. *Bizygomatic Diameter:* The greatest distance between the most lateral projections of the cheekbones (zygomatic arches). This measurement defines the maximum breadth limits of the face and can be useful as design information for equipment extending to and covering these lateral areas. (Figure 2 and Table 3).

D. *Bigonial Diameter:* The greatest distance between the lateral angles (gonial angles) of the jaw (mandible). (Figure 2 and Table 4).

E. *Nose Length:* The distance between the upper nasal root depression and the bottom of the nose (point subnasale). This measurement, when used with other related measurements, will define an upper limit of the face or terminal point of vertical mask height and a locator point for the measurement of maximum anterior nose projection. (Figure 1 and Table 5).

F. *Nasion-Stomion Distance:* The distance between the nasal root depression and the point of upper and lower lip intersection. For practical design purposes, this measurement approximates the level of superior margin of the mouth opening. (Figure 1 and Table 6).

G. *Nasion-Supramentale:* The distance between the nasal root depression and the line of depression between the lower lip and chin projection (usually the most posterior point along the symphysis menti, inferior to the infradentale point and superior to the mental protuberance). This measurement may be considered of some importance to the design of oxygen masks for two reasons. The depression marking the lower measuring point is a convenient area for the inferior sealing edge of the mask and represents the highest point on the chin area desirable for mask-edge contact and minimum mouth-lip clearance. (Figure 1 and Table 7).

H. *Nasion-Menton:* This measurement, taken from the nasal root depression to the lower point on the chin, defines total face height and is useful as a maximum vertical dimension of a mask. (Figure 1 and Table 8).

I. *Interocular Diameter:* The distance between the inner corners of the eyes (internal canthus points). This measurement becomes significant for use when the upper part of a mask is designed for maximal vertical height and extends into the nasal root depression. In this event, the measurement would define the maximum limits of mask width covering the upper nose structure to preclude interference with the eyes. (Figure 2 and Table 9).

J. *Nasal Root Breadth:* A bilateral measurement of nose breadth taken at the level of the nasal root depression. This measurement can be used to define a width dimension for mask nosepiece design. (Figure 2 and Table 10).

K. *Nasal Bridge Breadth:* A bilateral measurement of the nasal bridge structure taken from points of bridge and face intersection (a point where the frontal process of the maxillary bone bends anteriorly to form the nasal bridge base). For practical purposes, this measurement defines the widest breadth dimension of the nose base structure concerned with mask contact and the lowest desirable level of mask coverage for the oronasal area. The level of this particular dimension along the nose structure approximates the lower (distal) ends of the solid bone foundation (nasal bones). In addition, for practical design purposes, the level of this measurement can be considered to lie in a plane that bisects the total nose structure along its length axis. (Figure 2 and Table 11).

L. *Nose Breadth:* A bilateral measurement of the maximum external breadth (diameter across the nasal alae). (Figure 2 and Table 12).

M. *Lip Length, Normal:* A bilateral measurement (bichelion diameter) of distance between the external corners of the mouth. This measurement is taken with all facial muscles relaxed. (Figure 2 and Table 13).

N. *Lip Length, Extended:* A bilateral measurement (bichelion diameter) of maximum distance between the corners of the mouth in a condition of voluntary extension using muscles of facial expression. This measurement is of prime importance since it represents a minimum width dimension of a mask. (Figure 2 and Table 14.)

O. *Nasal Root Projection:* A measurement of outward projection of the nasal root depression from base points just medial to the inner corners of the eyes (canthi). This measurement together with the nasal root breadth describes a relative width and depth configuration for mask design at this point. (Figure 3 and Table 15.)

P. *Nasal Bridge Projection:* A measurement of outward projection of the nasal bridge structure from the base points used to define nasal bridge breadth. This distance, measured perpendicular to a plane approximating the anterior surface plane of the nose structure, is used to indicate the width and depth measurement of a mask configuration correlating to the midbridge area. (Figure 3 and Table 16.)

Q. *Bialar Nose Projection:* A measurement of outward projection of the nose tip from the plane of the face. This measurement is occasionally used to indicate a minimum mask depth (anterior-posterior) dimension for nose clearance and corresponds to the nasal root and bridge projection measurements. (Figure 3 and Table 17.)

R. *Nasion-Menton Nose Projection:* A measurement of nose projection from a plane passing through the base points of nasal root depression and the most anterior surface of chin projection. This measurement may also be used to indicate a minimum depth dimension, like that of the bialar nose projection, for masks designed to cover the chin area. (Figure 1 and Table 18.)

IV. Conclusions.

To assure the most effective and efficient utilization of these dimensional data as design criteria, consideration is given to the specific design needs and application of specific face dimensions. Certain measurements of facial structure are used to define a maximum design-limit dimension while others establish minimum dimensional limitations for a particular design feature.

The specific measurements of nasion-menton distance and lip length, extended, as examples, illustrate the practical application of these dimensional data. Limitations of a vertical mask-length dimension would be determined by the *smallest* nasion-menton measurement revealed by the population considered for design accommodation. Any dimension greater than this would most certainly result in excessive mask coverage extending into or above the eyes and brow ridges, below the chin, or both. An effective mask seal could not be realized in this condition. In a similar fashion, a mask-width dimension must be determined by the *greatest* lip length, extended measurement. Anything less could result in an ineffective seal with the corners of the mouth extending beyond the mask edge. This is a realistic problem for design consideration, realizing the possibility of inadvertent actions of coughing, sneezing, and other face-distorting causes. One additional measurement that should be considered in regard to face-distortion problems is a dimension taken from points nasion to supramentale with the mouth fully open. This measurement would indicate a maximum vertical mask dimension, similar in function to that of the lip length, extended measurement. These data will be provided for use at a later date.

The other primary facial dimensions of specific design value are those measuring the relative projection of the nose structure. These four measurements define certain areas of nose projection away from the adjacent face surfaces. They are considered as minimum design dimensions to accommodate the largest and most projecting nose structures. Since these dimensions are measured from the adjacent face surface, they may be used with the nose-breadth measurement to determine the desired relative depths and widths of the mask design.

In view of the extreme range of variability found in these dimensions for our population of less than 1 year to adult size, these measurements may serve merely as a general guide to support major efforts of using unique designs and materials to provide a suitable universal-type mask.

It may be noted that in the tables of dimensions, certain facial measurements of an older age group

are equal to or less than the same measurements of a younger age group. This occurrence is due, in part, to a factor of sampling error and total subject distribution; however, this should not detract from the usefulness of this dimensional information. If a particular measurement is one for use in determining a maximum dimension, the largest figure should be used regardless of age and, similarly, the smallest figure for a minimum dimension. All measurements referred to in the tables are given in inches.

V. Summary.

The development of a universal-type oxygen mask that will adequately fit an entire flying passenger population presents a difficult design problem. One of the primary reasons for this difficulty is due to the extreme ranges of variability found in face structure and the infinite number of face size and shape combinations.

A comprehensive field survey was conducted, using 978 Caucasian male and female subjects of ages 1 month through 17 years to measure 18 specific face structures and areas. These selected measurements were considered significant for design use and establishing the ranges of dimensional variability that determine the limitations of a mask configuration. In Figure 4, the outlined areas superimposed on the face illustrate the limitations of overall mask coverage imposed by these ranges of variability. Observe the smaller area illustrating the minimum mask size and similarly the larger area indicating a maximum mask size. The significance of these dimensional ranges (Tables 1 to 18) becomes apparent when the measurements that define the gross mask dimensions are examined and compared. In some instances, the dimensional difference of a range is greater than 50% of the actual maximum measurement.

To assist design efforts in mask development and functional evaluations, sets of realistic dimensional data of face structure and areas have been provided as a guide to establish practical design criteria. Each measurement is defined, described, and discussed with respect to a particular design problem.

Due to the nature of face variability and the present need to accommodate all age groups with a single mask type, consideration must be given to both unique design approaches and highly flexible materials to compensate for these extreme variations.

APPENDIX

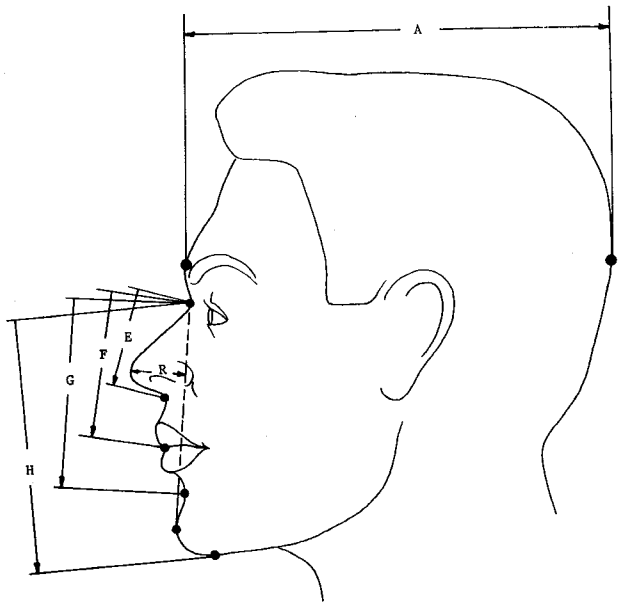

FIGURE 1. Locations of head and face measurements established by anatomical landmarks (side view).

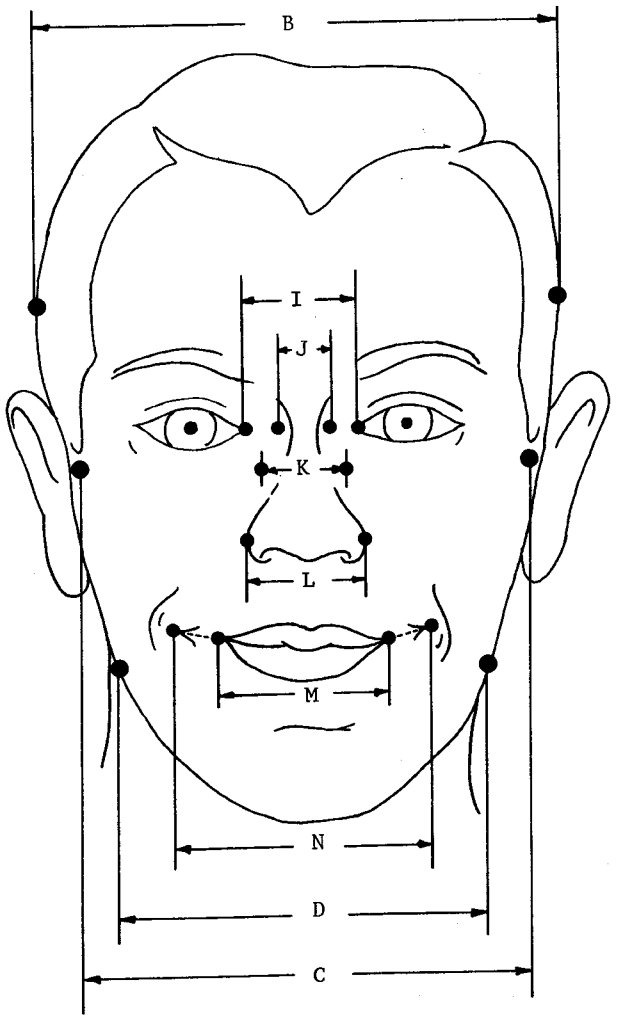

FIGURE 2. Locations of head and face measurements established by anatomical landmarks (front view).

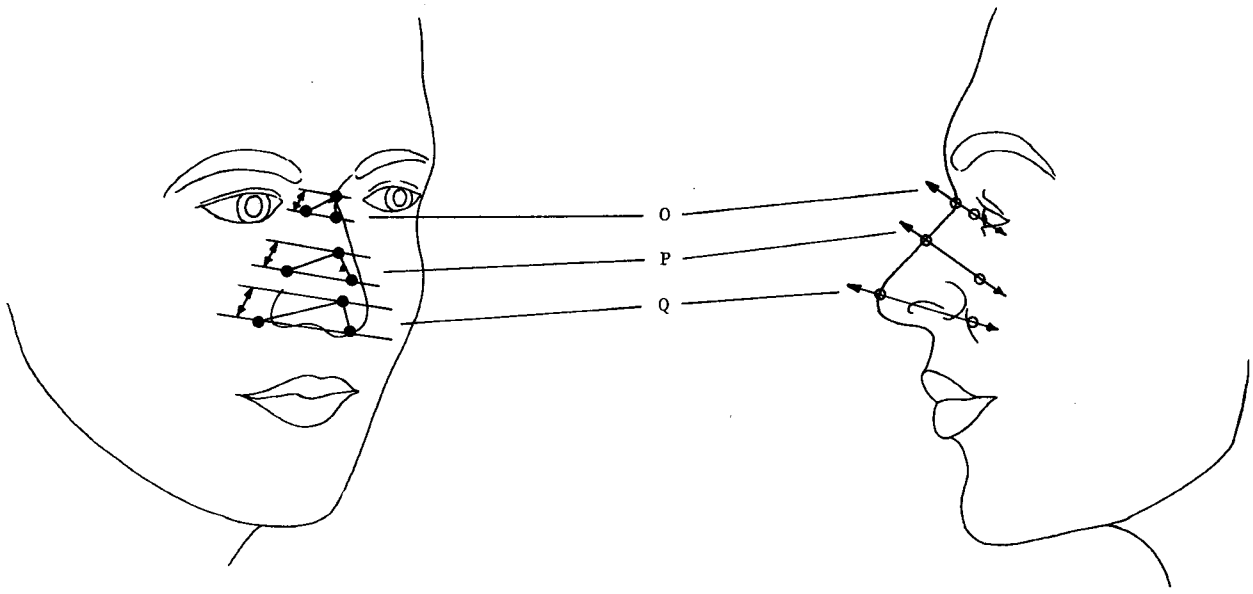

FIGURE 3. Locations of head and face measurements established by anatomical landmarks (nasal area)

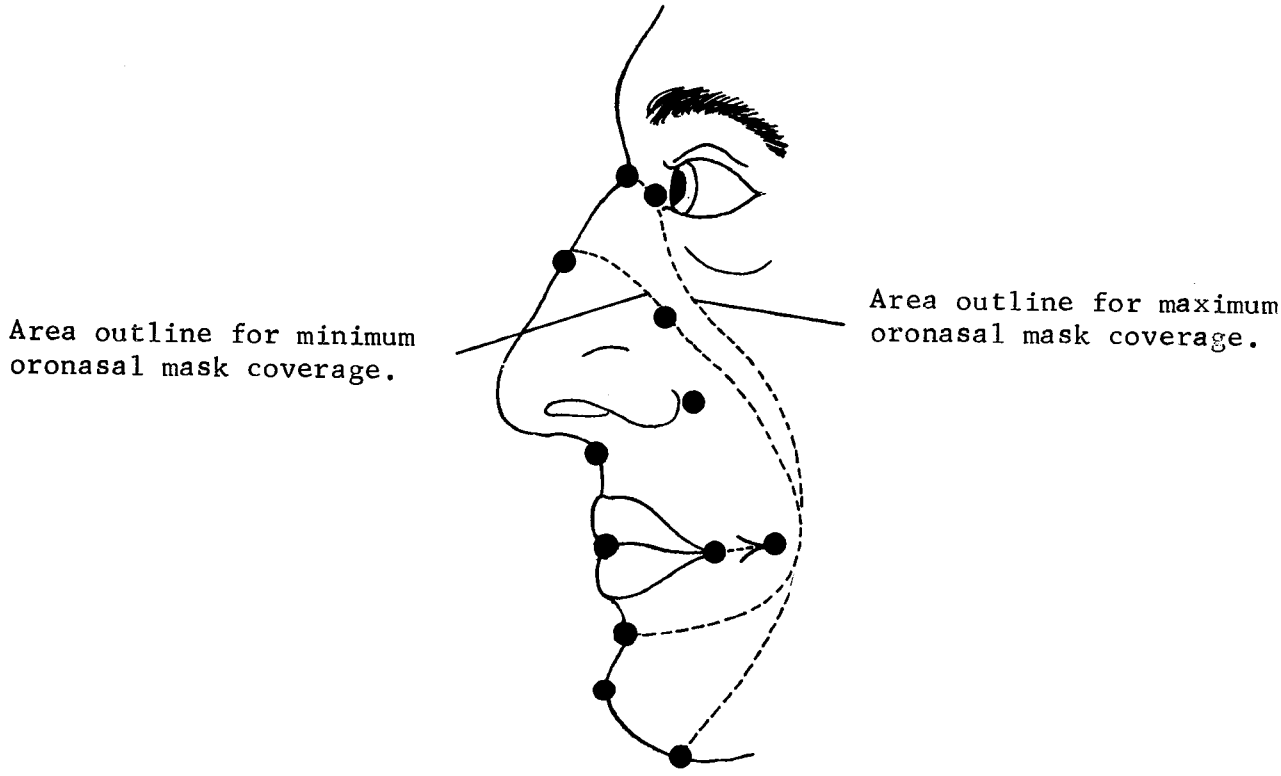

FIGURE 4. Area outlines illustrating practical range limitations of oronasal-mask design and relationships to selected anatomical points for facial measurement.

Table 1. Head Length.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	5. 17	4. 80–5. 35		
6 mo	5. 81	5. 63–5. 87		
1 yr	6. 36	6. 14–6. 54		
2 yr	6. 71	6. 42–7. 01	(Male and female	
3 yr	6. 85	6. 65–7. 20	combined)	
4 yr	6. 91	6. 50–7. 52		
5 yr	6. 87	6. 30–7. 24	7. 07	6. 65–7. 36
6 yr	6. 93	6. 26–7. 80	7. 20	6. 73–7. 64
7 yr	6. 96	6. 65–7. 56	7. 13	6. 50–7. 76
8 yr	7. 00	6. 50–7. 52	7. 34	6. 81–7. 99
9 yr	7. 00	6. 18–7. 52	7. 30	6. 73–7. 72
10 yr	7. 11	6. 61–7. 28	7. 33	6. 54–8. 07
11 yr	7. 17	6. 57–7. 56	7. 27	6. 54–7. 72
12 yr	7. 13	6. 97–7. 28	7. 14	6. 54–7. 64
13 yr	7. 33	6. 54–7. 83	7. 33	6. 38–7. 99
14 yr	7. 27	6. 89–7. 72	7. 38	7. 01–8. 07
15 yr	7. 26	6. 81–7. 60	7. 45	7. 01–7. 72
16 yr	7. 30	6. 73–7. 87	7. 53	6. 81–8. 07
17 yr	7. 34	6. 85–7. 80	7. 54	6. 85–7. 99

Table 2. Head Breadth.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	4. 11	3. 98–4. 29		
6 mo	4. 59	4. 13–4. 96		
1 yr	4. 84	4. 53–5. 00	(Male and female	
2 yr	4. 98	4. 80–5. 43	combined)	
3 yr	5. 06	4. 92–5. 28		
4 yr	5. 20	4. 92–5. 43		
5 yr	5. 31	5. 04–5. 83	5. 40	5. 12–5. 71
6 yr	5. 34	5. 00–5. 83	5. 51	4. 96–5. 91
7 yr	5. 36	4. 92–5. 79	5. 54	5. 16–5. 91
8 yr	5. 39	4. 96–5. 83	5. 52	5. 00–5. 94
9 yr	5. 46	5. 16–6. 18	5. 65	5. 28–6. 22
10 yr	5. 50	5. 16–5. 87	5. 62	5. 24–5. 98
11 yr	5. 51	5. 12–5. 94	5. 62	5. 28–5. 98
12 yr	5. 60	5. 39–5. 79	5. 62	5. 28–5. 83
13 yr	5. 67	5. 39–6. 10	5. 75	5. 51–5. 98
14 yr	5. 74	5. 47–6. 06	5. 81	5. 35–6. 30
15 yr	5. 67	5. 24–6. 06	5. 87	5. 55–6. 30
16 yr	5. 70	5. 39–6. 02	5. 91	5. 43–6. 22
17 yr	5. 69	5. 43–6. 06	5. 96	5. 59–6. 34

Table 3. Bizygomatic Diameter.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	3. 67	3. 54–3. 82		
6 mo	3. 76	3. 54–4. 41		
1 yr	3. 81	3. 52–4. 09	(Male and female	
2 yr	3. 79	3. 58–4. 08	combined)	
3 yr	4. 23	4. 09–4. 45		
4 yr	4. 35	4. 13–4. 57		
5 yr	4. 24	3. 78–4. 02	4. 27	4. 09–4. 53
6 yr	4. 35	4. 02–4. 72	4. 45	4. 13–4. 76
7 yr	4. 39	3. 90–4. 88	4. 53	4. 13–5. 04
8 yr	4. 47	4. 13–4. 84	4. 56	4. 02–5. 08
9 yr	4. 57	4. 29–4. 96	4. 73	4. 29–5. 47
10 yr	4. 67	4. 37–5. 08	4. 70	3. 58–5. 08
11 yr	4. 74	4. 45–5. 12	4. 79	4. 37–5. 12
12 yr	4. 87	4. 76–5. 00	4. 86	4. 53–5. 24
13 yr	5. 02	4. 57–5. 51	5. 06	4. 76–5. 51
14 yr	5. 08	4. 72–5. 43	5. 11	4. 80–5. 51
15 yr	5. 04	4. 37–5. 31	5. 25	4. 88–5. 63
16 yr	5. 08	4. 65–5. 43	5. 34	4. 92–5. 83
17 yr	5. 13	4. 69–5. 94	5. 42	4. 82–5. 83

Table 4. Bigonial Diameter.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	2. 85	2. 72–3. 07		
6 mo	2. 99	2. 76–3. 15		
1 yr	3. 06	2. 92–3. 27	(Male and female	
2 yr	3. 03	2. 72–3. 35	combined)	
3 yr	3. 12	2. 87–3. 27		
4 yr	3. 37	3. 11–3. 66		
5 yr	3. 28	2. 92–3. 58	3. 31	3. 11–3. 58
6 yr	3. 44	3. 03–3. 70	3. 38	3. 03–3. 74
7 yr	3. 50	3. 03–3. 70	3. 43	3. 11–3. 86
8 yr	3. 45	3. 19–3. 82	3. 57	3. 27–4. 06
9 yr	3. 59	3. 15–4. 02	3. 70	3. 23–4. 37
10 yr	3. 62	3. 15–4. 13	3. 71	2. 44–4. 17
11 yr	3. 72	3. 50–3. 98	3. 80	3. 50–4. 02
12 yr	3. 81	3. 62–4. 06	3. 74	3. 35–3. 98
13 yr	3. 80	3. 46–4. 17	3. 90	2. 54–4. 33
14 yr	3. 83	3. 54–4. 17	3. 93	3. 66–4. 25
15 yr	3. 80	3. 43–4. 21	4. 03	3. 74–4. 25
16 yr	3. 85	3. 58–4. 17	4. 14	3. 86–4. 76
17 yr	3. 83	3. 43–4. 09	4. 16	3. 66–4. 41

Table 5. Nose Length.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	0. 88	0. 75–0. 98		
6 mo	0. 96	0. 83–1. 02		
1 yr	1. 02	0. 91–1. 34	(Male and female combined)	
2 yr	1. 16	1. 06–1. 30		
3 yr	1. 30	1. 14–1. 42		
4 yr	1. 40	1. 02–1. 46		
5 yr	1. 41	1. 26–1. 61	1. 45	1. 34–1. 65
6 yr	1. 51	1. 30–1. 77	1. 52	1. 26–1. 73
7 yr	1. 54	1. 26–1. 81	1. 58	1. 38–1. 81
8 yr	1. 61	1. 34–1. 85	1. 61	1. 30–1. 81
9 yr	1. 66	1. 46–1. 85	1. 68	1. 46–1. 93
10 yr	1. 70	1. 42–2. 05	1. 70	1. 42–2. 01
11 yr	1. 71	1. 54–1. 89	1. 76	1. 61–1. 89
12 yr	1. 82	1. 69–2. 01	1. 84	1. 40–2. 17
13 yr	1. 90	1. 73–2. 24	1. 92	1. 65–2. 32
14 yr	1. 95	1. 69–2. 20	1. 94	1. 61–2. 24
15 yr	1. 90	1. 54–2. 20	2. 01	1. 73–2. 28
16 yr	1. 95	1. 69–2. 28	2. 07	1. 77–2. 32
17 yr	1. 93	1. 69–2. 20	2. 10	1. 81–2. 44

Table 6. Nasion-Stomion Distance.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	1. 58	1. 46–1. 69		
6 mo	1. 61	1. 54–1. 73		
1 yr	1. 76	1. 69–2. 13	(Male and female combined)	
2 yr	1. 98	1. 81–2. 17		
3 yr	2. 05	1. 89–2. 20		
4 yr	2. 08	1. 57–2. 20		
5 yr	2. 16	2. 05–2. 40	2. 27	2. 13–2. 48
6 yr	2. 23	2. 01–2. 56	2. 32	2. 05–2. 64
7 yr	2. 27	1. 81–2. 72	2. 35	2. 13–2. 68
8 yr	2. 34	2. 01–2. 60	2. 40	2. 17–2. 76
9 yr	2. 39	2. 09–2. 64	2. 47	2. 20–2. 87
10 yr	2. 48	2. 09–2. 92	2. 45	2. 17–2. 83
11 yr	2. 49	2. 32–2. 68	2. 53	2. 28–2. 72
12 yr	2. 60	2. 52–2. 68	2. 61	2. 32–2. 87
13 yr	2. 62	2. 28–2. 87	2. 67	2. 40–3. 07
14 yr	2. 60	2. 40–2. 83	2. 73	2. 32–2. 99
15 yr	2. 61	2. 20–3. 07	2. 83	2. 52–3. 11
16 yr	2. 65	2. 28–2. 99	2. 88	2. 48–3. 31
17 yr	2. 64	2. 32–2. 99	2. 91	2. 60–3. 23

Table 7. Nasion-Supramentale Distance.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	1. 87	1. 69–2. 01		
6 mo	2. 02	1. 81–2. 20		
1 yr	2. 15	1. 97–2. 60	(Male and female combined)	
2 yr	2. 53	2. 28–2. 80		
3 yr	2. 62	2. 40–2. 87		
4 yr	2. 67	2. 36–2. 87		
5 yr	2. 68	2. 52–2. 83	2. 80	2. 52–3. 11
6 yr	2. 76	2. 48–3. 15	2. 89	2. 60–3. 19
7 yr	2. 82	2. 28–3. 39	2. 89	2. 60–3. 39
8 yr	2. 92	2. 44–3. 23	2. 99	2. 68–3. 50
9 yr	2. 95	2. 60–3. 23	3. 08	2. 76–3. 54
10 yr	3. 06	2. 72–3. 46	3. 06	2. 76–3. 66
11 yr	3. 07	2. 83–3. 31	3. 11	2. 92–3. 39
12 yr	3. 19	3. 11–3. 35	3. 20	2. 95–3. 50
13 yr	3. 22	2. 92–3. 50	3. 30	3. 03–3. 78
14 yr	3. 26	3. 03–3. 43	3. 38	2. 80–3. 78
15 yr	3. 23	2. 87–3. 86	3. 53	3. 07–3. 94
16 yr	3. 31	2. 87–3. 78	3. 56	3. 03–3. 98
17 yr	3. 31	2. 99–3. 74	3. 60	3. 11–3. 98

Table 8. Nasion-Menton Distance.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	2. 36	2. 28–2. 72		
6 mo	2. 77	2. 56–2. 95		
1 yr	2. 85	2. 68–3. 03	(Male and female combined)	
2 yr	3. 14	3. 03–3. 27		
3 yr	3. 37	3. 15–3. 66		
4 yr	3. 41	3. 19–3. 58		
5 yr	3. 49	3. 23–3. 78	3. 61	3. 31–3. 98
6 yr	3. 60	3. 11–3. 98	3. 76	3. 43–4. 17
7 yr	3. 67	3. 15–4. 06	3. 82	3. 39–4. 29
8 yr	3. 75	2. 99–4. 13	3. 87	3. 46–4. 37
9 yr	3. 84	3. 43–4. 29	4. 01	3. 54–4. 57
10 yr	3. 93	3. 58–4. 37	3. 97	3. 62–4. 37
11 yr	3. 99	3. 70–4. 33	4. 03	3. 78–4. 33
12 yr	4. 04	3. 94–4. 13	4. 13	3. 78–4. 53
13 yr	4. 17	3. 70–4. 61	4. 26	3. 74–4. 84
14 yr	4. 23	3. 94–4. 45	4. 32	3. 70–4. 76
15 yr	4. 17	3. 78–4. 53	4. 53	4. 02–4. 96
16 yr	4. 28	3. 74–5. 00	4. 59	4. 06–5. 00
17 yr	4. 29	3. 90–4. 80	4. 68	4. 09–5. 12

Table 9. Interocular Diameter.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	0. 93	0. 71–0. 98		
6 mo	0. 95	0. 87–1. 06		
1 yr	0. 99	0. 95–1. 18	(Male and female combined)	
2 yr	0. 99	0. 79–1. 06		
3 yr	1. 07	0. 91–1. 22		
4 yr	1. 10	0. 98–1. 22		
5 yr	1. 09	0. 95–1. 26	1. 08	0. 95–1. 26
6 yr	1. 15	0. 98–1. 34	1. 15	0. 98–1. 34
7 yr	1. 13	0. 95–1. 26	1. 15	0. 98–1. 34
8 yr	1. 14	0. 98–1. 34	1. 15	0. 91–1. 34
9 yr	1. 16	0. 98–1. 30	1. 19	0. 95–1. 42
10 yr	1. 17	0. 87–1. 42	1. 19	0. 98–1. 38
11 yr	1. 18	1. 06–1. 34	1. 20	1. 14-1. 30
12 yr	1. 17	1. 06–1. 22	1. 19	1. 06–1. 22
13 yr	1. 23	1. 10–1. 38	1. 22	0. 98-1. 38
14 yr	1. 22	1. 10–1. 38	1. 26	1. 10–1. 54
15 yr	1. 21	0. 95–1. 46	1. 26	1. 06–1. 42
16 yr	1. 20	0. 98–1. 38	1. 30	1. 14–1. 50
17 yr	1. 22	0. 91–1. 46	1. 26	1. 10–1. 50

Table 10. Nasal Root Breadth.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	0. 47	0. 24–0. 59		
6 mo	0. 49	0. 47–0. 59		
1 yr	0. 51	0. 43–0. 55	(Male and female combined)	
2 yr	0. 52	0. 35–0. 59		
3 yr	0. 58	0. 51–0. 63		
4 yr	0. 55	0. 47–0. 59		
5 yr	0. 59	0. 47–0. 71	0. 61	0. 47–0. 71
6 yr	0. 61	0. 47–0. 71	0. 62	0. 51–0. 79
7 yr	0. 62	0. 51–0. 75	0. 62	0. 51–0. 71
8 yr	0. 63	0. 47–0. 75	0. 63	0. 43–0. 83
9 yr	0. 63	0. 47–0. 75	0. 65	0. 47–0. 87
10 yr	0. 63	0. 51–0. 83	0. 63	0. 47–0. 83
11 yr	0. 64	0. 52–0. 79	0. 65	0. 51–0. 75
12 yr	0. 61	0. 51–0. 71	0. 64	0. 59–0. 71
13 yr	0. 67	0. 51–0. 75	0. 68	0. 51–0. 87
14 yr	0. 64	0. 55–0. 83	0. 69	0. 51–0. 91
15 yr	0. 70	0. 51–0. 95	0. 75	0. 63–0. 83
16 yr	0. 68	0. 55–0. 83	0. 75	0. 47–0. 91
17 yr	0. 72	0. 59–0. 87	0. 74	0. 63-0. 91

Table 11. Nasal Bridge Breadth.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	0. 81	0. 59–1. 02		
6 mo	0. 83	0. 71–0. 95		
1 yr	0. 90	0. 79–0. 95	(Male and female combined)	
2 yr	0. 93	0. 75–1. 10		
3 yr	1. 00	0. 91–1. 10		
4 yr	1. 05	0. 95–1. 14		
5 yr	1. 05	0. 91–1. 22	1. 12	1. 02–1. 26
6 yr	1. 11	0. 95–1. 30	1. 14	0. 98–1. 22
7 yr	1. 14	0. 98–1. 30	1. 15	0. 98–1. 34
8 yr	1. 14	0. 95–1. 30	1. 16	0. 95–1. 30
9 yr	1. 14	0. 98–1. 26	1. 20	0. 98–1. 38
10 yr	1. 15	0. 83–1. 34	1. 18	0. 95–1. 34
11 yr	1. 19	1. 06–1. 34	1. 20	1. 10–1. 34
12 yr	1. 16	1. 14–1. 22	1. 21	1. 14–1. 42
13 yr	1. 26	1. 06–1. 46	1. 24	1. 02–1. 46
14 yr	1. 29	1. 14–1. 46	1. 28	1. 10–1. 46
15 yr	1. 21	0. 98–1. 38	1. 28	1. 02–1. 50
16 yr	1. 18	0. 98–1. 34	1. 28	1. 02–1. 46
17 yr	1. 19	1. 02–1. 42	1. 27	1. 02–1. 42

Table 12. Nose Breadth.

Age	Female Mean	Female Range	Male Mean	Male Range
1 mo	0. 91	0. 83–0. 98		
6 mo	0. 92	0. 79–1. 06		
1 yr	0. 95	0. 83–1. 14	(Male and female combined)	
2 yr	1. 05	0. 95–1. 30		
3 yr	1. 06	0. 98–1. 18		
4 yr	1. 10	0. 98–1. 26		
5 yr	1. 05	0. 95–1. 18	1. 08	0. 98–1. 18
6 yr	1. 09	0. 87–1. 22	1. 13	0. 98–1. 30
7 yr	1. 12	0. 95–1. 22	1. 13	1. 02–1. 30
8 yr	1. 11	0. 95–1. 22	1. 14	0. 98–1. 26
9 yr	1. 13	0. 98–1. 22	1. 16	1. 02–1. 34
10 yr	1. 15	1. 02–1. 42	1. 17	1. 02–1. 30
11 yr	1. 18	1. 14–1. 22	1. 19	1. 02–1. 34
12 yr	1. 18	1. 10–1. 42	1. 19	1. 10–1. 38
13 ry	1. 26	1. 10–1. 42	1. 25	1. 06–1. 50
14 yr	1. 28	1. 14–1. 46	1. 26	1. 10–1. 57
15 yr	1. 25	1. 06–1. 42	1. 33	1. 14–1. 50
16 yr	1. 23	1. 10–1. 42	1. 38	1. 22–1. 57
17 yr	1. 26	2. 06–1. 38	1. 36	1. 18–1. 50

Table 13. Lip Length, Normal.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	1. 08	0. 98–1. 26		
6 mo	1. 09	0. 95–1. 34		
1 yr	1. 28	1. 14–1. 50	(Male and female combined)	
2 yr	1. 18	0. 98–1. 50		
3 yr	1. 38	1. 22–1. 57		
4 yr	1. 49	1. 26–1. 69		
5 yr	1. 43	1. 22–1. 61	1. 46	1. 22–1. 65
6 yr	1. 51	1. 26–1. 69	1. 55	1. 38–1. 77
7 yr	1. 57	1. 34–2. 20	1. 56	1. 30–1. 81
8 yr	1. 58	1. 34–1. 81	1. 59	1. 42–1. 81
9 yr	1. 63	1. 42–1. 81	1. 65	1. 34–1. 89
10 yr	1. 65	1. 50–1. 81	1. 69	1. 46–1. 97
11 yr	1. 69	1. 42–1. 85	1. 72	1. 46–1. 97
12 yr	1. 77	1. 69–1. 85	1. 77	1. 59–2. 17
13 yr	1. 72	1. 42–1. 97	1. 78	1. 54–1. 93
14 yr	1. 84	1. 57–1. 97	1. 80	1. 57–2. 05
15 yr	1. 77	1. 56–2. 05	1. 84	1. 65–2. 09
16 yr	1. 78	1. 54–2. 01	1. 90	1. 50–2. 17
17 yr	1. 81	1. 50–2. 09	1. 90	1. 65–2. 13

Table 14. Lip Length, Extended.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo				
6 mo				
1 yr	(No measurements were taken on these age groups)			
2 yr				
3 yr				
4 yr				
5 yr	1. 97	1. 61–2. 40	2. 00	1. 65–2. 24
6 yr	2. 00	1. 69–2. 24	2. 05	1. 73–2. 36
7 yr	2. 10	1. 85–2. 44	2. 12	1. 69–2. 40
8 yr	2. 09	1. 77–2. 48	2. 13	1. 77–2. 48
9 yr	2. 19	1. 85–2. 44	2. 21	1. 77–2. 68
10 yr	2. 26	2. 05–2. 56	2. 29	1. 93–2. 72
11 yr	2. 26	2. 01–2. 68	2. 29	2. 09–2. 52
12 yr	2. 34	2. 24–2. 60	2. 34	2. 13–2. 60
13 yr	2. 37	2. 13–2. 76	2. 45	2. 13–2. 68
14 yr	2. 44	2. 28–2. 64	2. 43	2. 01–2. 80
15 yr	2. 30	1. 89–2. 80	2. 48	2. 17–2. 83
16 yr	2. 36	1. 98–2. 83	2. 55	2. 01–2. 92
17 yr	2. 34	1. 93–2. 64	2. 48	2. 09–2. 99

Table 15. Nasal Root Projection.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	0. 16	0. 08–0. 20		
6 mo	0. 20	0. 12–0. 28		
1 yr	0. 23	0. 08–0. 28	(Male and female combined)	
2 yr	0. 20	0. 16–0. 28		
3 yr	0. 25	0. 16–0. 35		
4 yr	0. 22	0. 12–0. 43		
5 yr	0. 31	0. 20–0. 47	0. 35	0. 28–0. 47
6 yr	0. 32	0. 24–0. 47	0. 33	0. 24–0. 51
7 yr	0. 33	0. 16–0. 43	0. 36	0. 28–0. 47
8 yr	0. 35	0. 28–0. 51	0. 37	0. 28–0. 47
9 yr	0. 38	0. 20–0. 51	0. 38	0. 24–0. 51
10 yr	0. 37	0. 24–0. 47	0. 37	0. 20–0. 51
11 yr	0. 37	0. 28–0. 51	0. 39	0. 28–0. 47
12 yr	0. 38	0. 20–0. 43	0. 47	0. 35–0. 87
13 yr	0. 37	0. 28–0. 55	0. 41	0. 28–0. 63
14 yr	0. 43	0. 35–0. 59	0. 44	0. 28–0. 63
15 yr	0. 40	0. 28–0. 47	0. 52	0. 31–0. 71
16 yr	0. 40	0. 28–0. 51	0. 50	0. 28–0. 63
17 yr	0. 41	0. 28–0. 63	0. 50	0. 28–0. 63

Table 16. Nasal Bridge Projection.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	0. 29	0. 20–0. 39		
6 mo	0. 30	0. 28–0. 35		
1 yr	0. 31	0. 20–0. 39	(Male and female combined)	
2 yr	0. 37	0. 35–0. 55		
3 yr	0. 50	0. 35–0. 63		
4 yr	0. 54	0. 28–0. 75		
5 yr	0. 59	0. 43–0. 79	0. 64	0. 51–0. 79
6 yr	0. 62	0. 55–0. 75	0. 64	0. 47–0. 91
7 yr	0. 64	0. 51–0. 79	0. 68	0. 51–0. 87
8 yr	0. 67	0. 51–0. 83	0. 69	0. 51–0. 91
9 yr	0. 70	0. 55–0. 87	0. 73	0. 55–1. 02
10 yr	0. 72	0. 47–0. 95	0. 71	0. 55–0. 83
11 yr	0. 72	0. 55–0. 83	0. 76	0. 63–0. 91
12 yr	0. 81	0. 71–0. 87	0. 81	0. 67–1. 10
13 yr	0. 80	0. 59–0. 98	0. 84	0. 67–1. 22
14 yr	0. 82	0. 71–1. 02	0. 87	0. 63–1. 14
15 yr	0. 80	0. 59–0. 98	0. 94	0. 75–1. 18
16 yr	0. 79	0. 63–1. 06	0. 92	0. 71–1. 14
17 yr	0. 80	0. 59–1. 10	0. 91	0. 71–1. 30

Table 17. Bilar Nose Projection.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	0. 54	0. 47–0. 63		
6 mo	0. 58	0. 51–0. 63		
1 yr	0. 63	0. 47–0. 75	(Male and female combined)	
2 yr	0. 60	0. 24–0. 71		
3 yr	0. 70	0. 51–0. 83		
4 yr	0. 71	0. 55–0. 98		
5 yr	0. 81	0. 67–1. 02	0. 85	0. 79–0. 98
6 yr	0. 84	0. 67–0. 98	0. 86	0. 75–0. 98
7 yr	0. 86	0. 71–1. 02	0. 89	0. 79–1. 02
8 yr	0. 90	0. 79–1. 10	0. 92	0. 79–1. 06
9 yr	0. 94	0. 79–1. 10	0. 95	0. 83–1. 18
10 yr	0. 99	0. 83–1. 18	0. 96	0. 63–1. 10
11 yr	1. 02	0. 87–1. 22	0. 99	0. 63–1. 18
12 yr	1. 07	1. 02–1. 14	1. 07	0. 91–1. 26
13 yr	1. 15	0. 71–1. 26	1. 16	0. 75–1. 38
14 yr	1. 18	1. 02–1. 30	1. 25	0. 94–1. 46
15 yr	1. 16	0. 71–1. 38	1. 37	1. 02–1. 65
16 yr	1. 19	1. 06–1. 38	1. 35	1. 02–1. 57
17 yr	1. 22	1. 06–1. 38	1. 35	1. 14–1. 57

Table 18. Nasion-Menton Nose Projection.

Age	Female		Male	
	Mean	Range	Mean	Range
1 mo	0. 52	0. 35–0. 63		
6 mo	0. 53	0. 31–0. 67		
1 yr	0. 56	0. 47–0. 75	(Male and female combined)	
2 yr	0. 62	0. 55–0. 75		
3 yr	0. 63	0. 51–0. 79		
4 yr	0. 65	0. 47–0. 79		
5 yr	0. 73	0. 63–0. 91	0. 75	0. 63–0. 91
6 yr	0. 75	0. 59–0. 98	0. 76	0. 55–0. 95
7 yr	0. 77	0. 59–0. 98	0. 79	0. 63–0. 91
9 yr	0. 80	0. 63–0. 98	0. 80	0. 63–0. 95
9 yr	0. 83	0. 63–1. 02	0. 83	0. 67–0. 98
10 yr	0. 87	0. 67–1. 10	0. 83	0. 71–0. 95
11 yr	0. 88	0. 83–1. 06	0. 88	0. 79–0. 98
12 yr	0. 90	0. 83–0. 98	0. 91	0. 79–1. 06
13 yr	0. 96	0. 83–1. 14	0. 97	0. 71–1. 22
14 yr	0. 95	0. 75–1. 14	1. 07	0. 79–1. 30
15 yr	0. 97	0. 79–1. 18	1. 13	0. 87–1. 42
16 yr	0. 99	0. 71–1. 18	1. 10	0. 91–1. 26
17 yr	0. 99	0. 75–1. 14	1. 14	0. 87–1. 26

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