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An Anthropometric Survey of 500 Royal Air Force Aircrew Heads, 1972

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An Anthropometric Survey of 500 Royal Air Force Aircrew Heads, 1972

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Summary

An anthropometric survey of 500 R.A.F. aircrew heads was undertaken in 1972. 45 measurements were taken from each subject. Data obtained from these, together with those from 17 derived measurements, are presented in the standard percentile table form. This information is supplementary to the data gathered from the 13 head dimensions measured in the 1970/1971 anthropometric survey of 2000 R.A.F. aircrew (R.A.E. Technical Report 73083, A.R.C. R. & M. 3772).

The photogrammetric method used will enable other dimensions, if required at a later date, to be measured from the permanent record photographs without recalling the subject.

This survey is part of an anthropometric programme being carried out jointly by the Royal Air Force Institute of Aviation Medicine and the Royal Aircraft Establishment, Farnborough.

* Replaces R.A.E. Technical Report 73137-A.R.C. 35 084.

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1. Introduction

In 1966, during a large scale clothing fitting trial, 44 measurements (of which only two related to the head) were taken on 200 R.A.F. and R.N. aircrew.[1] This R.A.E. survey involved many more measurements than earlier British surveys, but the number of subjects was small. As a result of the 200 survey report recommendation, supported by the Royal Air Force Institute of Aviation Medicine, a survey of 2000 R.A.F. aircrew was undertaken during 1970 and 1971.

Over the past 3 years or so, this survey or 2000 R.A.F. aircrew has amassed data on their bodily dimensions. These data were needed for four main reasons:

(a) To determine sizes for aircrew clothing and personal equipment.
(b) To determine cockpit workspace requirements.
(c) Some of the dimensions needed for current protective clothing development and sizing have not hitherto been recorded.
(d) The body sizes of the populations of countries with a high standard of living are increasing and knowledge of this change of size is needed.

The 2000 R.A.F. aircrew anthropometric survey[2] included 13 direct head measurements and six derived head measurements. The information obtained from these measurements is already being used by firms developing new aircrew protective helmets. However, still more information was wanted of the head and to avoid making the list of measurements taken in the 2000 survey inordinately long, a separate survey of head dimensions was decided upon. This survey, sponsored by M.O.D.(P.E.), took place in 1972 and is part of an anthropometric programme being carried out jointly by the Royal Air Force Institute of Aviation Medicine and the Royal Aircraft Establishment, Farnborough.

From 500 R.A.F. aircrew subjects the survey has provided detailed information on 62 head dimensions of which:

17 dimensions were measured by tapes or calipers,
28 dimensions were measured from photographs, and
17 dimensions are derived measurements.

The photogrammetric technique used will enable other dimensions, if required at a later date, to be measured from the permanent record photographs without recalling the subject. This Report deals mainly with the collection and presentation, in the standard percentile table form, of the anthropometric data. It includes tables of comparison with other surveys and also, for possible interest, a table of observations taken from the subjects, i.e. colour and parting of hair, colour of eyes, etc.

The survey subjects, 500 R.A.F. aircrew of Wing Commander rank and below with ages ranging from 18 to 45 years, were a random sample taken from the selected R.A.F. stations visited. This sample was generally representative of the then current R.A.F. aircrew population in respect of age, crew-duty and operational role.

Glossaries of the statistical and anatomical terms used in this Report are included at Appendix A and Appendix B respectively.

2. Apparatus (Photographic)

2.1. Photographic Rig

The photographic rig (Fig. 1), designed and made at R.A.E. specially for the survey, enables four views of the head to be photographed simultaneously using a 600 mm telephoto lens mounted on a single lens reflex camera on a tripod at a distance of 18·9 metres from the rig. The photographic apparatus used is shown in Fig. 2 and a diagrammatic sketch of the apparatus layout is shown in Fig. 3. The rig consists of three mirrors angled at 45 degrees which give reflected images of the subject's front face, top of head and back of head. Centrally placed horizontal and vertical scales, under which the subject sits, are also reflected in these three mirrors. A direct fourth (profile) view is taken at the same time (Fig. 4). The rig can be dismantled quite easily and the mirrors are hinged so that the rig may be collapsed for transportation.

2.2. Photographic Lighting

Considerable experimentation was needed to determine the positions of the photo-flash heads to give adequate, shadow-free illumination of the face and avoid glare from the mirrors. Trial and error photographs were taken with the two flash-heads in various positions, and an optimum setting was achieved which gave acceptable lighting. The mains powered flash unit with twin flash-heads was triggered by the camera through a

synchronisation lead. The relative positions of the flash heads, rig and camera were measured and recorded so that setting up at each station was a simple task (Fig. 3).

2.3. Film and Camera

Photographic trials were made, using black and white film and colour film. Colour, when produced as a positive transparency, was by far the best for detail definition when enlarged on the X–Y axis digital reader machine used for subsequent analysis. The camera used was a 35-mm single lens reflex 'Praktica' fitted with a 600-mm 'Hanimex' telephoto lens set at an aperture of $f22$.

3. Apparatus (Measuring)

3.1. X–Y Axis Digital Reader

The equipment, shown in Fig. 5, allows the cartesian co-ordinates (X, Y) of any manually selected position on a plane section to be measured easily. The X, Y co-ordinates may be referenced to any desired zero position within the screen area and the scales of each may be adjusted independently. A 35 mm film projection unit was fitted to the reader machine to carry the survey colour positive transparency film. The machine is simple and easy to operate and, as proved later, very accurate for this type of survey analysis.

3.2. Calipers

Eight of the head dimensions were measured by conventional means using calipers. The R.A.E. head caliper (Fig. 6) consists of a beam with two tubular arms perpendicular to it. One of these is mounted at the end of the beam and is fixed in position. The second arm, which is spring loaded, slides along the beam over the full scale length. Each of the two arms carries a measuring pad which may be rotated through 180 degrees according to whether a flat disc (44 mm diameter) or a ball end (6 mm diameter) is required. Fine adjustments of the sliding arm are made by means of a knurled thumb wheel.

The 'Abawerk' parallel jaw 20 cm spreading caliper (Fig. 7) was used for only one dimension, *viz*: Lip length (Bichelion diameter). The lip points of measure could not be seen clearly in the photographs and the tapes and head caliper were unsuitable for this measurement.

3.3. Measuring Tape

A glass-cloth tape 10 mm wide by 1·5 m long, graduated in cm and mm, was used for measuring the circumference and arc dimensions.

3.4. Data Recording Sheets

The subject's personal details were recorded on a proforma (Fig. 8). His tape and caliper measurements were recorded on a second proforma (Fig. 9). These proformae were then clipped to the photographic rig and included in the photograph as part of the permanent record of the subject.

The details on these two proformae and the XY co-ordinates measured from the photograph were transcribed onto the statistical proforma (Fig. 10) from which the data were transferred to I.C.L. punched cards. All dimensions were recorded in millimetres and all the data were scrutinised for omissions and obvious errors. Where errors were apparent, the values were deleted. A further check was made by computing percentile tables independently for each batch of 100 subjects as well as for the complete 500 sample.

4. Choice of Measurements

The measurements taken in this survey were chosen to cover those required for aircrew protective helmet and other headgear design purposes. They were selected after consultation with the relevant manufacturing and research organisations and specialist staffs at M.O.D.(P.E.) and the R.A.F. Institute of Aviation Medicine. Considerable effort was required to keep the number of measurements within manageable proportions, particularly the derived measurements.

The survey repeated five tape or caliper measurements which were taken during the 2000 survey. By comparing the percentile tables for these measurements taken from this survey and the 2000 survey, the accuracy and standardisation of technique was progressively assessed. Eight photogrammetric measurements were also repeats of measurements taken in the 2000 survey. This gave a valuable guide as to the accuracy of the photogrammetry technique (Tables 66, 67 and 68).

Of the 45 direct measurements taken in this survey, 25 were measured in 1950 during an Anthropometric Survey of U.S.A.F. Flying Personnel.[3] This too provided information for comparison of techniques subject to errors due to the different populations and dates of measurement.

The full list of measurements taken on this survey is shown at Appendix D together with annotations for those measurements taken on the 2000 R.A.F. survey, [2,3] the U.S.A.F. survey, [4] and surveys of military aircrew of Turkey, Greece and Italy.[5] Visual and alphabetical indexes of the measurements made or derived are given at Figs. 13 and 14 respectively.

5. Pre-Survey R.A.E. Trial and Work Study

5.1. Introduction

A major consideration during the planning of the survey was the time required of a subject whilst the selected dimensions were measured. Any reduction in this time would, it was thought, benefit the survey because:

(a) The subjects would be rather more willing if the time required of them was short.
(b) Fatigue and boredom of both measurer and subject would be reduced.

The photogrammetric measuring technique is an ideal method of reducing subject time because the majority of measurements and information can be obtained from the photographs at a later date and in surroundings more comfortable and relaxed for the measurer. However, before setting out on the actual survey a small work study was carried out to establish:

(i) The validity of taking measurements from photographs.
(ii) What dimensions could not satisfactorily be measured from the photographs.
(iii) The method and order of measuring.
(iv) The training of the author, who is neither anthropometrist nor doctor, in taking measurements from the human head and in the survey administrative procedures.

5.2. Subject's Sitting Position in Photographic Rig

The whole success of any anthropometric survey is in the accuracy of the information obtained from each subject and the proven repeatability of the measuring technique. Standardisation of measuring techniques and thorough training by the operator in the use of measuring tape and caliper resulted in a high standard of repeatability for these measurements. The photogrammetry measurements, using the X–Y axis digital reader are very accurate provided that the machine is accurately zeroed and calibrated and the operator is adequately trained. However, there was sometimes a marked decline in repeatability accuracy between two photographs of the same subject from two separate sittings. This decline was due to change of head attitude in succeding photographs. It became obvious during the work study period that there was no easy positive method for positioning the subject's head in the same constant attitude. Any change in head attitude up or down considerably alters the majority of vertical and horizontal measurements. It does not, however, affect the relative positions of the various features with respect to each other.

After lengthy studies the method adopted of posing the subject in the photographic rig was as follows: The subject was requested to sit up comfortably erect on the adjustable height stool, with the left side of his face and body towards the camera. The stool was then adjusted so that the top of the subject's head came into contact with and maintained a light pressure on the horizontal scale. The back of his head at the same time maintained a light pressure on the vertical scale. The head was positioned centrally under the two scales in a normal horizontally forward looking attitude with the eyes focussed on the camera lens which could be seen in the distance *via* the 45 degree angled mirror in front of the subject. This pose was selected as being likely to approximate that adopted by a pilot in flight. In many subjects it was markedly different from that obtained by horizontal alignment of the Frankfort Plane.

5.3. Skull Caps and Blue Cape

The ideal subject for head measurement, especially from photographs, would be bald. The advantages of that would be that the subject's scalp outline could clearly be seen in all four views of the photograph and would thus permit easier, more detailed and accurate measurement. Obviously it was impractical to shave each subject's head, so an alternative method was sought.

The method adopted was for the subject to wear some form of close-fitting cap which would tightly compress the hair. The outline then seen would approximate to that of the subject wearing a flying helmet and give a good idea of the scalp/skull shape and size. Various forms of headwear were tried ranging from bathing caps to cut-down meteorological balloons. After being inspired by a B.B.C. television series, the author put the problem to the make-up department at the B.B.C. Television Centre, London. They were very interested and helpful and made for the survey's use bald 'wigs' similar to those worn by actors and actresses. The bald wigs, or skull caps, made for the survey were slightly thicker than normal so that they would be more durable, and were made in three different sizes to accommodate the range of head sizes. A simple guide on the production of these skull caps is given at Appendix C. The caps were easy to fit to the subject and compressed the hair very well as can be seen from the photograph at Fig. 4.

Each subject was dressed in a blue cape which provided a suitable and uniform background for the light-coloured skull cap when viewing the photograph of the top of head.

5.4. Pre-Survey R.A.E. Trial and Work Study

As mentioned in Section 5.1 above, a small work study preceded the actual survey, measurements being taken from 24 R.A.E. subjects. The purposes of this study and trial were to:

(a) Prove the technique and the method of processing the subjects through the measuring and photographing sequences.
(b) Determine which measurements would have to be taken by conventional methods (i.e. tapes and calipers) and which measurements could be obtained from the photograph.
(c) Practice fitting the skull caps, taking the conventional measurements and positioning the subjects correctly in the rig.
(d) Analyse the film for determining the convenient and logical order of measurements.
(e) Validate the measurements taken from the photographs by comparing with measurements of the same subject taken by other methods.

5.5. Validation Exercise

This exercise was quite lengthy and involved the following:

(a) Each subject was positioned and repositioned in the rig and photographed to ascertain any change in head attitude. The positioning of the head was the most difficult part of the whole exercise, and it was only after lengthy practice that the head could be aligned repeatably in the same attitude. Any tilt of the head down or up affects the majority of X and Y dimensions taken from the profile picture.

(b) Three different persons used the X–Y axis reader to measure each photograph. After initial training on the use of the machine, the measurement accuracy obtained by all three persons was ± 1 mm on any one photograph for dimensions with clearly defined measuring 'landmarks'.

(c) Ten subjects were recalled and measurements were taken of the head with the R.A.E. head measuring apparatus used in the 2000 Anthropometric Survey. The measuring was done by the survey team from the 2000 survey. Their measurements were then compared with those obtained from the photographs.

(d) Fifteen subjects were again recalled and processed through the sequences by a member of the R.A.F. Institute of Aviation Medicine. After the photographs had been analysed, the measurements were then compared with those obtained previously.

(e) As a final check of the photographic measurement validation, a plastercast head was photographed (Fig. 11). The measurements taken from the 4-view photograph were compared with those obtained using the 2000 survey head box. The comparison of these measurements is shown in Table 71.

As can be seen from the foregoing, the success of accurate repeatability was dependent upon the positioning of the head in the rig. Constant practice and experience overcame this problem to a great extent.

6. Survey Organisation and Procedures

6.1. Choice of R.A.F. Stations

Formal approval was obtained by M.O.D.(P.E.) from the appropriate R.A.F. Commands and Groups for the survey team to visit the following R.A.F. Stations and to measure all available aircrew:

R.A.F. Odiham, R.A.F. Thorney Island, R.A.F. Valley, R.A.F. Tern Hill,
R.A.F. Linton-on-Ouse, R.A.F. Finningley and R.A.E. Farnborough.

These stations were chosen to obtain representative selection of the types of aircraft flown in the Royal Air Force and the various aircrew duties. Taken into consideration also was whether the station was able to provide a reasonable number of subjects for measuring. Prior to the commencement of measuring at each station, a liaison visit was made to the station to discuss the organisation of the survey and to approve the allocation of the work space. During these visits, the team took the opportunity to discuss the survey with the Commanding Officer and the Officer Commanding Flying Wing thereby ensuring their fullest co-operation in providing sufficient 'volunteer' subjects for measuring.

6.2. The Survey Team

The survey team consisted of the author ably assisted by a young lady. The author was locally trained in the taking of measurements direct from the head using tapes and calipers as well as in the use of the X–Y axis reader. This resulted in the author taking all of the direct and photographic measurements (approx. 23 000). Although this became tedious at times, it ensured that there was only one interpretation of each measurement. The interpretation was periodically checked by representatives of R.A.E. and I.A.M.

The young lady's tasks were not only to be an attractive bait for the 'volunteer' subjects but, more important, to assist in the recording of the personal details required from each subject, the measurements taken of them and sundry administrative details of the survey.

6.3. Subject Criteria

The criteria for the selection of subjects for head measuring remained the same as those adopted for the 2000 Anthropometric Survey: aircrew under the age of 46 up to, and including, the rank of Wing Commander were eligible. Loadmasters were not eligible. Aircrew who were on a ground tour and still in receipt of flying pay were included together with any younger aircrew who were in a 'holding' or supernumerary post.

6.4. Programming of Subjects

It had been found in the 2000 survey that an appointment system was the only way to ensure a regular, even flow of subjects. During the liaison visits to stations, it was suggested that an officer be appointed as the programme co-ordinator. His job was to liaise with the flying squadrons and to draw up an attendance roster detailing by name the subjects who were to attend at the specified times. To check and maintain the accuracy of measurements, a number of subjects (approx. 7 per cent) were re-measured (tape and caliper only). The co-ordinator was requested, when detailing the subjects each day, to include a subject who had been previously measured. The appointment system worked very well and maintained a steady work rate for the measuring team.

6.5. Procedure at the Survey Area

On arrival at the survey area, the subject to be measured and photographed was requested to strip to the waist and don the blue cape. The subject's personal details were then recorded on the proforma (Fig. 8). The subject then sat on a high stool and the 17 conventional measurements using the tape and calipers were taken and recorded on the proforma (Fig. 9). (These details and measurements were subsequently transcribed, by the lady assistant, to the statistical proforma (Fig. 10).)

The rubber cap was then fitted to the subject and the two proformae were clipped to the photographic rig. The subject was then positioned in the rig, as explained in Section 5.2. above, and two photographs were taken (the second photograph was taken in case the subject's eyes were closed in the first). The lady assistant operated the camera on the signal that the subject was in the correct sitting position. The skull cap and blue cape were then removed and the subject dressed. The two proformae were filed and the the paperwork for the next subject was prepared.

6.6. Photograph Analysis and Checks

The 35-mm colour films taken at the various stations were processed as a positive film strip. These strips were spliced together as one continuous film and loaded into the X–Y axis digital reader projector.

The following set procedure was carried out on each photograph when projected on the analyser screen:

(a) The photographs of each subject were scrutinised and the best one selected for measuring.

(b) This photograph was further checked for correct head attitude. The photograph was not used if the head was obviously incorrectly positioned.

(c) The photograph was accurately aligned by traversing the X–Y axis cross-hairs marker sight along the horizontal scale in the profile view of the head.

(d) The sight was then placed over the horizontal and vertical scales' zero intersect point and the X–Y axis digital displays zeroed.

(e) The sight was then moved along the horizontal scale to the 20 cm mark and the digital display was adjusted to read 20·00 cm. This was repeated for the vertical scale. The sight was returned to the zero point as a check of sight positioning accuracy.

(f) The sight was then moved around the profile view of the head, for measurements 18 to 39, and positioned over each measuring landmark. The X–Y measurements (i.e. to back of head and to top of head) being read off the digital displays and recorded, by the assistant, on the statistical proforma.

(g) For measurements 40 to 45, the front view of the head was used and the digital displays zeroed and scaled as described above.

Summarising: each view of each photograph for analysis was individually aligned, zeroed and calibrated.

Before the photographic measurements were finally accepted as accurate, three independent checks were made. Using random number tables, 20 subject serial numbers were listed and those photographs analysed by an I.A.M. representative and by each of two R.A.E. representatives other than the author. When the difference between the initial measure and check measure was more than 3 mm (5.5 per cent of cases), the difference was investigated. Apart from measurement No. 32 (vertical location of measurement 33 from vertex), which is discussed later, the differences were invariably due to the measuring 'landmark' of the subject not being sufficiently clear and sharp in the photograph. 94·5 per cent of check measures were within 3 mm of the initial measure.

6.7. Survey Time Scales

Once the survey was under way, the team worked to the following time schedule:

(a) Tape and caliper measurement and photograph (i.e. time of arrival to time of departure from survey area)—15 minutes.
(b) Repeat measuring (tape and caliper only)—5 minutes.
(c) Number of subjects measured per day—20.
(d) Number of subjects per day analysed on the X–Y axis reader—50.

7. Discussion

Certain head measurements are greatly influenced by head attitude therefore repeatability of such measurements is poor: menton to vertex and menton to back of head are two such measurements. If on a repeat measurement the head is tilted back more than in the first session, then menton to vertex distance will be reduced and the menton to back of head will be increased.

During this survey, no attempt was made to position the head in the Frankfort Plane because this would not have been the natural or 'piloting' head attitude for many of the subjects. The positioning of the head, as adopted for this survey, is explained in Section 5.2. One of the main advantages however of this photogrammetry technique is the ability to view each photograph separately and at leisure and to judge whether the head appears to be reasonably positioned. Eleven subjects were eliminated at this stage because their heads were in seemingly unnatural attitudes; grossly tilted backwards or forwards. That only 11 subjects out of 516 were eliminated indicates considerable success in head attitude setting in the photographic rig.

During the pre-survey trial and also during the survey, the tape and caliper measuring techniques were periodically checked. However, after the computer analysis of the first 200 subjects was received, it was apparent that the Bitragion-Coronal Arc measurement was generally higher than that in the 2000 survey. On investigation it was seen that when the tape passed over the rubber skull cap the subject was wearing, a small portion of the rubber cap at either side of the head was crimped under the tape as it was drawn tight: this effectively increased the measurement. A change in technique was applied and the first 200 subjects' measurement of this dimension were scrapped (i.e. only the 305 subjects subsequently correctly measured are included in that particular table (Table 3)). The change in technique was to dress the subject in the skull cap after the tape and caliper measurements had been taken.

Comparatively few problems arose in taking measurements from the photographs. No measurements were taken of the few isolated points of measure which were indefinable. But measurements 33 (maximum distance of back of neck to back of head) and 32 (vertical location of measurement 33 from vertex) did cause some problems in deciding the point of measure. Only when the point of measure was clearly defined was the

measurement taken (376 subjects). In most cases where these measurements were not taken it was because the subject's back neck continued straight down and out of the photograph.

The check on measuring accuracy from the photographs is mentioned in Section 6.6. This involved three independent measurers measuring the photographs of 20 randomly selected subjects and then comparing their results with the original measurement. There were no major unexplained discrepancies. During the survey, 7 per cent of the subjects were re-measured with the tape and calipers. Again, accuracy of the original measurement was substantiated.

The mean head circumference in this survey of 500 aircrew heads differs by only 0·3 mm from that found in the survey of 2000 R.A.F. aircrew in 1970/71,[2] the mean maximum head diagonals measured over the menton in the two surveys differ by 3·4 mm and the means of the bitragion diameters by 1·5 mm. Those measurements were taken similarly in both surveys. It seems likely, therefore, that the somewhat greater differences between the two surveys shown in those dimensions most affected by head attitude (menton to vertex, 9·2 mm; pupil to vertex, 7·6 mm; etc) are in fact due to differences in head attitude. However, as pointed out in Section 5.2, the relative positions of landmarks are unaffected.

Those linear measurements taken from the photographs seem to be consistently slightly larger than their equivalents measured direct from the head in the 2000 survey. It is thought that that is likely to be due to the ability to set the X–Y axis reader graticule 'against the flesh' without causing the slight flattening produced by even light contact pressure from a solid probe on flesh. Another likely cause is that the rubber skull cap worn by the subjects does not compress the hair as much as the caliper pads—hence the head breadth means differ by 5·6 mm.

The differences pointed out are all depicted graphically in Tables 68 and 70. They must of course also include those due to any actual differences in the samples measured in the two surveys and to the different measurers. It is surely rare for the accuracy of a survey to be immediately assessable by reference to another similar survey of the same population—and gratifying when it stands the test so well.

Included for interest only, Table 72 is the result of observations made by the survey team. The hair texture was arbitrarily assessed under the five headings (thick, medium, thin, balding and bald). No attempt was made to measure the thickness or depth of hair when compressed by the bald cap.

Finally, again for the interest only, Fig. 12 shows the silhouette profiles of two heads measured in the survey. These appeared to be generally the largest and the smallest heads measured and illustrate the problems that headgear designers have to contend with in providing protective helmets to fit all aircrew.

8. Conclusions

The measuring apparatus and photogrammetry techniques used for this survey have given a high standard of accuracy and repeatability. However, particular care must be exercised in positioning the subject's head if a consistently high standard of accuracy is to be maintained.

The experience gained from this survey has highlighted the following points:

(a) A thorough work study to determine the sequence of measuring most convenient to both measurer and subject is an essential preliminary of any survey.
(b) The photogrammetry measuring technique has the following advantages:

(i) Time required of each subject is reduced.
(ii) Movement of subject is frozen.
(iii) Permanent record which can be referred to for additional measurements if required.

The techniques used in this survey are simple, requiring only diligence and adequate training. The important requirements for a survey team are that its members should be interested in the project, methodical in the organisation of the work, meticulous in handling the data and possess a sense of humour.

Acknowledgments

The author wishes to record his appreciation and thanks to the following:

(a) The 500 officers who submitted their heads for measuring and the Officers Commanding and staffs of the stations visited with particular mention of the station liaison officers.
(b) C. B. Bolton and R. E. Simpson, E.P. Dept., R.A.E., who designed the apparatus and gave encouragement, advice and help.
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APPENDIX A

Glossary of Statistical Terms and Symbols

A.1. Frequency Distribution

If we consider the neck circumferences of a given collection of individuals, these can be arranged in categories. Thus there might be 17 individuals whose neck circumference falls within the category 33 to 35 cm, 24 individuals in the 35 to 37 cm group and so on. This device for summarising information may be presented in graphical form when it is called a bar-chart or histogram.

With a large enough sample, collection, or population of individuals and a small enough circumference interval, the broken outline of the bar-chart can be idealised as a continuous curve of frequency plotted against circumference (the variable quantity). Then, instead of being limited to information on the number whose neck circumference lies between certain fixed limits, we may consider the proportion of the whole population above or below a given neck circumference or between any two circumferences under the curve.

In many cases this frequency curve or distribution is symmetrical. The symmetrical normal curve is a particularly important shape as it is often assumed to be a satisfactory way in which to approximate to the true frequency distribution of a population.

A.2. Percentile

The Q per cent point, or the Q-percentile, of a frequency distribution is that value of the variable quantity (x) below which Q per cent of all values in the population lie. In this Report the percentiles have been estimated directly from the original data, not from an idealised frequency curve.

A.3. Mean

The mean ($\bar{x}$) of a distribution is the arithmetic average of all values of x. For the normal curve this is also the commonest value in the population.

A.4. Standard Deviation

The standard deviation of a distribution is a measure of the variability of the quantity being studied:

$$\text{s.d.} = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}} \quad .$$

It is useful to remember that, in the case of a normal distribution, approximately 68·2 per cent of the values lie within ±1 s.d. of the mean, 95·4 per cent within ±2 s.d. and 99·7 per cent within ±3 s.d. of the mean.

A.5. Coefficient of Variation

This is a method of expressing the variability in a dimensionless form as the percentage given by:

$$\frac{\text{s.d.}}{\text{mean}} \times 100.$$

A.6. Standard Error

When the mean, standard deviation, or any other quality is measured for a sample of a population the result will vary with the sample used. The possible results of repeated sampling will themselves form a frequency distribution whose variability depends inversely on the sample size.

The standard deviation of this derived distribution is called the standard error of the mean, s.d., or other quality under consideration. In the case of a normal population the true value of the mean, s.d., etc., lies within ±1 s.e. of the sample value on 68 per cent of occasions, within ±2 s.e. on 95 per cent of occasions and, etc.

A.7. List of Symbols

x = a basic size, number, unit, etc.
N = number of x, size of sample or population

Σx = the sum of $x, +x_2 + \ldots x_n$

$\bar{x}$ = mean (arithmetic) or average $= \dfrac{\Sigma x}{N}$

$\Sigma|x - \bar{x}|$ = the sum of the differences, neglecting sign, of x and $\bar{x}$

$\Sigma(x - \bar{x})^2$ = the sum of the squares of the differences of x and $\bar{x}$

σ = standard deviation $= \sqrt{\dfrac{\Sigma(x - \bar{x})^2}{N}}$

v = coefficient of variation $= \dfrac{\sigma}{\bar{x}} \times 100\%$

$\text{s.e.}_{\bar{x}}$ = standard error of the mean $= \dfrac{\sigma}{\sqrt{N}}$

s.e._{σ} = standard error of the standard deviation $= \dfrac{\sigma}{\sqrt{2N}}$

s.e._{v} = standard error of coefficient of variation $= \dfrac{v}{\sqrt{2N}}$

APPENDIX B

Glossary of Anatomical Terms

Anterior	—of or pertaining to the front of the body.
Brow ridges	—the bony elevations covered by the eyebrows.
Canthus	—the corner or angle formed by the meeting of the eyelids.
Cornea	—the transparent outer layer of the eyeball in the anterior plane.
Coronal plane	—a vertical lateral plane parallel to the coronal suture of the skull.
External	—away from the midsagittal plane of the body.
Frankfort plane	—the horizontal orientation plane of the head determined by locating the lower edges of the eye sockets and a single tragion in the same horizontal plane. This is approximated when the subject looks directly forward.
Gonial angle	—the angle at the back of the jaw formed by the intersection of the vertical portion with the lower edge of the horizontal portion of the jaw.
Internal	—near the midsagittal plane of the body.
Larynx	—the cartilaginous walled cavity at the top of the windpipe in the front of the neck which contains the vocal cords.
Menton	—the lower edge of the tip of the chin in the midsagittal plane.
Midsagittal plane	—the vertical plane through the long axis which divides the body into right and left sections.
Nasal root depression or nasion	—the point of maximum depression in the midsagittal plane at the junction of the nose and forehead.
Nasal septum	—the cartilaginous wall separating the right nostril from the left.
Occiput	—the bony prominence of the back of the skull.
Ocular	—of or pertaining to the eyes.
Philtrum	—the vertical groove running from the upper membranous lip to the base of the nasal septum.
Posterior	—of or pertaining to the back of the body.
Pupillary	—of or pertaining to the pupil of the eye.
Sits erect	—subject sits on a flat horizontal surface, his weight distributed equally, with his back held in and his shoulders held back. This position requires holding the torso straight but not rigid.
Submandibular	—pertaining to the region under the mandible or lower jaw.
Subnasale	—the point where the base of the nasal septum meets the philtrum.
Temporal crest	—a narrow, bony ridge running along the side of the head, curving up from the upper lateral margin of the eye socket, above and past the ear and downward, ending behind the ear. This serves as the area of attachment for the temporal muscles.
Temporal region	—the area on the side of the head between and above the eyes and ears.
Tragion	—the notch in the cartilage of the ear just above and immediately in front of the ear hole.
Vertex	—the top of the head in the midsagittal plane when the head is facing forward.
Zygomatic arch	—the bony arch extending horizontally along the side of the head from the cheek bone nearly to the external ear.

APPENDIX C

Notes on the Manufacture of the Rubber Skull Caps

C.1. Material Required

A pre-vulcanised latex rubber solution.
A metal or wooden head-form block.
2 sable or camel hair $\frac{3}{4}$-in. paint brushes.
French chalk.
Vaseline (for wooden block only).

C.2. Preparation

If using a metal head form block, no preparation is required. However, if a wooden head-form block is to be used, then a thin coating of vaseline should be applied over the area of the head-form block which will be coated with the latex rubber.

C.3. Application of Rubber

Mark the head-form block where the latex rubber is to be applied. Apply the latex solution sparingly with a $\frac{3}{4}$-in. paint brush using long sweeping strokes of the brush. Apply successive coats in different directions, i.e.:

1st coat—brush on fore to aft (and allow to dry between coats)
2nd coat—brush across the head form block (ear to ear)
3rd coat—brush on fore to aft, etc. etc. for approx. 10 coats.

C.4. Removal of Skull Cap from Former

When the final coat of latex solution is thoroughly dry, lift one corner of the skull cap with a finger nail and brush under with french chalk. By careful lifting of the skull cap edges, the paint brush with french chalk can be progressively worked under the cap which will part itself from the head former. Apply the french chalk liberally under the cap and dust down the external final surface for ease of removal. When completely removed from the former, trim the rough edges with scissors; this will stop the cap from splitting too easily.

APPENDIX D

Table of Dimensions showing which were also taken in the 2000 1970/71 R.A.F. Survey U.S.A.F. Survey and the Surveys of Turkey, Greece and Italy

	2000 R.A.F. survey (Ref. 2)	U.S.A.F. survey (Ref. 4)	Turkey, Greece Italy survey (Ref. 5)
Tape			
1. Neck circumference	√	√	
2. Head circumference	√	√	√
3. Bitragion—coronal arc	√	√	√
4. Bitragion—minimum frontal arc		√	√
5. Bitragion—subnasale arc		√	√
6. Bitragion—menton arc		√	√
7. Bitragion—submandibular arc		√	√
8. Bitragion—minimum posterior arc		√	√
9. Minimum frontal arc		√	√
Caliper			
10. Maximum head diagonal from menton	√		√
11. Head breadth over flattened ears			
12. Minimum frontal diameter		√	√
13. Maximum frontal diameter		√	√
14. Bitragion diameter	√	√	√
15. Bizygomatic diameter		√	√
16. Bigonial diameter		√	√
17. Lip length (Bichelion diameter)		√	√
Photogrammetry			
18. Brow-ridge crest to vertex			√
19. Head length	√		√
20. Nasion to vertex	√		√
21. Nasion to back of head		√	√
22. External canthus to vertex			√
23. External canthus to back of head		√	√
24. Tragion to vertex	√	√	√
25. Tragion to back of head	√	√	√
26. Bottom of nose to vertex			
27. Bottom of nose to back of head			
28. Maximum chin indent to vertex			
29. Maximum chin indent to back of head			
30. Juncture of chin and neck to vertex			
31. Juncture of chin and neck to back of head			
32. Vertical location of measurement 33 from vertex			
33. Maximum distance of back of neck to back of head			

APPENDIX D (*continued*)

		2000 R.A.F. survey (Ref. 2)	U.S.A.F. survey (Ref. 4)	Turkey, Greece, Italy survey (Ref. 5)
34. Back of head contact centre to vertex				
35. Centre line of abutting lips to vertex				√
36. Menton to vertex		√		√
37. Menton to back of head		√		
38. Nose tip to back of head				
39. Cornea to back of head				
40. Head breadth		√	√	√
41. Biocular diameter			√	√
42. Interpupillary diameter			√	√
43. Interocular diameter			√	√
44. Eye pupil (left) to vertex		√		
45. Maximum nose breadth			√	√
Derived				
46. Menton to tragion (Y)	= 36–24	√		
47. Menton to nasion (Y)	= 36–20	√		√
48. Menton to brow-ridge crest (X)	= 37–19			
49. Tragion to eye pupil (Y)	= 24–44	√		
50. Menton to eye pupil (Y)	= 36–44			
51. Eye pupil to nasion (Y)	= 44–20			
52. Centre line of abutting lips to nasion (Y)	= 35–20			
53. Menton to brow-ridge crest (Y)	= 36–18			
54. Tragion to external canthus (Y)	= 24–22			
55. Tragion to brow-ridge crest (Y)	= 24–18			
56. Brow-ridge crest to tragion (X)	= 19–25	√		
57. External canthus to tragion (X)	= 23–25			
58. Tragion to nasion (Y)	= 24–20	√		
59. Menton to tragion (X)	= 37–25	√		
60. Nose tip to nasion (X)	= 38–21			
61. Menton to bottom of nose (Y)	= 36–26			√
62. Bottom of nose to nasion (Y)	= 26–20			
63. Bottom of nose to tip of nose (X)	= 38–27			
64. Cornea to brow-ridge (X)	= 19–39			

X = Horizontal measurement. Y = Vertical measurement.

TABLE 1

Neck Circumference

Measurement by tape. Subject sitting erect facing forward, measurement of circumference around neck in a plane perpendicular to axis of neck immediately below larynx.

Percentile values

%ile	cm	in.
Min	30·30	11·93
1	32·92	12·96
2	33·46	13·17
3	33·75	13·29
5	34·12	13·43
10	34·61	13·63
15	35·12	13·83
20	35·43	13·95
25	35·70	14·06
30	35·91	14·14
35	36·12	14·22
40	36·28	14·28
45	36·59	14·41
50	36·80	14·49
55	36·99	14·56
60	37·26	14·67
65	37·48	14·75
70	37·77	14·87
75	38·06	14·98
80	38·31	15·08
85	38·70	15·24
90	39·22	15·44
95	39·92	15·72
97	40·48	15·94
98	40·89	16·10
99	41·20	16·22
Max	43·40	17·09

Mean: 36·93 (0·08) cm; 14·54 (0·03) in.
Standard deviation: 1·80 (0·06) cm; 0·71 (0·02) in.
Coefficient of variation: 4·89 (0·15)%
Range: 30·30–43·40 cm; 11·93–17·09 in.
Number of subjects: 505

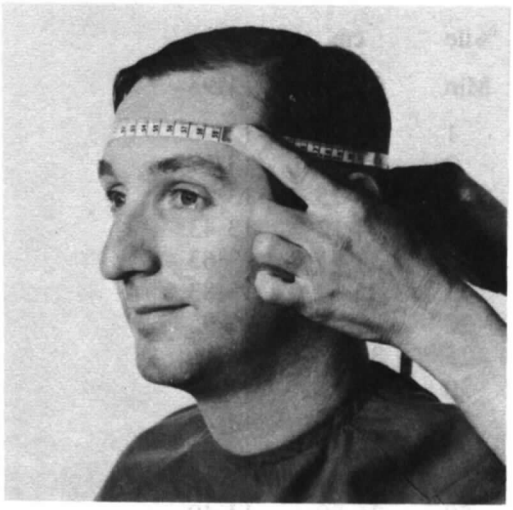
TABLE 2

Head Circumference

Measurement by tape. Subject sitting erect facing forward, measurement with tape passing around head just above brow-ridge and over occiput (tape tension sufficient to flatten hair).

Percentile values

%ile	cm	in.
Min	52·90	20·83
1	54·60	21·50
2	55·00	21·65
3	55·14	21·71
5	55·40	21·81
10	55·81	21·97
15	56·19	22·12
20	56·51	22·25
25	56·74	22·34
30	56·97	22·43
35	57·17	22·51
40	57·30	22·56
45	57·49	22·63
50	57·67	22·71
55	57·83	22·77
60	57·96	22·82
65	58·11	22·88
70	58·32	22·96
75	58·56	23·05
80	58·76	23·14
85	59·05	23·25
90	59·37	23·37
95	59·94	23·60
97	60·39	23·77
98	60·60	23·86
99	60·80	23·94
Max	62·00	24·41



Mean: 57·70 (0·06) cm; 22·72 (0·02) in.
Standard deviation: 1·37 (0·04) cm; 0·54 (0·02) in.
Coefficient of variation: 2·37 (0·07)%
Range: 52·90–62·00 cm; 20·83–24·41 in.
Number of subjects: 505

TABLE 3

Bitragion—Coronal Arc

Measurement by tape. Subject sitting erect facing forward, measurement from tragion of right ear vertically over head to tragion of left ear (tape tension sufficient to flatten hair).

Percentile values

%ile	cm	in.
Min	33·00	12·99
1	33·01	13·00
2	33·61	13·23
3	33·86	13·33
5	34·14	13·44
10	34·44	13·56
15	34·66	13·65
20	34·98	13·77
25	35·15	13·84
30	35·38	13·93
35	35·55	14·00
40	35·74	14·07
45	35·98	14·16
50	36·13	14·22
55	36·29	14·29
60	36·45	14·35
65	36·60	14·41
70	36·76	14·47
75	36·95	14·55
80	37·14	14·62
85	37·31	14·69
90	37·62	14·81
95	38·02	14·97
97	38·29	15·08
98	38·59	15·19
99	38·93	15·33
Max	41·80	16·46

Mean: 36·13 (0·07) cm; 14·23 (0·03) in.
Standard deviation: 1·26 (0·05) cm; 0·50 (0·02) in.
Coefficient of variation: 3·50 (0·14)%
Range: 33·00–41·80 cm; 12·99–16·46 in.
Number of subjects: 305

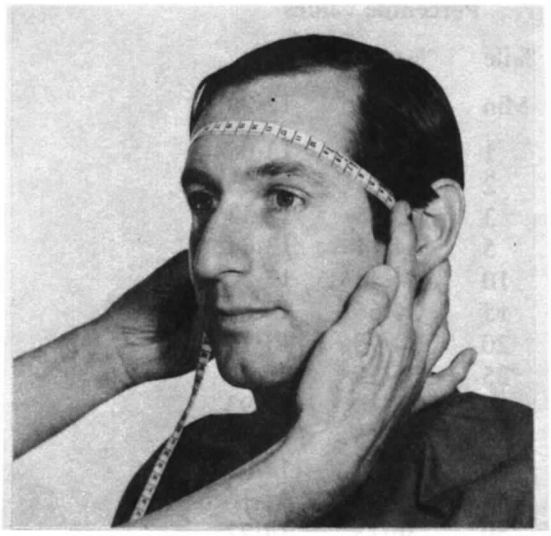
TABLE 4

Bitragion—Minimum Frontal Arc

Measurement by tape. Subject sitting erect facing forward, passing tape over the region of minimum frontal arc, measurement of arc from tragion of left ear to tragion of right ear.

Percentile values

%ile	cm	in.
Min	28·70	11·30
1	29·10	11·46
2	29·31	11·54
3	29·47	11·60
5	29·72	11·70
10	29·98	11·80
15	30·19	11·88
20	30·47	12·00
25	30·65	12·07
30	30·83	12·14
35	30·93	12·18
40	31·03	12·22
45	31·15	12·26
50	31·24	12·30
55	31·37	12·35
60	31·48	12·39
65	31·63	12·45
70	31·87	12·55
75	31·95	12·58
80	32·02	12·60
85	32·23	12·69
90	32·40	12·76
95	32·79	12·91
97	32·98	12·98
98	33·15	13·05
99	33·45	13·17
Max	34·60	13·62



Mean: 31·31 (0·04) cm; 12·33 (0·02) in.
Standard deviation: 0·94 (0·03) cm; 0·37 (0·01) in.
Coefficient of variation: 3·00 (0·09)%
Range: 28·70–34·60 cm; 11·30–13·62 in.
Number of subjects: 505

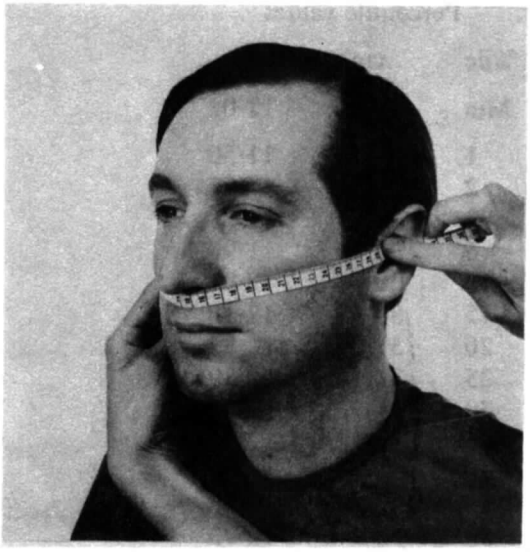
TABLE 5

Bitragion—Subnasale Arc

Measurement by tape. Subjest sitting erect facing forward, passing tape across face just below nose, measurement of arc from tragion of right ear to tragion of left ear.

Percentile values

%ile	cm	in.
Min	26·00	10·24
1	26·81	10·55
2	26·98	10·62
3	27·18	10·70
5	27·41	10·79
10	27·91	10·99
15	28·00	11·02
20	28·21	11·11
25	28·42	11·19
30	28·55	11·24
35	28·73	11·31
40	28·91	11·38
45	28·96	11·40
50	29·02	11·43
55	29·18	11·49
60	29·28	11·53
65	29·40	11·57
70	29·52	11·62
75	29·71	11·70
80	29·91	11·78
85	30·03	11·82
90	30·37	11·96
95	30·76	12·11
97	30·94	12·18
98	31·09	12·24
99	31·45	12·38
Max	32·50	12·80



Mean: 29·12 (0·04) cm; 11·46 (0·02) in.
Standard deviation: 1·00 (0·03) cm; 0·39 (0·01) in.
Coefficient of variation: 3·42 (0·11)%
Range: 26·00–32·50 cm; 10·24–12·80 in.
Number of subjects: 505

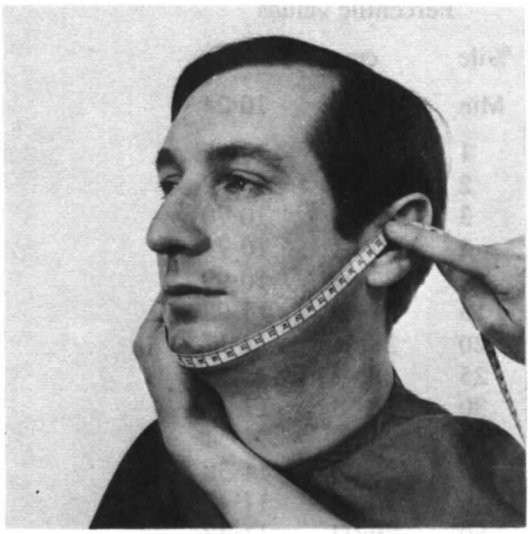
TABLE 6

Bitragion—Menton Arc

Measurement by tape. Subject sitting erect facing forward, passing tape over tip of chin (menton), measurement of arc from tragion of right ear to tragion of left ear.

Percentile values

%ile	cm	in.
Min	28·00	11·02
1	29·21	11·50
2	29·74	11·71
3	29·93	11·78
5	30·23	11·90
10	30·65	12·07
15	30·93	12·18
20	31·29	12·32
25	31·48	12·39
30	31·73	12·49
35	31·92	12·57
40	32·01	12·60
45	32·21	12·68
50	32·34	12·73
55	32·46	12·78
60	32·62	12·84
65	32·81	12·92
70	32·99	12·99
75	33·27	13·10
80	33·45	13·17
85	33·70	13·27
90	33·96	13·37
95	34·36	13·53
97	34·74	13·68
98	35·00	13·78
99	35·55	14·00
Max	37·00	14·57



Mean: 32·40 (0·06) cm; 12·76 (0·02) in.
Standard deviation: 1·30 (0·04) cm; 0·51 (0·02) in.
Coefficient of variation: 4·03 (0·13)%
Range: 28·00–37·00 cm; 11·02–14·57 in.
Number of subjects: 505

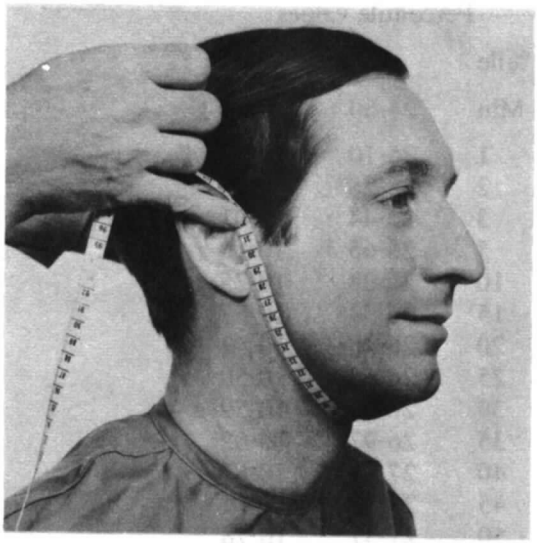
TABLE 7

Bitragion—Submandibular Arc

Measurement by tape. Subject sitting erect facing forward, passing tape under gonial angles of jaw and along juncture of jaw and neck, measurement of arc from tragion of left ear to tragion of right ear.

Percentile values

%ile	cm	in.
Min	25·00	9·84
1	26·61	10·47
2	26·90	10·59
3	27·21	10·71
5	27·45	10·81
10	27·84	10·96
15	28·18	11·09
20	28·48	11·21
25	28·74	11·32
30	28·95	11·40
35	29·14	11·47
40	29·32	11·54
45	29·48	11·61
50	29·68	11·69
55	29·91	11·77
60	30·00	11·81
65	30·30	11·93
70	30·46	11·99
75	30·74	12·10
80	30·96	12·19
85	31·28	12·31
90	31·53	12·41
95	32·24	12·69
97	32·43	12·77
98	32·59	12·83
99	33·14	13·05
Max	34·50	13·58



Mean: 29·78 (0·06) cm; 11·72 (0·03) in.
Standard deviation: 1·45 (0·05) cm; 0·57 (0·02) in.
Coefficient of variation: 4·85 (0·15)%
Range: 25·00–34·50 cm; 9·84–13·58 in.
Number of subjects: 505

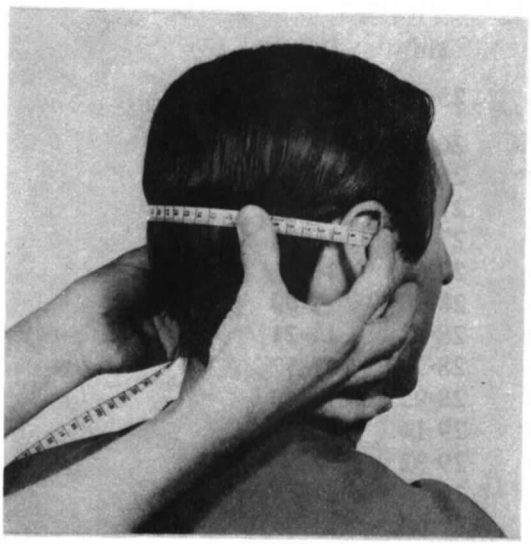
TABLE 8

Bitragion—Minimum Posterior Arc

Measurement by tape. Subject sitting erect facing forward, passing tape over lowest point of skull which can be felt with fingers, measurement of arc from tragion of right ear to tragion of left ear.

Percentile values

%ile	cm	in.
Min	24·60	9·69
1	25·10	9·88
2	25·28	9·95
3	25·44	10·01
5	25·65	10·10
10	26·04	10·25
15	26·34	10·37
20	26·48	10·43
25	26·68	10·50
30	26·90	10·59
35	26·97	10·62
40	27·11	10·67
45	27·19	10·71
50	27·37	10·78
55	27·49	10·82
60	27·61	10·87
65	27·85	10·97
70	27·96	11·01
75	28·14	11·08
80	28·28	11·14
85	28·58	11·25
90	28·96	11·40
95	29·41	11·58
97	29·73	11·70
98	29·94	11·79
99	30·29	11·93
Max	33·00	12·99



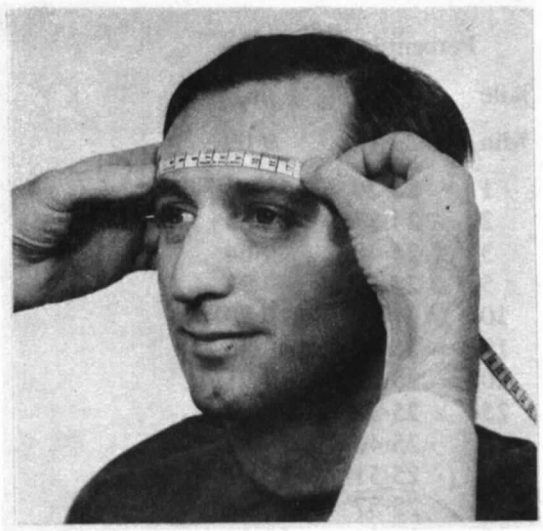
Mean: 27·49 (0·05) cm; 10·82 (0·02) in.
Standard deviation: 1·13 (0·04) cm; 0·44 (0·01) in.
Coefficient of variation: 4·10 (0·13)%
Range: 24·60–33·00 cm; 9·69–12·99 in.
Number of subjects: 505

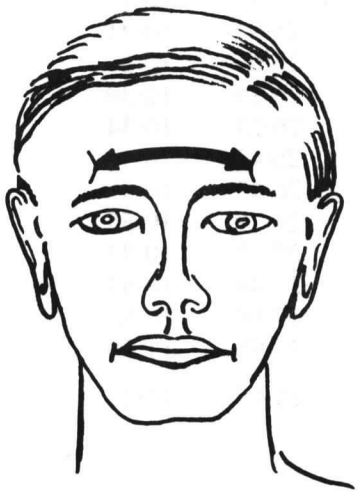
TABLE 9

Minimum Frontal Arc

Measurement by tape. Subject sitting erect facing forward, measurement of arc across forehead between points of greatest indentation of temporal crests.

Percentile values		
%ile	cm	in.
Min	11·20	4·41
1	11·60	4·57
2	11·85	4·67
3	11·94	4·70
5	12·15	4·79
10	12·33	4·85
15	12·48	4·91
20	12·60	4·96
25	12·71	5·01
30	12·80	5·04
35	12·92	5·09
40	12·96	5·10
45	12·99	5·11
50	13·12	5·16
55	13·19	5·19
60	13·28	5·23
65	13·36	5·26
70	13·45	5·30
75	13·58	5·35
80	13·74	5·41
85	13·93	5·48
90	14·00	5·51
95	14·28	5·62
97	14·46	5·69
98	14·66	5·77
99	14·92	5·87
Max	15·10	5·94





Mean: 13·21 (0·03) cm; 5·20 (0·01) in.
Standard deviation: 0·67 (0·02) cm; 0·26 (0·01) in.
Coefficient of variation: 5·07 (0·16)%
Range: 11·20–15·10 cm; 4·41–5·94 in.
Number of subjects: 505

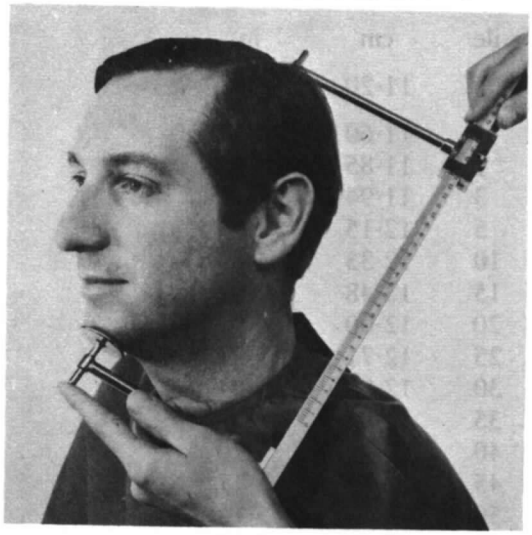
TABLE 10

Maximum Head Diagonal Over Menton

Measurement by head caliper. Subject sitting erect facing forward, with fixed disc head of caliper placed on chin of closed jaw and other disc head moved about vertex, determine position of maximum diagonal. Measurement from vertex to fixed disc head of caliper in light contact with chin.

Percentile values

%ile	cm	in.
Min	23·10	9·09
1	24·20	9·53
2	24·37	9·59
3	24·48	9·64
5	24·68	9·72
10	24·87	9·79
15	25·04	9·86
20	25·17	9·91
25	25·32	9·97
30	25·40	10·00
35	25·51	10·04
40	25·57	10·07
45	25·66	10·10
50	25·75	10·14
55	25·83	10·17
60	25·94	10·21
65	26·09	10·27
70	26·16	10·30
75	26·27	10·34
80	26·42	10·40
85	26·65	10·49
90	26·79	10·55
95	27·25	10·73
97	27·46	10·81
98	27·60	10·86
99	27·95	11·00
Max	28·60	11·26



Mean: 25·87 (0·03) cm; 10·18 (0·01) in.
Standard deviation: 0·78 (0·02) cm; 0·31 (0·01) in.
Coefficient of variation: 3·02 cm (0·10)%
Range: 23·10–28·60 cm; 9·09–11·26 in.
Number of subjects: 505

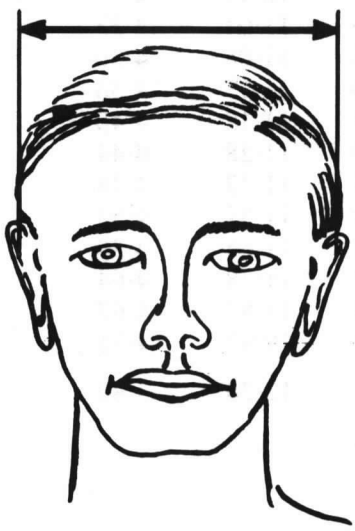
TABLE 11

Head Breadth Over Flattened Ears

Measurement by head caliper. Subjest sitting erect facing forward, with disc heads of caliper placed gently over ears and gradual pressure applied to flatten ears back, measurement of breadth over flattened ears.

Percentile values

%ile	cm	in.
Min	13·90	5·47
1	14·67	5·77
2	14·76	5·81
3	14·84	5·84
5	14·95	5·89
10	15·18	5·98
15	15·32	6·03
20	15·40	6·06
25	15·51	6·11
30	15·57	6·13
35	15·64	6·16
40	15·72	6·19
45	15·78	6·21
50	15·86	6·24
55	15·93	6·27
60	15·98	6·29
65	16·08	6·33
70	16·16	6·36
75	16·23	6·39
80	16·32	6·43
85	16·39	6·45
90	16·54	6·51
95	16·84	6·63
97	16·97	6·68
98	17·07	6·72
99	17·20	6·77
Max	17·60	6·93



Mean: 15·92 (0·02) cm; 6·27 (0·01) in.
Standard deviation: 0·55 (0·02) cm; 0·22 (0·01) in.
Coefficient of variation: 3·45 (0·11)%
Range: 13·90–17·60 cm; 5·47–6·93 in.
Number of subjects: 505

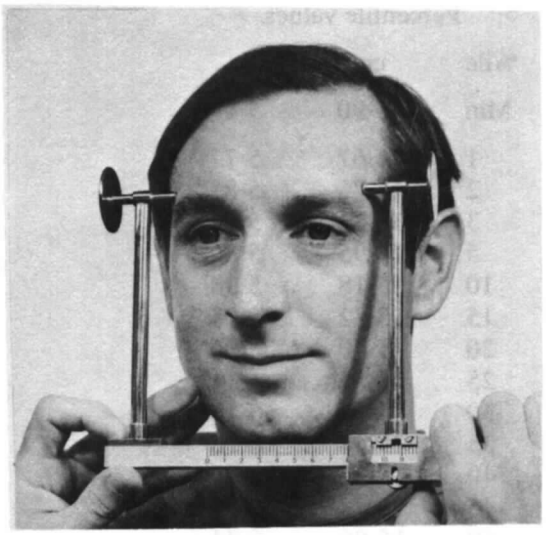
TABLE 12

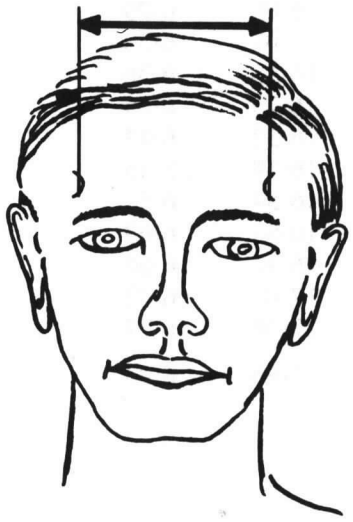
Minimum Frontal Diameter

Measurement by head caliper. Subject sitting erect facing forward, with ball ends of caliper in light contact at points of greatest indentation, measurement of horizontal distance across temporal crests.

Percentile values

%ile	cm	in.
Min	9·90	3·90
1	10·00	3·94
2	10·17	4·00
3	10·23	4·03
5	10·31	4·06
10	10·45	4·11
15	10·54	4·15
20	10·61	4·18
25	10·68	4·21
30	10·73	4·22
35	10·77	4·24
40	10·82	4·26
45	10·89	4·29
50	10·93	4·30
55	10·97	4·32
60	11·01	4·33
65	11·08	4·36
70	11·13	4·38
75	11·18	4·40
80	11·28	4·44
85	11·37	4·48
90	11·51	4·53
95	11·64	4·58
97	11·78	4·64
98	11·87	4·67
99	11·97	4·71
Max	12·20	4·80





Mean: 11·00 (0·02) cm; 4·33 (0·01) in.
Standard deviation: 0·40 (0·01) cm; 0·16 (0·00) in.
Coefficient of variation: 3·66 (0·12)%
Range: 9·90–12·20 cm; 3·90–4·80 in.
Number of subjects: 505

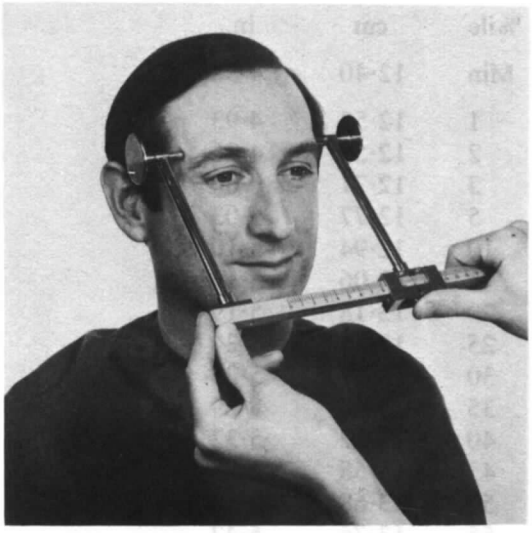
TABLE 13

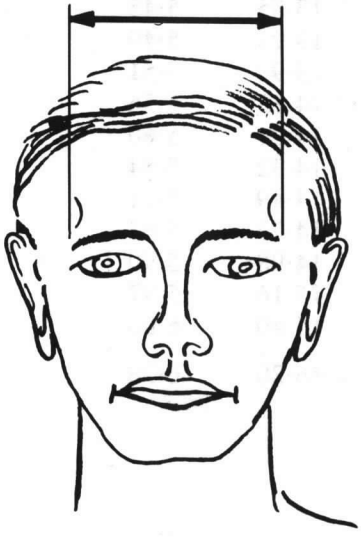
Maximum Frontal Diameter

Measurement by head caliper. Subject sitting erect facing forward, using ball ends of caliper, measurement of horizontal distance between maximum bulges of brow-ridges just below minimum frontal region at about ends of eyebrows.

Percentile values

%ile	cm	in.
Min	10·10	3·98
1	10·30	4·06
2	10·43	4·11
3	10·49	4·13
5	10·55	4·15
10	10·66	4·20
15	10·74	4·23
20	10·82	4·26
25	10·89	4·29
30	10·94	4·31
35	10·98	4·32
40	11·03	4·34
45	11·10	4·37
50	11·13	4·38
55	11·17	4·40
60	11·22	4·42
65	11·29	4·45
70	11·34	4·46
75	11·38	4·48
80	11·46	4·51
85	11·54	4·54
90	11·62	4·58
95	11·77	4·63
97	11·92	4·69
98	11·98	4·72
99	12·14	4·78
Max	12·40	4·88





Mean: 11·19 (0·02) cm; 4·41 (0·01) in.
Standard deviation: 0·38 (0·01) cm; 0·15 (0·00) in.
Coefficient of variation: 3·38 (0·11)%
Range: 10·10–12·40 cm; 3·98–4·88 in.
Number of subjects: 505

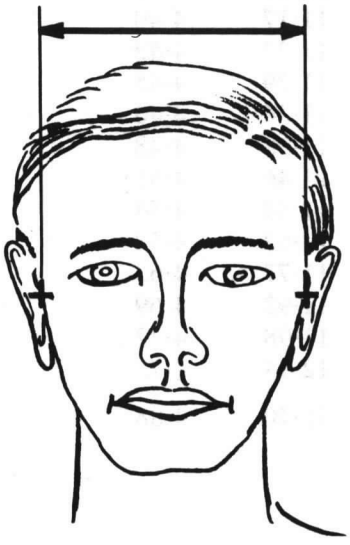
TABLE 14

Bitragion Diameter

Measurement by head caliper. Subject sitting erect facing forward, with ball ends of caliper in light contact, measurement of diameter from right tragion to left tragion.

Percentile values

%ile	cm	in.
Min	12·40	4·88
1	12·53	4·93
2	12·59	4·96
3	12·71	5·00
5	12·77	5·03
10	12·94	5·10
15	13·06	5·14
20	13·18	5·19
25	13·30	5·24
30	13·37	5·26
35	13·44	5·29
40	13·52	5·32
45	13·58	5·35
50	13·68	5·38
55	13·76	5·42
60	13·85	5·45
65	13·93	5·49
70	13·99	5·51
75	14·13	5·56
80	14·21	5·60
85	14·32	5·64
90	14·49	5·71
95	14·77	5·82
97	14·98	5·90
98	15·16	5·97
99	15·40	6·06
Max	16·20	6·38



Mean: 13·76 (0·03) cm; 5·42 (0·01) in.
Standard deviation: 0·61 (0·02) cm; 0·24 (0·01) in.
Coefficient of variation: 4·45 (0·14)%
Range: 12·40–16·20 cm; 4·88–6·38 in.
Number of subjects: 505

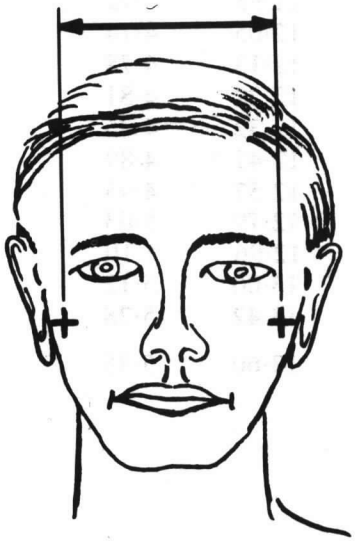
TABLE 15

Bizygomatic Diameter

Measurement by head caliper. Subject sitting erect facing forward, using disc ends of caliper, measurement of maximum horizontal breadth of face across most laterally projecting bones of cheek (zygomatic arches).

Percentile values

%ile	cm	in.
Min	12·90	5·08
1	13·11	5·16
2	13·15	5·18
3	13·19	5·19
5	13·33	5·25
10	13·48	5·31
15	13·59	5·35
20	13·72	5·40
25	13·77	5·42
30	13·88	5·46
35	13·95	5·49
40	14·02	5·52
45	14·10	5·55
50	14·15	5·57
55	14·20	5·59
60	14·27	5·62
65	14·33	5·64
70	14·38	5·66
75	14·46	5·69
80	14·55	5·73
85	14·66	5·77
90	14·85	5·85
95	14·99	5·90
97	15·15	5·96
98	15·23	6·00
99	15·60	6·14
Max	16·20	6·38



Mean: 14·20 (0·02) cm; 5·59 (0·01) in.
Standard deviation: 0·52 (0·02) cm; 0·20 (0·01) in.
Coefficient of variation: 3·66 (0·12)%
Range: 12·90–16·20 cm; 5·08–6·38 in.
Number of subjects: 505

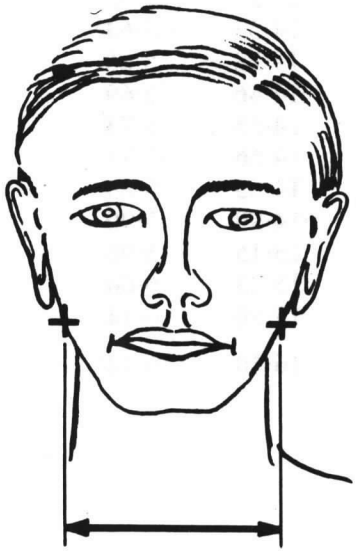
TABLE 16

Bigonial Diameter

Measurement by head caliper. Subject sitting erect facing forward, using disc ends of caliper, measurement of maximum horizontal width of jaw across gonial angles.

Percentile values

%ile	cm	in.
Min	10·60	4·17
1	10·82	4·26
2	10·91	4·29
3	10·95	4·31
5	11·10	4·37
10	11·26	4·43
15	11·35	4·47
20	11·44	4·50
25	11·55	4·55
30	11·62	4·58
35	11·71	4·61
40	11·75	4·62
45	11·78	4·64
50	11·86	4·67
55	11·93	4·70
60	11·98	4·72
65	12·05	4·74
70	12·13	4·78
75	12·22	4·81
80	12·32	4·85
85	12·41	4·89
90	12·57	4·95
95	12·79	5·03
97	12·96	5·10
98	13·00	5·12
99	13·42	5·28
Max	13·60	5·35



Mean: 11·94 (0·02) cm; 4·70 (0·01) in.
Standard deviation: 0·52 (0·02) cm; 0·21 (0·01) in.
Coefficient of variation: 4·38 (0·14)%
Range: 10·60–13·60 cm; 4·17–5·35 in.
Number of subjects: 505

TABLE 17

Lip Length (Bichelion Diameter)

Measurement by 'Abawerk' spreading caliper. Subject sitting erect facing forward, with facial muscles relaxed and jaws closed, measurement of distance between corners of mouth.

Percentile values

%ile	cm	in.
Min	3·80	1·50
1	3·93	1·55
2	3·98	1·57
3	4·03	1·59
5	4·13	1·62
10	4·28	1·68
15	4·35	1·71
20	4·41	1·74
25	4·47	1·76
30	4·53	1·78
35	4·57	1·80
40	4·62	1·82
45	4·66	1·84
50	4·70	1·85
55	4·75	1·87
60	4·79	1·89
65	4·87	1·92
70	4·94	1·94
75	5·00	1·97
80	5·07	2·00
85	5·16	2·03
90	5·28	2·08
95	5·43	2·14
97	5·52	2·17
98	5·58	2·20
99	5·70	2·24
Max	6·10	2·40

Mean: 4·79 (0·02) cm; 1·89 (0·01) in.
Standard deviation: 0·39 (0·01) cm; 0·15 (0·00) in.
Coefficient of variation: 8·13 (0·26)%
Range: 3·80–6·10 cm; 1·50–2·40 in.
Number of subjects: 505

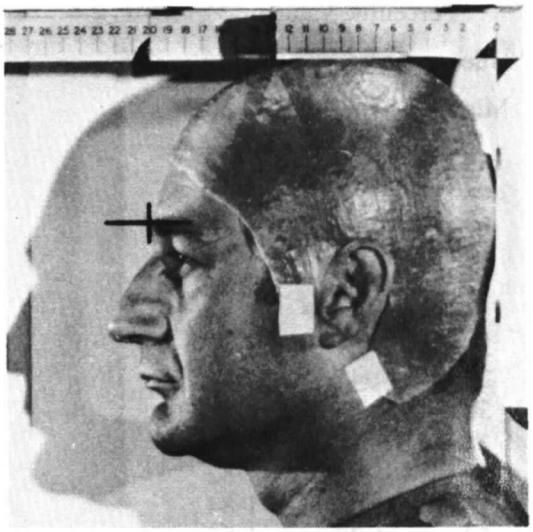
TABLE 18

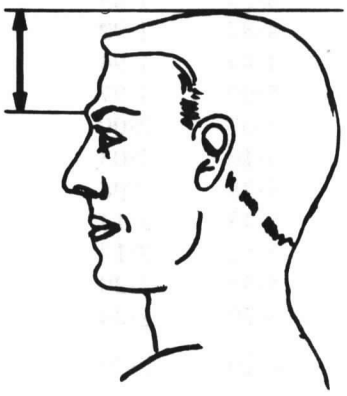
Brow-Ridge Crest to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on most forward point of brow ridges, measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	7·60	2·99
1	8·04	3·17
2	8·26	3·25
3	8·37	3·30
5	8·53	3·37
10	8·80	3·47
15	8·97	3·53
20	9·11	3·59
25	9·22	3·63
30	9·34	3·68
35	9·44	3·72
40	9·55	3·76
45	9·67	3·81
50	9·76	3·84
55	9·86	3·88
60	9·95	3·92
65	10·04	3·95
70	10·16	4·00
75	10·26	4·04
80	10·38	4·09
85	10·50	4·13
90	10·67	4·20
95	10·87	4·28
97	10·98	4·32
98	11·07	4·36
99	11·18	4·40
Max	11·80	4·65





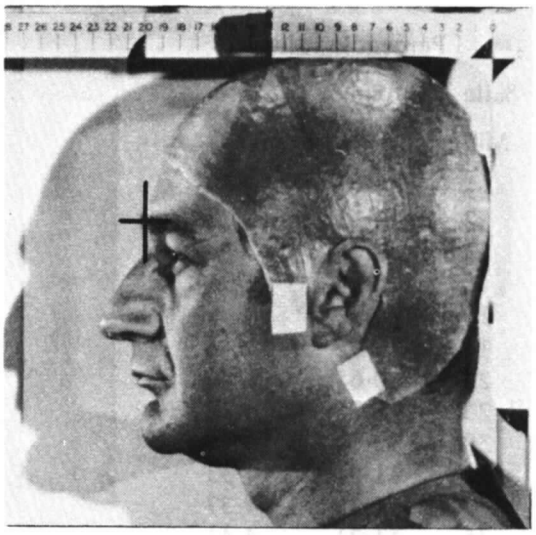
Mean: 9·79 (0·03) cm; 3·85 (0·01) in.
Standard deviation: 0·71 (0·02) cm; 0·28 (0·01) in.
Coefficient of variation: 7·30 (0·23)%
Range: 7·60–11·80 cm; 2·99–4·65 in.
Number of subjects: 484

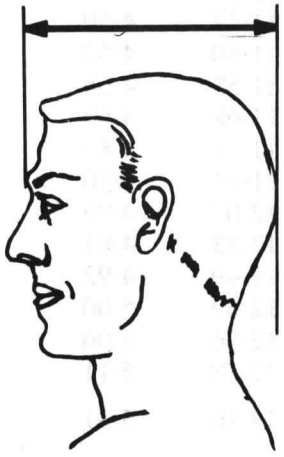
TABLE 19

Head Length

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on most forward point of brow-ridge, measurement of horizontal distance to back of head.

Percentile values		
%ile	cm	in.
Min	18·80	7·40
1	19·13	7·53
2	19·25	7·58
3	19·34	7·61
5	19·49	7·67
10	19·69	7·75
15	19·84	7·81
20	19·98	7·87
25	20·09	7·91
30	20·17	7·94
35	20·26	7·98
40	20·34	8·01
45	20·41	8·04
50	20·49	8·07
55	20·56	8·10
60	20·64	8·13
65	20·72	8·16
70	20·80	8·19
75	20·88	8·22
80	20·96	8·25
85	21·08	8·30
90	21·25	8·37
95	21·51	8·47
97	21·64	8·52
98	21·73	8·56
99	22·02	8·67
Max	22·30	8·78



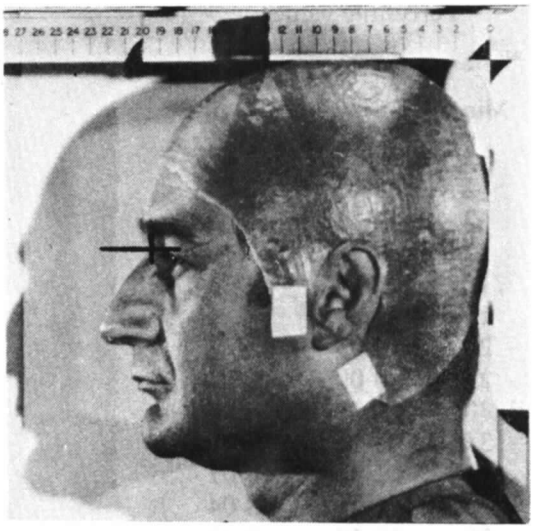


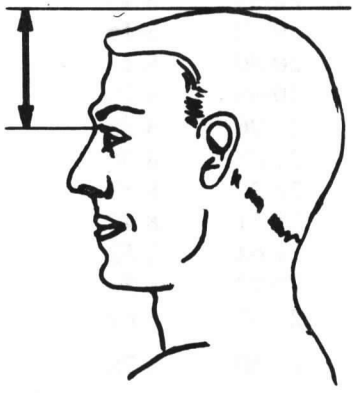
Mean: 20·53 (0·03) cm; 8·08 (0·01) in.
Standard deviation: 0·60 (0·02) cm; 0·24 (0·01) in.
Coefficient of variation: 2·95 (0·09)%
Range: 18·80–22·30 cm; 7·40–8·78 in.
Number of subjects: 484

TABLE 20

Nasion to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point of greatest indentation where nose meets forehead (nasal root), measurement of vertical distance to top of head.





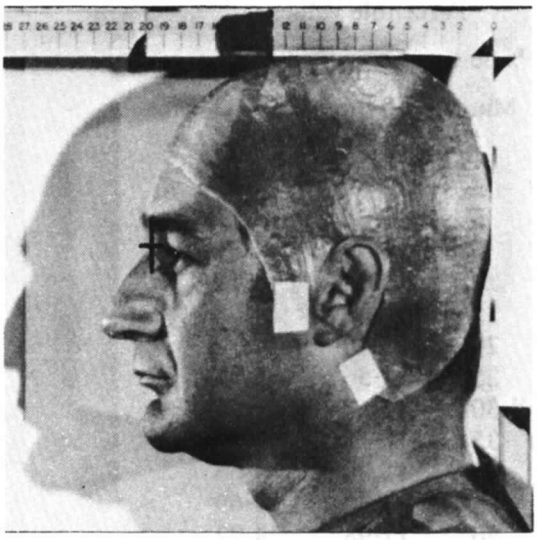
Percentile values		
%ile	cm	in.
Min	8·70	3·43
1	9·37	3·69
2	9·52	3·75
3	9·68	3·81
5	10·00	3·94
10	10·30	4·06
15	10·52	4·14
20	10·65	4·19
25	10·78	4·25
30	10·88	4·28
35	11·01	4·33
40	11·10	4·37
45	11·21	4·41
50	11·33	4·46
55	11·42	4·50
60	11·50	4·53
65	11·58	4·56
70	11·68	4·60
75	11·81	4·65
80	11·93	4·70
85	12·07	4·75
90	12·23	4·81
95	12·49	4·92
97	12·69	5·00
98	12·86	5·06
99	12·98	5·11
Max	13·50	5·31

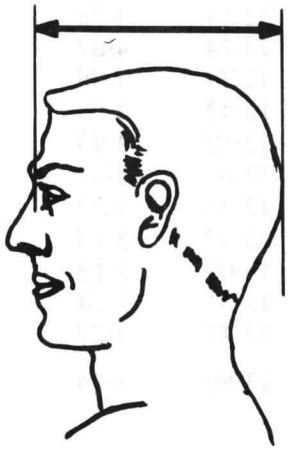
Mean: 11·33 (0·03) cm; 4·46 (0·01) in.
Standard deviation: 0·77 (0·02) cm; 0·30 (0·01) in.
Coefficient of variation: 6·78 (0·22)%
Range: 8·70–13·50 cm; 3·43–5·31 in.
Number of subjects: 484

TABLE 21

Nasion to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point of greatest indentation where nose meets forehead (nasal root), measurement of horizontal distance to back of head.





Percentile values		
%ile	cm	in.
Min	18·50	7·28
1	18·78	7·40
2	18·94	7·46
3	19·08	7·51
5	19·24	7·57
10	19·44	7·65
15	19·57	7·71
20	19·68	7·75
25	19·80	7·79
30	19·91	7·84
35	20·01	7·88
40	20·08	7·91
45	20·15	7·93
50	20·21	7·96
55	20·28	7·99
60	20·36	8·01
65	20·44	8·05
70	20·52	8·08
75	20·59	8·11
80	20·67	8·14
85	20·78	8·18
90	20·94	8·24
95	21·25	8·37
97	21·38	8·42
98	21·52	8·47
99	21·59	8·50
Max	21·90	8·62

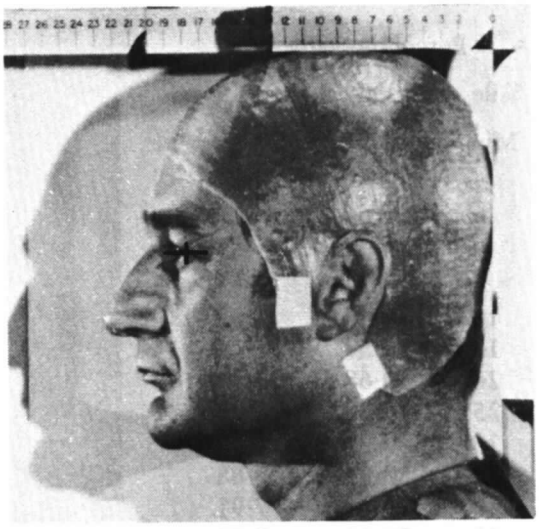
Mean: 20·25 (0·03) cm; 7·97 (0·01) in.
Standard deviation: 0·60 (0·02) cm; 0·23 (0·01) in.
Coefficient of variation: 2·94 (0·09)%
Range: 18·50–21·90 cm; 7·28–8·62 in.
Number of subjects: 484

TABLE 22

External Canthus to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on outer corner (external canthus) of left eye, measurement of vertical distance to top of head.

Percentile values		
%ile	cm	in.
Min	10·20	4·02
1	10·49	4·13
2	10·63	4·18
3	10·75	4·23
5	10·95	4·31
10	11·17	4·40
15	11·38	4·48
20	11·48	4·52
25	11·56	4·55
30	11·67	4·60
35	11·78	4·64
40	11·85	4·66
45	11·91	4·69
50	11·98	4·72
55	12·06	4·75
60	12·14	4·78
65	12·24	4·82
70	12·34	4·86
75	12·42	4·89
80	12·52	4·93
85	12·62	4·97
90	12·76	5·02
95	12·97	5·10
97	13·09	5·15
98	13·31	5·24
99	13·43	5·29
Max	13·80	5·43



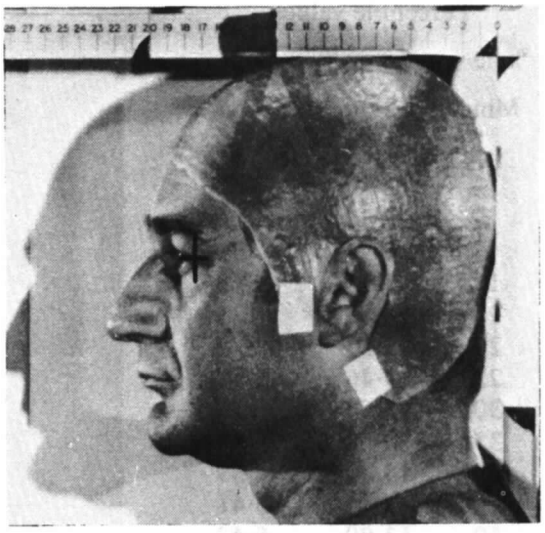
Mean: 12·04 (0·03) cm; 4·74 (0·01) in.
Standard deviation: 0·62 (0·02) cm; 0·24 (0·01) in.
Coefficient of variation: 5·13 (0·16)%
Range: 10·20–13·80 cm; 4·02–5·43 in.
Number of subjects: 484

TABLE 23

External Canthus to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of *X*–*Y* axis reader on outer corner (external canthus) of left eye, measurement of horizontal distance to back of head.

	Percentile values	
%ile	cm	in.
Min	16·00	6·30
1	16·38	6·45
2	16·67	6·56
3	16·75	6·59
5	16·90	6·65
10	17·08	6·73
15	17·19	6·77
20	17·31	6·81
25	17·40	6·85
30	17·50	6·89
35	17·60	6·93
40	17·67	6·96
45	17·74	6·98
50	17·81	7·01
55	17·87	7·04
60	17·94	7·06
65	18·02	7·09
70	18·09	7·12
75	18·20	7·17
80	18·32	7·21
85	18·46	7·27
90	18·58	7·31
95	18·77	7·39
97	18·92	7·45
98	18·97	7·47
99	19·07	7·51
Max	19·40	7·64



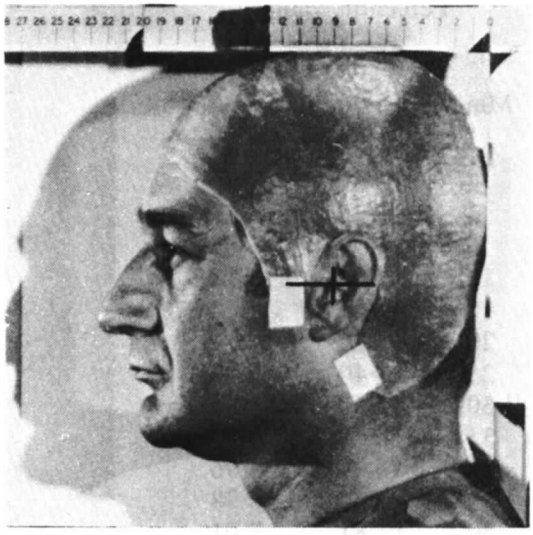
Mean: 17·86 (0·03) cm; 7·03 (0·01) in.
Standard deviation: 0·57 (0·02) cm; 0·23 (0·01) in.
Coefficient of variation: 3·22 (0·10)%
Range: 16·00–19·40 cm; 6·30–7·64 in.
Number of subjects: 483

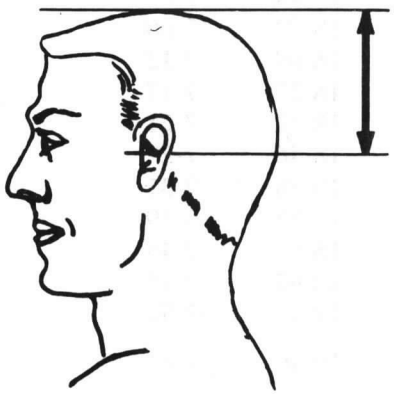
TABLE 24

Tragion to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on left ear tragion, measurement of vertical distance to top of head.

Percentile values		
%ile	cm	in.
Min	12·30	4·84
1	12·58	4·95
2	12·73	5·01
3	12·81	5·04
5	12·94	5·09
10	13·15	5·18
15	13·30	5·23
20	13·38	5·27
25	13·46	5·30
30	13·54	5·33
35	13·62	5·36
40	13·68	5·39
45	13·74	5·41
50	13·80	5·43
55	13·89	5·47
60	13·97	5·50
65	14·03	5·52
70	14·09	5·55
75	14·16	5·58
80	14·27	5·62
85	14·37	5·66
90	14·51	5·71
95	14·67	5·77
97	14·82	5·84
98	14·89	5·86
99	15·14	5·96
Max	15·70	6·18





Mean: 13·87 (0·02) cm; 5·46 (0·01) in.
Standard deviation: 0·53 (0·02) cm; 0·21 (0·01) in.
Coefficient of variation: 3·82 (0·12)%
Range: 12·30–15·70 cm; 4·84–6·18 in.
Number of subjects: 483

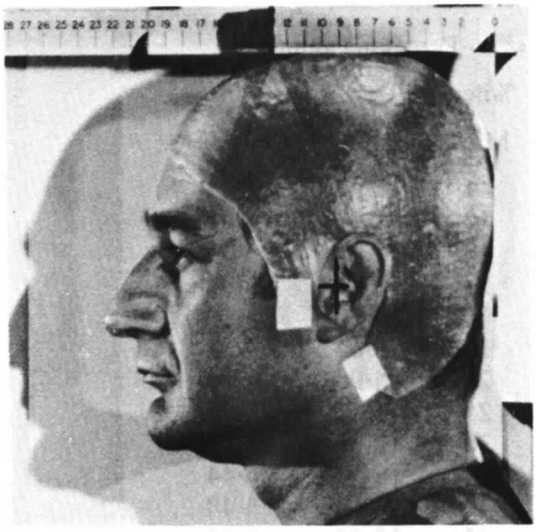
TABLE 25

Tragion to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on left ear tragion, measurement of horizontal distance to back of head.

Percentile values

%ile	cm	in.
Min	8·30	3·27
1	8·53	3·36
2	8·77	3·45
3	8·83	3·48
5	8·94	3·52
10	9·17	3·61
15	9·32	3·67
20	9·41	3·71
25	9·50	3·74
30	9·59	3·78
35	9·66	3·80
40	9·73	3·83
45	9·79	3·86
50	9·86	3·88
55	9·93	3·91
60	10·02	3·95
65	10·08	3·97
70	10·18	4·01
75	10·29	4·05
80	10·39	4·09
85	10·49	4·13
90	10·58	4·17
95	10·81	4·26
97	10·97	4·32
98	11·11	4·37
99	11·22	4·42
Max	12·50	4·92



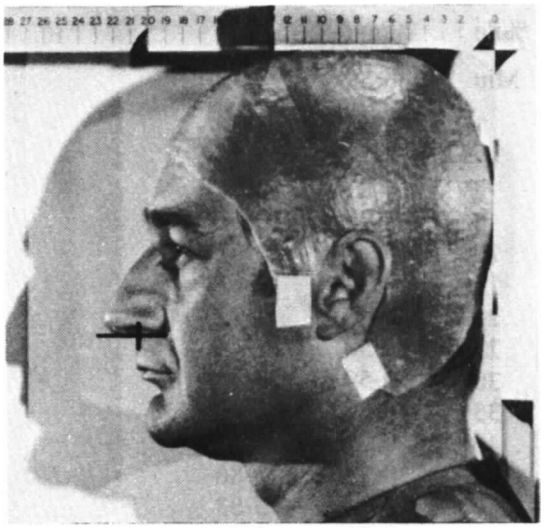
Mean: 9·94 (0·03) cm; 3·91 (0·01) in.
Standard deviation: 0·57 (0·02) cm; 0·22 (0·01) in.
Coefficient of variation: 5·73 (0·18)%
Range: 8·30–12·50 cm; 3·27–4·92 in.
Number of subjects: 483

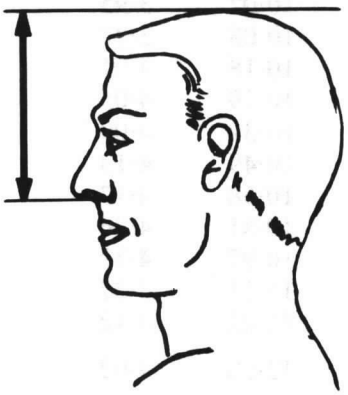
TABLE 26

Bottom of Nose to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on point at bottom of nose (subnasale) at junction of nose and upper lip, measurement of vertical distance to top of head.

Percentile values		
%ile	cm	in.
Min	14·50	5·71
1	14·85	5·84
2	15·02	5·91
3	15·21	5·99
5	15·40	6·06
10	15·66	6·17
15	15·83	6·23
20	15·98	6·29
25	16·13	6·35
30	16·25	6·40
35	16·37	6·44
40	16·46	6·48
45	16·56	6·52
50	16·68	6·56
55	16·76	6·60
60	16·86	6·64
65	16·98	6·68
70	17·10	6·73
75	17·23	6·78
80	17·33	6·82
85	17·43	6·86
90	17·58	6·92
95	17·88	7·04
97	17·97	7·08
98	18·11	7·13
99	18·27	7·19
Max	18·80	7·40





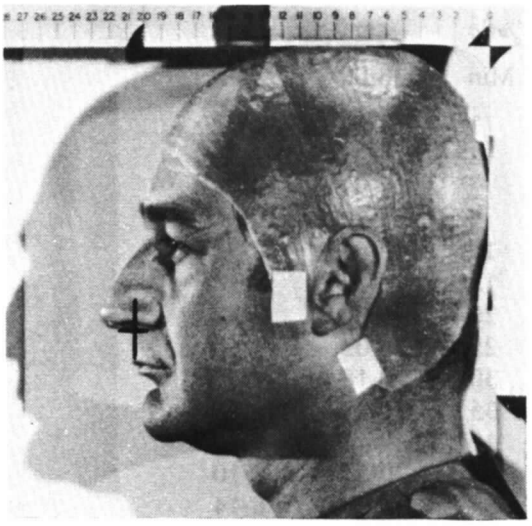
Mean: 16·70 (0·03) cm; 6·57 (0·01) in.
Standard deviation: 0·76 (0·02) cm; 0·30 (0·01) in.
Coefficient of variation: 4·53 (0·15)%
Range: 14·50–18·80 cm; 5·71–7·40 in.
Number of subjects: 484

TABLE 27

Bottom of Nose to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point at bottom of nose (subnasale) at junction of nose and upper lip, measurement of horizontal distance to back of head.

Percentile values		
%ile	cm	in.
Min	18·20	7·17
1	19·12	7·53
2	19·24	7·58
3	19·44	7·65
5	19·64	7·73
10	19·80	7·79
15	20·05	7·89
20	20·15	7·93
25	20·24	7·97
30	20·34	8·01
35	20·45	8·05
40	20·55	8·09
45	20·63	8·12
50	20·71	8·15
55	20·81	8·19
60	20·91	8·23
65	21·02	8·28
70	21·12	8·31
75	21·21	8·35
80	21·31	8·39
85	21·43	8·44
90	21·67	8·53
95	21·95	8·64
97	22·07	8·69
98	22·25	8·76
99	22·35	8·80
Max	23·50	9·25



Mean: 20·79 (0·03) cm; 8·18 (0·01) in.
Standard deviation: 0·71 (0·02) cm; 0·28 (0·01) in.
Coefficient of variation: 3·42 (0·11)%
Range: 18·20–23·50 cm; 7·17–9·25 in.
Number of subjects: 484

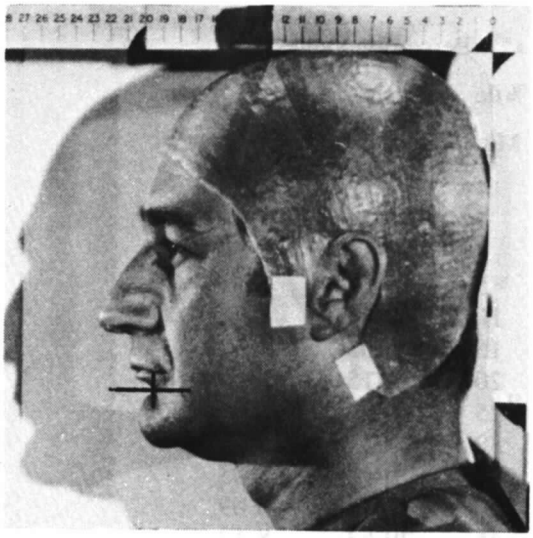
TABLE 28

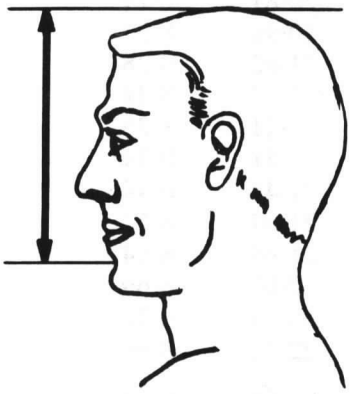
Maximum Chin Indent to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point of greatest indentation of chin below lips, measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	18·00	7·09
1	18·58	7·32
2	18·91	7·45
3	18·99	7·48
5	19·30	7·60
10	19·61	7·72
15	19·77	7·78
20	19·88	7·83
25	20·05	7·90
30	20·18	7·95
35	20·33	8·00
40	20·44	8·05
45	20·57	8·10
50	20·67	8·14
55	20·79	8·18
60	20·90	8·23
65	21·01	8·27
70	21·11	8·31
75	21·26	8·37
80	21·39	8·42
85	21·53	8·48
90	21·68	8·53
95	21·95	8·64
97	22·11	8·71
98	22·27	8·77
99	22·52	8·86
Max	23·50	9·25



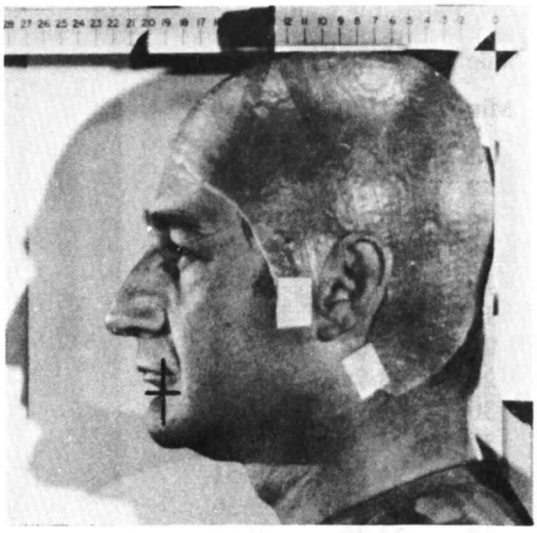


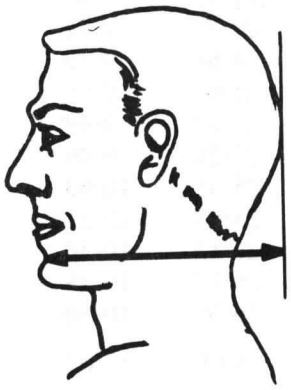
Mean: 20·70 (0·04) cm; 8·15 (0·02) in.
Standard deviation: 0·84 (0·03) cm; 0·33 (0·01) in.
Coefficient of variation: 4·06 (0·13)%
Tange: 18·00–23·50 cm; 7·09–9·25 in.
Number of subjects: 484

TABLE 29

Maximum Chin Indent to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point of greatest indentation of chin below mouth, measurement of horizontal distance to back of head.





Percentile values		
%ile	cm	in.
Min	17·50	6·89
1	17·55	6·91
2	17·67	6·96
3	17·84	7·02
5	17·99	7·08
10	18·36	7·23
15	18·53	7·30
20	18·75	7·38
25	18·86	7·42
30	18·97	7·47
35	19·08	7·51
40	19·20	7·56
45	19·30	7·60
50	19·41	7·64
55	19·49	7·67
60	19·61	7·72
65	19·71	7·76
70	19·84	7·81
75	19·95	7·85
80	20·11	7·92
85	20·29	7·99
90	20·51	8·08
95	20·81	8·19
97	20·95	8·25
98	21·04	8·29
99	21·24	8·36
Max	21·90	8·62

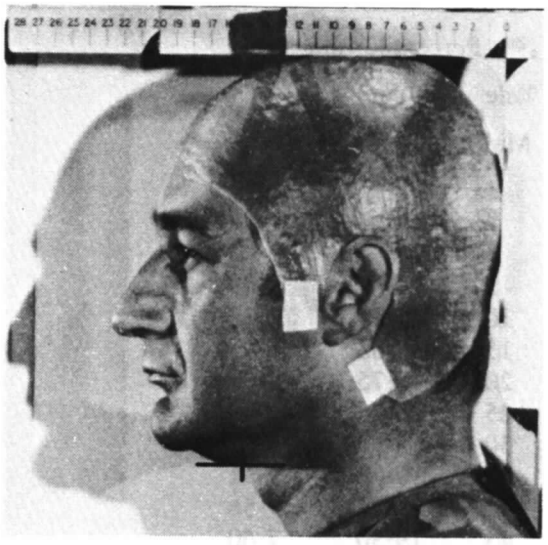
Mean: 19·46 (0·04) cm; 7·66 (0·01) in.
Standard deviation: 0·82 (0·03) cm; 0·32 (0·01) in.
Coefficient of variation: 4·21 (0·14)%
Range: 17·50–21·90 cm; 6·89–8·62 in.
Number of subjects: 484

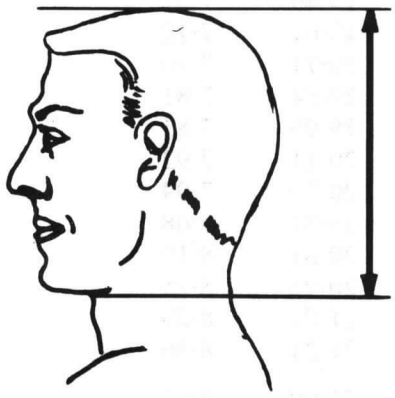
TABLE 30

Juncture of Chin and Neck to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point where neck joins chin, measurement of vertical distance to top of head.

Percentile values		
%ile	cm	in.
Min	21·70	8·54
1	22·10	8·70
2	22·51	8·86
3	22·67	8·92
5	22·87	9·00
10	23·26	9·16
15	23·46	9·24
20	23·64	9·31
25	23·79	9·37
30	23·91	9·42
35	24·04	9·46
40	24·16	9·51
45	24·28	9·56
50	24·40	9·60
55	24·52	9·65
60	24·62	9·69
65	24·73	9·74
70	24·86	9·79
75	25·01	9·85
80	25·13	9·89
85	25·29	9·96
90	25·49	10·03
95	25·95	10·21
97	26·15	10·30
98	26·37	10·38
99	26·67	10·50
Max	28·00	11·02





Mean: 24·44 (0·04) cm; 9·62 (0·02) in.
Standard deviation: 0·93 (0·03) cm; 0·36 (0·01) in.
Coefficient of variation: 3·79 (0·12)%
Range: 21·70–28·00 cm; 8·54–11·02 in.
Number of subjects: 466

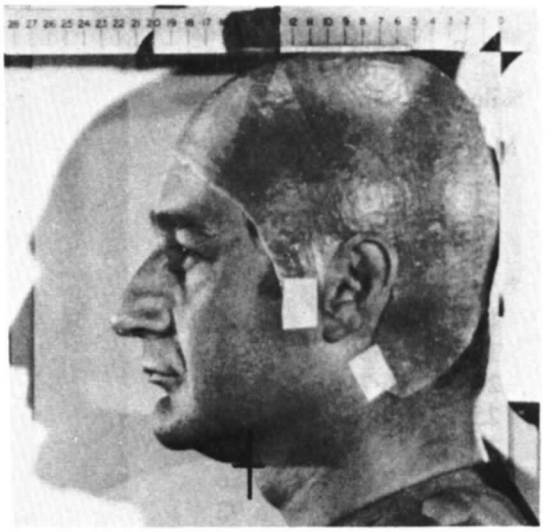
TABLE 31

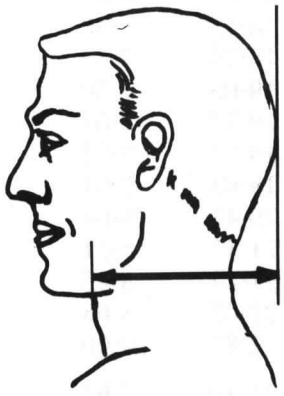
Juncture of Chin and Neck to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point where neck joins chin, measurement of horizontal distance to back of head.

Percentile values

%ile	cm	in.
Min	11·40	4·49
1	12·78	5·03
2	12·97	5·10
3	13·10	5·16
5	13·32	5·24
10	13·61	5·36
15	13·81	5·44
20	13·97	5·50
25	14·10	5·55
30	14·25	5·61
35	14·38	5·66
40	14·52	5·72
45	14·63	5·76
50	14·75	5·81
55	14·87	5·85
60	15·01	5·91
65	15·12	5·95
70	15·28	6·02
75	15·47	6·09
80	15·71	6·19
85	15·89	6·25
90	16·23	6·39
95	16·54	6·51
97	16·75	6·59
98	17·07	6·72
99	17·60	6·93
Max	19·30	7·60





Mean: 14·89 (0·05) cm; 5·86 (0·02) in.
Standard deviation: 1·04 (0·03) cm; 0·41 (0·01) in.
Coefficient of variation: 6·96 (0·23)%
Range: 11·40–19·30 cm; 4·49–7·60 in.
Number of subjects: 465

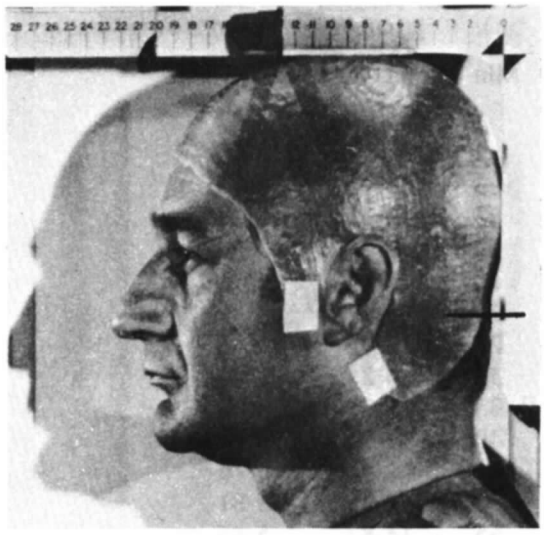
TABLE 32

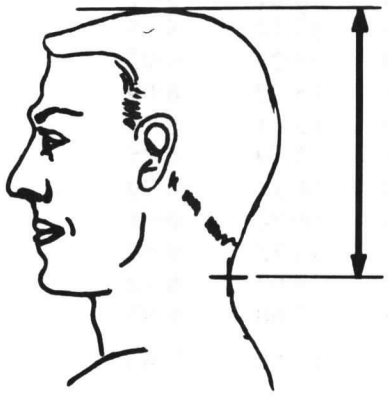
Vertical Location of Measurement 33 from Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on point of greatest distance of back of neck from vertical scale, measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	13·80	5·43
1	14·81	5·83
2	15·08	5·94
3	15·21	5·99
5	15·56	6·13
10	15·95	6·28
15	16·37	6·44
20	16·70	6·58
25	16·98	6·68
30	17·19	6·77
35	17·42	6·86
40	17·57	6·92
45	17·79	7·00
50	18·07	7·11
55	18·31	7·21
60	18·55	7·30
65	18·76	7·39
70	19·05	7·50
75	19·32	7·61
80	19·60	7·72
85	19·83	7·81
90	20·43	8·04
95	21·11	8·31
97	21·47	8·45
98	22·05	8·68
99	22·85	9·00
Max	24·40	9·61





Mean: 18·22 (0·09) cm; 7·17 (0·03) in.
Standard deviation: 1·71 (0·06) cm; 0·67 (0·02) in.
Coefficient of variation: 9·38 (0·34)%
Range: 13·80–24·40 cm; 5·43–9·61 in.
Number of subjects: 376

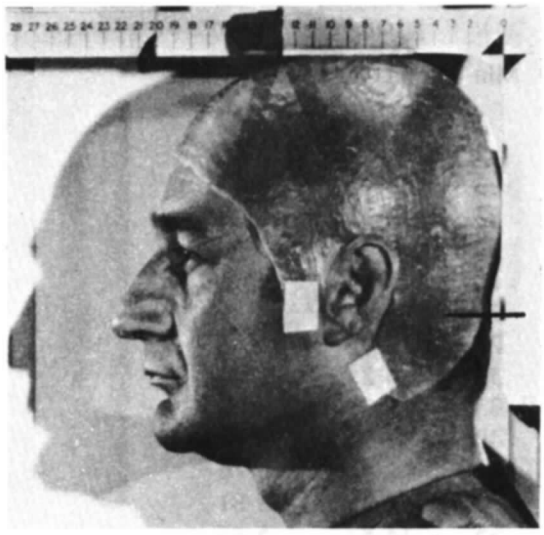
TABLE 32

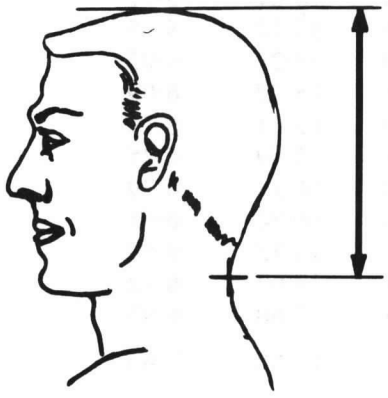
Vertical Location of Measurement 33 from Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on point of greatest distance of back of neck from vertical scale, measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	13·80	5·43
1	14·81	5·83
2	15·08	5·94
3	15·21	5·99
5	15·56	6·13
10	15·95	6·28
15	16·37	6·44
20	16·70	6·58
25	16·98	6·68
30	17·19	6·77
35	17·42	6·86
40	17·57	6·92
45	17·79	7·00
50	18·07	7·11
55	18·31	7·21
60	18·55	7·30
65	18·76	7·39
70	19·05	7·50
75	19·32	7·61
80	19·60	7·72
85	19·83	7·81
90	20·43	8·04
95	21·11	8·31
97	21·47	8·45
98	22·05	8·68
99	22·85	9·00
Max	24·40	9·61





Mean: 18·22 (0·09) cm; 7·17 (0·03) in.
Standard deviation: 1·71 (0·06) cm; 0·67 (0·02) in.
Coefficient of variation: 9·38 (0·34)%
Range: 13·80–24·40 cm; 5·43–9·61 in.
Number of subjects: 376

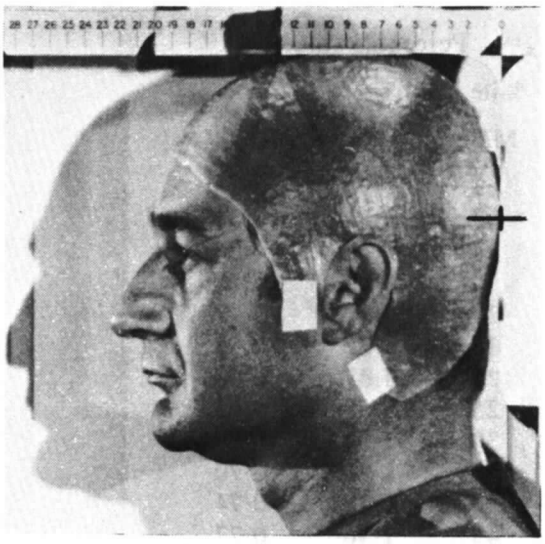
TABLE 34

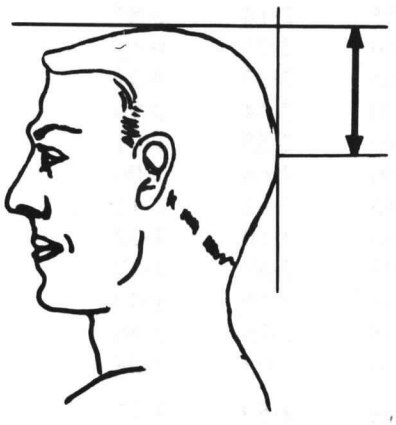
Back of Head Contact Centre to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on point which is centre of contact of back of head with vertical scale, measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	7·40	2·91
1	7·76	3·05
2	7·98	3·14
3	8·09	3·18
5	8·19	3·22
10	8·36	3·29
15	8·45	3·33
20	8·53	3·36
25	8·62	3·39
30	8·73	3·44
35	8·79	3·46
40	8·85	3·49
45	8·91	3·51
50	8·98	3·53
55	9·05	3·56
60	9·13	3·59
65	9·19	3·62
70	9·28	3·65
75	9·37	3·69
80	9·46	3·72
85	9·55	3·76
90	9·70	3·82
95	9·97	3·92
97	10·12	3·98
98	10·32	4·06
99	10·50	4·14
Max	10·60	4·17





Mean: 9·06 (0·02) cm; 3·57 (0·01) in.
Standard deviation: 0·55 (0·02) cm; 0·21 (0·01) in.
Coefficient of variation: 6·02 (0·19)%
Range: 7·40–10·60 cm; 2·91–4·17 in.
Number of subjects: 477

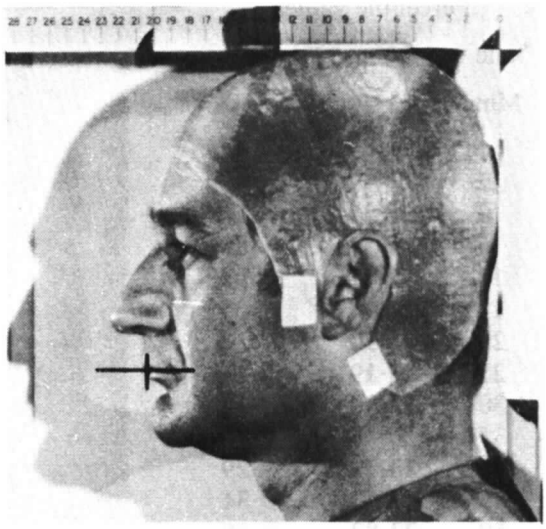
TABLE 35

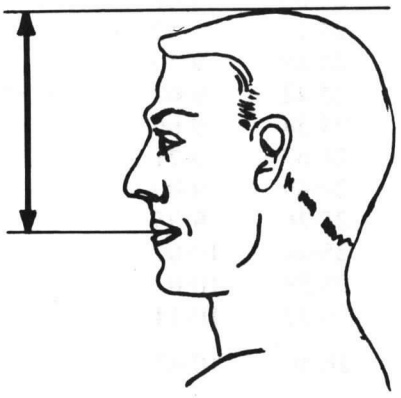
Centre Line of Abutting Lips to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on line where lips abut, measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	16·60	6·54
1	16·99	6·69
2	17·23	6·78
3	17·39	6·85
5	17·64	6·94
10	17·88	7·04
15	18·06	7·11
20	18·20	7·17
25	18·32	7·21
30	18·44	7·26
35	18·56	7·31
40	18·72	7·37
45	18·81	7·40
50	18·92	7·45
55	19·02	7·49
60	19·09	7·51
65	19·19	7·56
70	19·28	7·59
75	19·39	7·63
80	19·53	7·69
85	19·65	7·74
90	19·79	7·79
95	20·07	7·90
97	20·28	7·98
98	20·41	8·04
99	20·62	8·12
Max	21·00	8·27





Mean: 18·92 (0·03) cm; 7·45 (0·01) in.
Standard deviation: 0·76 (0·02) cm; 0·30 (0·01) in.
Coefficient of variation: 4·02 (0·13)%
Range: 16·60–21·00 cm; 6·54–8·27 in.
Number of subjects: 483

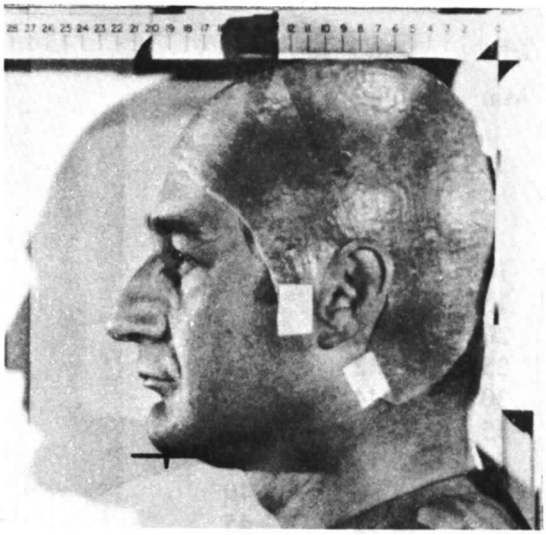
TABLE 36

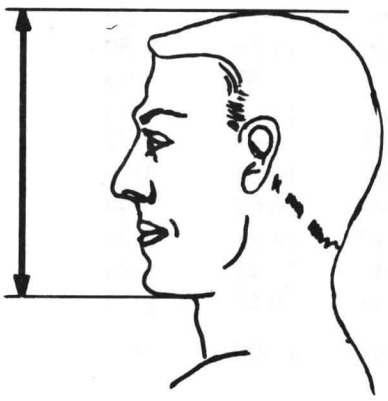
Menton to Vertex

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on under surface of chin (menton), measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	21·40	8·43
1	21·69	8·54
2	21·92	8·63
3	22·21	8·74
5	22·56	8·88
10	22·81	8·98
15	22·98	9·05
20	23·10	9·10
25	23·19	9·13
30	23·30	9·17
35	23·46	9·24
40	23·59	9·29
45	23·73	9·34
50	23·82	9·38
55	23·94	9·42
60	24·05	9·47
65	24·17	9·52
70	24·29	9·56
75	24·42	9·62
80	24·54	9·66
85	24·67	9·71
90	24·89	9·80
95	25·26	9·95
97	25·44	10·02
98	25·59	10·07
99	25·77	10·14
Max	26·50	10·43





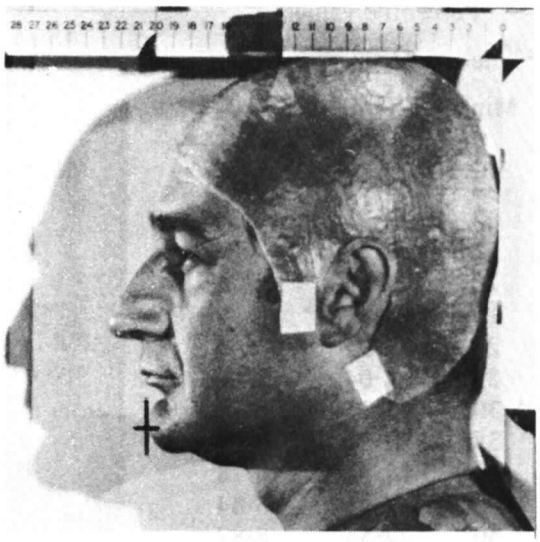
Mean: 23·87 (0·04) cm; 9·40 (0·02) in.
Standard deviation: 0·85 (0·03) cm; 0·33 (0·01) in.
Coefficient of variation: 3·56 (0·12)%
Range: 21·40–26·50 cm; 8·43–10·43 in.
Number of subjects: 473

TABLE 37

Menton to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on most forward surface of chin (menton), measurement of horizontal distance to back of head.

Percentile values		
%ile	cm	in.
Min	17·50	6·89
1	17·69	6·97
2	17·91	7·05
3	17·99	7·08
5	18·22	7·17
10	18·60	7·32
15	18·85	7·42
20	19·03	7·49
25	19·15	7·54
30	19·28	7·59
35	19·41	7·64
40	19·51	7·68
45	19·59	7·71
50	19·76	7·78
55	19·87	7·82
60	20·00	7·87
65	20·10	7·91
70	20·19	7·95
75	20·29	7·99
80	20·48	8·06
85	20·66	8·13
90	20·93	8·24
95	21·20	8·35
97	21·31	8·39
98	21·51	8·47
99	21·72	8·55
Max	22·40	8·82



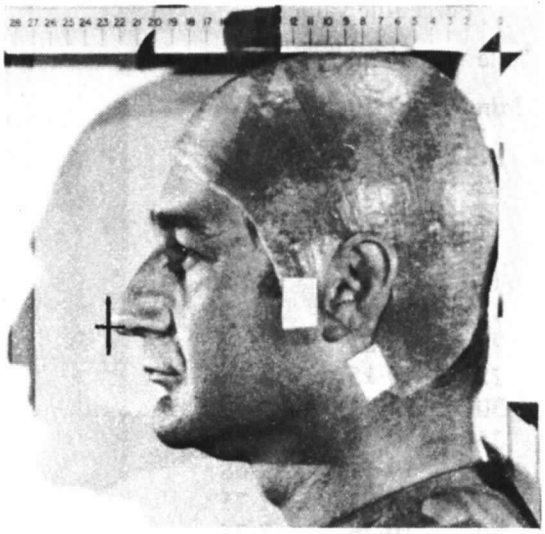
Mean: 19·79 (0·04) cm; 7·79 (0·02) in.
Standard deviation: 0·88 (0·03) cm; 0·35 (0·01) in.
Coefficient of variation: 4·46 (0·14)%
Range: 17·50–22·40 cm; 6·89–8·82 in.
Number of subjects: 484

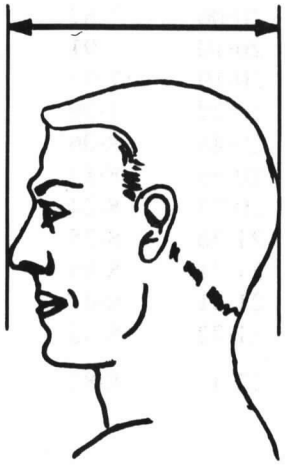
TABLE 38

Nose Tip to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of X–Y axis reader on most forward point of nose, measurement of horizontal distance to back of head.

Percentile values		
%ile	cm	in.
Min	20·50	8·07
1	20·96	8·25
2	21·12	8·31
3	21·23	8·36
5	21·36	8·41
10	21·69	8·54
15	21·81	8·59
20	21·94	8·64
25	22·04	8·68
30	22·13	8·71
35	22·21	8·74
40	22·30	8·78
45	22·44	8·84
50	22·54	8·87
55	22·63	8·91
60	22·72	8·94
65	22·81	8·98
70	22·92	9·02
75	22·99	9·05
80	23·10	9·09
85	23·23	9·15
90	23·50	9·25
95	23·69	9·32
97	23·85	9·39
98	24·02	9·46
99	24·16	9·51
Max	24·60	9·69





Mean: 22·58 (0·03) cm; 8·89 (0·01) in.
Standard deviation: 0·70 (0·02) cm; 0·28 (0·01) in.
Coefficient of variation: 3·10 (0·10)%
Range: 20·50–24·60 cm; 8·07–9·69 in.
Number of subjects: 484

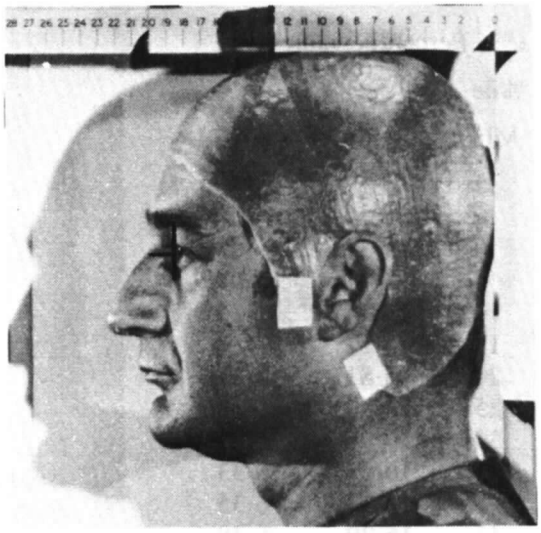
TABLE 39

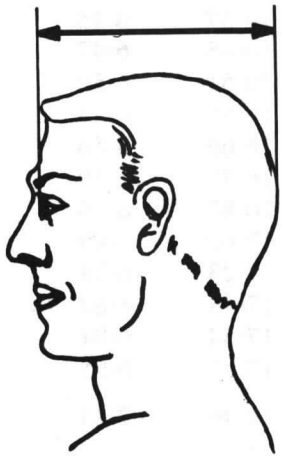
Cornea to Back of Head

Measurement from profile view of photograph. Placing cross-hair graticule of *X–Y* axis reader on front of eye ball (cornea), measurement of horizontal distance to back of head.

Percentile values

%ile	cm	in.
Min	17·00	6·69
1	17·53	6·90
2	17·61	6·93
3	17·66	6·95
5	17·80	7·01
10	18·03	7·10
15	18·15	7·14
20	18·25	7·18
25	18·38	7·24
30	18·50	7·28
35	18·57	7·31
40	18·63	7·34
45	18·70	7·36
50	18·77	7·39
55	18·83	7·41
60	18·89	7·44
65	18·96	7·46
70	19·05	7·50
75	19·18	7·55
80	19·28	7·59
85	19·41	7·64
90	19·52	7·69
95	19·72	7·76
97	19·89	7·83
98	20·02	7·88
99	20·18	7·94
Max	20·40	8·03





Mean: 18·82 (0·03) cm; 7·41 (0·01) in.
Standard deviation: 0·58 (0·02) cm; 0·23 (0·01) in.
Coefficient of variation: 3·10 (0·10)%
Range: 17·00–20·40 cm; 6·69–8·03 in.
Number of subjects: 484

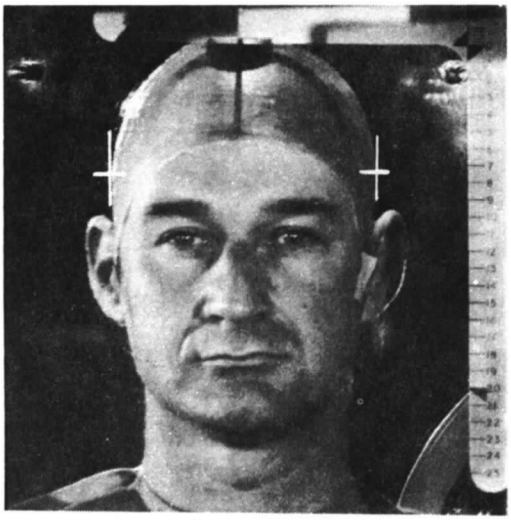
TABLE 40

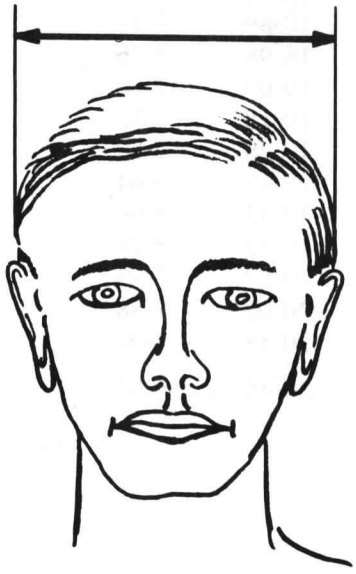
Head Breadth

Measurement from front face view of photograph. Placing cross-hair graticule of X–Y axis reader on broadest part of head then moving horizontally across to other side of head, measurement of maximum head breadth.

Percentile values

%ile	cm	in.
Min	14·60	5·75
1	15·13	5·96
2	15·24	6·00
3	15·32	6·03
5	15·41	6·07
10	15·56	6·13
15	15·71	6·19
20	15·81	6·22
25	15·89	6·26
30	15·98	6·29
35	16·07	6·33
40	16·14	6·35
45	16·20	6·38
50	16·28	6·41
55	16·37	6·45
60	16·45	6·47
65	16·51	6·50
70	16·58	6·53
75	16·66	6·56
80	16·75	6·59
85	16·87	6·64
90	17·00	6·69
95	17·23	6·78
97	17·44	6·87
98	17·54	6·91
99	17·67	6·95
Max	18·40	7·24





Mean: 16·34 (0·03) cm; 6·44 (0·01) in.
Standard deviation: 0·56 (0·02) cm; 0·22 (0·01) in.
Coefficient of variation: 3·44 (0·11)%
Range: 14·60–18·40 cm; 5·75–7·24 in.
Number of subjects: 503

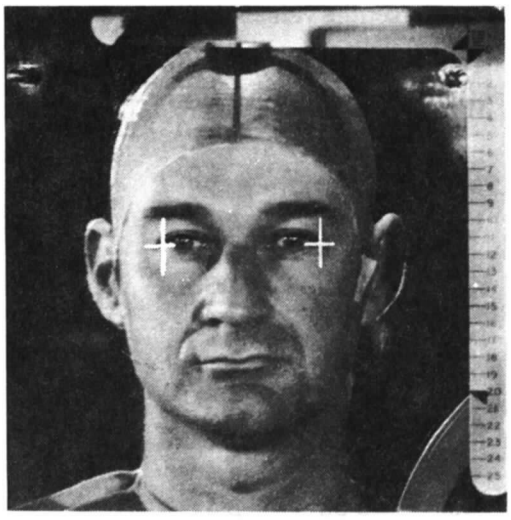
TABLE 41

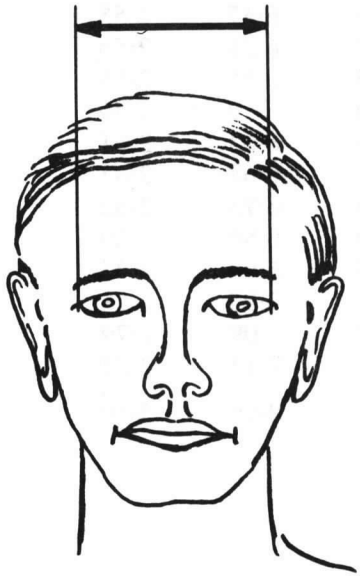
Biocular Diameter

Measurement from front face view of photograph. Placing cross-hair graticule of X–Y axis reader on outer corner (external canthus) of one eye then moving horizontally across head to other eye's outer corner, measurement of horizontal distance between outer corners of eyes.

Percentile values

%ile	cm	in.
Min	7·60	2·99
1	7·90	3·11
2	8·02	3·16
3	8·11	3·19
5	8·19	3·23
10	8·33	3·28
15	8·43	3·32
20	8·50	3·35
25	8·55	3·37
30	8·61	3·39
35	8·67	3·41
40	8·73	3·44
45	8·80	3·46
50	8·86	3·49
55	8·91	3·51
60	8·96	3·53
65	9·02	3·55
70	9·07	3·57
75	9·16	3·60
80	9·24	3·64
85	9·32	3·67
90	9·41	3·71
95	9·62	3·79
97	9·72	3·83
98	9·80	3·86
99	9·85	3·88
Max	9·90	3·90





Mean: 8·91 (0·02) cm; 3·51 (0·01) in.
Standard deviation: 0·43 (0·01) cm; 0·17 (0·01) in.
Coefficient of variation: 4·79 (0·15)%
Range: 7·60–9·90 cm; 2·99–3·90 in.
Number of subjects: 501

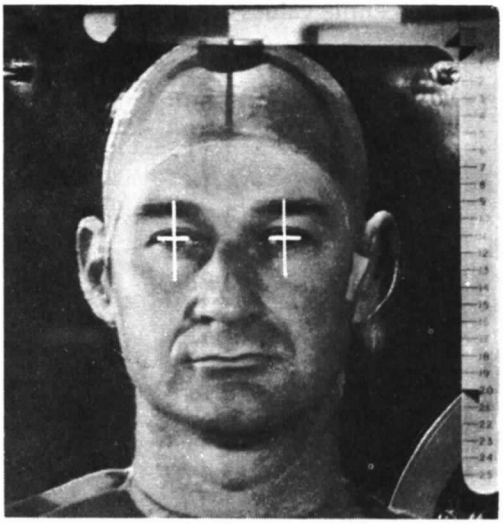
TABLE 42

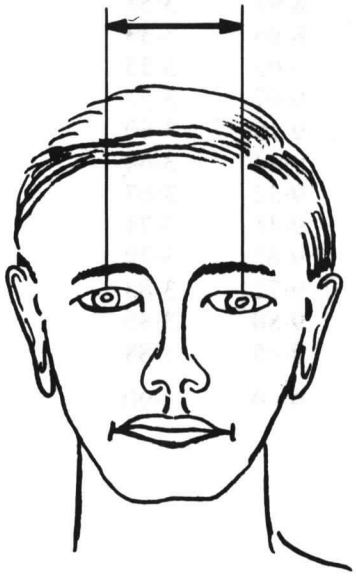
Interpupillary Diameter

Measurement from front face view of photograph. Placing cross-hair graticule of *X*–*Y* axis reader on eye pupil centre then moving horizontally across head to other eye pupil centre, measurement of horizontal distance between eye pupils.

Percentile values

%ile	cm	in.
Min	5·50	2·17
1	5·65	2·22
2	5·80	2·28
3	5·86	2·31
5	5·93	2·33
10	6·04	2·38
15	6·12	2·41
20	6·17	2·43
25	6·22	2·45
30	6·26	2·47
35	6·30	2·48
40	6·34	2·50
45	6·38	2·51
50	6·42	2·53
55	6·47	2·55
60	6·51	2·56
65	6·55	2·58
70	6·59	2·59
75	6·63	2·61
80	6·68	2·63
85	6·75	2·66
90	6·84	2·69
95	6·98	2·75
97	7·05	2·78
98	7·09	2·79
99	7·17	2·82
Max	8·90	3·50





Mean: 6·48 (0·01) cm; 2·55 (0·01) in.
Standard deviation: 0·33 (0·01) cm; 0·13 (0·00) in.
Coefficient of variation: 5·06 (0·16)%
Range: 5·50–8·90 cm; 2·17–3·50 in.
Number of subjects: 501

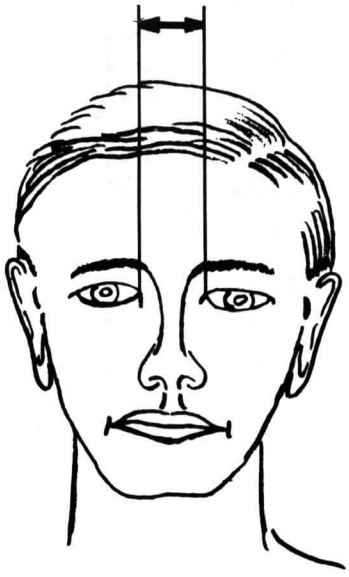
TABLE 43

Interocular Diameter

Measurement from front face view of photograph. Placing cross-hair graticule of *X–Y* axis reader on inner corner (internal canthus) of one eye then moving horizontally across head to other eye's inner corner, measurement of horizontal distance between inner corners of eyes.

Percentile values

%ile	cm	in.
Min	2·80	1·10
1	2·91	1·15
2	2·99	1·18
3	3·10	1·22
5	3·18	1·25
10	3·32	1·31
15	3·41	1·34
20	3·48	1·37
25	3·53	1·39
30	3·57	1·41
35	3·62	1·42
40	3·66	1·44
45	3·70	1·46
50	3·75	1·47
55	3·79	1·49
60	3·83	1·51
65	3·87	1·52
70	3·91	1·54
75	3·95	1·56
80	4·00	1·57
85	4·06	1·60
90	4·14	1·63
95	4·26	1·68
97	4·36	1·72
98	4·42	1·74
99	4·50	1·77
Max	4·80	1·89



Mean: 3·79 (0·01) cm; 1·49 (0·01) in.
Standard deviation: 0·33 (0·01) cm; 0·13 (0·00) in.
Coefficient of variation: 8·62 (0·27)%
Range: 2·80–4·80 cm, 1·10–1·89 in.
Number of subjects: 501

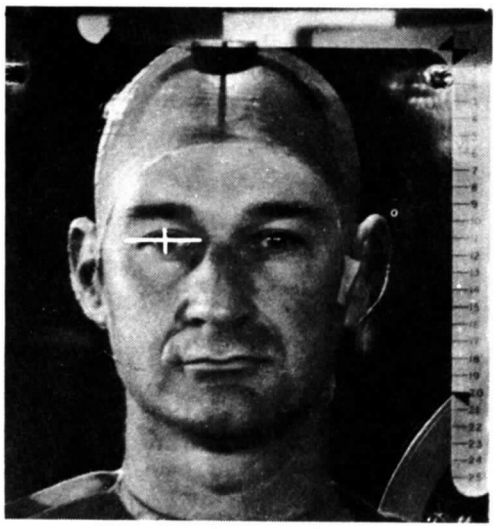
TABLE 44

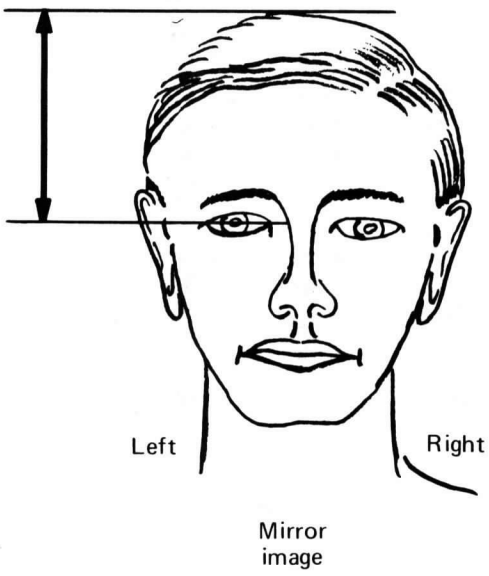
Eye Pupil (Left) to Vertex

Measurement from front face view of photograph. Placing cross-hair graticule of X–Y axis reader on left eye-pupil centre, measurement of vertical distance to top of head.

Percentile values

%ile	cm	in.
Min	10·10	3·98
1	10·49	4·13
2	10·62	4·18
3	10·73	4·23
5	10·85	4·27
10	11·14	4·38
15	11·29	4·44
20	11·44	4·50
25	11·55	4·55
30	11·68	4·60
35	11·76	4·63
40	11·83	4·66
45	11·91	4·69
50	12·00	4·72
55	12·07	4·75
60	12·15	4·78
65	12·23	4·81
70	12·31	4·84
75	12·38	4·87
80	12·51	4·92
85	12·61	4·96
90	12·76	5·02
95	12·98	5·11
97	13·15	5·18
98	13·23	5·21
99	13·41	5·28
Max	13·80	5·43





Mirror image

Mean: 12·02 (0·03) cm; 4·73 (0·01) in.
Standard deviation: 0·63 (0·02) cm; 0·25 (0·01) in.
Coefficient of variation: 5·27 (0·17)%
Range: 10·10–13·80 cm; 3·98–5·43 in.
Number of subjects: 487

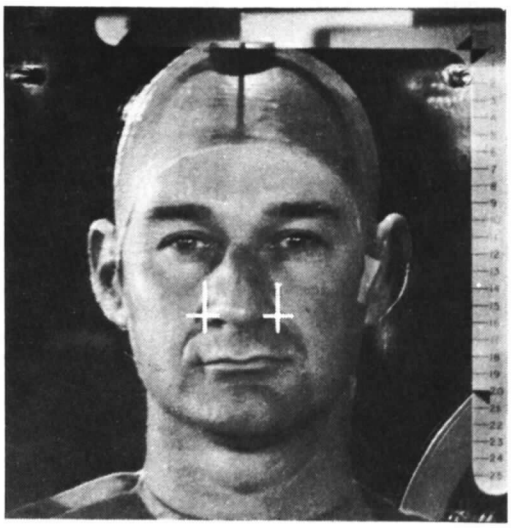
TABLE 45

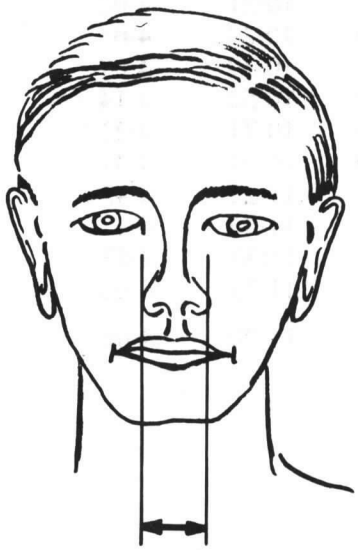
Maximum Nose Breadth

Measurement from front face view of photograph. Placing cross-hair graticule of X–Y axis reader on broadest part of nose then moving horizontally across to other side of nose, measurement of maximum nose breadth.

Percentile values

%ile	cm	in.
Min	2·80	1·10
1	3·08	1·21
2	3·13	1·23
3	3·18	1·25
5	3·24	1·27
10	3·33	1·31
15	3·39	1·33
20	3·44	1·35
25	3·49	1·37
30	3·54	1·39
35	3·58	1·41
40	3·61	1·42
45	3·64	1·43
50	3·67	1·44
55	3·70	1·46
60	3·73	1·47
65	3·77	1·48
70	3·80	1·50
75	3·85	1·51
80	3·89	1·53
85	3·98	1·57
90	4·06	1·60
95	4·16	1·64
97	4·22	1·66
98	4·28	1·68
99	4·40	1·73
Max	4·60	1·81





Mean: 3·73 (0·01) cm; 1·47 (0·00) in.
Standard deviation: 0·28 (0·01); 0·11 (0·00) in.
Coefficient of variation: 7·46 (0·24)%
Range: 2·80–4·60 cm; 1·10–1·81 in.
Number of subjects: 501

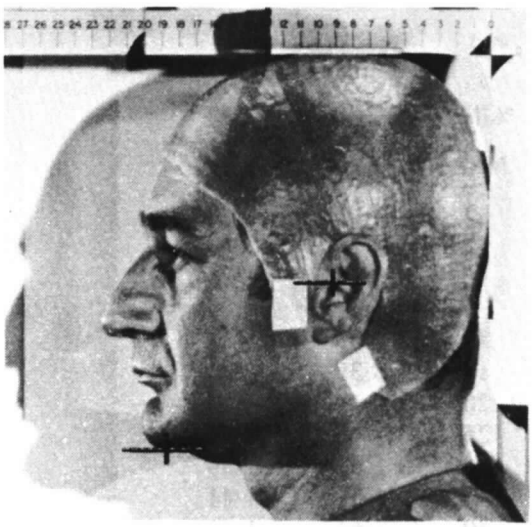
TABLE 46

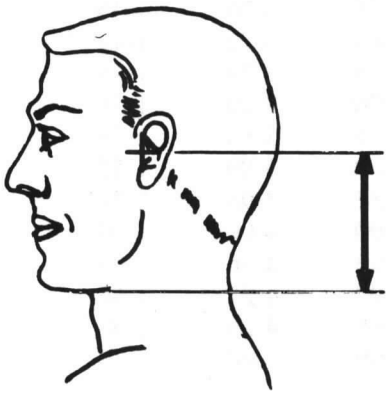
Menton to Tragion (Vertical)

Derived vertical measurement. Menton to vertex minus tragion to vertex. (36–24)

Percentile values

%ile	cm	in.
Min	8·10	3·19
1	8·33	3·28
2	8·56	3·37
3	8·65	3·41
5	8·83	3·48
10	9·07	3·57
15	9·22	3·63
20	9·34	3·68
25	9·45	3·72
30	9·58	3·77
35	9·67	3·81
40	9·78	3·85
45	9·87	3·89
50	9·97	3·92
55	10·05	3·96
60	10·13	3·99
65	10·21	4·02
70	10·29	4·05
75	10·39	4·09
80	10·52	4·14
85	10·71	4·22
90	10·94	4·31
95	11·22	4·42
97	11·36	4·47
98	11·51	4·53
99	11·73	4·62
Max	11·90	4·69





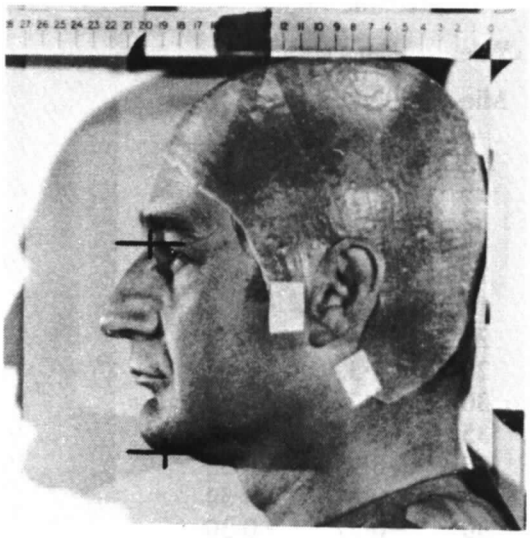
Mean: 10·01 (0·03) cm; 3·94 (0·01) in.
Standard deviation: 0·71 (0·02) cm; 0·28 (0·01) in.
Coefficient of variation: 7·11 (0·23)%
Range: 8·10–11·90 cm; 3·19–4·69 in.
Number of subjects: 472

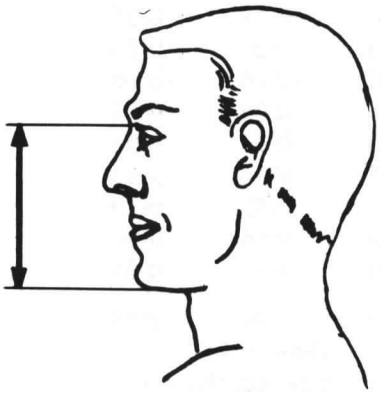
TABLE 47

Menton to Nasion (Vertical)

Derived vertical measurement. Menton to vertex minus nasion to vertex. (36–20)

Percentile values		
%ile	cm	in.
Min	10·80	4·25
1	11·07	4·36
2	11·31	4·45
3	11·40	4·49
5	11·57	4·55
10	11·77	4·63
15	11·87	4·67
20	11·97	4·71
25	12·08	4·76
30	12·17	4·79
35	12·24	4·82
40	12·31	4·85
45	12·39	4·88
50	12·47	4·91
55	12·53	4·93
60	12·58	4·95
65	12·66	4·98
70	12·75	5·02
75	12·85	5·06
80	12·97	5·10
85	13·09	5·15
90	13·30	5·24
95	13·55	5·34
97	13·78	5·43
98	13·95	5·49
99	14·24	5·61
Max	14·80	5·83





Mean: 12·54 (0·03) cm; 4·94 (0·01) in.
Standard deviation: 0·62 (0·02) cm; 0·24 (0·01) in.
Coefficient of variation: 4·92 (0·16)%
Range: 10·80–14·80 cm; 4·25–5·83 in.
Number of subjects: 473

TABLE 48

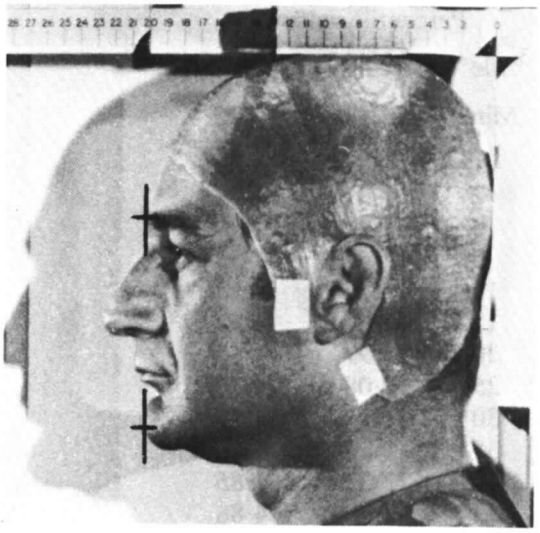
Menton to Brow-Ridge Crest (Horizontal)

Derived horizontal measurement. Menton to back of head minus head length. (37–19)

Percentile values

%ile	cm	in.
Min	−2·80	−1·10
1	−2·47	−0·97
2	−2·27	−0·89
3	−2·09	−0·82
5	−1·98	−0·78
10	−1·75	−0·69
15	−1·57	−0·62
20	−1·43	−0·56
25	−1·32	−0·52
30	−1·22	−0·48
35	−1·11	−0·44
40	−0·97	−0·38
45	−0·87	−0·34
50	−0·77	−0·30
55	−0·68	−0·27
60	−0·57	−0·23
65	−0·47	−0·19
70	−0·37	−0·15
75	−0·26	−0·10
80	−0·16	−0·06
85	−0·04	−0·01
90	0·12	0·05
95	0·36	0·14
97	0·52	0·20
98	0·66	0·26
99	0·91	0·36
Max	1·40	0·55

Minus value indicates that the brow-ridge crest is forward of the menton.



Mean: −0·74 (0·03) cm; −0·29 (0·01) in.
Standard deviation: 0·73 (0·02) cm; 0·29 (0·01) in.
Range: −2·80–1·40 cm; −1·10–0·55 in.
Number of subjects: 484

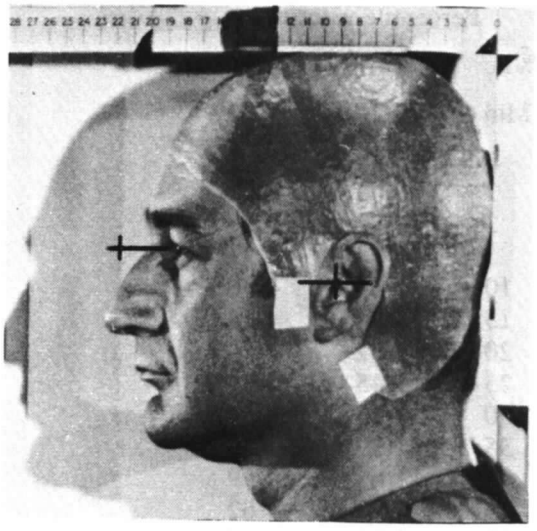
TABLE 49

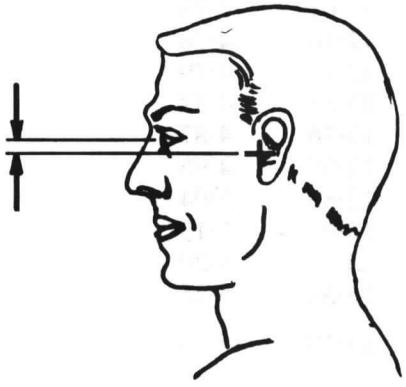
Tragion to Eye Pupil (Vertical)

Derived vertical measurement. Tragion to vertex minus eye pupil (left) to vertex. (24–44)

Percentile values

%ile	cm	in.
Min	0·50	0·20
1	0·61	0·24
2	0·69	0·27
3	0·76	0·30
5	0·93	0·37
10	1·14	0·45
15	1·28	0·50
20	1·36	0·53
25	1·43	0·56
30	1·50	0·59
35	1·58	0·62
40	1·65	0·65
45	1·71	0·68
50	1·81	0·71
55	1·91	0·75
60	1·97	0·78
65	2·03	0·80
70	2·10	0·83
75	2·17	0·86
80	2·26	0·89
85	2·38	0·94
90	2·51	0·99
95	2·72	1·07
97	2·80	1·10
98	2·95	1·16
99	3·11	1·23
Max	4·00	1·57





Mean: 1·87 (0·02) cm; 0·73 (0·01) in.
Standard deviation: 0·54 (0·02) cm; 0·21 (0·01) in.
Coefficient of variation: 29·18 (0·94)%
Range: 0·50–4·00 cm; 0·20–1·57 in.
Number of subjects: 477

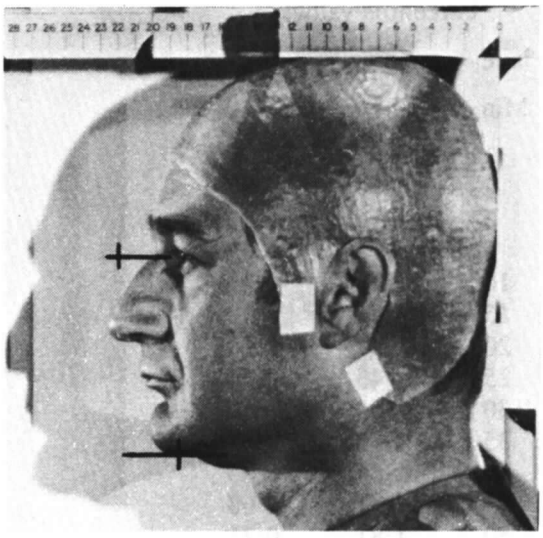
TABLE 50

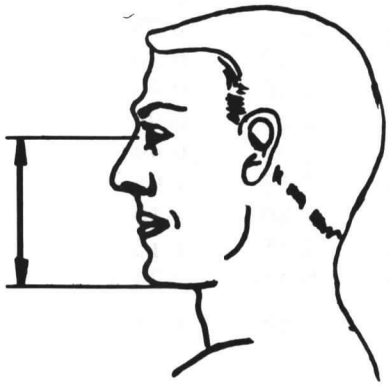
Menton to Eye Pupil (Vertical)

Derived vertical measurement. Menton to vertex minus eye pupil (left) to vertex. (36–44)

Percentile values

%ile	cm	in.
Min	10·20	4·02
1	10·53	4·15
2	10·68	4·21
3	10·82	4·26
5	10·98	4·32
10	11·14	4·38
15	11·27	4·44
20	11·37	4·48
25	11·45	4·51
30	11·53	4·54
35	11·59	4·56
40	11·65	4·59
45	11·72	4·62
50	11·81	4·65
55	11·90	4·68
60	11·95	4·71
65	12·01	4·73
70	12·10	4·76
75	12·17	4·79
80	12·25	4·82
85	12·36	4·87
90	12·58	4·95
95	12·80	5·04
97	13·02	5·13
98	13·21	5·20
99	13·33	5·25
Max	14·10	5·55





Mean: 11·88 (0·03) cm; 4·68 (0·01) in.
Standard deviation: 0·57 (0·02) cm; 0·22 (0·01) in.
Coefficient of variation: 4·78 (0·16)%
Range: 10·20–14·10 cm; 4·02–5·55 in.
Number of subjects: 467

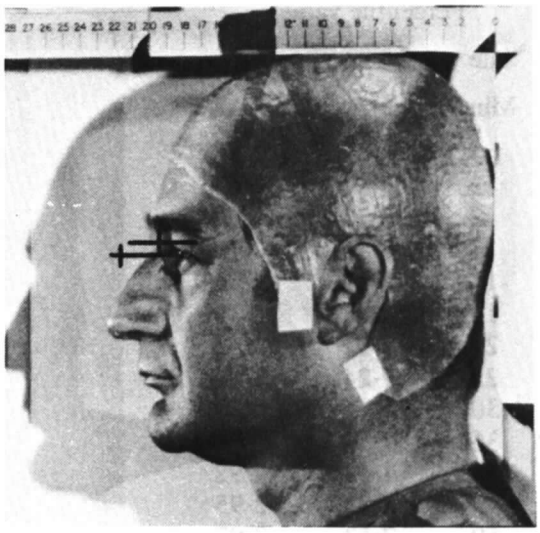
TABLE 51

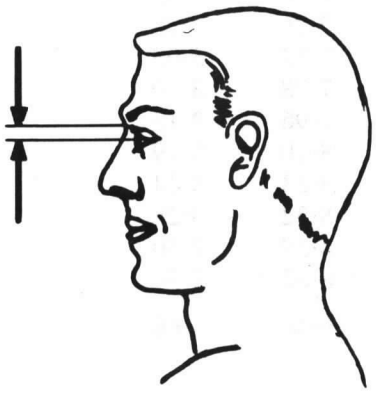
Eye Pupil to Nasion (Vertical)

Derived vertical measurement. Eye pupil (left) to vertex minus nasion to vertex. (44–20)

Percentile values

%ile	cm	in.
Min	−0·10	−0·04
1	−0·05	−0·02
2	0·01	0·01
3	0·05	0·02
5	0·12	0·05
10	0·21	0·08
15	0·29	0·11
20	0·34	0·13
25	0·39	0·15
30	0·44	0·17
35	0·49	0·19
40	0·53	0·21
45	0·56	0·22
50	0·60	0·24
55	0·65	0·26
60	0·70	0·27
65	0·74	0·29
70	0·78	0·31
75	0·82	0·32
80	0·87	0·34
85	0·93	0·37
90	1·01	0·40
95	1·13	0·44
97	1·23	0·48
98	1·31	0·52
99	1·44	0·57
Max	2·00	0·79





Mean: 0·66 (0·01) cm; 0·26 (0·01) in.
Standard deviation: 0·31 (0·01) cm; 0·12 (0·00) in.
Range: −0·10–2·00 cm; −0·04–0·79 in.
Number of subjects: 478

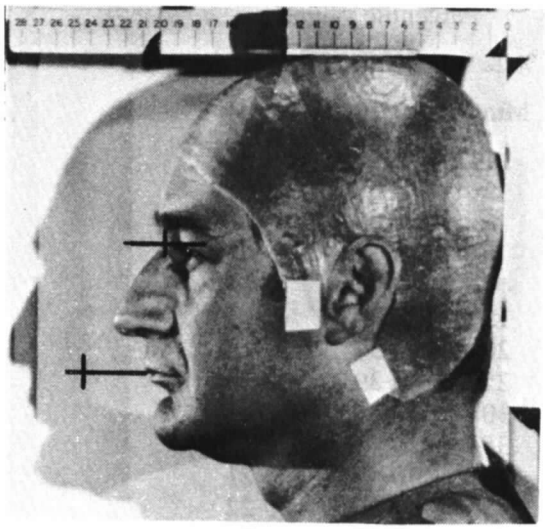
TABLE 52

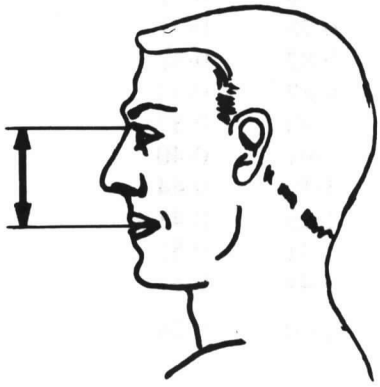
Centre Line of Abutting Lips to Nasion (Vertical)

Derived vertical measurement. Centre line of abutting lips to vertex minus nasion to vertex. (35–20)

Percentile values

%ile	cm	in.
Min	5·50	2·17
1	6·56	2·58
2	6·67	2·63
3	6·77	2·67
5	6·85	2·70
10	6·97	2·74
15	7·08	2·79
20	7·17	2·82
25	7·24	2·85
30	7·30	2·87
35	7·37	2·90
40	7·43	2·92
45	7·48	2·95
50	7·53	2·97
55	7·58	2·99
60	7·64	3·01
65	7·70	3·03
70	7·76	3·05
75	7·82	3·08
80	7·88	3·10
85	7·96	3·13
90	8·10	3·19
95	8·23	3·24
97	8·32	3·28
98	8·39	3·30
99	8·62	3·39
Max	9·30	3·66





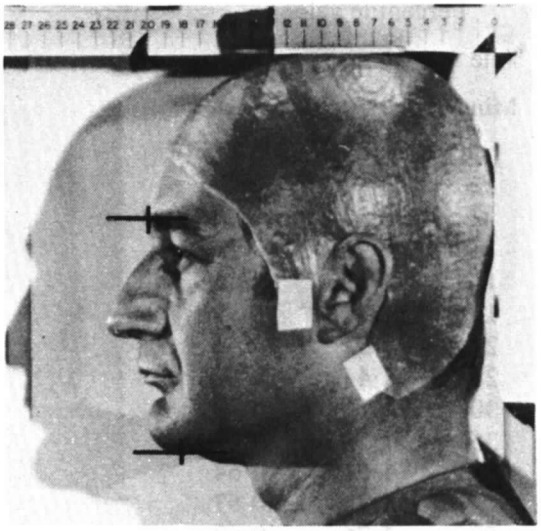
Mean: 7·58 (0·02) cm; 2·99 (0·01) in.
Standard deviation: 0·44 (0·01) cm; 0·17 (0·01) in.
Coefficient of variation: 5·79 (0·19)%
Range: 5·50–9·30 cm; 2·17–3·66 in.
Number of subjects: 483

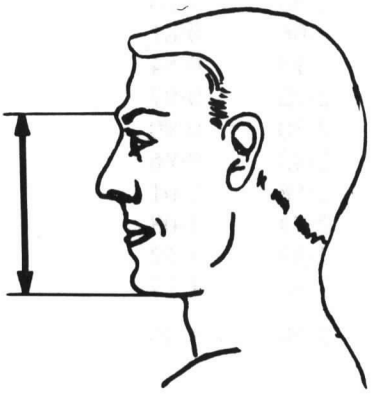
TABLE 53

Menton to Brow-Ridge Crest (Vertical)

Derived vertical measurement. Menton to vertex minus brow-ridge crest to vertex. (36–18)

Percentile values		
%ile	cm	in.
Min	12·10	4·76
1	12·49	4·92
2	12·85	5·06
3	12·96	5·10
5	13·08	5·15
10	13·27	5·23
15	13·41	5·28
20	13·52	5·32
25	13·60	5·36
30	13·69	5·39
35	13·76	5·42
40	13·85	5·45
45	13·94	5·49
50	14·02	5·52
55	14·10	5·55
60	14·19	5·59
65	14·26	5·61
70	14·33	5·64
75	14·42	5·68
80	14·53	5·72
85	14·69	5·78
90	14·83	5·84
95	15·09	5·94
97	15·39	6·06
98	15·58	6·14
99	15·81	6·23
Max	16·40	6·46





Mean: 14·09 (0·03) cm; 5·55 (0·01) in.
Standard deviation: 0·64 (0·02) cm; 0·25 (0·01) in.
Coefficient of variation: 4·55 (0·15)%
Range: 12·10–16·40 cm; 4·76–6·46 in.
Number of subjects: 473

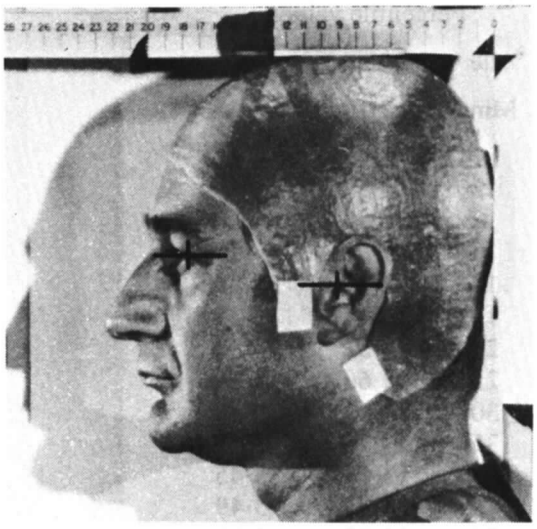
TABLE 54

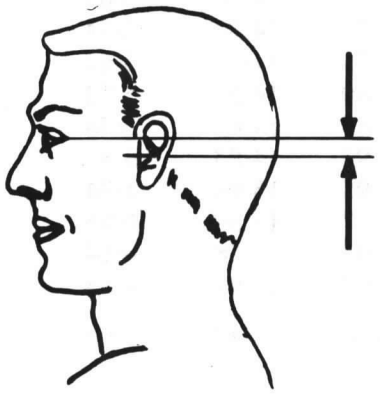
Tragion to External Canthus (Vertical)

Derived vertical measurement. Tragion to vertex minus external canthus to vertex. (24–22)

Percentile values

%ile	cm	in.
Min	0·60	0·24
1	0·68	0·27
2	0·76	0·30
3	0·82	0·32
5	0·94	0·37
10	1·16	0·46
15	1·29	0·51
20	1·37	0·54
25	1·44	0·57
30	1·50	0·59
35	1·56	0·62
40	1·63	0·64
45	1·70	0·67
50	1·76	0·69
55	1·83	0·72
60	1·91	0·75
65	1·98	0·78
70	2·06	0·81
75	2·14	0·84
80	2·22	0·87
85	2·30	0·90
90	2·43	0·96
95	2·58	1·01
97	2·74	1·08
98	2·84	1·12
99	2·96	1·17
Max	3·70	1·46





Mean: 1·83 (0·02) cm; 0·72 (0·01) in.
Standard deviation: 0·50 (0·02) cm; 0·20 (0·01) in.
Coefficient of variation: 27·43 (0·88)%
Range: 0·60–3·70 cm; 0·24–1·46 in.
Number of subjects: 483

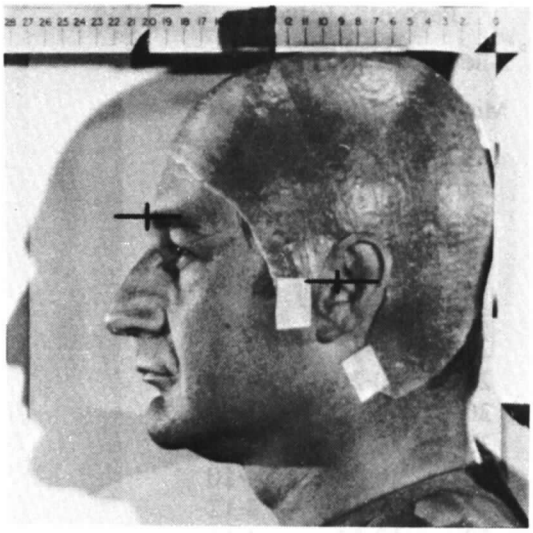
TABLE 55

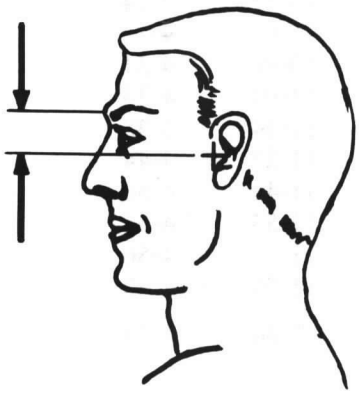
Tragion to Brow-Ridge Crest (Vertical)

Derived vertical measurement. Tragion to vertex minus brow-ridge crest to vertex. (24–18)

Percentile values

%ile	cm	in.
Min	2·40	0·94
1	2·66	1·05
2	2·77	1·09
3	2·85	1·12
5	2·95	1·16
10	3·17	1·25
15	3·32	1·31
20	3·45	1·36
25	3·58	1·41
30	3·66	1·44
35	3·75	1·48
40	3·88	1·53
45	3·97	1·56
50	4·06	1·60
55	4·15	1·63
60	4·23	1·67
65	4·30	1·69
70	4·39	1·73
75	4·47	1·76
80	4·56	1·80
85	4·67	1·84
90	4·83	1·90
95	5·07	1·99
97	5·31	2·09
98	5·41	2·13
99	5·52	2·17
Max	6·30	2·48





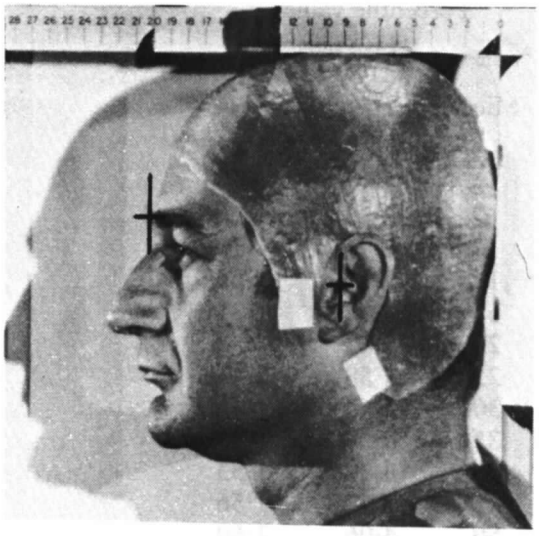
Mean: 4·08 (0·03) cm; 1·61 (0·01) in.
Standard deviation: 0·65 (0·02) cm; 0·25 (0·01) in.
Coefficient of variation: 15·86 (0·51)%
Range: 2·40–6·30 cm; 0·94–2·48 in.
Number of subjects: 483

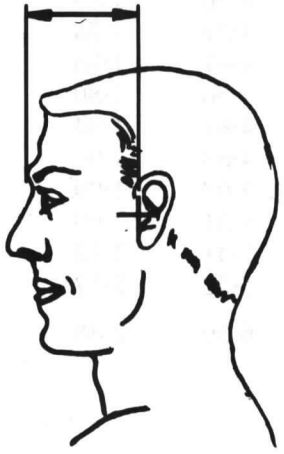
TABLE 56

Brow-Ridge Crest to Tragion (Horizontal)

Derived horizontal measurement. Head length minus tragion to back of head. (19–25)

Percentile values		
%ile	cm	in.
Min	8·40	3·31
1	9·18	3·62
2	9·35	3·68
3	9·42	3·71
5	9·62	3·79
10	9·86	3·88
15	10·00	3·94
20	10·11	3·98
25	10·20	4·02
30	10·29	4·05
35	10·35	4·08
40	10·41	4·10
45	10·47	4·12
50	10·52	4·14
55	10·58	4·17
60	10·66	4·20
65	10·77	4·24
70	10·86	4·28
75	10·94	4·31
80	11·01	4·33
85	11·14	4·38
90	11·27	4·44
95	11·44	4·50
97	11·53	4·54
98	11·58	4·56
99	11·76	4·63
Max	12·10	4·76





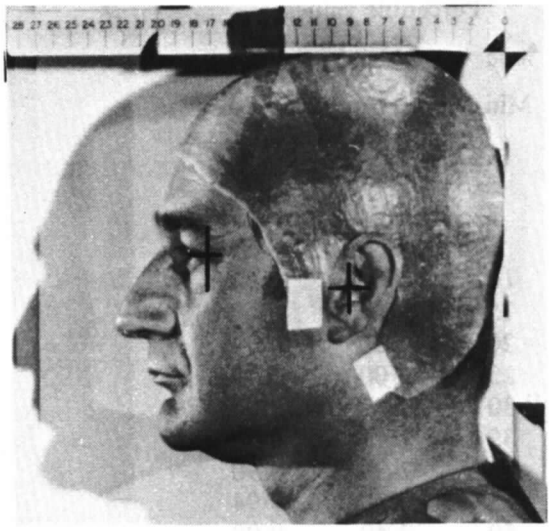
Mean: 10·60 (0·03) cm; 4·17 (0·01) in.
Standard deviation: 0·55 (0·02) cm; 0·22 (0·01) in.
Coefficient of variation: 5·18 (0·17)%
Range: 8·40–12·10 cm; 3·31–4·76 in.
Number of subjects: 483

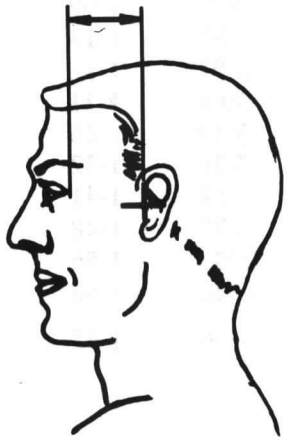
TABLE 57

External Canthus to Tragion (Horizontal)

Derived horizontal measurement. External canthus to back of head minus tragion to back of head. (23–25)

Percentile values		
%ile	cm	in.
Min	5·80	2·28
1	6·99	2·75
2	7·13	2·81
3	7·21	2·84
5	7·26	2·86
10	7·38	2·91
15	7·46	2·94
20	7·55	2·97
25	7·62	3·00
30	7·68	3·02
35	7·73	3·04
40	7·79	3·07
45	7·83	3·08
50	7·87	3·10
55	7·92	3·12
60	7·97	3·14
65	8·02	3·16
70	8·07	3·18
75	8·13	3·20
80	8·19	3·22
85	8·29	3·26
90	8·36	3·29
95	8·48	3·34
97	8·57	3·37
98	8·63	3·40
99	8·77	3·45
Max	9·20	3·62





Mean: 7·92 (0·02) cm; 3·12 (0·01) in.
Standard deviation: 0·39 (0·01) cm; 0·15 (0·00) in.
Coefficient of variation: 4·87 (0·16)%
Range: 5·80–9·20 cm; 2·28–3·62 in.
Number of subjects: 482

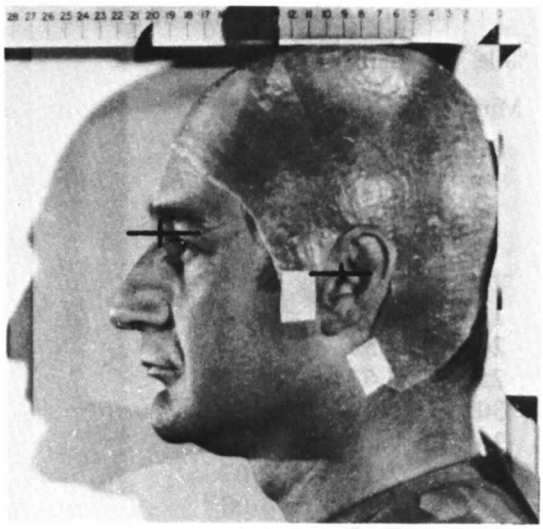
TABLE 58

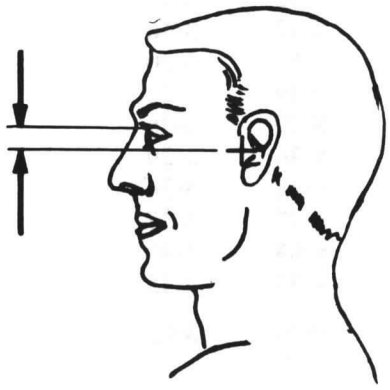
Tragion to Nasion (Vertical)

Derived vertical measurement. Tragion to vertex minus nasion to vertex. (24–20)

Percentile values

%ile	cm	in.
Min	0·60	0·24
1	0·98	0·39
2	1·17	0·46
3	1·24	0·49
5	1·36	0·54
10	1·57	0·62
15	1·74	0·69
20	1·89	0·74
25	2·00	0·79
30	2·09	0·82
35	2·18	0·86
40	2·30	0·90
45	2·39	0·94
50	2·49	0·98
55	2·59	1·02
60	2·67	1·05
65	2·77	1·09
70	2·87	1·13
75	2·97	1·17
80	3·06	1·21
85	3·19	1·26
90	3·36	1·32
95	3·59	1·41
97	3·77	1·48
98	3·97	1·56
99	4·26	1·68
Max	4·70	1·85





Mean: 2·53 (0·03) cm; 1·00 (0·01) in.
Standard deviation: 0·69 (0·02) cm; 0·27 (0·01) in.
Coefficient of variation: 27·41 (0·88)%
Range: 0·60–4·70 cm; 0·24–1·85 in.
Number of subjects: 483

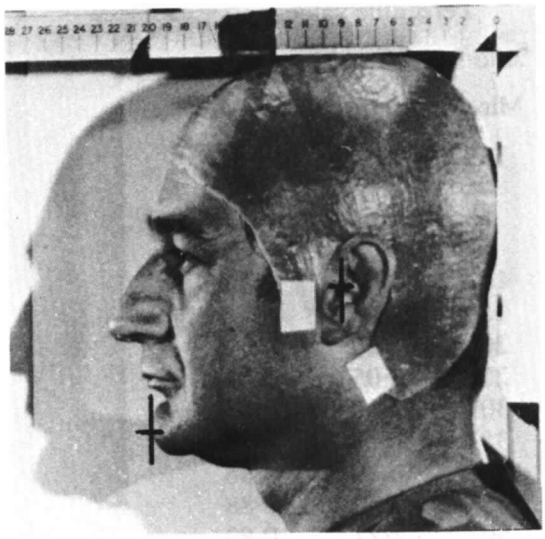
TABLE 59

Menton to Tragion (Horizontal)

Derived horizontal measurement. Menton to back of head minus tragion to back of head. (37–25)

Percentile values

%ile	cm	in.
Min	7·80	3·07
1	8·04	3·17
2	8·33	3·28
3	8·45	3·33
5	8·64	3·40
10	8·88	3·50
15	9·04	3·56
20	9·21	3·63
25	9·31	3·67
30	9·39	3·70
35	9·48	3·73
40	9·60	3·78
45	9·71	3·82
50	9·82	3·87
55	9·92	3·90
60	10·01	3·94
65	10·10	3·97
70	10·22	4·02
75	10·35	4·07
80	10·46	4·12
85	10·60	4·17
90	10·74	4·23
95	10·93	4·30
97	11·03	4·34
98	11·09	4·37
99	11·21	4·41
Max	12·40	4·88



Mean: 9·85 (0·03) cm; 3·88 (0·01) in.
Standard deviation: 0·71 (0·02) cm; 0·28 (0·01) in.
Coefficient of variation: 7·25 (0·23)%
Range: 7·80–12·40 cm; 3·07–4·88 in.
Number of subjects: 483

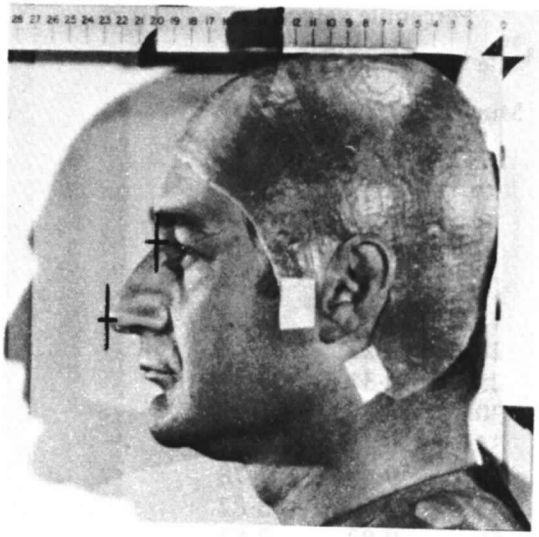
TABLE 60

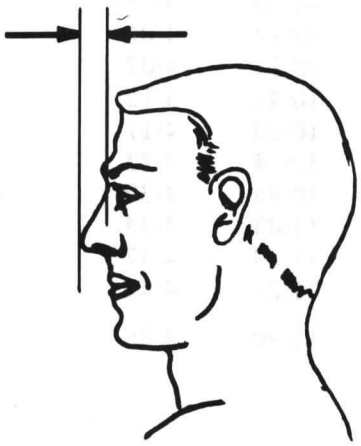
Nose Tip to Nasion (Horizontal)

Derived horizontal measurement. Nose tip to back of head minus nasion to back of head. (38–21)

Percentile values

%ile	cm	in.
Min	0·60	0·24
1	1·38	0·54
2	1·56	0·61
3	1·62	0·64
5	1·71	0·67
10	1·84	0·73
15	1·93	0·76
20	2·00	0·79
25	2·05	0·81
30	2·10	0·83
35	2·14	0·84
40	2·19	0·86
45	2·23	0·88
50	2·27	0·89
55	2·32	0·91
60	2·37	0·93
65	2·42	0·95
70	2·46	0·97
75	2·51	0·99
80	2·56	1·01
85	2·63	1·04
90	2·73	1·08
95	2·86	1·13
97	2·93	1·15
98	2·98	1·17
99	3·04	1·20
Max	3·30	1·30





Mean: 2·33 (0·02) cm; 0·92 (0·01) in.
Standard deviation: 0·35 (0·01) cm; 0·14 (0·00) in.
Coefficient of variation: 15·08 (0·48)%
Range: 0·60–3·30 cm; 0·24–1·30 in.
Number of subjects: 484

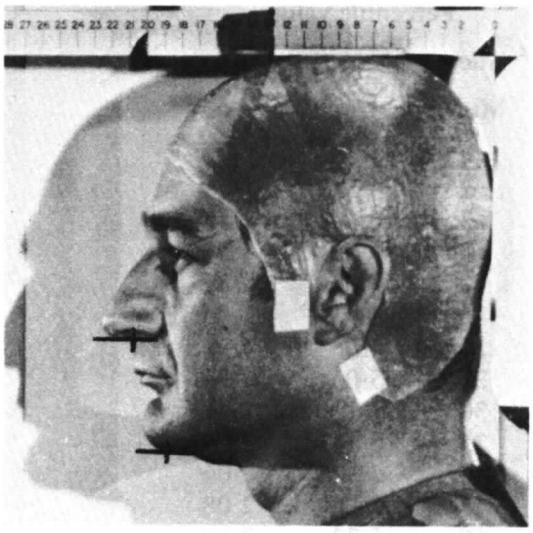
TABLE 61

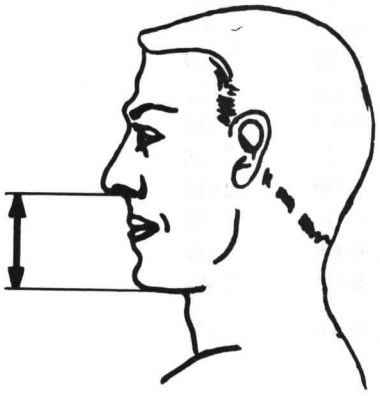
Menton to Bottom of Nose (Vertical)

Derived vertical measurement. Menton to vertex minus bottom of nose to vertex. (36–26)

Percentile values

%ile	cm	in.
Min	5·90	2·32
1	6·02	2·37
2	6·17	2·43
3	6·24	2·46
5	6·33	2·49
10	6·53	2·57
15	6·65	2·62
20	6·74	2·65
25	6·82	2·69
30	6·88	2·71
35	6·94	2·73
40	7·00	2·76
45	7·05	2·78
50	7·10	2·80
55	7·16	2·82
60	7·22	2·84
65	7·27	2·86
70	7·33	2·89
75	7·40	2·91
80	7·48	2·94
85	7·61	3·00
90	7·76	3·06
95	7·99	3·15
97	8·19	3·22
98	8·29	3·26
99	8·56	3·37
Max	9·20	3·62





Mean: 7·18 (0·02) cm; 2·83 (0·01) in.
Standard deviation: 0·50 (0·02) cm; 0·20 (0·01) in.
Coefficient of variation: 6·92 (0·22)%
Range: 5·90–9·20 cm; 2·32–3·62 in.
Number of subjects: 473

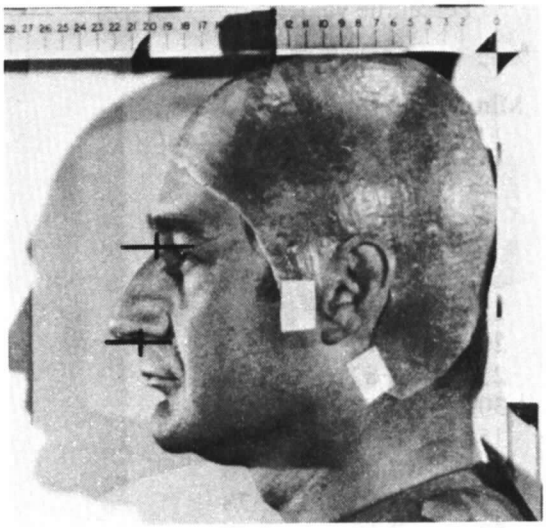
TABLE 62

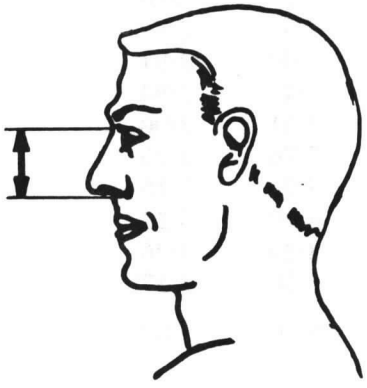
Bottom of Nose to Nasion (Vertical)

Derived vertical measurement. Bottom of nose to vertex minus nasion to vertex. (26–20)

Percentile values

%ile	cm	in.
Min	4·20	1·65
1	4·45	1·75
2	4·54	1·79
3	4·60	1·81
5	4·66	1·83
10	4·81	1·89
15	4·91	1·93
20	4·98	1·96
25	5·05	1·99
30	5·11	2·01
35	5·17	2·04
40	5·23	2·06
45	5·28	2·08
50	5·33	2·10
55	5·37	2·11
60	5·42	2·13
65	5·47	2·15
70	5·52	2·18
75	5·57	2·19
80	5·62	2·21
85	5·69	2·24
90	5·79	2·28
95	5·96	2·34
97	6·03	2·38
98	6·08	2·39
99	6·21	2·44
Max	7·10	2·80





Mean: 5·36 (0·02) cm; 2·11 (0·01) in.
Standard deviation: 0·39 (0·01) cm; 0·15 (0·00) in.
Coefficient of variation: 7·22 (0·23)%
Range: 4·20–7·10 cm; 1·65–2·80 in.
Number of subjects: 484

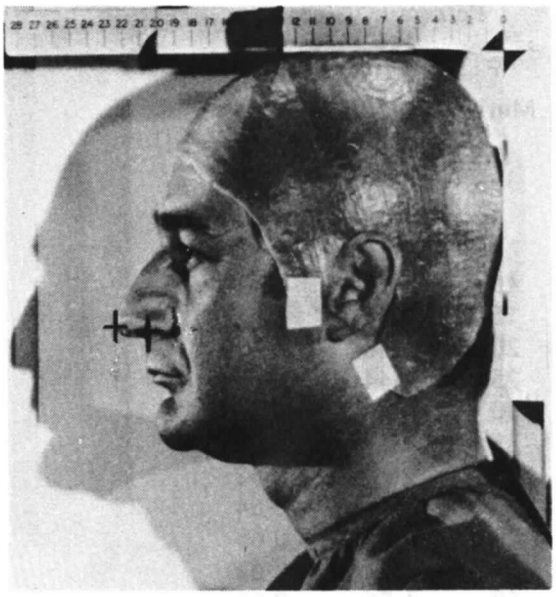
TABLE 63

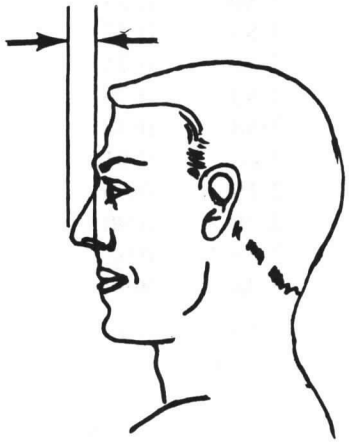
Bottom of Nose to Tip of Nose (Horizontal)

Derived horizontal measurement. Bottom of nose to tip of nose horizontal. (38–27)

Percentile values

%ile	cm	in.
Min	0·60	0·24
1	0·94	0·37
2	1·30	0·51
3	1·32	0·52
5	1·37	0·54
10	1·45	0·57
15	1·51	0·60
20	1·55	0·61
25	1·58	0·62
30	1·62	0·64
35	1·65	0·65
40	1·68	0·66
45	1·71	0·67
50	1·73	0·68
55	1·76	0·69
60	1·78	0·70
65	1·81	0·71
70	1·84	0·73
75	1·88	0·74
80	1·92	0·76
85	1·98	0·78
90	2·04	0·80
95	2·13	0·84
97	2·18	0·86
98	2·23	0·88
99	2·34	0·92
Max	2·60	1·02





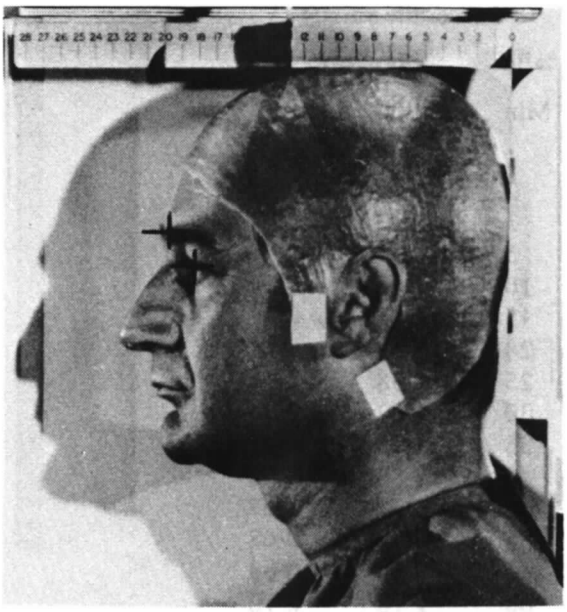
Mean: 1·79 (0·01) cm; 0·70 (0·00) in.
Standard deviation: 0·23 (0·01) cm; 0·09 (0·00) in.
Coefficient of variation: 12·88 (0·41)%
Range: 0·60–2·60 cm; 0·24–1·02 in.
Number of subjects: 483

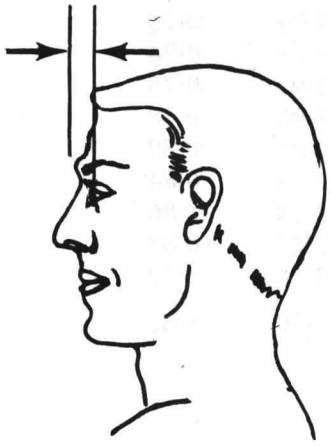
TABLE 64

Cornea to Brow-Ridge (Horizontal)

Derived horizontal measurement. Cornea to brow-ridge horizontal. (19–39)

Percentile values		
%ile	cm	in.
Min	0·60	0·24
1	0·75	0·30
2	0·99	0·39
3	1·05	0·41
5	1·16	0·46
10	1·29	0·51
15	1·35	0·53
20	1·40	0·55
25	1·44	0·57
30	1·48	0·58
35	1·53	0·60
40	1·58	0·62
45	1·63	0·64
50	1·67	0·66
55	1·71	0·67
60	1·76	0·69
65	1·80	0·71
70	1·84	0·73
75	1·88	0·74
80	1·93	0·76
85	1·98	0·78
90	2·06	0·81
95	2·19	0·86
97	2·28	0·90
98	2·33	0·92
99	2·38	0·94
Max	2·50	0·98





Mean: 1·72 (0·01) cm; 0·68 (0·01) in.
Standard deviation: 0·32 (0·01) cm; 0·12 (0·00) in.
Coefficient of variation: 18·47 (0·59)%
Range: 0·60–2·50 cm; 0·24–0·98 in.
Number of subjects: 483

TABLE 65

Age

Percentile values

%ile	Year
Min	18·34
1	19·05
2	19·19
3	19·33
5	19·58
10	20·49
15	21·09
20	22·07
25	22·85
30	23·61
35	24·19
40	24·67
45	25·12
50	25·86
55	26·61
60	27·48
65	28·30
70	29·03
75	30·33
80	32·33
85	34·72
90	37·16
95	40·67
97	42·01
98	43·45
99	44·09
Max	45·69

Mean: 27·44 (0·28)
Standard deviation: 6·29 (0·20)
Coefficient of variation: 22·94 (0·72)%
Range: 18·34–45·69
Number of subjects: 505

TABLE 66

Summary of Measurements

All measurements in centimetres	Mean	SD	Min	1st %ile	99th %ile	Max
Tape						
1. Neck circumference	36·93	1·80	30·30	32·92	41·20	43·40
2. Head circumference	57·70	1·37	52·90	54·60	60·80	62·00
3. Bitragion—coronal arc	36·13	1·26	33·00	33·01	38·93	41·80
4. Bitragion—minimum frontal arc	31·31	0·94	28·70	29·10	33·45	34·60
5. Bitragion—subnasale arc	29·12	1·00	26·00	26·81	31·45	32·50
6. Bitragion—menton arc	32·40	1·30	28·00	29·21	35·55	37·00
7. Bitragion—submandibular arc	29·78	1·45	25·00	26·61	33·14	34·50
8. Bitragion—minimum posterior arc	27·49	1·13	24·60	25·10	30·29	33·00
9. Minimum frontal arc	13·21	0·67	11·20	11·60	14·92	15·10
Caliper						
10. Maximum head diagonal from menton	25·87	0·78	23·10	24·20	27·95	28·60
11. Head breadth over flattened ears	15·92	0·55	13·90	14·67	17·20	17·60
12. Minimum frontal diameter	11·00	0·40	9·90	10·00	11·97	12·20
13. Maximum frontal diameter	11·19	0·38	10·10	10·30	12·14	12·40
14. Bitragion diameter	13·76	0·61	12·40	12·53	15·40	16·20
15. Bizygomatic diameter	14·20	0·52	12·90	13·11	15·60	16·20
16. Bigonial diameter	11·94	0·52	10·60	10·82	13·42	13·60
17. Lip length (Bichelion diameter)	4·79	0·39	3·80	3·93	5·70	6·10
Photogrammetry						
18. Brow-ridge crest to vertex	9·79	0·71	7·60	8·04	11·18	11·80
19. Head length	20·53	0·60	18·80	19·13	22·02	22·30
20. Nasion to vertex	11·33	0·77	8·70	9·37	12·98	13·50
21. Nasion to back of head	20·25	0·60	18·50	18·78	21·59	21·90
22. External canthus to vertex	12·04	0·62	10·20	10·49	13·43	13·80
23. External canthus to back of head	17·86	0·57	16·00	16·38	19·07	19·40

24. Tragion to vertex		13·87	0·53	12·30	12·58	15·14	15·70
25. Tragion to back of head		9·94	0·57	8·30	8·53	11·22	12·50
26. Bottom of nose to vertex		16·70	0·76	14·50	14·85	18·27	18·80
27. Bottom of nose to back of head		20·79	0·71	18·20	19·12	22·35	23·50
28. Maximum chin indent to vertex		20·70	0·84	18·00	18·58	22·52	23·50
29. Maximum chin indent to back of head		19·46	0·82	17·50	17·55	21·24	21·90
30. Juncture of chin and neck to vertex		24·44	0·93	21·70	22·10	26·67	28·00
31. Juncture of chin and neck to back of head		14·89	1·04	11·40	12·78	17·60	19·30
32. Vertical location of measurement 33 from vertex		18·22	1·71	13·80	14·81	22·85	24·40
33. Maximum distance of back of neck to back of head		2·15	0·72	0·70	0·74	4·02	4·50
34. Back of head contact centre to vertex		9·06	0·55	7·40	7·76	10·50	10·60
35. Centre line of abutting lips to vertex		18·92	0·76	16·60	16·99	20·62	21·00
36. Menton to vertex		23·87	0·85	21·40	21·69	25·77	26·50
37. Menton to back of head		19·79	0·88	17·50	17·69	21·72	22·40
38. Nose tip to back of head		22·58	0·70	20·50	20·96	24·16	24·60
39. Cornea to back of head		18·82	0·58	17·00	17·53	20·18	20·40
40. Head breadth		16·34	0·56	14·60	15·13	17·67	18·40
41. Biocular diameter		8·91	0·43	7·60	7·90	9·85	9·90
42. Interpupillary diameter		6·48	0·33	5·50	5·65	7·17	8·90
43. Interocular diameter		3·79	0·33	2·80	2·91	4·50	4·80
44. Eye pupil (left) to vertex		12·02	0·63	10·10	10·49	13·41	13·80
45. Maximum nose breadth		3·73	0·28	2·80	3·08	4·40	4·60
Derived (X = horizontal measurement and Y = Vertical measurement)							
46. Menton to tragion (Y)	= 36–24	10·01	0·71	8·10	8·33	11·73	11·90
47. Menton to nasion (Y)	= 36–20	12·54	0·62	10·80	11·07	14·24	14·80
48. Menton to brow-ridge crest (X)	= 37–19	−0·74	0·73	−2·80	−2·47	0·91	1·40
49. Tragion to eye pupil (Y)	= 24–44	1·87	0·54	0·50	0·61	3·11	4·00
50. Menton to eye pupil (Y)	= 36–44	11·88	0·57	10·20	10·53	13·33	14·10
51. Eye pupil to nasion (Y)	= 44–20	0·66	0·31	−0·10	−0·05	1·44	2·00
52. Centre line of abutting lips to nasion (Y)	= 35–20	7·58	0·44	5·50	6·56	8·62	9·30
53. Menton to brow-ridge crest (Y)	= 36–18	14·09	0·64	12·10	12·49	15·81	16·40
54. Tragion to external canthus (Y)	= 24–22	1·83	0·50	0·60	0·68	2·96	3·70
55. Tragion to brow-ridge crest (Y)	= 24–18	4·08	0·65	2·40	2·66	5·52	6·30
56. Brow-ridge crest to tragion (X)	= 19–25	10·60	0·55	8·40	9·18	11·76	12·10
57. External canthus to tragion (X)	= 23–25	7·92	0·39	5·80	6·99	8·77	9·20
58. Tragion to nasion (Y)	= 24–20	2·53	0·69	0·60	0·98	4·26	4·70

TABLE 66 (concluded)

All measurements in centimetres		Mean	SD	Min	1st %ile	99th %ile	Max
59. Menton to tragion (X)	= 37–25	9·85	0·71	7·80	8·04	11·21	12·40
60. Nose tip to nasion (X)	= 38–21	2·33	0·35	0·60	1·38	3·04	3·30
61. Menton to bottom of nose (Y)	= 36–26	7·18	0·50	5·90	6·02	8·56	9·20
62. Bottom of nose to nasion (Y)	= 26–20	5·36	0·39	4·20	4·45	6·21	7·10
63. Bottom of nose to tip of nose (X)	= 38–27	1·79	0·23	0·60	0·94	2·34	2·60
64. Cornea to brow-ridge (X)	= 19–39	1·72	0·32	0·60	0·75	2·38	2·50
Age (years)		27·44	6·29	18·34	19·05	44·09	45·69

X = horizontal measurement.
Y = vertical measurement.

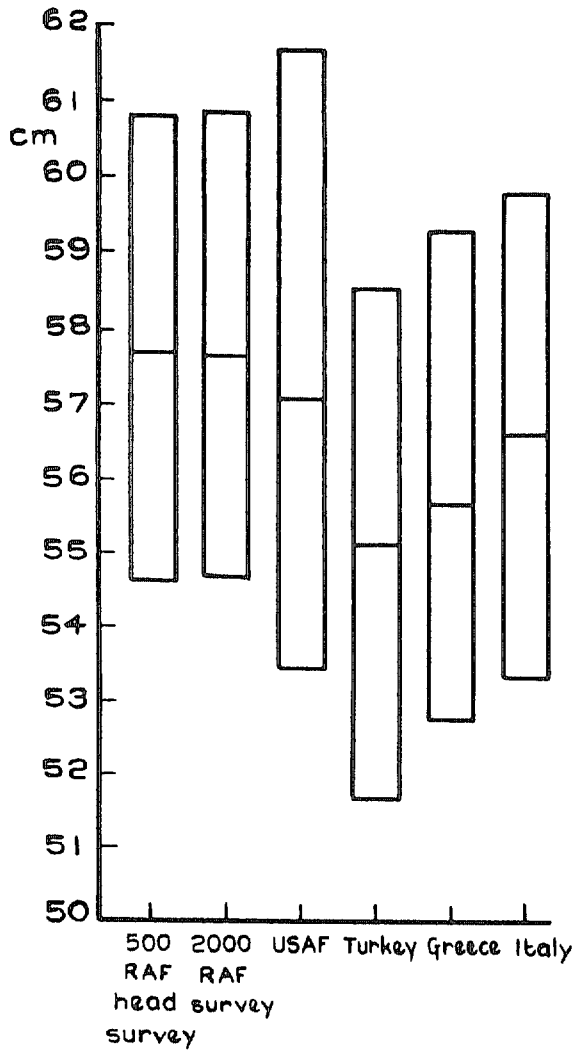
TABLE 67

Comparison Table of Anthropometric Data on 500 R.A.F. Aircrew Measured in 1972 and 4000 U.S.A.F. Flying Personnel Measured in 1950

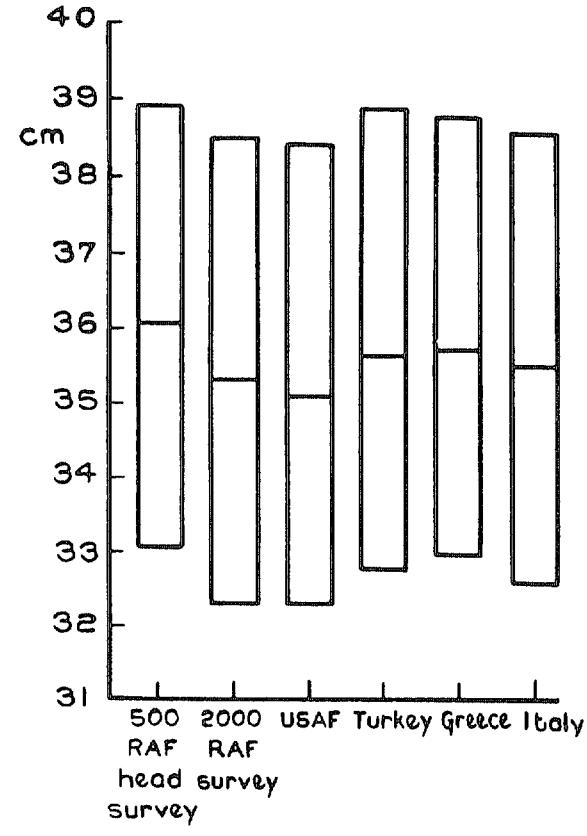
No.	Measurement (cm)	SD		Mean		Min		Max		1st %ile		99th %ile	
		R.A.F.	U.S.A.F.	R.A.F.	U.S.A.F.	R.A.F.	U.S.A.F.	R.A.F.	U.S.A.F.	R.A.F.	U.S.A.F.	R.A.F.	U.S.A.F.
1.	Neck circumference	1·80	1·89	36·93	38·00	30·30	26·00	43·40	49·00	32·92	34·00	41·20	42·70
2.	Head circumference	1·37	1·58	57·70	57·07	52·90	51·00	62·00	62·00	54·60	53·40	60·80	61·70
3.	Bitragion—coronal arc	1·26	1·29	36·13	35·14	33·00	30·00	41·80	39·00	33·01	32·30	38·93	38·40
4.	Bitragion—minimum frontal arc	0·94	1·12	31·31	30·61	28·70	25·00	34·60	39·00	29·10	28·20	33·45	33·30
5.	Bitragion—subnasale arc	1·00	1·10	29·12	29·08	26·00	25·00	32·50	33·00	26·81	26·70	31·45	31·60
6.	Bitragion—menton arc	1·30	1·28	32·40	32·45	28·00	27·00	37·00	37·00	29·21	29·50	35·55	35·50
7.	Bitragion—submandibular arc	1·45	1·57	29·78	30·69	25·00	22·00	34·50	37·00	26·61	27·30	33·14	34·70
8.	Bitragion—minimum posterior arc	1·13	1·22	27·49	27·20	24·60	20·00	33·00	32·00	25·10	24·60	30·29	30·30
9.	Minimum frontal arc	0·67	1·01	13·21	13·83	11·20	10·00	15·10	17·00	11·60	11·50	14·92	16·10
12.	Minimum frontal diameter	0·40	0·49	11·00	11·05	9·90	9·00	12·20	12·70	10·00	9·86	11·97	12·20
13.	Maximum frontal diameter	0·38	0·50	11·19	11·97	10·10	10·20	12·40	13·90	10·30	10·82	12·14	13·21
14.	Bitragion diameter	0·61	0·53	13·76	14·22	12·40	12·10	16·20	16·00	12·53	12·93	15·40	15·45
15.	Bizygomatic diameter	0·52	0·51	14·20	14·08	12·90	12·00	16·20	15·80	13·11	12·87	15·60	15·30
16.	Bigonial diameter	0·52	0·55	11·94	10·85	10·60	8·90	13·60	12·90	10·82	9·55	13·42	12·26
17.	Lip length (Bichelion diameter)	0·39	0·36	4·79	5·16	3·80	3·40	6·10	6·70	3·93	4·37	5·70	6·04
21.	Nasion to back of head	0·60	0·87	20·25	19·69	18·50	16·60	21·90	22·90	18·78	17·69	21·59	21·69
23.	External canthus to back of head	0·57	0·80	17·86	17·21	16·00	14·00	19·40	20·10	16·38	15·20	19·07	18·99
24.	Tragion to vertex	0·53	0·76	13·87	12·97	12·30	10·00	15·70	15·90	12·58	11·18	15·14	14·73
25.	Tragion to back of head	0·57	0·76	9·94	10·23	8·30	7·80	12·50	13·20	8·53	8·54	11·22	12·10
40.	Head breadth	0·56	0·51	16·34	15·41	14·60	13·60	18·40	17·50	15·13	14·26	17·67	16·65
41.	Biocular diameter	0·43	0·44	8·91	9·59	7·60	8·10	9·90	11·30	7·90	8·59	9·85	10·65
42.	Interpupillary diameter	0·33	0·36	6·48	6·33	5·50	5·10	8·90	7·60	5·65	5·55	7·17	7·21
43.	Interocular diameter	0·33	0·27	3·79	3·17	2·80	2·20	4·80	4·20	2·91	2·62	4·50	3·81
45.	Maximum nose breadth	0·28	0·27	3·73	3·34	2·80	2·30	4·60	4·70	3·08	2·76	4·40	4·02

TABLE 68

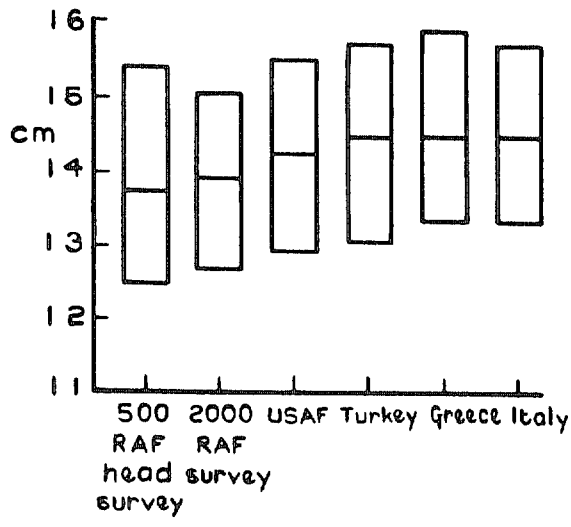
Bar Charts Showing Comparison of Mean, 1st and 99th Percentile Values Obtained from Recent Anthropometric Surveys



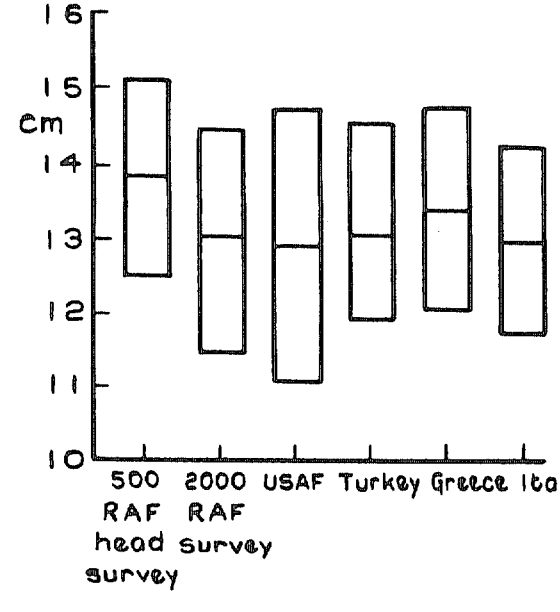
Head circumference



Bitragion-coronal arc

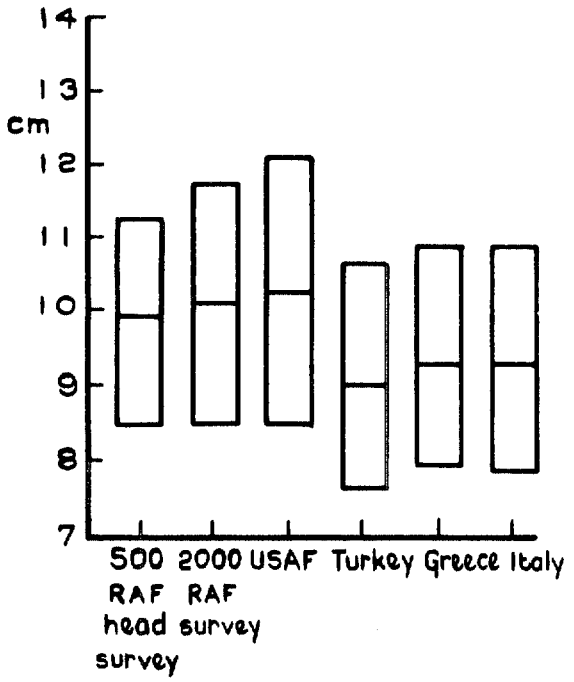


Bitragion diameter

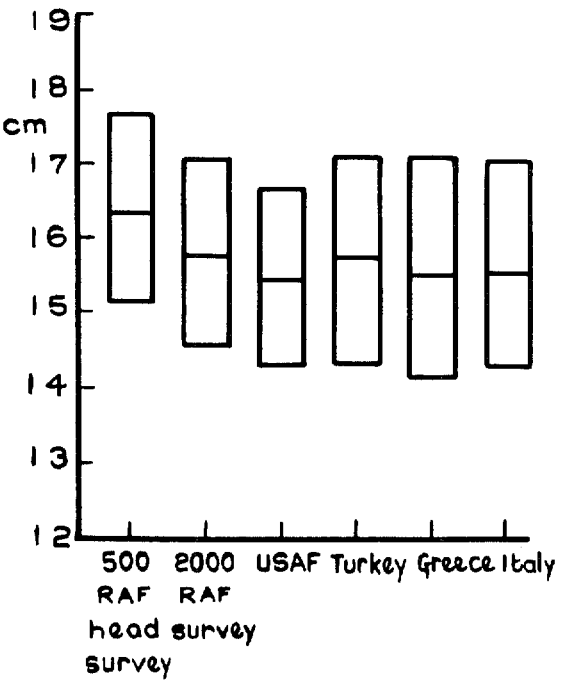


Tragion to vertex

TABLE 68 (continued)



Tragion to back of head



Head breadth

Dates of surveys

500 RAF aircrew heads 1972
2000 RAF aircrew 1970-71
4000 USAF aircrew 1950
1084 Greek military personnel
1357 Italian military personnel
915 Turkish military personnel
} 1960

TABLE 68 (continued)

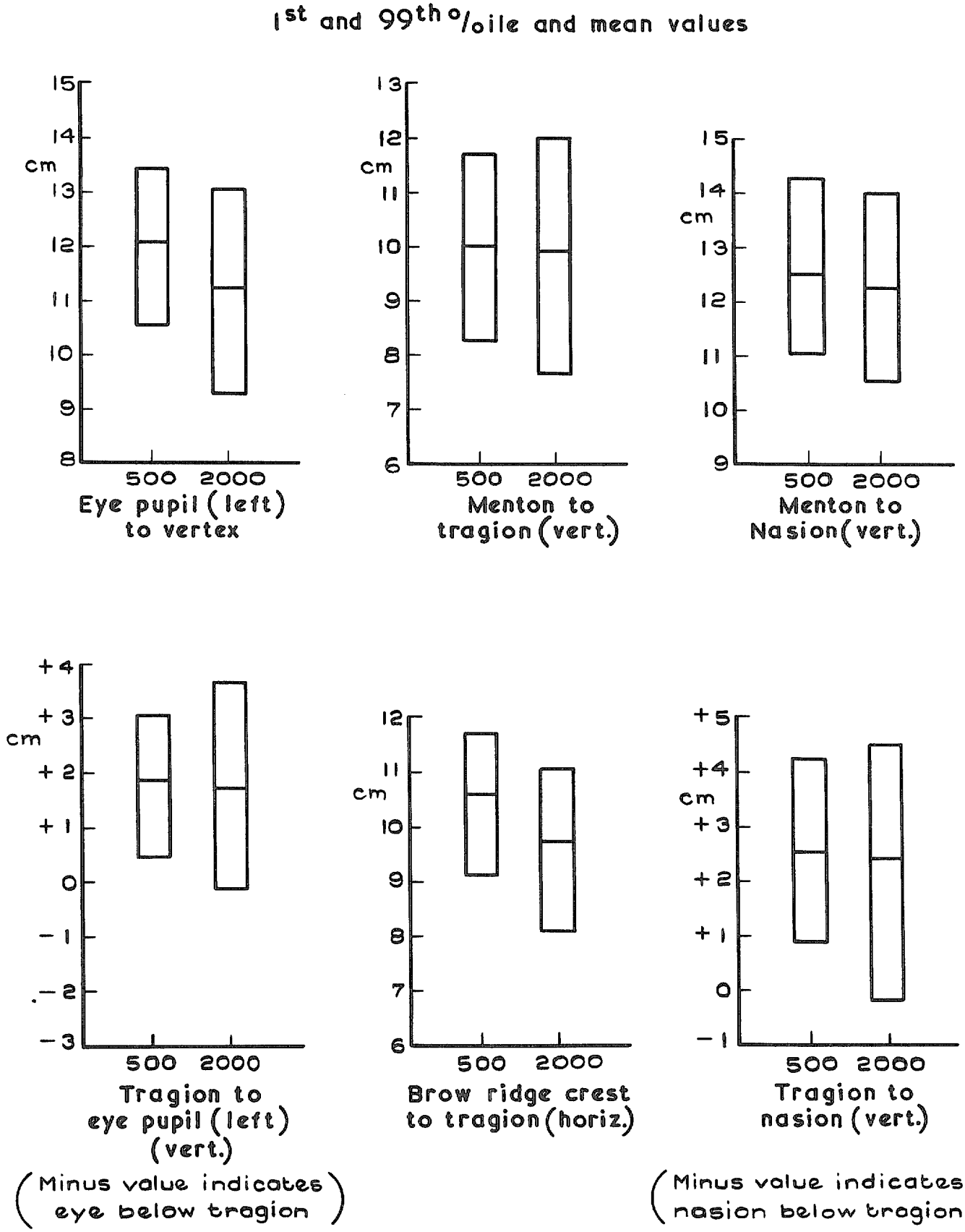
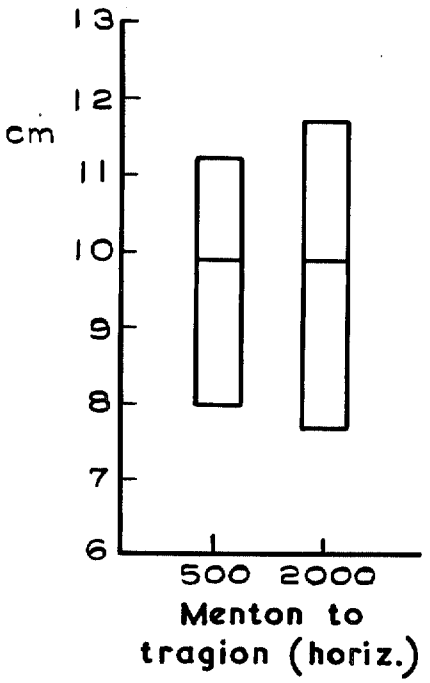


TABLE 68 (concluded)

1st and 99th %ile and mean values



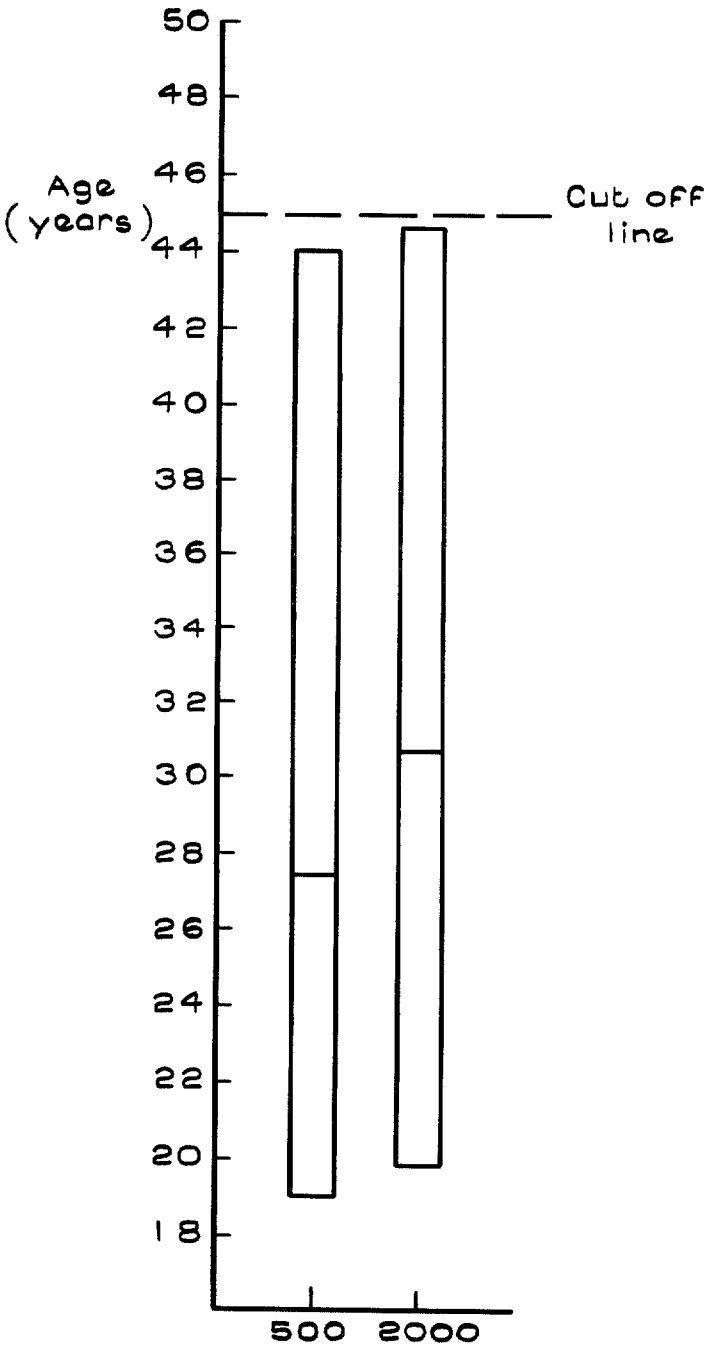


TABLE 69

Comparison Table of Anthropometric Data taken in the 500 Head Survey (1972) and the 2000 (1970/71) Survey of R.A.F. Aircrew

No.	Measurement (cm)	SD		Mean		Min		Max		1st %ile		99th %ile	
		500 survey	2000 survey	500 survey	2000 survey	500 survey	2000 survey	500 survey	2000 survey	500 survey	2000 survey	500 survey	2000 survey
1.	Neck circumference	1·80	1·69	36·93	38·15	30·30	33·20	43·40	44·80	32·92	34·30	41·20	42·08
2.	Head circumference	1·37	1·36	57·70	57·67	52·90	53·00	62·00	62·40	54·60	54·66	60·80	60·84
3.	Bitragion—coronal arc	1·26	1·26	36·13	35·34	33·00	31·10	41·80	40·40	33·01	32·36	38·93	38·52
10.	Max head diagonal from menton	0·78	0·77	25·87	26·21	23·10	23·70	28·60	28·60	24·20	24·47	27·95	28·03
14.	Bitragion diameter	0·61	0·50	13·76	13·91	12·40	12·20	16·20	15·70	12·53	12·71	15·40	15·15
19.	Head length	0·60	0·64	20·53	19·90	18·80	17·80	22·30	22·00	19·13	18·32	22·02	21·33
20.	Nasion to vertex	0·77	0·96	11·33	10·63	8·70	7·50	13·50	13·60	9·37	8·37	12·98	12·75
24.	Tragion to vertex	0·53	0·64	13·87	13·03	12·30	9·50	15·70	15·60	12·58	11·42	15·14	14·46
25.	Tragion to back of head	0·57	0·69	9·94	10·14	8·30	7·80	12·50	14·10	8·53	8·55	11·22	11·77
36.	Menton to vertex	0·85	1·01	23·87	22·95	21·40	19·10	26·50	26·20	21·69	20·39	25·77	25·24
37.	Menton to back of head	0·88	1·07	19·79	19·98	17·50	16·00	22·40	24·00	17·69	17·44	21·72	22·40
40.	Head breadth	0·56	0·54	16·34	15·78	14·60	14·00	18·40	18·00	15·13	14·48	17·67	17·06
44.	Eye pupil (left) to vertex	0·63	0·82	12·02	11·26	10·10	8·50	13·80	13·80	10·49	9·24	13·41	13·02
46.	Menton to tragion—vertical	0·71	0·95	10·01	9·92	8·10	6·60	11·90	14·20	8·33	7·62	11·73	12·00
47.	Menton to nasion—vertical	0·62	0·72	12·54	12·32	10·80	8·60	14·80	15·50	11·07	10·55	14·24	14·01
49.	Tragion to eye pupil—vertical	0·54	0·79	1·87	1·78	0·50	−2·10	4·00	4·40	0·61	−0·10	3·11	3·61
56.	Brow-ridge crest to tragion—horizontal	0·55	0·65	10·60	9·75	8·40	6·20	12·10	11·90	9·18	8·07	11·76	11·17
58.	Tragion to nasion—vertical	0·69	0·94	2·53	2·40	0·60	−1·70	4·70	5·60	0·98	−0·20	4·26	4·51
59.	Menton to tragion—horizontal	0·71	0·91	9·85	9·84	7·80	6·50	12·40	14·40	8·04	7·67	11·21	11·74
	Age (years)	6·29	6·49	27·44	30·76	18·34	18·67	45·69	45·92	19·05	19·89	44·09	44·63

TABLE 70

Comparison Bar Charts of Anthropometric Data Taken on the 2000 R.A.F. Survey and the 500 R.A.F. Head Survey not Shown in Table 68

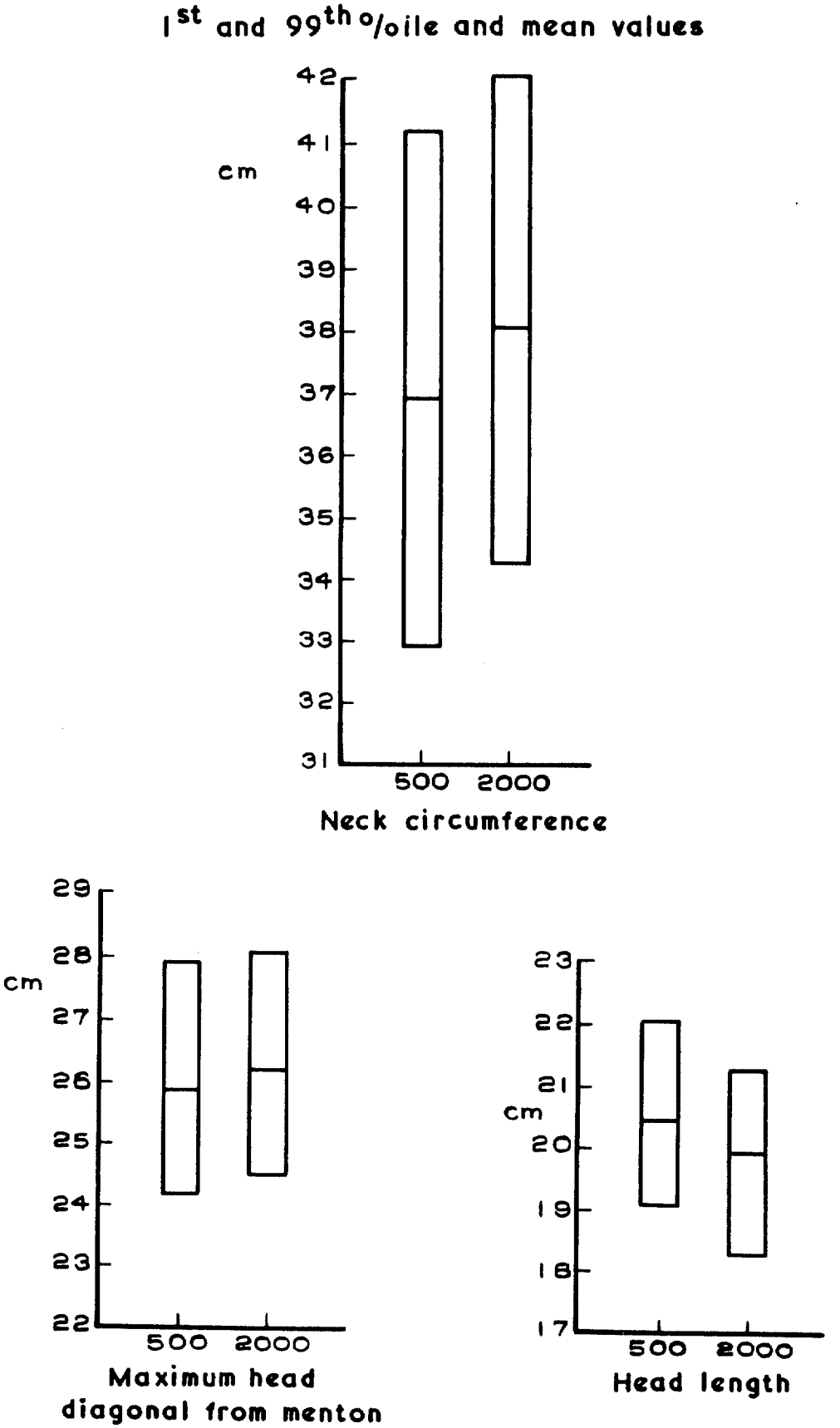
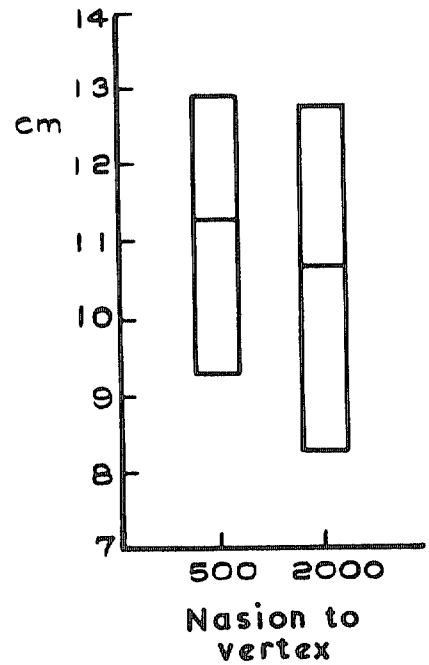
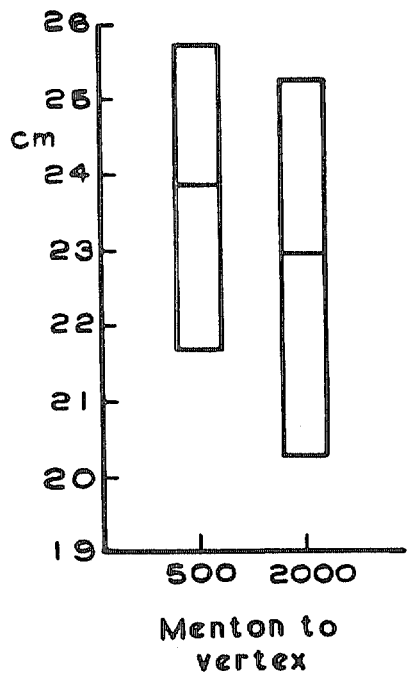


TABLE 70 (continued)

1st and 99th %ile and mean values





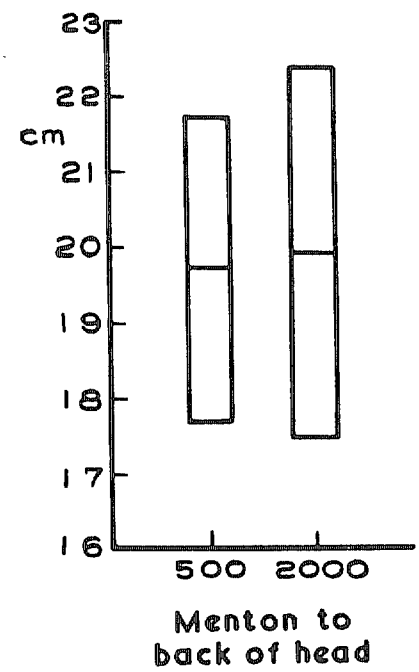
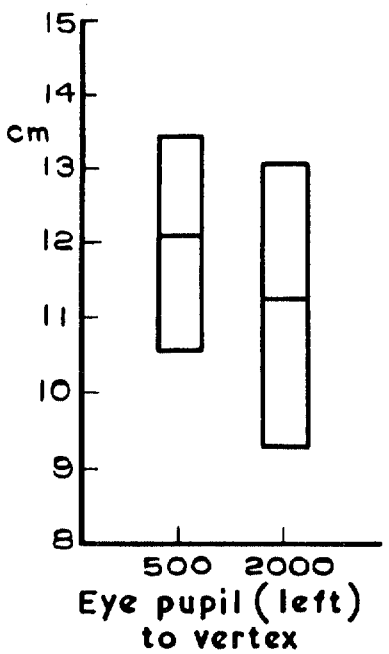
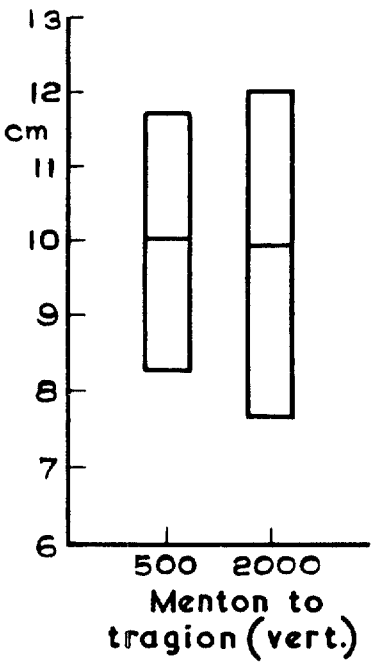


TABLE 70 (continued)

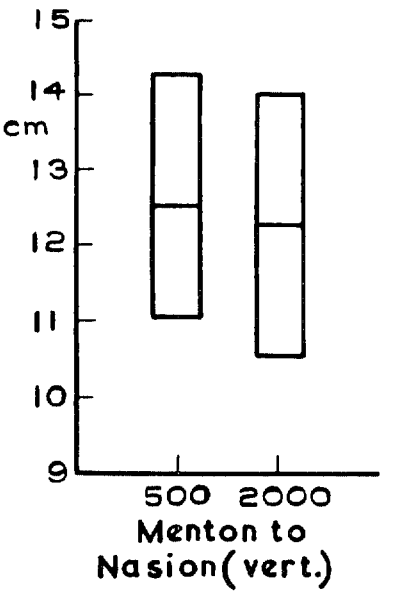
1st and 99th %ile and mean values



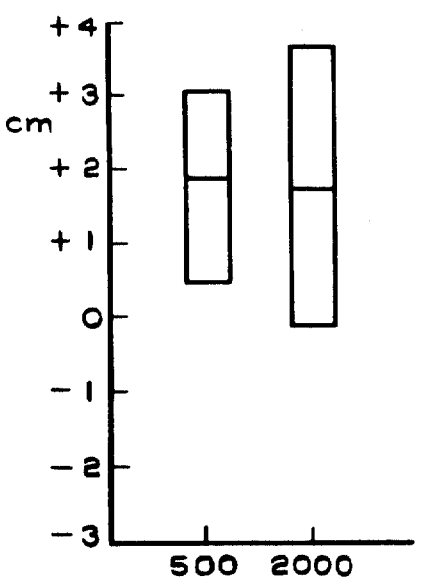
Eye pupil (left) to vertex



Menton to tragion (vert.)

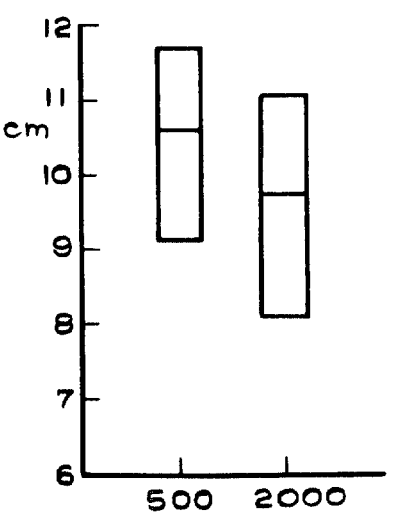


Menton to Nasion (vert.)

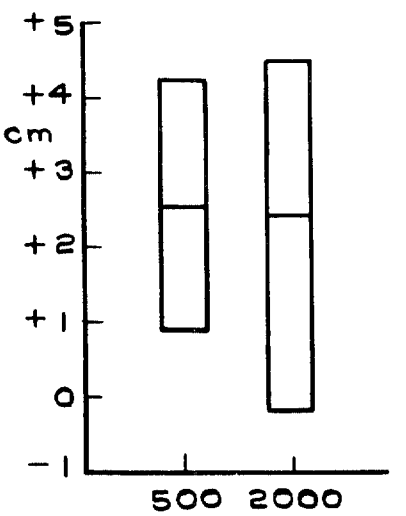


Tragion to eye pupil (left) (vert.)

(Minus value indicates eye below tragion)



Brow ridge crest to tragion (horiz.)



Tragion to nasion (vert.)

(Minus value indicates nasion below tragion)

TABLE 70 (concluded)

1st and 99th %ile and mean values

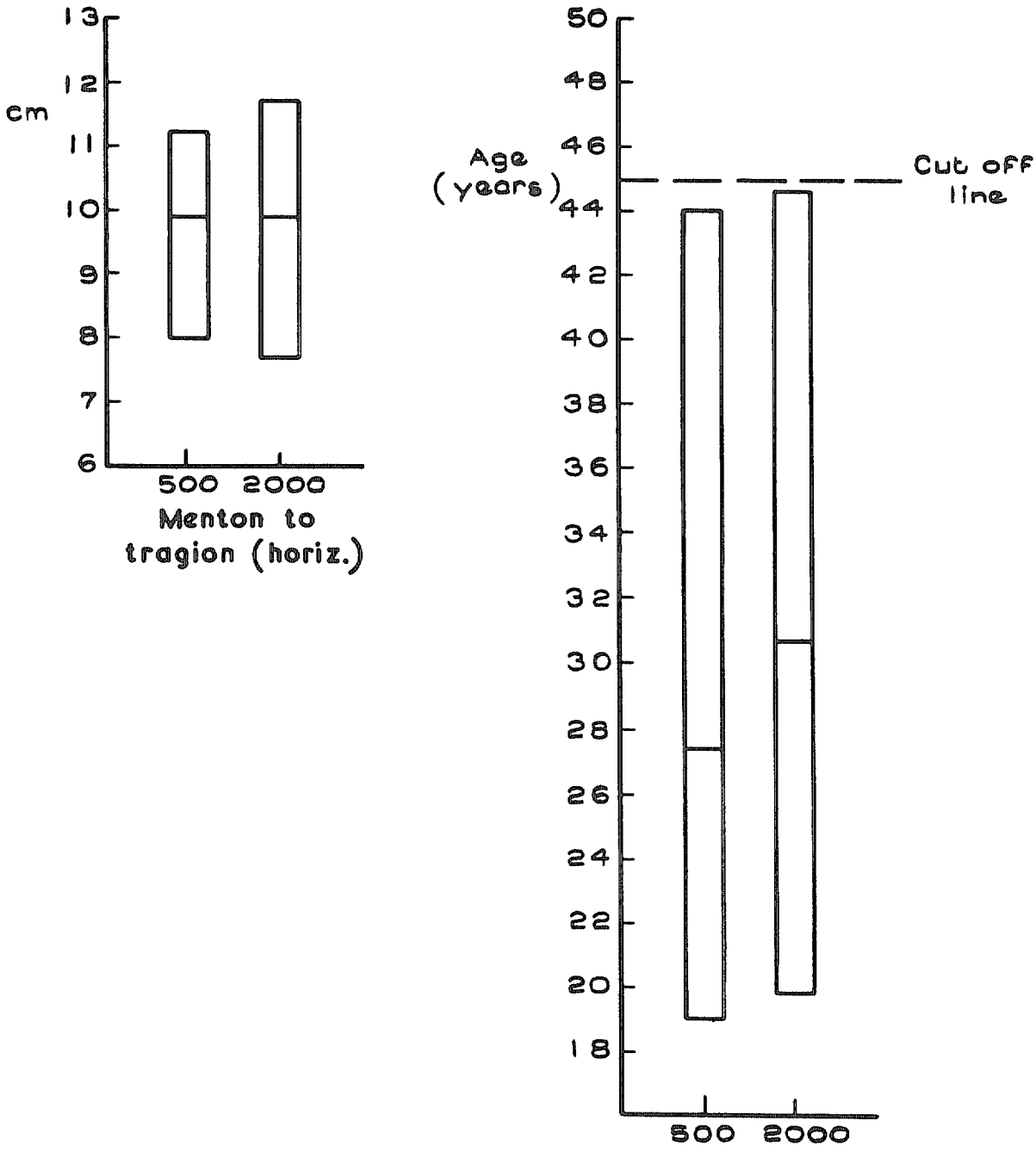


TABLE 71

Comparison Table of Measurements Obtained from the 4-View Photograph and from the R.A.E. Head Box Rig and Caliper of a Plaster Cast 'Standard' Head

	Photograph measurement millimetres	Head box measurement millimetres
18. Brow-ridge crest to vertex	088	087
19. Head length	197	196
20. Nasion to vertex	103	105
21. Nasion to back of head	196	196
22. External canthus to vertex	106	107
23. External canthus to back of head	168	167
24. Tragion to vertex	131	130
25. Tragion to back of head	099	101
26. Bottom of nose to vertex	155	155
27. Bottom of nose to back of head	207	206
28. Maximum chin indent to vertex	196	196
29. Maximum chin indent to back of head	197	196
30. Juncture of chin and neck to vertex	226	227
31. Juncture of chin and neck to back of head	159	157
35. Centre line of abutting lips to vertex	178	178
36. Menton to vertex	222	223
37. Menton to back of head	199	198
38. Nose tip to back of head	224	223
39. Cornea to back of head	181	179
		Caliper measurement
40. Head breadth	153	152
41. Biocular diameter	090	090
43. Interocular diameter	034	034
45. Maximum nose breadth	032	034

TABLE 72

Observations Made of Subjects During Survey

Hair state (quantity not quality)	Thick	Medium	Thin	Balding	Bald		
	109	294	72	24	6		Total 505
	21·6%	58·2%	14·2%	4·8%	1·2%		
	(This was an arbitrary visual assessment)						
Hair parting	Left	Centre	Right	None			
	348	10	57	90			Total 505
	68·9%	2·0%	11·3%	17·8%			
Hair colour	Black	Dark brown	Brown	Light brown	Ginger	Fair	
	18	52	92	43	3	50	Total 258
	7%	20%	36%	17%	1%	19%	
	(This information was taken from the R.A.F. identification pass)						
Colour of eyes	Blue	Brown	Hazel	Green	Grey	Blue/ green	Blue/ grey
	94	66	35	32	10	9	12 Total 258
	36%	26%	14%	12%	4%	3%	5%
	(This information was taken from the R.A.F. identification pass)						
Hair on chest	Yes	No					
	97	161					Total 215
	38%	62%					
Moustache	Yes	No					
	21	194					Total 215
	10%	90%					

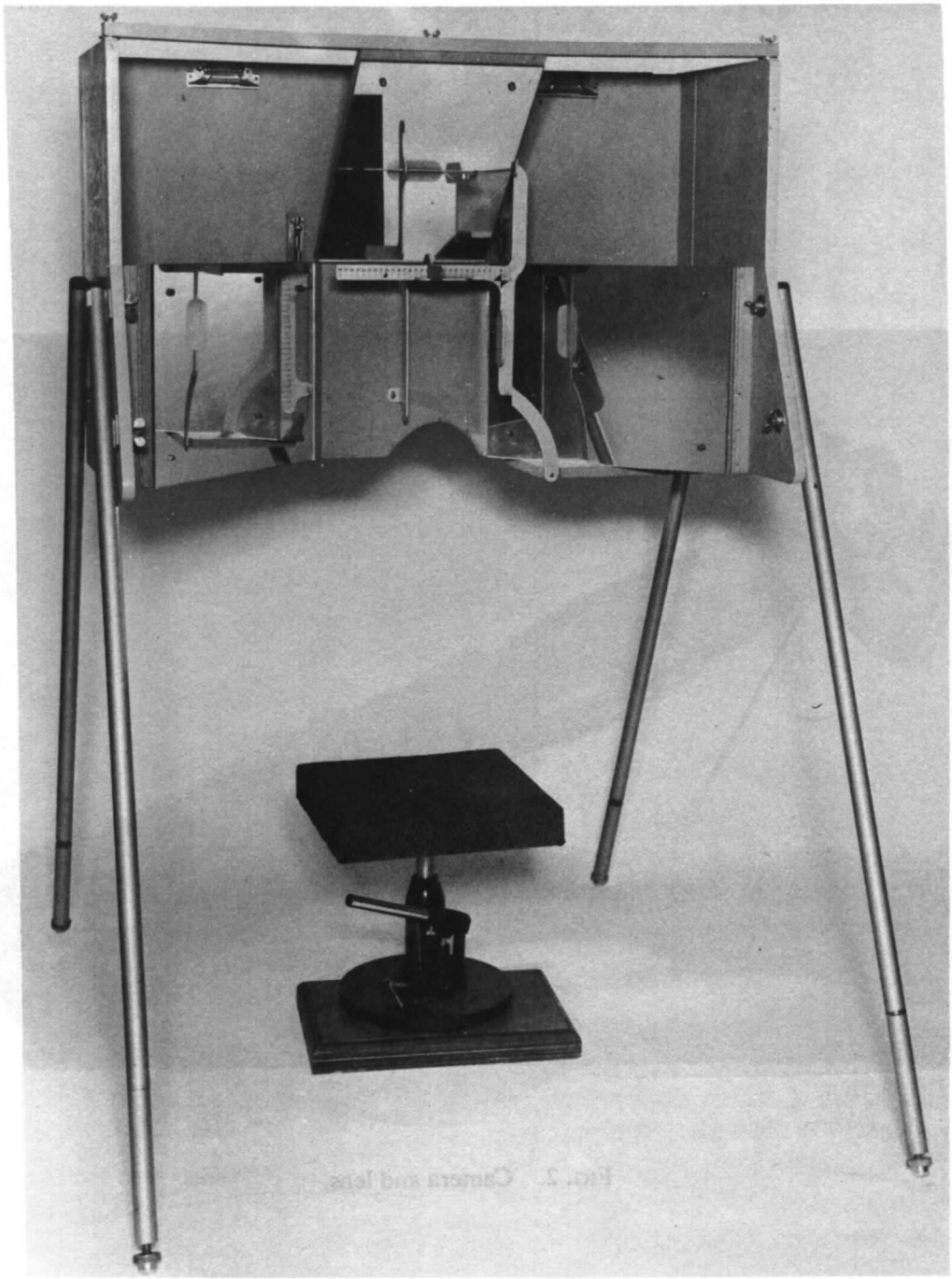


FIG. 1. R.A.E. head anthropometry photographic rig.

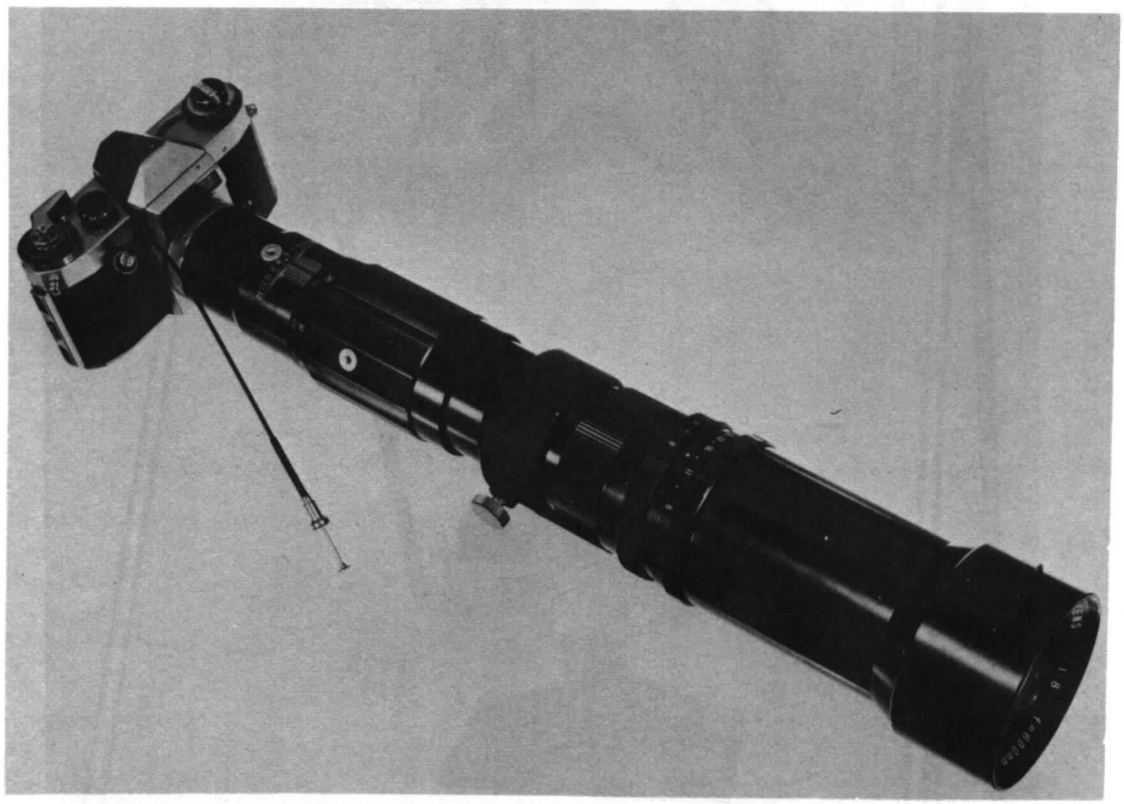


FIG. 2. Camera and lens.

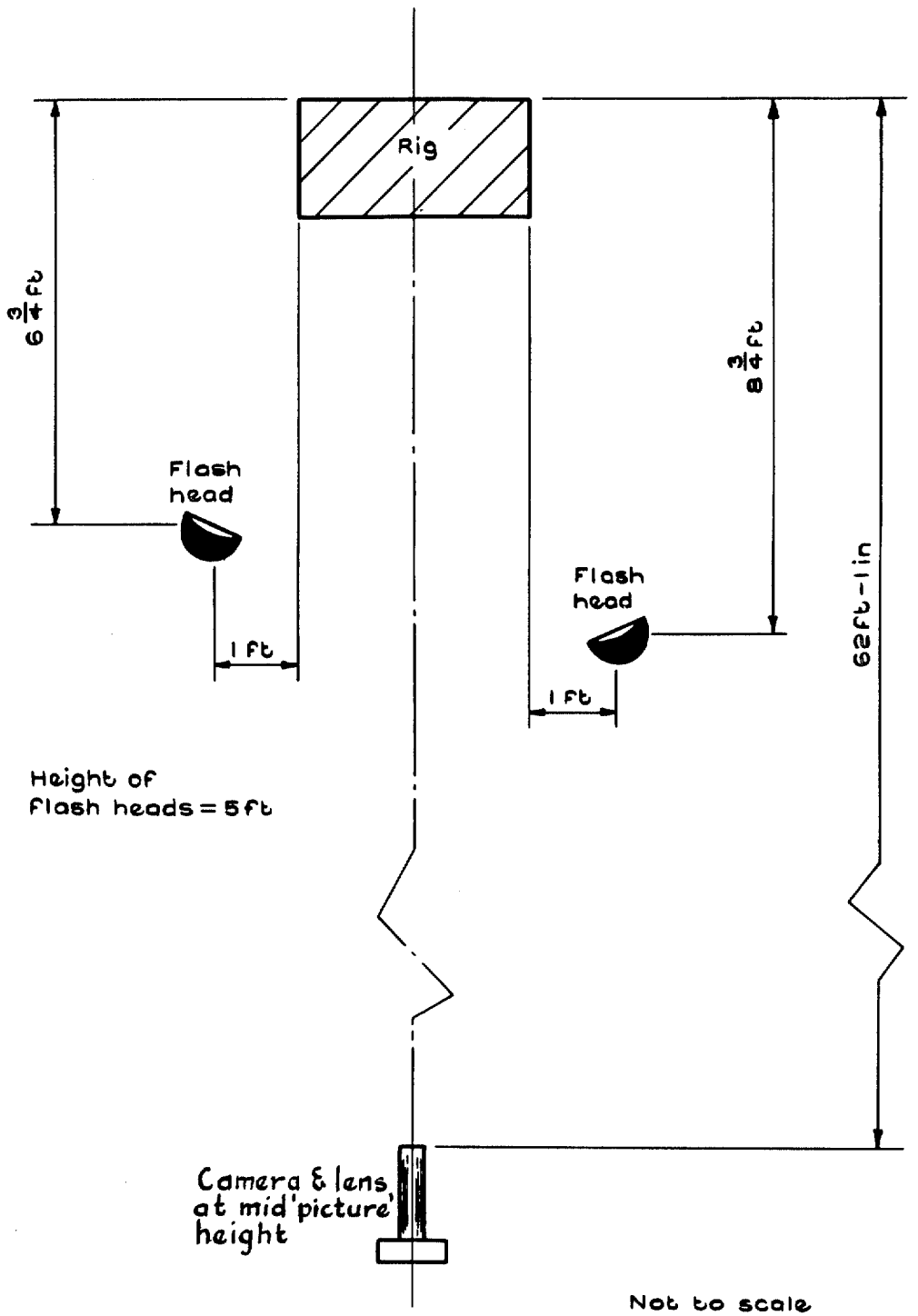


FIG. 3. Diagrammatic sketch of photographic apparatus layout.

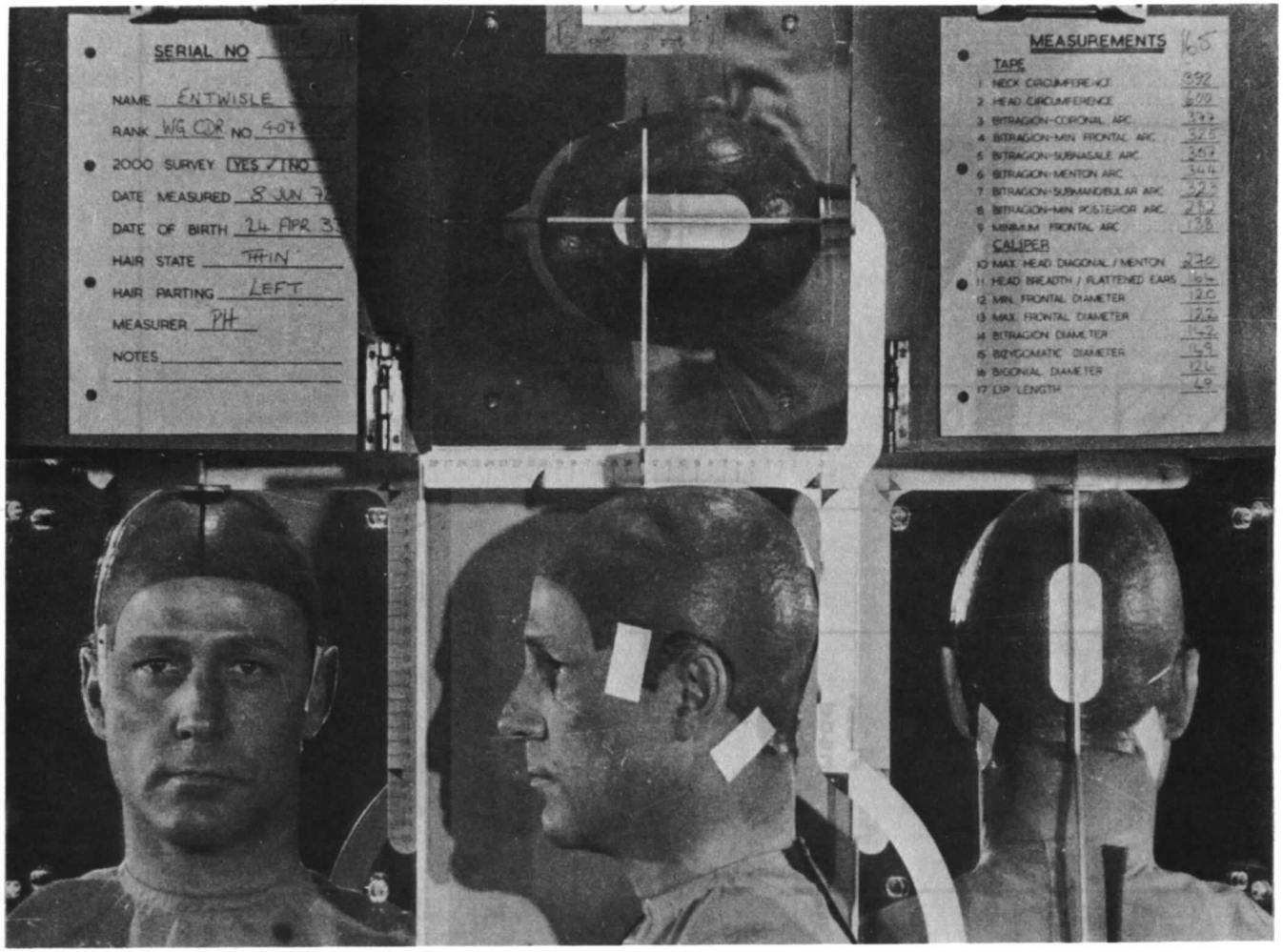


FIG. 4. An example of the 4-view photograph.

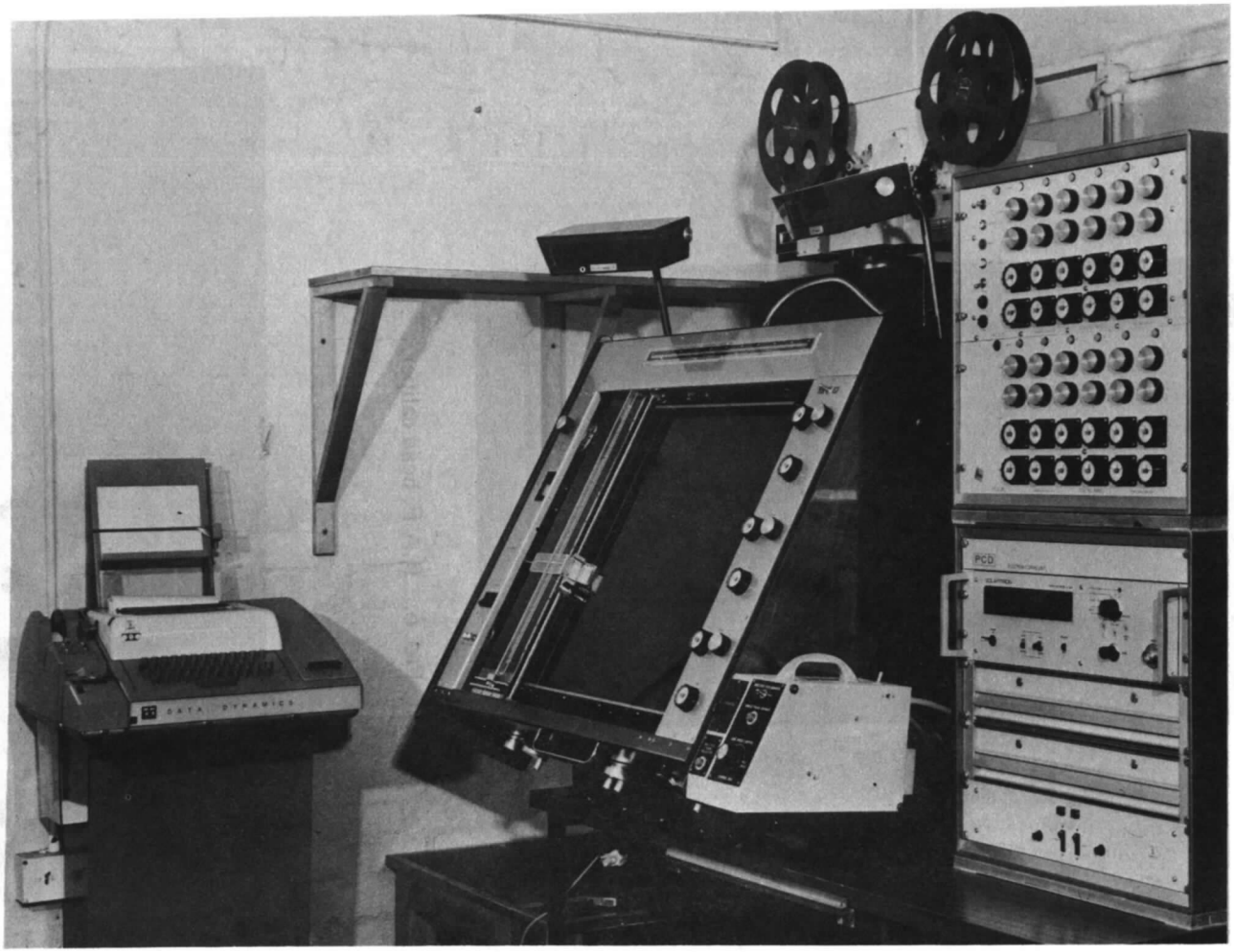


FIG. 5. *X–Y* axis digital reader.

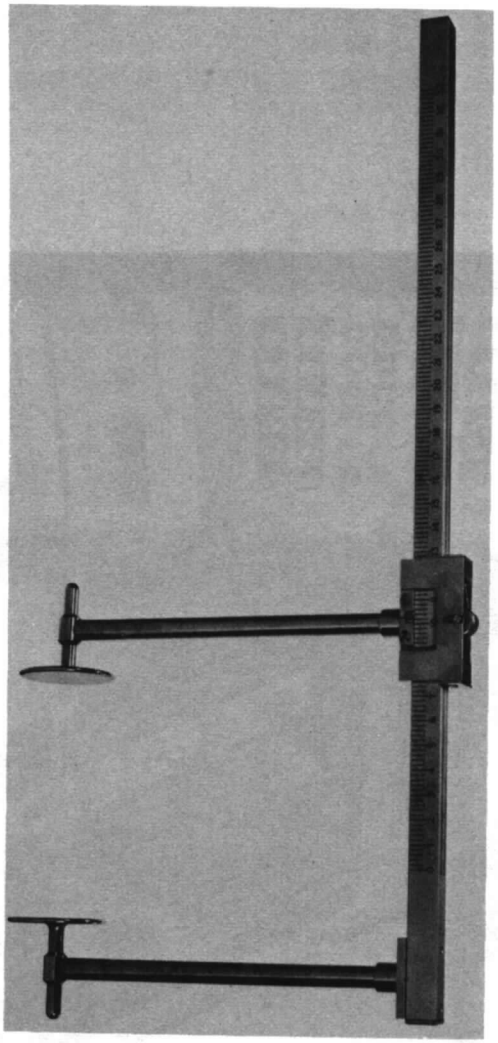


FIG. 6. R.A.E. head caliper.

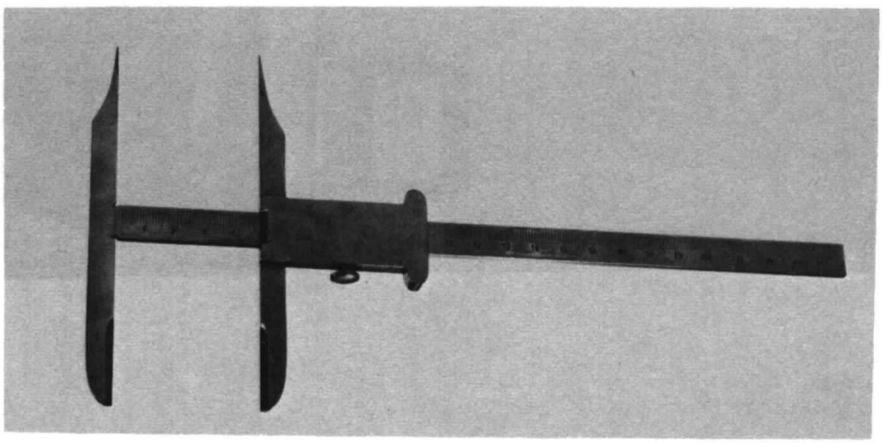


FIG. 7. 'Abawerk' sliding caliper.

SERIAL NO _____/___

NAME _____

RANK _____ NO _____

2000 SURVEY | YES | NO |

DATE MEASURED _____

DATE OF BIRTH _____

HAIR STATE _____

HAIR PARTING _____

MEASURER _____

NOTES _____

_____

FIG. 8. Personal detail proforma.

MEASUREMENTS

TAPE

1 NECK CIRCUMFERENCE . . . . . _____
2 HEAD CIRCUMFERENCE . . . . . _____
3 BITRAGION-CORONAL ARC. . . . . _____
4 BITRAGION-MIN. FRONTAL ARC. . . _____
5 BITRAGION-SUBNASALE ARC. . . . . _____
6 BITRAGION-MENTON ARC. . . . . _____
7 BITRAGION-SUBMANDIBULAR ARC. . _____
8 BITRAGION-MIN. POSTERIOR ARC. . _____
9 MINIMUM FRONTAL ARC . . . . . _____

CALIPER

10 MAX. HEAD DIAGONAL / MENTON. . _____
11 HEAD BREADTH / FLATTENED EARS _____
12 MIN. FRONTAL DIAMETER . . . . . _____
13 MAX. FRONTAL DIAMETER . . . . . _____
14 BITRAGION DIAMETER. . . . . _____
15 BIZYGOMATIC DIAMETER . . . . . _____
16 BIGONIAL DIAMETER . . . . . _____
17 LIP LENGTH . . . . . _____

FIG. 9. Measurement proforma.

HEAD ANTHROPOMETRIC SURVEY OF RAF AIRCREW 1972

Serial No .....

NAME ..... (Surname)

..... (Christian names)

Card 1

Serial No ..... 1 [1]

Measured in 1970-1971 2000 survey [Yes] [No] 5

RANK .....

SERVICE NUMBER .....

DATE MEASURED 6

DATE OF BIRTH 11

AGE .....

HAIR STATE 16

HAIR PARTING 17

MEASURER 18

TAPE

1. Neck circumference 19
2. Head circumference 22
3. Bitragion - coronal arc 25
4. Bitragion - minimum frontal arc 28
5. Bitragion - subnasale arc 31
6. Bitragion - menton arc 34
7. Bitragion - submandibular arc 37
8. Bitragion - minimum posterior arc 40
9. Minimum frontal arc 43

CALIPER

10. Max. head diagonal over menton 46
11. Head breadth over flattened ears 49
12. Minimum frontal diameter 52
13. Maximum frontal diameter 55
14. Bitragion diameter 58
15. Bizygomatic diameter 61
16. Bigonial diameter 64
17. Lip length (Bichelion diameter) 67

Serial No .....

Surname .....

Photo No .....

PHOTOGRAMMETRY

18. Brow ridge crest to vertex 69
19. Head length 72
20. Nasion to vertex 75
21. Nasion to back of head 78

Card 2

Serial No ..... 1 [2]

22. External canthus to vertex 5
23. External canthus to back of head 8
24. Tragion to vertex 11
25. Tragion to back of head 14
26. Bottom of nose to vertex 17
27. Bottom of nose to back of head 20
28. Max. chin indent to vertex 23
29. Max. chin indent to back of head 26
30. Juncture of chin and neck to vertex 29
31. Juncture of chin and neck to back of head 32
32. Vertical location of measurement 33 from vertex 35
33. Max. distance of back neck to back of head 38
34. Back of head centre contact to vertex 40
35. Centre line of abutting lips to vertex 43
36. Menton to vertex 46
37. Menton to back of head 49
38. Nose tip to back of head 52
39. Cornea to back of head 55
40. Head breadth 58
41. Biocular diameter 61
42. Interpupillary diameter 63
43. Interocular diameter 65
44. Eye pupil (left) to vertex 67
45. Max. nose breadth 70

Notes: .....

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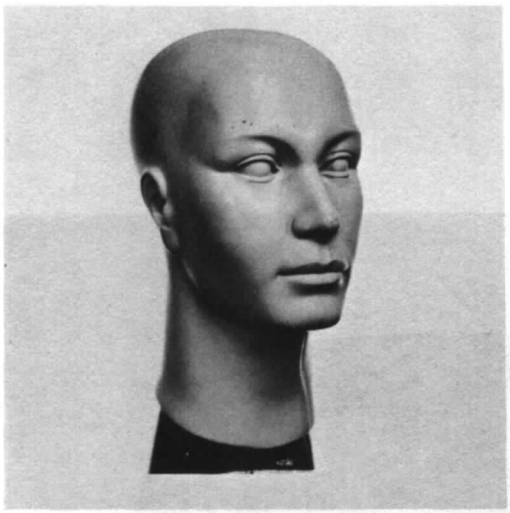
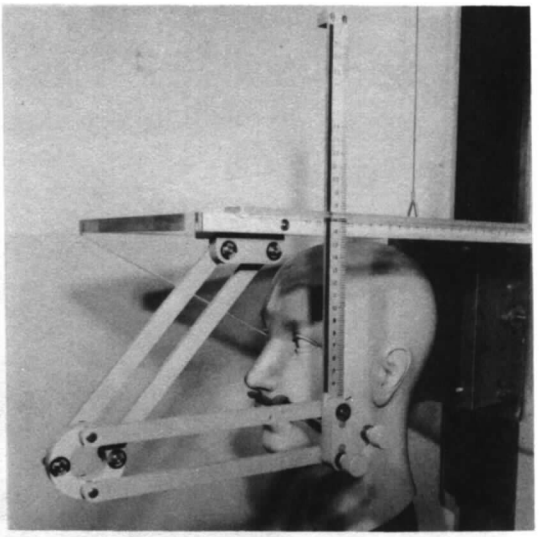
FIG. 10. Statistical proforma.



The model head



Measurement in head box

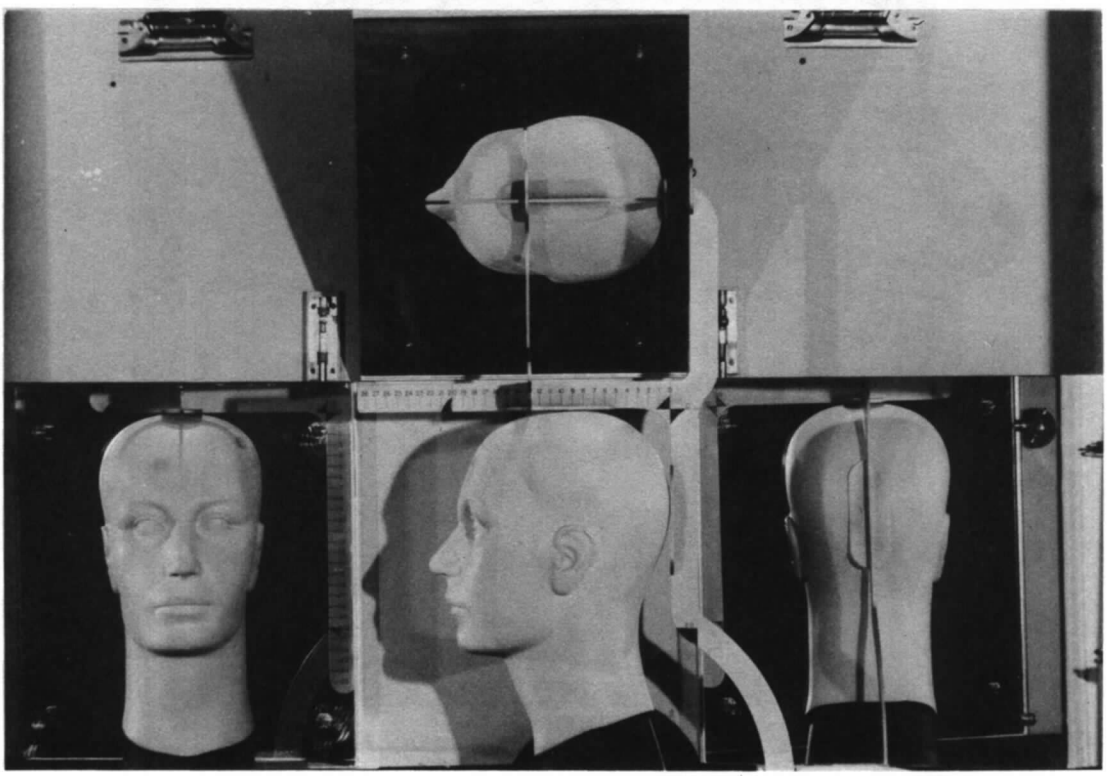


FIG. 11 Model head used during validation exercise.

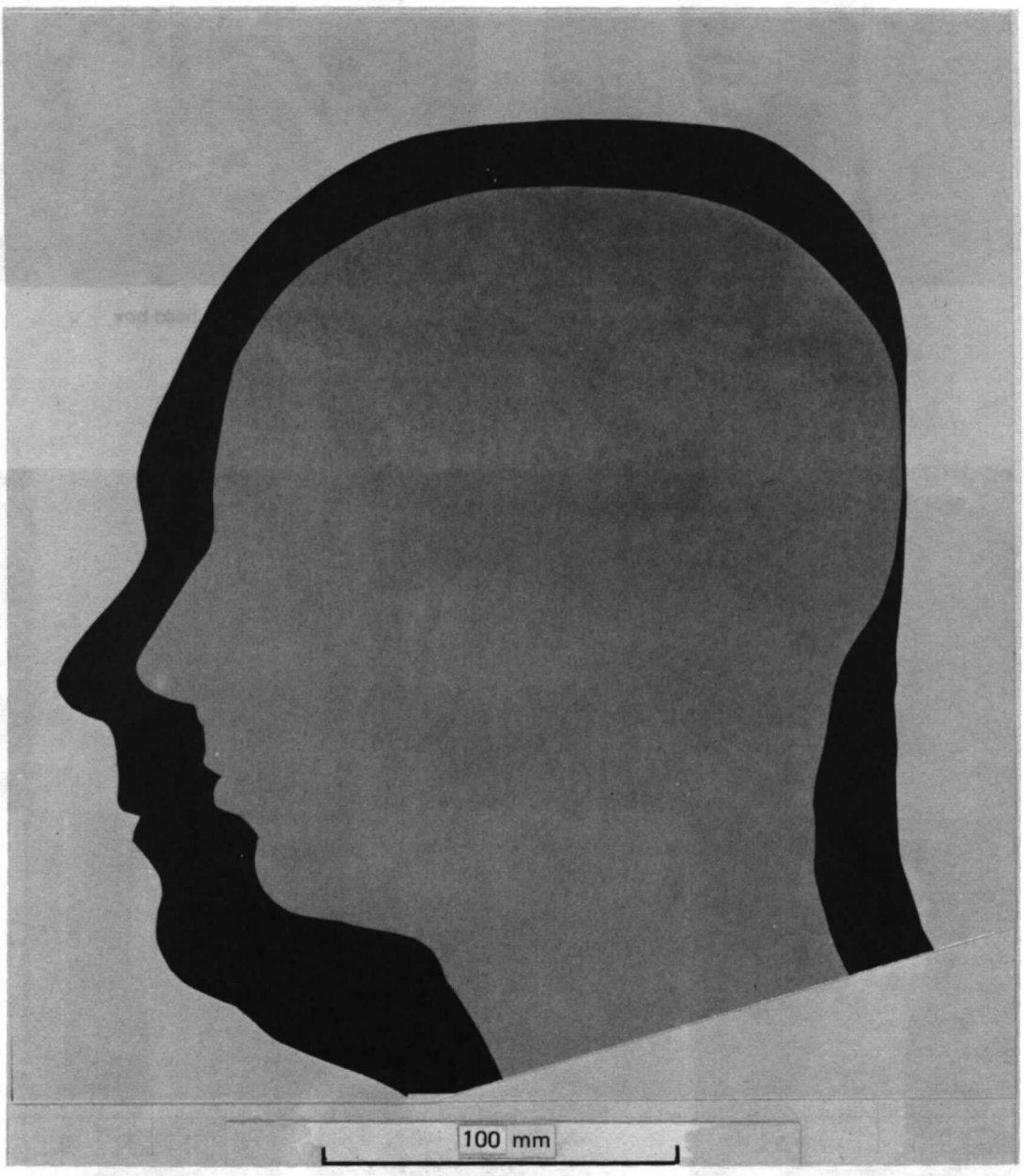
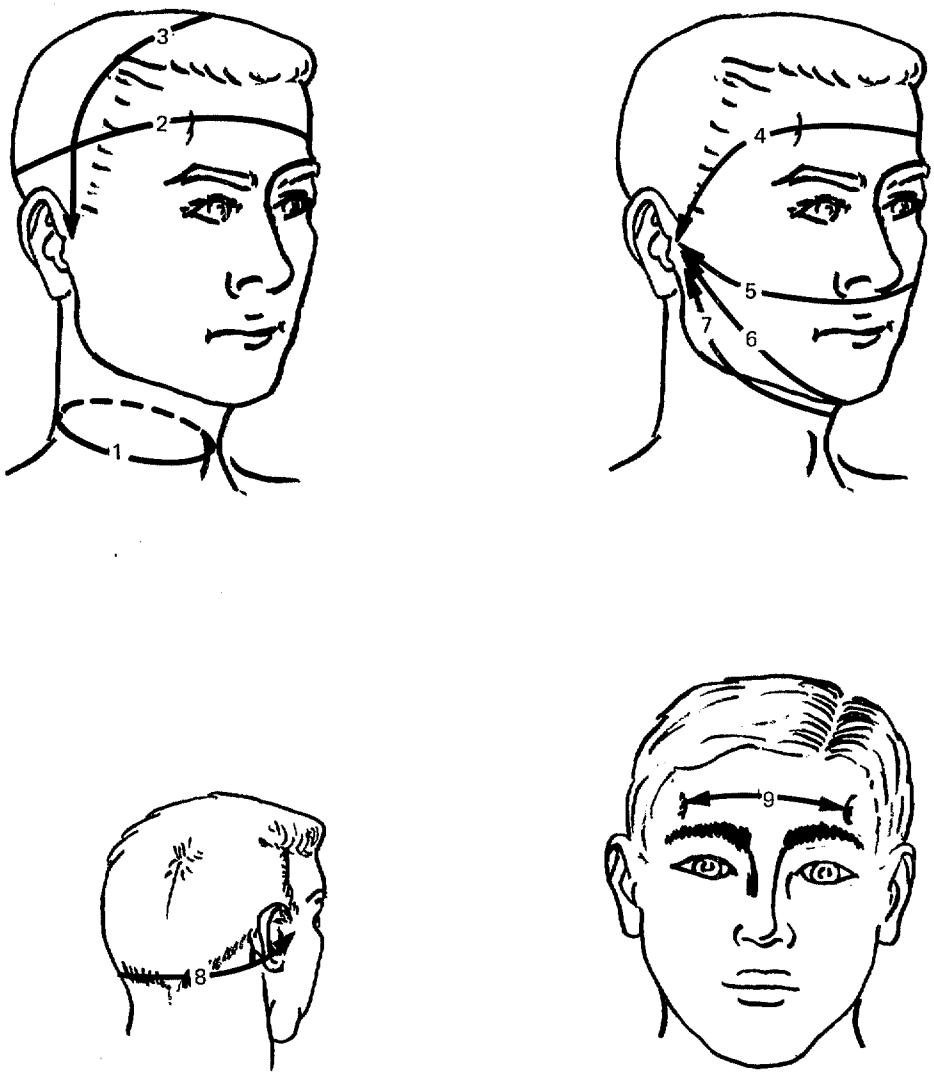
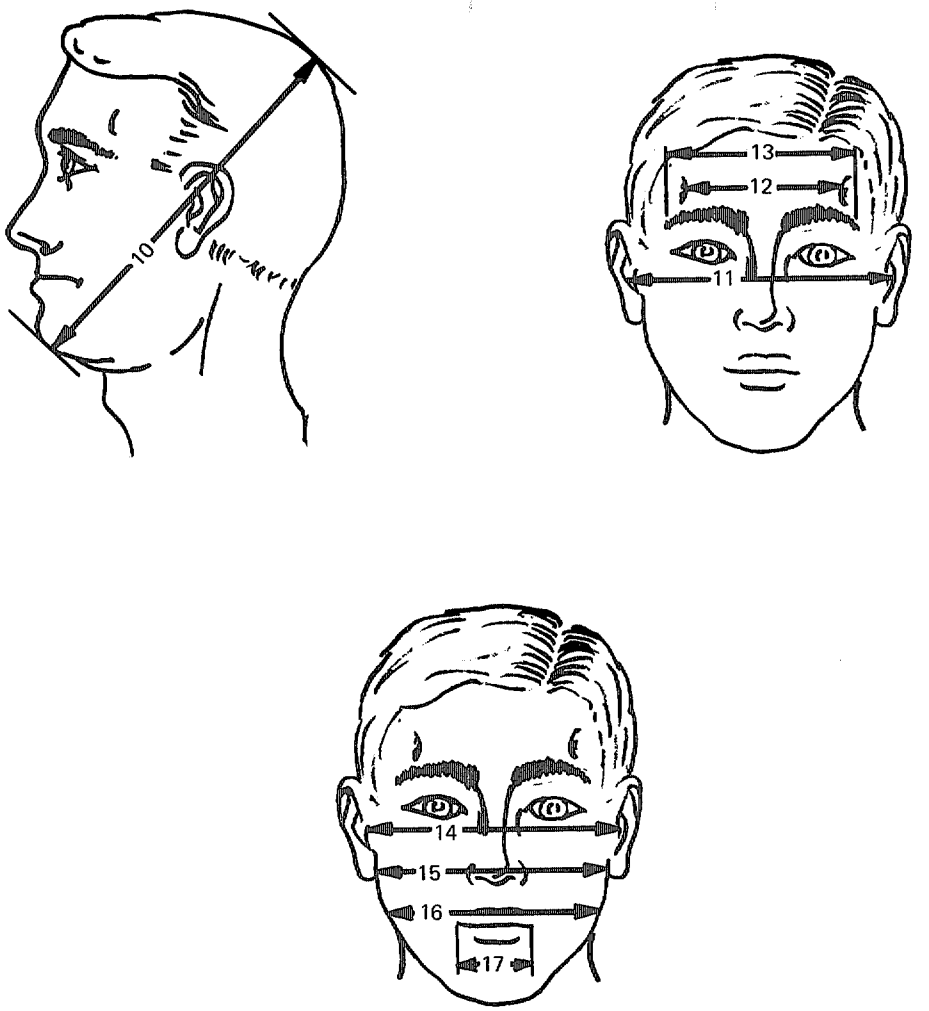


FIG. 12. Silhouette of largest and smallest head measured during the survey.



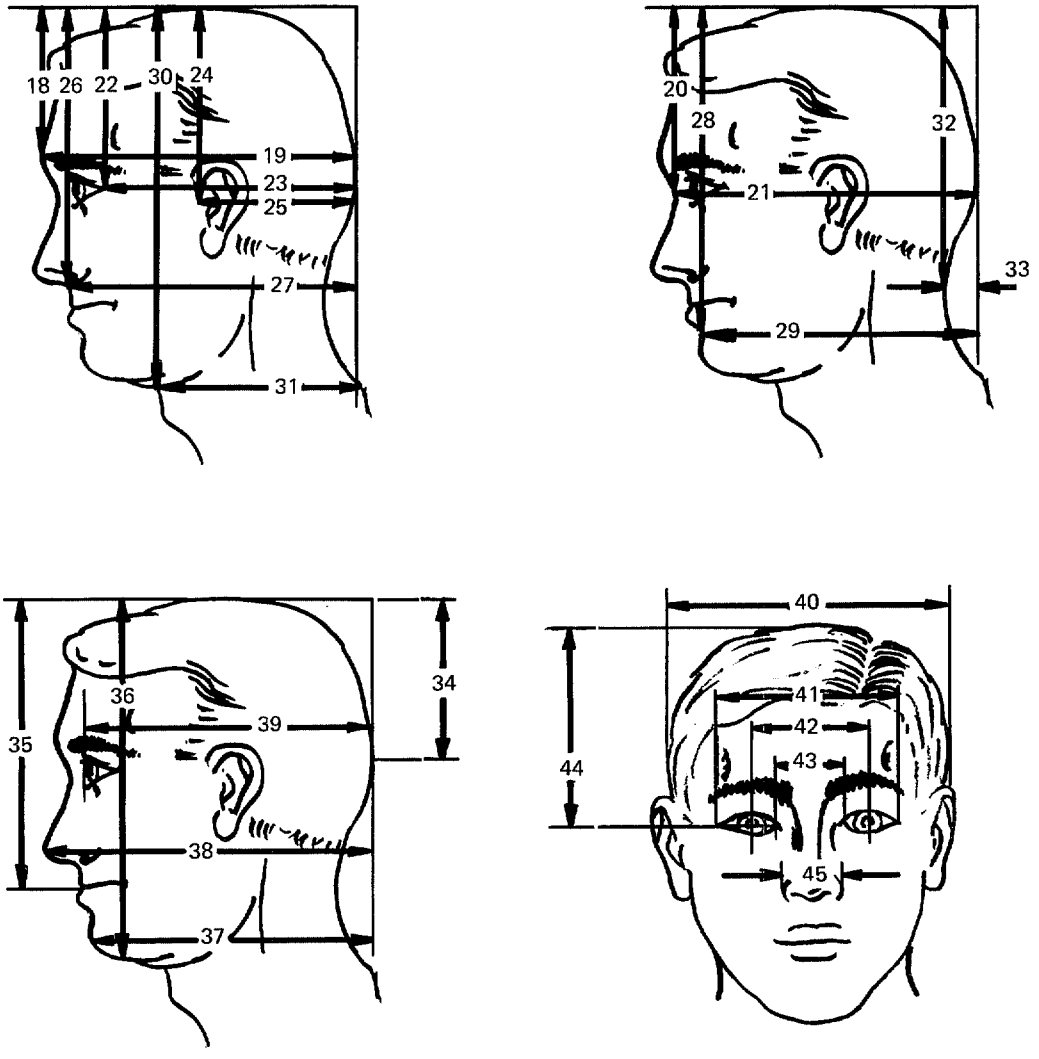
1. Neck circumference
2. Head circumference
3. Bitragion-coronal arc
4. Bitragion-minimum frontal arc
5. Bitragion-subnasale arc
6. Bitragion-menton arc
7. Bitragion-submandibular arc
8. Bitragion-minimum posterior arc
9. Minimum frontal arc

FIG. 13A. Visual index—Measurement tables 1 to 9 (tape).



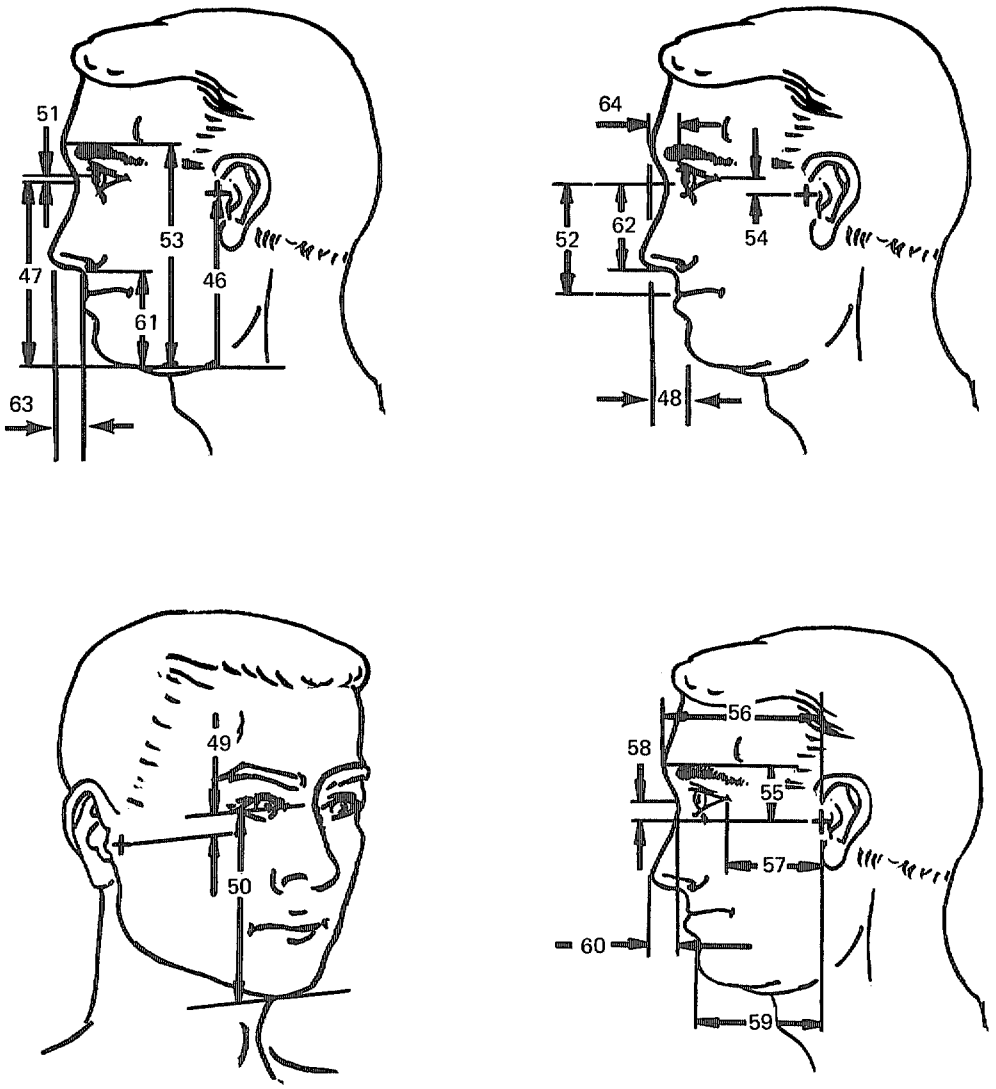
10. Maximum head diagonal from menton
11. Head breadth over flattened ears
12. Minimum frontal diameter
13. Maximum frontal diameter
14. Bitragion diameter
15. Bizygomatic diameter
16. Bigonial diameter
17. Lip length (Bichelion diameter)

FIG. 13b. Visual index—Measurement tables 10 to 17 (caliper).



18. Brow ridge crest to vertex
19. Head length
20. Nasion to vertex
21. Nasion to back of head
22. External canthus to vertex
23. External canthus to back of head
24. Tragion to vertex
25. Tragion to back of head
26. Bottom of nose to vertex
27. Bottom of nose to back of head
28. Max. chin indent to vertex
29. Max. chin indent to back of head
30. Juncture of chin and neck to vertex
31. Juncture of chin and neck to back of head
32. Vertical location of measurement 33 to vertex
33. Max. distance of back of neck to back of head
34. Back of head contact centre to vertex
35. Centre line of abutting lips to vertex
36. Menton to vertex
37. Menton to back of head
38. Nose tip to back of head
39. Cornea to back of head
40. Head breadth
41. Biocular diameter
42. Interpupillary diameter
43. Interocular diameter
44. Eye pupil (left) to vertex
45. Max. nose breadth

FIG. 13c. Visual index—Measurement tables 18 to 45 (photogrammetry).



Y = Vertical measurement

X = Horizontal measurement

46. Menton to tragion (Y)
47. Menton to nasion (Y)
48. Menton to brow-ridge crest (X)
49. Tragion to eye pupil (Y)
50. Menton to eye pupil (Y)
51. Eye pupil to nasion (Y)
52. C/L of abutting lips to nasion (Y)
53. Menton to brow ridge crest (Y)
54. Tragion to external canthus (Y)
55. Tragion to brow-ridge crest (Y)
56. Brow-ridge crest to tragion (X)
57. External canthus to tragion (X)
58. Tragion to nasion (Y)
59. Menton to tragion (X)
60. Nose tip to nasion (X)
61. Menton to bottom of nose (Y)
62. Bottom of nose to nasion (Y)
63. Bottom of nose to tip (X)
64. Cornea to brow-ridge crest (X)

FIG. 13d. Visual index—Measurement tables 46 to 64 (derived).

Fig. 14 ALPHABETICAL INDEX OF DIMENSIONS

(Measurement table number shown after each dimension)

X = Horizontal measurement *Y* = vertical measurement

Fig. 14 (concluded)

X = horizontal measurement

Y = vertical measurement

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