Chapter 1: Introduction

We have seen thousands faces of people in our lifetime. Each face is recognized to us as a different individual and this is due to the range of variation in the shape of their faces. It is a fact that the face is the most important part of the human body. It is involved in interpersonal communication, emotional expression and most other forms of social interaction. The face is also the primary feature of the body by which people recognize one another. Even newborn infants have a natural ability to recognize familiar faces.

Every person's face is unique and different. It has been said that the face of man is his window to the world and such reflects his health, emotion and character.
The face comprises a few components; a lower jaw and chin, cheekbones, a mouth and upper jaw, a nose, two orbits and the forehead and supra orbital ridges for the neuro cranial parts relating to the face. Even though the face comprises only a few components but this few components can underlie such great variation in facial form. Very slight alterations in the configuration of one component that comprise the face can make a substantial difference in the appearance and the character of one's face as a whole.

For facial harmony to exist there must be some degree of relative proportion of the various parts through which an overall balance is achieved. No individual component of the face exists or functions in isolation from the other integral parts.

Many attempts throughout history have been made to develop parameters to quantify idealized facial proportions and in essence to quantify human faces. Attempts to quantify human faces initially stemmed from the Greek philosophy that all beauty and aesthetics were based on mathematics. Significant studies related to selected facial proportion and dimensions with large numbers of subjects were not conducted until the 20th century. In the last one hundred years, the studies were conducted primarily by plastic surgeons and orthodontists who were continuously studying faces and attempting to quantify selected facial proportions and dimensions (Marquardt, 1997).

1.1 Facial growth

Growth and development is a strictly controlled biological process. Growth itself is the composite changes of all components. Child development refers to change or growth that occurs in a child during the life span from birth to adolescence. This change occurs in an orderly sequence. Growth of the facial skeleton during puberty and adolescence results in the characteristic curves and angle of adult face (Ridley, 1992).

There are many changes in the shape of an individual's face over his lifetime. In young adults, there is considerable growth of the skeletal structures along with an increase in muscle tissue and changes in the volume of fatty tissue. In middle life there is little change in the bone structure but continued growth in cartilage especially in men and in later life changes in both muscle tone and skin elasticity affect the outer shape of the face considerably (Hutton et al, 2003).

Craniofacial deformity arises as variations of the normal development process. Therefore must be evaluated against a perspective of normal development especially for those performing reconstructive and aesthetic facial surgery. They must adhere to the principles of proportions, symmetry and balance. Hence measurement of the craniofacial complex is important for studies of human growth, population variation and clinical treatment (Kolar & Salter, 1996). Here is where the study of anthropometry has an important role to play.

1.2 What is anthropometry

Human have long been keenly interested in depicting the characteristics of human anatomy. In classical Greece and Rome, artists used numerous canons, rules of simple proportions to describe the ideal form of human figure.

The term “anthropometry” is derived from the Greek word anthropos which means ‘human’ and metron, which means ‘measure’. It is the biological science of measuring the size, weight and proportions of the human body thus it replaces the visual examination (anthroscopy) which is very subjective and not reliable (Farkas 1994).

Face anthropometry is the science that is specifically dedicated to the measurement of human face thus it will provide valuable information on differences in shape and size of the face of different race, age and sex.

Measurement of the human face has been performed since the Greek era’ (Vegter and Hage, 2000).

Throughout the last century, anthropometry has witnessed an extensive development. Anthropometry evaluation begins with the identification of particular locations on a subject called landmark points; defined in terms of visible or palpable features (skin or bones) on the subject. A series of measurement between these landmarks is then taken using carefully specified procedure and measuring instruments such as calliper, ruler or measuring tape. As a result, repeated measurements of the same individual which is taken a few days apart are very reliable and measurements of different individuals can be successfully compared (De Carlo 1998).

In general, anthropometry has many practical uses, at individual level it is used to assess the person as being in need of special consideration or to assess a response to some intervention. In populations, anthropometric data are used to make decisions about the need for intervention programme, what type of interventions is needed and to whom they should be delivered.

1.3 Why this research area

Every person's face is different and has its own characteristic. The improvement of a patient's facial appearance is an objective common to a number of clinicians. Therefore planning an improvement requires guidelines or some kind of generally agreed 'ideal' set of facial proportions.

Current concept in diagnosis and treatment planning focus on the balance and harmony of the various facial features however harmony and facial balance are not fixed concepts. Subjective as it is, a concept of normal is essential for the surgeon to identify the normal from the abnormal (Zarnecki, 1993).

For years, the anthropometric measurements for surgical reconstructions are based on basic values for western population, resulting in the time of surgical repair being based on western growth pattern which actually differs from the Malay populations.

In other words, it means that the control or normative data are not readily available to be used as a guide during surgery.

This problem has not been given a serious thought. Based on this observation the rationale for this research area begins. Essentially this study has been conducted to generate our own data for pre pubertal Malay children at age seven and twelve year old.

Anthropometric analysis of the craniofacial framework in children is the first step in establishing the morphological changes of the aging faces as well to study the growth and development in these groups.

As the result it can provide the surgeon with anthropometric normal values and establishes the first set of specific craniofacial parameters in seven and twelve year old healthy Malay children in Malaysia. Basically these norms will be helpful in the diagnosis, prognosis and therapy of craniofacial disturbances in pre pubertal boys and girls. The mean value will help us to identify patterns for craniofacial growth at this age group. These norm data can readily available act as facial references whenever we do the facial analysis or whenever diagnosis needs to be made. Lastly the proportion analysis can be used for the evaluation of treatment results.

Chapter 2 : Literature review

2.1 Craniofacial anatomy

The face is part of the front head between the ears and from the chin to hairline (Sinnatamby, 2001).

The basic shape of the face is determined by the underlying bones, the facial muscles and the subcutaneous tissue. The skin of the face is thin and pliable (Moore & Agur, 2002).

The skin of the face possesses numerous sweat and sebaceous glands. It is connected to the underlying bones by connective tissue in which are embedded the muscles of facial expression (Snell, 1992).

The skeleton of the head is called the skull. It consists of several bones that are joined together to form the cranium. The skull also includes the mandible even though it is a separate bone. The skull is then divided into calvarium which encloses the brain and the facial skeleton. The joints of the skull are immovable and fibrous in type and known as sutures. However this excludes the temporomandibular joint which permits free movement. In old age the sutures are gradually obliterated by fusion of the adjoining bones (Chaurasia, 2003).

2.2 Development of the bones

Bone develops by two main process, intra membranous and endochondral ossification. In general the craniofacial skeleton is form both endochondrally and intramembranously. The cranial base, the nasal septum and the condyle of mandible are of endochondral origin whereas the maxilla and cranial vault are intramembranous in origin (Sadowsky, 1998).

During all the years of growth there is constant remodelling with destruction by osteoclasts and replacement by osteoblast whether the original development was intramembranous or endochondral (Sinnatamby, 2001).

Enlow described that in all areas of skeletal growth, bone grows intramembranously in tension areas and endochondrally in pressure areas. He said that the growth of all bones has cartilage growth plate and this is presumed to be regulated entirely and directly by the intrinsic genetic programming within the cartilage cells. In endochondral ossification they provide linear growth of bone towards the direction of pressure. As a result, as the interstitial cartilage expansions provides pressure adapted growth on the pressure side of the cartilage plate, an equal amount of cartilage is removed and replaced by bone on the other side. So the bone will lengthen towards its force and weight bearing area (Enlow, 1982).

It is essential to appreciate that the cartilage is not converted into bone but it is destroyed and then replaced by bone (Sinnatamby, 2001).

Alternatively the intramembranous bone growth was believed to have a different source of control. This osteogenic process is sensitive to biomechanical stresses and strains and it responds to tension and pressure by either bone deposition or resorption. Tension specifically induces bone formation while pressure triggers resorption.

The membranes associated with bone (periosteum, sutures, periodontium) have their own internal growth and remodelling process. As the new bone is deposited, the membrane does not move away but undergoes extensive fibrous changes in order to sustain constant connections with the bone. It forms the collagenous fibre continuity from the membrane into the matrix of the bone. As the fibres in the membrane became enclosed within the new bone deposits, the membrane-produced fibres become incorporated as bone fibres. It is followed by fibrous remodelling within the membrane to provide continuity between membrane and bone fibres (Enlow, 1982)

2.3 Embryology of the head and face

The development of the human embryo from the time of fertilization through birth is an important period for human appearance.

In early embryonic development of the head and neck, a series of distinct bilateral mesenchymal swellings appear on the ventral aspect of the embryo. These swelling are pharyngeal or brachial arches that form most of the structures of the head and neck (Stiernberg, 1997).

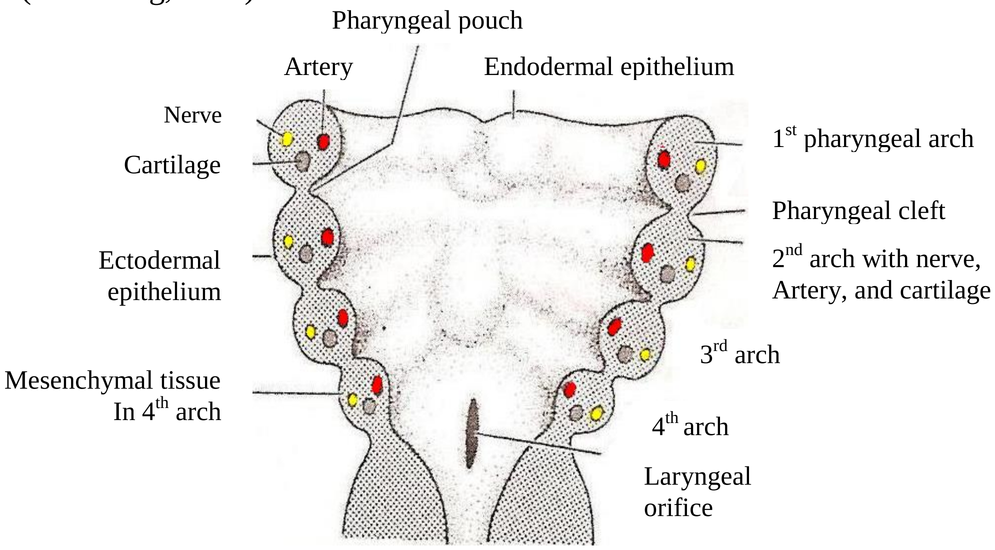


Figure 2.3.1

The pharyngeal arch consists of a core of mesenchyme covered externally by ectoderm and covered internally by endoderm (Figure 2.3.1)

Facial development occurs mainly between the fourth and eight weeks of gestation. At the end of fourth week, facial prominences consisting primarily of neural crest-derived mesenchyme and formed mainly by the first pair of pharyngeal arch appear (Figure 2.3.2) (Sadler, 1995).

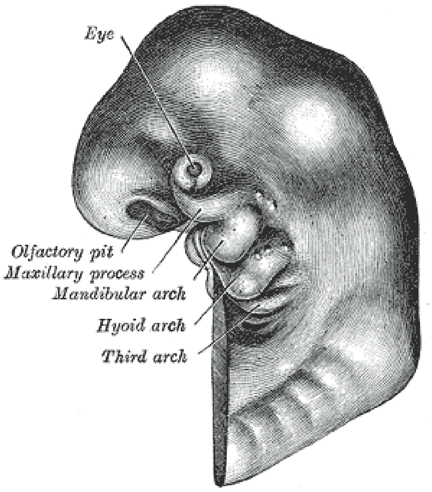


Figure 2.3.2

Early in development, the face of the embryo is bounded cranially by neural plate, caudally by the pericardium and laterally by the mandibular process of the first pharyngeal arch on each side. In the centre of this area is a depression of ectoderm known as stomadeum and in the floor of the depression is the buccopharyngeal membrane (Snell, 1992), Figure 2.3.3

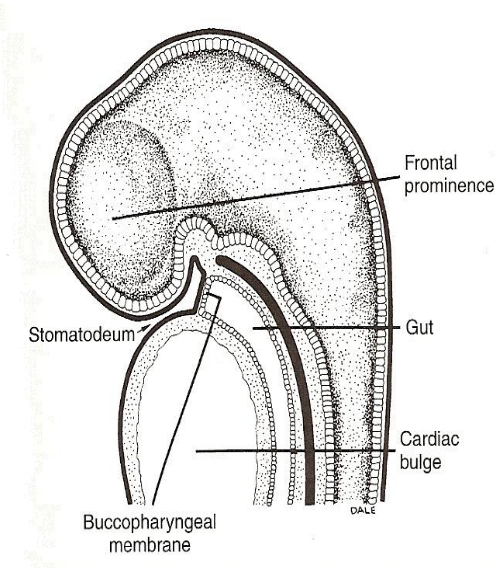


Figure 2.3.3

Buccopharyngeal membrane separates the stomadeum from the primitive gut and with the beginning of facial development the buccopharyngeal membranes breaks down so that the stomadeum communicates with the pharynx. The face is derived from five facial processes surrounding the stomadeum (Meikle, 2002).

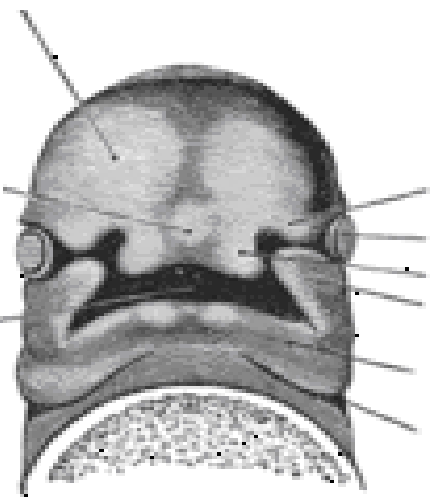


Figure 2.3.4

The processes are frontonasal process which lies above, the two mandibular processes lying below and the two maxillary processes located at the side of the stomadeum (Figure 2.3.4). These processes are produced by proliferating zone of mesenchyme lying beneath the surface of ectoderm. The mandibular and maxillary processes are from the first pharyngeal arches (Berkowitz, 2002).

The frontonasal process begins as proliferation of mesenchyme on the ventral surface of the developing brain. It later forms the forehead and dorsum apex of the nose (Snell, 1992).

During the fourth week the lower jaw is the first part of the face to form. It results from the merging of the medial ends of the mandibular process. This process also forms the lower lip and chin (Meikle, 2002).

During the second month, proliferation of the underlying mesenchyme of the lower part of the frontonasal process creates prominent elevations, the medial and lateral nasal processes (Figure 2.3.5).

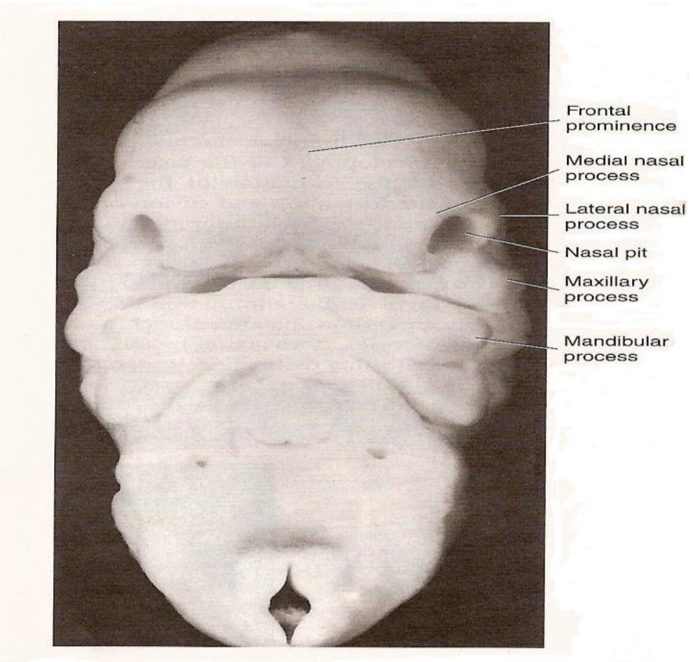


Figure 2.3.5

During the sixth week, the maxillary processes grow medially and fuse with the lateral nasal processes and then with the medial nasal process. The lateral nasal process forms the alae and sides of the nose (Meikle, 2002) (Figure 2.3.6)

The medial nasal process forms the philtrum of the upper lip and premaxilla. The maxillary processes extend medially to form the upper jaw and the cheek (Snell, 1992) (Figure 2.3.6)

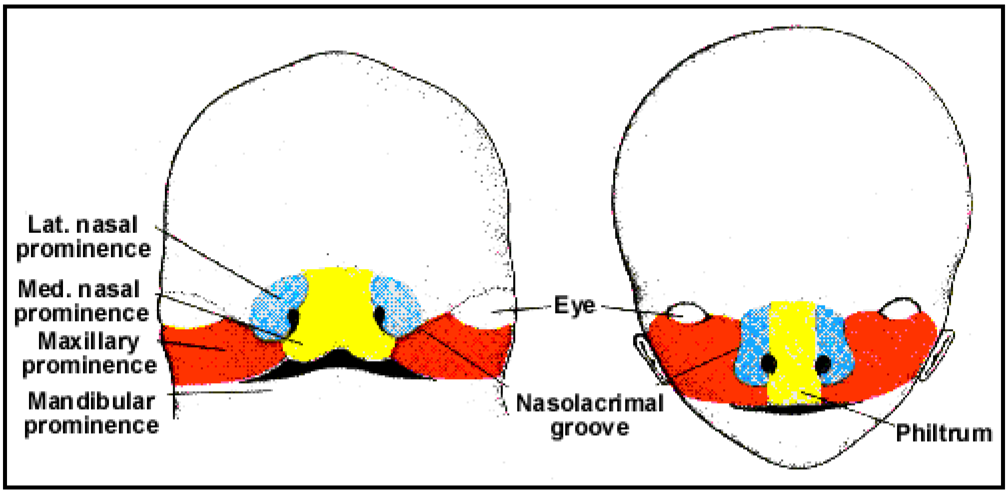


Figure 2.3.6

There has been a divergence of opinion regarding the embryological origins of the upper lip. One view suggests that the maxillary processes overgrow the medial nasal processes to meet in midline and form the upper lip. It is based on the innervations of the fully form of upper lip by maxillary nerve with no input from the ophthalmic division. The maxillary processes are being supplied by the maxillary nerve and the frontonasal process by the ophthalmic nerve. Alternatively, it has been suggested that the maxillary processes meet the medial nasal processes without such overgrowth, the middle third of the upper lip derived from the frontonasal process (Berkowitz, 2002).

This view was supported by Warbrick (1960) who made a microscopic study of fifteen serially sectioned human embryos and could find no evidence for the overgrowth of the medial nasal process by maxillary processes (Meikle, 2002).

2.4 Basic concepts in growth and development

Growth and development involve complex mechanism and progressive changes over time. Developmental change is a basic fact of human existence and each person is developmentally unique.

Growth is defined as increase in number and size whereas development refers to a stage of growth and maturation encompassing morphogenesis, differentiation and acquisition of functioning (Mao & Nah, 2004).

The agents responsible for growth can be divided into genetic factors originating in the genome and environmental factors which are usually mechanical or functional activity and both arising externally (Meikle, 2002).

Genes can be regulated by environmental cues including myriad types of mechanical stimuli. However much less is known how environmental cues such as mechanical forces regulate genes involved in skeletal growth (Mao & Nah, 2004).

2.5 Craniofacial growth and development

Enlow in many publications detailed descriptively and spatially the growth and development of the craniofacial complex and how changes in various areas affecting the relationship of anatomic parts in other areas.

Facial growth is a process requiring intimate morphogenesis interrelationships among its entire component growing, changing and functioning soft and hard tissues parts. No part is developmentally independent and self contained. The multiple growth processes in all the various parts of the face and cranium occurs simultaneously so that the same craniofacial form and pattern are maintain throughout the growth processes. It means that the proportions, shape, relative sizes and angles are not altered as each separate region enlarges. As the result the geometric form of the whole face for the first and last stages is exactly the same, the only changes occurs are the overall size (Enlow, 1982).

Enlow and Hans (1996) emphasized that the face of a child undergoes sequential alterations in profile and in facial proportions as growth progresses (Enlow & Hans, 1996).

As an example the mandible of young child look small in relation to his maxilla but later this small mandible will 'catches up' to provide a balance anatomy of the face. The forehead looks bulbous in a young child but becomes sloping as the frontal sinus develops. The nasal region is shallow early in post natal life but later becomes markedly expanded relative to other cranial and facial regions (Enlow, 1982).

Schever and Back (2004) stated that the growth of the vault and eyes in their contained orbits follow the rapid pattern of neural growth whilst the lower part of the facial complex is primarily related to the development of the dentition and muscle of mastication. This results in a skull in foetus, infant and young child that has very different proportions from that seen in later childhood, adolescence and adult life hence the large head and eyes and relatively small face of infants and young child (Schever & Back, 2004).

2.6 Theories of growth control

It is necessary to learn how facial growth is influenced and controlled in order to understand the aetiology process of craniofacial deformity. However what determines growth remains unclear and continues to be the subject of intensive research. It also has a long and controversial history.

Even though there is a large considerable data that exists with regard to craniofacial growth, we still have limited understanding in many areas. All we have are theories or hypothesis.

Over the years many theories or hypothesis of growth controls have been proposed, ranging from sutural concept by Sicher, the importance of chondrocranial development by Scott and the functional matrix theory by Moss (Sadowsky, 1998).
It is also important to distinguish between the theories of growth control and a site of growth and a centre of growth.

A site of growth is a location at which growth occurs and a centre is a location at which independent (genetically controlled) growth occurs. All centres of growth are also sites but the reverse is not true (Proffit, 2000).

Three major theories in recent years have been attempted to explain the determinants of craniofacial growth (Proffit, 2000) :

i) Bone like other tissues, is the primary determinant of its own growth however this view was discarded in 1960s (Proffit,2000).
ii) The cartilage is the primary determinant of its own growth while bone responds secondarily and passively (Proffit, 2000).
iii) The functional matrix theory in which the skeletal elements are embedded is the primary determinant of growth and both bone and cartilage are secondary followers (Proffit, 2000).

The major difference in these theories is the location at which genetic control is expressed.

The cartilage theory suggests that genetic control is expressed in the cartilage while bone responds passively to being displaced. This indirect genetic controlled is called epigenetic (Proffit, 2000).

The functional matrix theory was put formally by Moss in 1960s. Currently it is the most popular theory. Moss's theory, postulates that the bones of the head grow in response to the function of two types of matrix; the periosteal matrix which includes the facial muscles and the teeth and the capsular matrix which includes the neural mass and functional spaces of the mouth, nose and pharynx. He further emphasize that the periosteal matrix is responsible for altering the size and shape of the bones while the capsular matrix alters spatial relationships between various parts of the head. Moss's point of view is when this functional matrix grow or is moved (muscles, glands, nerves, vessels, fat etc…) the related skeletal unit responds appropriately to this morphogenetically primary demand (Moss & Salentijn, 1969).
In the functional matrix theory, the genetic control is located outside the skeletal system and that growth of both bone and cartilage is controlled epigenetically, occurring only in response to a signal from other tissues (Profit, 2000).

Moss provided a revision of the functional matrix hypothesis in 1997. In a series of articles he examined the relatives' roles of the biophysical and biochemical factors in the regulation of morphogenesis as well the genomic and epigenetic process in the regulation of craniofacial development (Moss, 1997).

2.7 How the cartilage and functional matrix theories plays a role in craniofacial growth

In the cartilage theory, the major determinant of craniofacial growth is the growth of the cartilage. This theory is quite attractive because if cartilaginous growth was the primary influence then the cartilage at the condyle could be considered as a pacemaker for growth of that bone and the remodelling of the ramus and other surface changes could be viewed as secondary to the primary cartilaginous growth (Proffit, 2000).

The traditional concept of mandibular growth also views the condyle as a primary growth centres which is under the control of intrinsic factors. It also displaces the mandible downward and forward (Meikle, 1973).

Condylar cartilage is defined as a secondary cartilage because it develops on a pre existing piece of membranous bone and the only movable joint to play a significance role in bone growth of the mandible through the activity of a growth centre contained within the joint capsule (Mckay &Yemm, 1992).

The question of whether secondary condylar cartilage possesses a similar growth potential as primary cartilages has been the subject of controversial viewpoints and much experimentation (Copray et al, 1986).

Copray et al. did an experiment where he tried to establish an intrinsic growth potential of the mandibular cartilage in a well-defined serum free organ culture system and it showed limited intrinsic growth potential and the tissue separating capacity, making the mandibular condylar cartilage not fulfilling criteria as a primary growth centre (Copray et al, 1986).

Moss in his concept suggested the growth of the condyle occurs as a secondary or adaptive response to its functional matrix (Moss and Salentijn, 1969).

It has been suggested that the proliferation of the condylar cartilage is a response to growth not its cause. This view has been supported by experiment showing that mandibular growth is relatively unaffected following condylectomy providing normal mandibular function is maintained (Ogus and Toller, 1986).

As for the nasomaxillary growth, there is a cartilage in the nasal septum that is involved. According to the cartilage theory, the cartilaginous nasal septum serves as a pacemaker for other aspects of maxillary growth (Proffit, 2000).

From the transplantation experiments, it demonstrates that the nasal septal cartilage was found to grow nearly as well in culture as epiphyseal plate cartilage (Copray, 1986).

The location of the cartilage makes the downward and forward translation of maxilla possible. If the sutures of maxilla served as reactive areas, they would respond to this translation by forming new bone when the sutures were pulled apart by forces from the growing cartilage (Proffit, 2000).

As for the functional matrix theory, Moss maintained that post natal growth of the middle third of the face is in part an adaptation to the functional demands of increase nasal respiration. As the nasal air spaces expand, the associated cartilages and bone grow and this is in response to the increase in nasal cavity space not the cause of it. However the role of the functioning spaces has been the most controversial part of the theory because if a functional nasal airway does play a significant role in maxillary growth, the cause and effect relationship might be expected to be demonstrable between the nasal airway obstruction and altered facial morphology (Meikle, 2002).

Attempt to support or disprove these theories have been extensive. However experimental models for both hypotheses have experienced flaws and opinion remains divided (Howe, 2004).

Basically growth and development is the net result of environmental modulation of genetic inheritance. Cells are influence by genes and environmental cues to migrate, proliferate, differentiate and synthesize extracellular matrix in specific directions and magnitudes. Mechanical forces, one of the environmental cues readily modulate bone and cartilage growth. This forces are transmitted to tissue-borne and cell-borne mechanical strain that in turn regulate gene expression, cell proliferation, differentiation, maturation and matrix synthesis, the totality of which is growth and development (Mao & Nah, 2004).

2.8 The changing features of the growing face

The post natal changes of the craniofacial complex that occur with growth have been studied by numerous investigators. In order to extend the understanding of growth, researchers have investigated pre natal growth and development as well. Studies have shown that the pre natal craniofacial growth patterns during the last two trimesters are similar to post natal craniofacial growth. However little is known about early development of patterns of facial morphology and the mechanisms of differential growth during the embryonic and early foetal periods (Diewert, 1985).

We always think that a baby face is a cute face. Baby face has large appearing eyes, puffy cheeks, dainty jaws, a smallish pug nose, a low nasal bridge, a small mouth and overall wide and short proportions. However as the face grows and develop through years, these and many of other features of the baby's face gradually undergo marked changes. The chin develops, jaw size catches up and the eyes appear less wide set. Actually the general features of any fully grown face are quite different from those of the same individual as an infant and young child (Enlow and Hans, 1996).

Growth increments and development progress rates vary considerably during pre and post natal periods in the life of human being. The coordinated regulation of parts growing at different rates and in different directions, together with the modelling of bone by apposition and resorption, is what converts the foetal skull into the mature-appearing adult skull. Comparing the infant skull to an adult skull, the face at birth equals about one eight of the entire skull, whereas in adulthood it occupies about one half of the skull. The facial skeleton grows more rapidly after birth and this growth takes place over a longer period of time (Levihn, 1967).

Growth is not merely a process of size increases. Instead the facial enlargement is a developmental process which involved of many component parts. These components may mature earlier or later than the others, to different extends in different directions and different rates. It involves a gradual maturation with a complex of different but functionally interrelated organs. At the end it will requires a regional changes in proportion by localised ongoing adjustment to achieved proper fitting and function among all the parts (Enlow & Hans, 1996).

Basically the child's face is not merely a miniature of the adult face. Brodie (1941) in a roentgenographic study found that the morphogenetic pattern of the head by the third month of post natal life or perhaps earlier and once attained does not change (Levihn, 1967).

Below is just the example of the changing features of the growing face:

The baby's face appears diminutive relative to the larger cranium above and behind it. However these respective proportions will change as the growth of the brain shows considerably after about the third or fourth year of childhood, the facial bones otherwise continues to enlarge for many years to accommodate airway and masticatory growth and functions. The eyes appear large in the young child but appear smaller in proportion in adults. This is because as facial growth continues, the nasal and jaw regions which is developed later cause the disproportion to the earlier maturing orbit and its soft tissues. It is the same where the eyes of the infant seem quite wide set with a broad appearing nasal bridge between them. This is due to the low nasal bridge and much of the width of the bridge has already been attained in the infant. When the growth continues, the eyes spread further laterally but only to a relatively small extend. Actually the eyes of the adult face are not much apart than those in the child but it look so because of the larger nose, higher nasal bridge, and increase in the vertical facial dimension and the widening of cheekbones makes the eyes of the adult appear much close together (Enlow and Hans, 1996).

2.9 Child versus adult features

The face of prepubertal boys and girls are essentially comparable. In the female, facial development begins to slow markedly after about thirteen or so years of life. For the male, at about the time of puberty the sex related dismorphic facial features just described begin to fully manifest and this maturation process of the facial superstructures continues actively throughout the adolescent period and into early adulthood (Enlow & Hans, 1996).

Growth of the facial skeleton during puberty and adolescence results in the characteristic curves and angles of the adult face. Infants and children have a large amount of subcutaneous fat in their face and together with highly elastic skin and not fully develop of facial skeleton give them a round face and cherubic appearance (Ridley, 1992).

The young child's head form looks more brachycephalic because it is still wide and vertically short. This is due to the precocious of basicranium relative to facial development. They have the short nose, round and pug-like, the nasal bridge is low, the nasal profile is concave, the forehead is bulbous and upright, cheekbone are prominent, the face looks flat and the eyes seem wide set and bulging. The face is vertically looks short because the nasal part is still small, the secondary dentition has not fully established and the jaw bones have not yet grown to the vertical extend that later support the full dentition and the enlarging masticatory muscles and airways (Enlow and Hans, 1996).

According to Marion, the effects of aging begin to appear at the age of thirty. Skin laxity is first noted when the upper eyelids begin to overhang the palpebral lines. The inferior palpebral sulci and nasolabial folds become noticeable.

At about age of forty the wrinkles and glabellar furrow begin to appear. During this time, eyelid skin laxity became noticeable excess, and crow's feet began to appear at the lateral canthi. Mandibular sagging line also becomes detectable.

By fifty years of age the wrinkles at forehead and glabellar become prominent and may unite to form continuous line. Nasal tip began to drop and wrinkles around the mouth and neck start to develop. Early loss of subcutaneous fat indicated by sagging of the cheek skin.

At age sixty all skin wrinkles deepen. The size of the eyes diminutive because of progressive encroachment of the surrounding lid skin. Skin thickness begins to decrease and the loss of subcutaneous adipose tissue accelerates, thus producing noticeable deficits in the temporal, orbital and buccal areas.

By age of seventy the nasal tip has descended even further and the excess skin of the lower eyelids may develop bag like deformities. Continued loss of subcutaneous fat makes the malar complexes appear quite prominent and the orbits more hollow.

By age of eighty years old, wrinkles around the face produce typical appearance of advanced senescence. Loss of skin thickness, absence of subcutaneous fat, diminution in the size of cranial vault combine to make the facial skeleton more conspicuous than at any other time in life (Marion, 1992).

The interesting question sometimes is how about the people who look younger than his or her years? or older?

The reasons are only partially understood. Enlow mentioned that the onset of smile line and some other facial wrinkles is delayed or at least such lines look less marked in youthful-appearing individuals. Conversely if the lines appear more prominent and develop at earlier age the person may look older. Intrinsic physiologic as well the environment factors also contribute to this (Enlow and Hans, 1996). Eg. Exposure to sun can accelerate the aging process of skin. Major loss of adipose tissue also can accelerate the onset of facial wrinkles.

2.10 Anthropometry

Anthropometry is the study of human measurement for use in anthropological classification and comparison. The measurement of living subject was first developed by a German anatomist, Johanne Sigismund Elsholtz for his doctoral thesis in 1654 (Kolar & Salter, 1996).

In the 18^{th} and 19^{th} centuries most facial measurements were taken directly from skulls and only a few soft tissue measurements were performed. These measurements were used predominantly to prove that certain groups of people were superior to others (Vegter & Hage, 2000).

In the 19^{th} and 20^{th} centuries, anthropometry was a pseudoscience used to classify potential criminals by facial characteristics. Cesare Lombroso's criminal anthropology (1895) claimed that murderers have prominent jaws and pickpockets have long hands and scanty beards. He described how gangsters, murderers, alcoholics, fire-raisers, epileptics and dwarfs could be distinguished from normal people by anthropometric assessment of skull shape, the face, shape of nostrils, tooth form, size of masseter muscle and the size of frontal sinus (Vegter & Hage, 2000).

However anthropometric studies are today conducted for numerous different purposes. In spite of the appearance of more sophisticated technologies, it remains an efficient, cheap, non invasive method for describing craniofacial morphology. Even though anthropometry lacks the detail if compare to more powerful technologies, but it is still better suited for population studies because of the availability of comparative normal databases. The major advantage afforded by anthropometry is its technical simplicity a fact which makes it a readily available tool for evaluating patients, planning facial surgery or delineating basic features of craniofacial syndromes (Ward, 1989).

However the anthropometry is not void of errors because the disadvantage of anthropometry are improper identification of landmarks and improper measuring technique but this can overcome if the examiner becomes familiar with the measurement and as pointed out by Ward & Jamison (1991) in their study that the magnitude of error was low (within a millimetre) and significant errors related inversely to the size of the measurement and landmark identification that would be difficult to identify are admittedly not particularly reliable (Edler, 2001).

2.11 Antropometry vs sophisticated technologies

2.11.1 Anthropometry vs Cephalometry

Cephalometry has been used to provide a vast array of data useful for the representation of ideal proportions (Edler, 2001).

However as pointed out by Moyers and Bookstein, the traditional cephalometric analysis provided limited or even misleading information regarding the true shape and size of craniofacial structures. They argued that two dimensional measurements cannot reveal differences clearly visible in three dimensions (Moyers and Booktein, 1979).

Direct anthropometric measurement of the face cannot overcome all these problems but it clearly provides a more accurate representation of size dimensions than can measurements from two dimensional (Farkas et al, 2002).

Budai et al. compared the relations and proportions of the face in healthy young white adult men and women using anthropometric and cephalometric measurements and found that the vertical anthropometric and cephalopmetric measurements in the facial profile were in highly significant percentage normal as compared with their normative data established for healthy populations. In fact the cephalometric normal measurements were smaller than those of the anthropometric. There also significant differences between proportions on the surface and skeleton of the subjects. This gives an idea to us to be cautious in clinical practice to judge the morphological changes of the face separately and on the skeleton of the patient (Budai et al, 2003).

2.11.2 Anthropometry vs Photogrammetry

Routine medical photogrammetry complements the narrative of a patient's chart as suggested by Dickson and Hanna (1976) and Morello et al (1977) but its usefulness is limited unless the prints are of standardized views and sizes (Farkas et al. 1980).

A number of precautions must be taken to ensure the scientific accuracy of photogrammetry and the routine use of photogrammetry has also been hindered by the high cost of equipment such as high quality camera lens for photography and cepholometry chair for positioning the subject (Guyot et al, 2003).

In 1991, Diliberti and Olson emphasized four potential sources of error in photogrammetry which is unreliable landmarks, focal angle and distance in relation to the subject, alignment between negative and paper surface during enlargement and measurement errors on pictures (Guyot et al, 2003).

Farkas et al (1980) reported that only twenty of a total of hundred photographic measurements were correlated with clinical measurement. They also founds that depth measurements on profile views are always smaller when made by direct measurement since the tragus is always in a more anterior plane than the other landmarks (nasion, subnasale and gnation). They also found a 46% differences in the distance between the base of columella (subnasale) and tip of nose when obtained by direct measurement and by photographic measurements on frontal view (Farkas et al, 1980).

Logically photographic measurements are reliable only if the points being measured are located on the same plane (Guyot et al, 2003).

2.11.3 Anthropometry vs Computer-Assisted Three Dimensional Technique

Traditionally the 3D data can be generated from computed tomography (CT) and magnetic resonance imaging (MRI). Axial, sagittal and coronal views and 3D reconstruction can be included (Xia et al, 2000).
However neither CT nor MRI can provide the natural photographic appearance of the texture of the facial surface (Ayoub et al, 1998).

The human face is three dimensional, so the clinicians must have accurate three dimensional information about the craniofacial region to plan their operations effectively. Without this, the surgeons cannot precisely estimate the outcome of a particular procedure. We can't denied that the three dimensional human face creation and modelling are important subjects such as computer aided simulation surgery since they are used widely in maxillofacial surgery (Xia et al, 2000).

This technique generates stunningly detailed images that can reveal important information about the underlying anatomy not obtainable through two dimensional cephalometric imaging or direct measurement of the surface of the head and face. The only disadvantages are they are very expensive and increase radiation exposure. The other deficiency is the lack of published reference data from which population means and standard deviations can be obtained (Ward, 2002).

2.11.4 Future Hope for the Anthropometry

It is well known that the anthropometric data feeds a range of enterprises that depend on knowledge of the distribution of measurement across human population. This range from the design of products or devises to fit most people to the uses in medicine such as to assess nutritional status, monitor the growth of the children, planning and assessment for plastic and reconstructive surgery to the use in forensic anthropology.

Recently attempt was made to use the anthropometric data in the construction of face models for computer graphics application.

De Carlo in his works used the published proportion data done by Farkas in young North American Caucasian men and women. He use this published direct measurement data to form a facial geometric variation in the young North American Caucasian. Basically there were two step involved in the process where the first step is to produces a plausible set of constraints on the geometry using anthropometry statistics and the second step is to derives a surface that satisfies the constrains using variation modelling. His work is a new computational approaches for the task that rely on anthropometry results, and it could also figure in a user interface for editing face models by allowing feature to be edited while related features systematically changed but preserving natural proportions or ensuring that faces respect anthropometry properties common to their population group (De Carlo et al, 1998).

It gives an idea the importance of continuing to gather and analyze anthropometric data of diverse human population.

2.12 Craniofacial Anthropometry

The first clinical program in craniofacial anthropometry was carried out at Charles University Prague in 1960s as part of extensive, long term study of children with cleft lip and palate (Kolar & Salter, 1996).

Farkas is considered to have most importantly influenced modern facial and soft tissue anthropometry and his core work is based on meticulous direct measurements of different ages and ethnic's origin. It is now augmented by a large group of Asians of various ages and group of young African-Americans (Farkas, 1994).

During the post natal development of the face, growth occurs in all three planes, vertically (height), transversely (width) and anteroposteriorly (depth). With age, differences in rates and extent of growth among these dimensions produce major changes in facial proportions, observed until the time of maturity (Farkas et al, 1992).

Information about the normal growth of the craniofacial skeleton and soft tissue and the relationship between regions is essential if abnormal growth patterns are to be understood and reconstructive surgery is to be carried out. Many investigators and clinicians have emphasized the usefulness of anthropometry in gathering such information (Farkas & Posnick, 1992).

In the past the diagnosis of craniofacial dysmorphism was based mainly on visual inspection (anthroposcopy) rather than direct measurement on the craniofacial complex. As a result it is often difficult to reach agreement on anthroposcopy diagnosis among clinicians. By right the congenital and post traumatic deformities are best treated with the knowledge of normal values for the involved region to produce the best aesthetic and functional result. For these reason, standards based on ethnic data are desirable because these standards reflect the potentially different patterns of craniofacial growth resulting from racial, ethnic and sexual differences (Evereklioglu et al, 2002).

In 2003, Farkas et al provide the normal data of the anthropometric proportion indices of craniofacial complex in boys and girl in healthy North American (1-5 years old).

Goel et al provided the normal anthropometric data of the orbits in Indian populations in six months to fourteen years of age. They use this value to diagnosed hypertelorism or telecanthus (Goel et al., 1987).

Similar studies was done by Madjarova (1999) to establish a anthropometric normal data for the orbits in Bulgarian newborns. They compared their data with published data for other Caucasian ethnic group of infants and found the differences in measurement. They concluded that the anthropometric differences between ethnic groups of Caucasian already exist shortly after birth. It shows that the knowledge of the soft orbital data in early post natal development in healthy populations is essential for determination in individuals of deviations from normal data (Madjarova et al.1999).

Evereklioglu et al provide a normal craniofacial anthropometric data in Turkish population of the age 7 – 40 years old. They found that these developmental data and normal values of the measurements in healthy subject are useful for dysmorphologist in the early identification of some craniofacial syndromes (Evereklioglu et al, 2002).

Ocular measurement has been done in healthy normal Chinese children in Taiwan and they compared their data with published data for Caucasian children and found that the inner and outer canthal and interpupillary distance were wider for the Chinese children but the palpebral fissure length was not significantly different. They also noted that the inner canthal distance was wider than palpebral fissure length at the same age and they argued that it was not right to diagnose hypertelorism in Chinese children in Taiwan. As the result they suggested that the measurements should be adjusted with normal standards specific for the race (Wu et al, 2000).

The study of the nasal morphology in cleft lip and palate operated adult patients was done where they compare with a normal subjects and they found that nasal width, alar base width and inferior width of the nostrils were larger than the reference subjects. Nasolabial and nasal tip angles were smaller and facial convexity angle was larger. They concluded that the surgical corrections of the cleft lip and palate failed to provide a completely normal appearance (Ferrario et al, 2003).

El- Hakim (2003) did an anthropometric measurement pre and post external septoplasty in children to test the hypothesis that surgery on the growing nasal septum does not adversely affect nasal and midfacial dimensions. The result showed that there was no effect on development of the nose and midface if the nasal surgery was performed during childhood (El-akim et al. 2003).

Those findings shows that the pre operative facial measurements assists in the determination of which facial features need change to produce harmony with the face as a whole. Post operative determination of the same measurements allows for assessment of the adequacy and appropriates of the degree of improvement.

When corrective surgery is indicated it is important for the surgeon to know the mean and standard deviations of key measurements at varying age, the rates of growth of each facial region, completion of growth and times of maturation. This information can help the surgeon to determine both the extent and preferred timing of surgery within specific regions of craniofacial skeleton (Farkas et al. 1992).

Cross sectional studies of the patterns of post natal facial growth based on anthropometric surface measurements have been carried out in growing Caucasian children (Farkas and Posnick, 1992; Farkas et al, 1992, 1992b,1992c).

Farkas et al. performed head and face measurement in North American Caucasians between 1-18 years of age. This study was intended to enhance the knowledge of the age related growth changes in the surface anatomy within specific regions of the head and face in general population. He found that growth trends and relationship between aspects of the head are predictable. He reported that by one year of age the circumference and length of the head showed the highest levels of developmental level compared with their adult size. By ten years of age, head length reach full maturations in females and for the males, the maturation reach by age of fourteen. Head width showed the most advanced maturation by age of fourteen in female and fifteen in males. Early rapid growth in head height and head length took placed between 1 and 4 years of age and between 1 and 6 years in forehead width. As a result the data that obtained from this study can be used for planning the timing and reconstructive surgery in patients with cranial vault growth disturbances such as craniosynostosis (Farkas et al, 1992).

Vertical skeletal growth has been measured using anthropometric technique developed by Farkas (1981). It was found that there was average annual changes of 1-2mm in the pre pubertal period. The zygomatic and gonial widths each increased by about 7mm from 6-10 years of age. As the gonial width was initially less, the proportionally changed more. Sex differences in zygomatic width of about 1mm and bi-gonial width of 3mm also have been found. The sex difference in nasal dimensions has generally been found to be quite small in the pre pubertal period, but the male nose was found to be up to 1mm larger in most of its dimensions (Nute & Moss, 2000).

Recently Cozza et al (2005) carried out the anthropometry pilot study on pre pubertal children of aged between 7 and 12 years old. About thirty craniofacial measurement and body measurement of height, weight, length and circumference were taken. They found that skull and face measurements increased less than body dimensions but face increased more than skull and the result was valid for both males and females. They found the differences between males and females for standing height, mandibular height and lower facial height. However they concluded that there is no body parameter was found to be a good indicator of craniofacial growth during this period and jaw is the area of face showed the higher development (Cozza et al, 2005).

In conclusion the knowledge of the normal data in healthy population is essential for determinations in individuals of deviations from normal data. These values also help in identification of some craniofacial syndrome and can be used for the pre and post operative evaluation.

2.13 Anthropometry role in aesthetic of different ethnic

Proportion of aesthetic face started when people trying to define the concept of beauty. Aristotle wrote that the chief forms of beauty are in order and symmetry and definites. However Immanuel Kent suggested that the beautiful is that which pleases universally without requiring a concept. While the philosophers unsettles with the definitions of beauty, artists and artisans took a much more practical approach, settling on reference plane and ideal proportions. These ideas form the basis of facial analysis begins with rules. Many of aesthetic rules were developed through the study of accepted beautiful faces. The general concepts of aesthetic analysis include symmetry, equality of portions and repetitive proportions. This concept forms the divine or golden proportions. However one must bear in mind constantly that the number of all facial proportions influences by culture and ethnicity (Richard, 1997).

Anthropometry studies are an integral part of craniofacial surgery and syndromology (Farkas et al, 1992).

The knowledge of the normal values of the specific region of the craniofacial is essential to produce the best aesthetic and functional results. Some surgeons still used the neoclassical canons in facial analysis. Neoclassical canons of facial proportions were derived by the artists and anatomists of the 17th and 18th centuries. Studies using anthropometry have shown little applicability of these neoclassical canons to white, Asian, Carribean and African-American populations (Farkas et al, 1985, Sim et al, 2000, Porter and Olson, 2001)

Farkas with his extensive works, comparing and measuring more than 100 dimensions and proportions in hundreds of people gave him the ability to define the standards for almost every soft tissue measurement in the head and face (Farkas, 1994).

Hajnis et al. (1994) found significant differences between facial measurements in white ethnics and various races and these contributed to the knowledge of diversity in facial proportions.

Comparison study of the facial proportions between Southern Chinese and white women by Sim et al., showed the differences in facial proportions between these groups. It showed that the Chinese face were wider in intercanthal distance, nasal base and has a different profile in lower face and eyelid. The Chinese nose also less prominent with the alae more flared and nasal tip less prominent (Sim et al. 2000).

Kawakami done the comparison study of facial position between typical Japanese and Caucasians. However he used the golden proportion for this relationship. They found that the Japanese tend to have a larger upper lip and shorter chin length compared with the Caucasians. The data they obtained was used in their pre and post operative aesthetic facial analysis (Kawakami et al. 1989).

A comparison of aesthetic populations between Oriental and Caucasian nose was done by Leong and White.(2004) They found that the oriental nose projected less from the face and was broader at the intercanthal level and the alae base but not bony base (Leong and White, 2004).

Le et al. (2002) tested the validity of six neoclassical facial canons between Asian groups comprising Vietnamese and Thais to the North American Caucasian. They found that the validity of the five other facial canons was more frequent in the Caucasian as compared to Asian. The Asians has a wider intercanthal distance in relation to shorter palpebral fissure, a much wider nose with a wide facial contour, a smaller mouth width and a lower face smaller than the forehead height (Le et al, 2002).

Jennifer in 2004 showed that the proportional facial relationships of the African American men significantly different from those of the North American white men and from neoclassical standards. As a result they set a new standard from their normative data for pre operative facial analysis (Jennifer, 2004).

In making a diagnosis of certain anomalies and syndromes, abnormal facial features such as telecanthus, ocular hypertelorism or hypotelosrism are taken consideration by clinicians or surgeons. As example visual impression is mostly used to describe the anatomical inter papillary distance. However this is not adequate because of variations in facial features such as wide nasal bridge, epicanthus ad telecanthus (Evereklioglu, 2002).

As a result from these findings, the normal data that measured from the healthy subjects and different ethnic are useful in the early identification of some craniofacial syndromes.

As for the facial plastic and reconstructive surgery, even though the basic principle of the surgery are applied to everyone but the important fact that should be borne in mind, are the aim is to retain ethnicity and natural appearance of the face as well to restore the good functional result.

Anthropometry represents a snapshot in time and measurements not taken are lost forever as the individual grows, age and dies. It would be very useful to have some system that would preserve as much as possible of this transitory information for later re-analysis as measurement and statistical technique improved.

Chapter 3 : Methodology

3.1 Subject

The study group consisted of convenient samples of Malay primary school children comprising of seven and twelve years old boys and girls. The study group are selected from Sekolah Rendah Kebangsaan Bandar Baru Bangi Selangor. Each age group totalled one hundred participants with equal number of boys and girls subjects. The participants were generally healthy and exhibited no craniofacial abnormalities either acquired through road traffic accidents or other forms of trauma, congenital or developmental discrepancies and had no history of plastic or reconstructive surgery. Subjects of mixed parentage or mixed grandparents were excluded from this study.

3.2 Physical facilities

Clinical measurements were conducted in a room well lite by natural light and the subjects were seated upright in the examining chair with the examiner seated facing the subject at eye level. This will provide the best view of the head and face. To prevent the subjects from feel tired during the examination the provided chair should has a straight back with armrests.

A vertical leg rest is required to enable the examiner approaches the subjects close enough to apply the callipers without having to stretch forward constantly which will tire the arms and back. A swivel chair allows the subjects to be turned to the desired view and the examiner to be stationary during the examination.

3.3 Anthropometry measurements in selected craniofacial region

3.3.1. Positioning of the subject

The subjects will be seated upright on a straight backed chair. The examiner is standing or sitting in front of the subject. Readings are taken at rest and standard position of the head. The rest position of the head is determined by the subject's own feeling of natural head balance. The standard orientation of the head is achieved by positioning the head in the Frankfort Horizontal Plane (FHP). FHP is a horizontal line from the top of the external auditory canal to the lowest point on the inferior border of the orbit. FHP is the standard position for measurement of the vertical dimensions of the head and face.

3.3.2. Instruments

a. Sliding caliper

The sliding caliper is the standard anthropometric instrument and the sliding caliper used was the Mitutoyo Sliding caliper. It consists of two basic parts namely the metric digital scale with wo pairs of perpendicular arms at the origin of the scale, a slide and a thumbscrew. Both arms have two tips; the larger pair was mainly used for linear measurements in which the shortest distance is determined between two landmarks.

b. Spreading caliper

This type of caliper consists of two curved arms connected at their bases with a pivoting screw. The gradations on the scale are reduced in size in order to make them match the width at the tips. The readings are taken at the inner edge of the bracket on the right arm. This calliper did not have an attached metric scale so the measurements were made against a millimetre metal ruler.

c. Modified double callipers with a bubble level

A modified double sliding calliper is made by using a 45cm T – shaped plastic ruler. The horizontal arm is attached at 90° to the vertical arm in anteroposterior view. It consists of a sliding block which moves along the vertical arm of the instrument base. A bubble is attached to the side of the upper horizontal arm of the ruler. The bubble level is used to correct any tilt in the instrument during measurement.

d. Measuring tape

This plastic measuring tape has millimetre markings along both edges and is used in measuring head circumference. When doing the measurement the tape must be pulled tight around the hair to get an accurate reading.

e. Skin marker

When the landmark is used for more than one measurement for example nasion or subnasale then these landmarks are marked on the skin. The purpose of marking this landmark is to avoid error in locating these landmarks so that the same spot will used.

f. Printed data entry forms

The data entry form was printed on different coloured papers for easier identification of each group of subjects. (Appendix B)

3.4 Measuring sequence

In order to maximize data entry in the minimum time, only one instrument is used at a time. This is because switching one instrument to another will slows down the examination process and affects the precision of each reading.

3.5 Measurements of the craniofacial complex

Twenty two linear measurement were taken; five for the head, seven for the face, four for the orbits, 3 for the nose and 3 for the lips and mouth. The relationship between these measurements was determined using seventeen proportion indices; 2 for the head, six for the face, two for the orbits, four for the nose and three for the lips and mouth. Every measurement was taken twice by the same examiner and recorded in the corresponding form. In case if there is a large discrepancy between initial two measurements than the third measurement must be taken and two closer readings would then be used. Prior to this study, an intra examiner and inter-examiners calibration exercise was done at the Department of Oral and Maxillofacial Surgery. This methodology and evaluation of indices of the craniofacial region was adapted from Hajnis et al. (1994).

3.6 Craniofacial landmarks

To ease orientation and ensure uniformity in anthropometric terminology, the landmarks are named according to Greek or Latin anatomical terminology. Abbreviations of the landmarks are used instead of full names and lowercase letters are used instead of uppercase letters. As for example n denotes nasal point on the surface as oppose to uppercase N in roentgenocephalometry.

Table 3.6.1 Craniofacial landmarks of the head

No	Landmark	Definition
1	Vertex(v)	The highest point of the head when the head is in the Frankfort Horizontal Plane
2	Glabella (g) or nasal eminence	The most prominent point in the median sagittal plane between the supra orbital ridges
3	Opyhron (on)	The point at the mid plane of a line tangent to the upper limits of the eyebrow
4	Opisthocranium (op)	The most prominent posterior point of the occiput
5	Eurion (eu)	The most prominent lateral point on each side of the skull in the area of parietal and temporal bones

Table 3.6.2 Craniofacial landmarks of the face

No	Landmark	Definition
1	Zygion (z)	The most lateral point on the zygomatic arch, identified by the maximum bizygomatic (facial) breadth
2	Nasion (n)	The midpoint of the nasofrontal suture
3	Subnasale (sn)	The midpoint of the angle at the columella base where the lower border of the nasal septum and the surface of the upper lip meet. The landmark is identified in base view of the nose or from the side
4	Stomion (sto)	The midpoint of the labial fissure when the lips are closed and the teeth shut in the natural position
5	Gnathion (gn) or Menton	The lowest median landmark on the lower border of the mandible. This is a bony landmark and requires pressing the instrument down to reduce the effect of the soft tissue as much as possible
6	Tragion (t)	The notch on the upper margin of the tragus

Table 3.6.3 Craniofacial landmark of the orbit

No	Landmark	Definition
1	Endocanthion (en)	The point at the inner commisure of the eye fissure
2	Exocanthion (ex)	The point at the outer commisure of the eye fissure
3	Palpebrale Superius (ps)	The highest point in the mid portion of the free margin of each upper eyelid
4	Palpebrale inferius (pi)	The lowest point in the mid portion of the free margin of each lower eyelid

Table 3.6.4 Craniofacial landmark of the nose

No	Landmark	Definition
1	Alare (al)	The most lateral point on each alar contour
2	Nasion (n)	The point in the midline of both nasal and root and the frontonasal suture
3	Subnasale (sn)	The midpoint of the angle of the columella base where the lower border of the nasal septum and the surface of the upper lip meet
4	Pronasale (prn)	The most protruded point of the nasal tip, identified on the lateral view of the rest position of the head

Table 3.6.5 Craniofacial landmark of the lips and mouth

No	Landmark	Definition
1	Cheilion (ch)	Point located at each labial commisure
2	Sublabiale (sl)	Determines the lower border of the lower lip or the upper border of chin correspond with the mentolabial ridge

3.7 The proportion index

The relationship of two or more measurements taken from the surface of the head and face is quantified by the numerical proportion index. The formulation of an index is derived by;

$$\text{Index (I)} = \frac{\text{Numerator (smaller measurement)}}{\text{Denominator (larger measurement)}} \times 100$$

From the formula, the smaller measurement is expressed by a percentage of the larger one. It provides information about relative sizes of two parts of the body. The mean index value is obtained from a representative number of selected similar subjects and represents the average proportion between the related measurements.

Standard deviation (SD) quantifies the normal differences between the index values of the members of the samples. It determines the width of the normal range of the index from 2 SD below to 2 SD above the mean. All indices in the normal range are regarded as variations of normal proportions. Even in the most homogenous sample, individual proportion indices may differ somewhat due to individuality.

There are numerous proportion indices that have been developed but in this study only seventeen indices were chosen from the craniofacial region which was thought best to represent the differences in these subjects.

3.8 Anthropometric measurement

The measurements of the head, face, orbits, nose, lips and mouth are carried out according to standard methods of physical anthropometry (Farkas, 2000)

Table 3.8.1 Head measurement

No	Landmark	Measurement definition and instrument
1	head width (eu-eu)	The distance between the eurions. Instrument; spreading calliper
2	Length of the head (g-op)	The distance between the glabella and the occipital Instrument; spreading calliper
3	Height of the head (v-n)	The distance between vertex and nasion Instrument; modified double sliding calliper
4	Craniofacial height (v-gn)	The distance between vertex and gnathion, it measured the vertical height of the head and the face. Instrument; modified double sliding calliper
5	Head circumference (on-op)	The circular distance of the head Instrument; soft measuring tape

The proportion derived from the se measurement are :

1. Cephalic index = eu-eu x 100/g-op
2. Head craniofacial height index = v-n x 100/v-gn

Table 3.8.2 Facial measurement

No	Landmark	Measurement definition and instrument
1	Face width (zy-zy)	The widest part of the face between the zygons Instrument spreading calliper
2	Mandible width (go-go)	The distance between the gonions Instrument; spreading calliper
3	Face height (n-gn)	The distance between the nasion and the gnathion Instrument; sliding calliper
4	Upper face height (n-sto)	The distance between the nasion and the stomion Instrument; sliding calliper
5	Mandible height (sto-gn)	The distance between the stomion and the gnathion Instrument; sliding calliper
6	Maxillary depth (t-sn), left	The distance between tragion and the subnasale Instrument; spreading calliper
7	Mandible depth (t-gn), left	The distance between tragion and gnathion Instrument; spreading calliper

The proportion derived from the se measurements are:

1. Facial index = n-gn x100/zy-zy
2. Mandibular index = sto-gn x 100/go-go
3. Upper face-face height index = n-sto x 100/n-gn
4. Mandible-face height index = sto-gn x 100/n-gn
5. Mandible face width index = go-go x 100/zy-zy
6. Middle lower third face index = t-sn x 100/t-gn

Table 3.8.3 Orbital measurements

No	Landmark	Measurement definition and instrument
1	Intercanthal width (en-en)	The distance between the endocanthions Instrument; sliding calliper
2	Binocular width (ex-ex)	The distance between exocanthions Instrument; sliding calliper
3	Eye fissure length (ex-en), left	The distance between the endocanthion and the exocanthion Instrument; sliding calliper
4	Eye fissure height (ps-pi), left	The distance between the free edges of each eyelid Instrument; sliding calliper

The proportions derived from the se measurements are

1. Intercanthal index = en-en x 100/ex-ex
2. Eye fissure index = ps-pi x 100/ex-en

Table 3.8.4 Nasal measurement

No	Landmark	Measurement definition and instrument
1	Nose width (al-al)	The distance between the most lateral points on the alae Instrument; sliding calliper
2	Nose height (n-sn)	The distance between the nasion and the subnasale Instrument; sliding calliper
3	Nasal tip protrusion (sn-prn)	The distance between the subnasale and the pronasale Instrument; sliding calliper

The proportion derived from the se measurements are

1. Nasal index = al-al x 100/n-sn
2. Nasal tip protrusion length-nose width index = sn-prn x 100/al-al
3. Nose-face height index = n-sn x 100/n-gn
4. Nose-face width index = al-al x 100/zy-zy

Table 3.8.5 Lips and mouth measurements

No	Landmark	Measurement definition and instrument
1	Upper lip height (sn-sto)	The distance between subnasale and the stomion Instrument; sliding calliper
2	Mouth width (ch-ch)	The distance between the cheilions of the closed mouth Instrument; sliding calliper
3	Lower lip height (sto-sl)	The distance between the stomion and the sublabiale Instrument; sliding calliper

The proportions derived from the se measurements are

1. Upper lip height-mouth width index = sn-sto x 100/ch-ch
2. Lower-upper lip height index = sto-sl x 100/sn-sto
3. Mouth-face width index = ch-ch x 100/zy-zy

3.9 Statistic analysis

Data collected are entered into SPSS software (version 11.5) and statistical analysis was performed by the use of parametric test, one way ANOVA test to compare the difference in means between two groups. It is well accepted that the one way ANOVA is to test for significant differences between two means of two or more groups and it is more efficient at detecting a true difference. If only two means are compared, ANOVA will give the same results as the t-test. Rather than conducting multiple t-test, a one way ANOVA test would be appropriate to obtain results for multiple comparisons of the 2 age group in this study. The significant value is set at 95% (p=0.05). Data are presented as mean ± SD.

Chapter 4 : Results

4.1 Head

In the head region, five anthropometric measurements were measured; head width (eu-eu), head length (g-op), head height (v-n), craniofacial height (v-gn) and head circumference (on-op)

4.1.1 Head width (eu-eu)

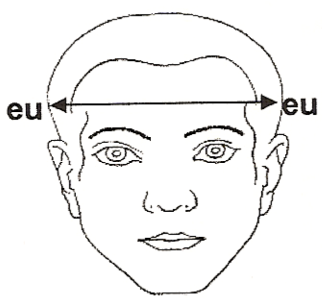


Table 4.1.1 Head width (eu-eu)

Gender / Group	Age	Mean ± SD	p-value
Male	7	142.62 ± 5.15	0.00
Female	7	138.76 ± 4.87	
Male	12	146.36 ± 5.39	0.78
Female	12	145.28 ± 7.17	
Male	7	142.62 ± 5.15	0.00
Male	12	146.36 ± 5.39	
Female	7	138.76 ± 4.87	0.00
Female	12	145.28 ± 7.17	

The mean value for the head width (eu-eu) for the female and male aged 7 and 12 years are shown in Table 4.2.1. The head width in both 7 and 12 year old male are generally larger than the female's. There is a significance difference in head width between male and female in the 7 year old ($p<0.05$) but no significance difference is noted in the 12 year old ($p>0.05$). It also shows that there is a significant difference ($p<0.05$) when comparing the head width in both gender as the age increased. Interestingly the result shows that the 7 year old male has a larger head width as compared to 12 year old female but statistically the differences are not significant ($p=0.09$).

4.1.2 Head length (g-op)

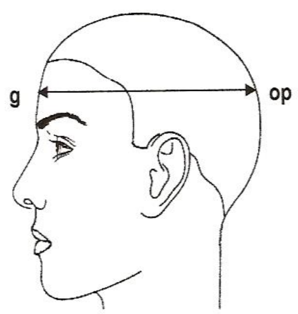


Table 4.1.2 Head Length (g-op)

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	175.20 ± 9.33	0.02
Female	7	169.34 ± 7.28	
Male	12	179.10 ± 9.21	0.99
Female	12	179.66 ± 14.27	
Male	7	175.20 ± 9.33	0.23
Male	12	179.10 ± 9.21	
Female	7	169.34 ± 7.28	0.00
Female	12	179.66 ± 14.27	

The head length of the 7 year old male is higher than the female and the difference is significant ($p<0.05$). However the female in 12 year old group has a higher head length compared to the male of the same age, but statistically the difference is not significant ($p>0.05$). The head length are higher in elder group in both gender however there is no significance difference ($p>0.05$) between males but a significant different ($p<0.05$) between females.

4.1.3 Head height (v-n)

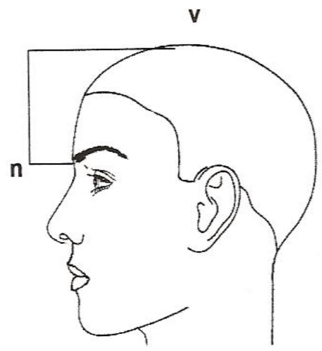


Table 4.1.3 Head height

Gender / Group	Age	Mean ± SD	p-value
Male	7	86.74 ± 9.56	1.00
Female	7	86.58 ± 8.26	
Male	12	95.12 ± 11.92	0.15
Female	12	91.06 ± 8.09	
Male	7	86.74 ± 9.56	0.00
Male	12	95.12 ± 11.92	
Female	7	86.58 ± 8.26	0.09
Female	12	91.06 ± 8.09	

For this parameter, it is found that the head height (v-n) is higher in male in for both age groups as compared to female, however the differences were not statistically significant ($p<0.05$). The head height is higher in elder group than younger group in both genders. However only the males shows a significant difference ($p<0.05$).

4.1.4 Craniofacial height (v-gn)

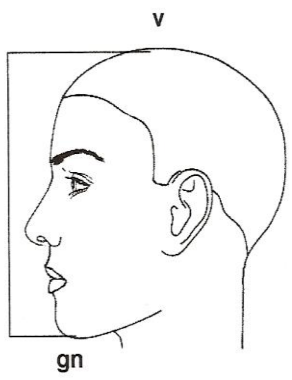


Table 4.1.4 Craniofacial height (v-gn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	190.72 ± 7.60	0.88
Female	7	189.02 ± 10.31	
Male	12	208.52 ± 12.09	0.00
Female	12	200.56 ± 15.19	
Male	7	190.72 ± 7.60	0.00
Male	12	208.52 ± 12.09	
Female	7	189.02 ± 10.31	0.00
Female	12	200.56 ± 15.19	

When measuring the craniofacial height, males in both age group have a higher measurement in comparison to female. The result shows no significance difference when comparing male and female in 7 years old ($p>0.05$). However the craniofacial height is higher in elder group and this difference was statistically significant for both genders ($p<0.05$).

4.1.5 Head circumference(on-op)

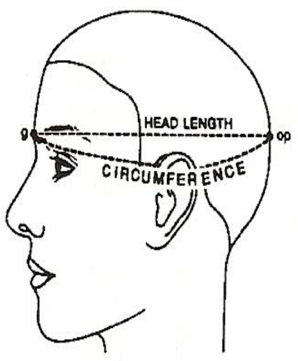


Table 4.1.5 Head circumference (on-op)

Gender / Group	Age	Mean ± SD	p-value
Male	7	512.90 ± 13.28	0.33
Female	7	496.06 ± 65.97	
Male	12	537.92 ± 17.12	0.95
Female	12	532.62 ± 72.42	
Male	7	512.90 ± 13.28	0.06
Male	12	537.92 ± 17.12	
Female	7	496.06 ± 65.97	0.00
Female	12	532.62 ± 72.42	

The head circumference of male shows the largest value in both age groups however this different is not statistically significant ($p>0.05$). It is also found that the head circumference is higher in elder group. However the result is statistically significant only in female ($p<0.05$).

4.1.6 Cephalic Index (eu-eu x 100/g-op)

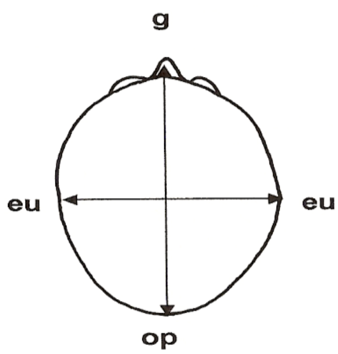


Table 4.1.6 Cephalic Index (eu-eu x 100/g-op)

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	81.61 ± 4.95	0.96
Female	7	82.06 ± 4.05	
Male	12	81.92 ± 4.98	0.88
Female	12	82.20 ± 5.74	
Male	7	81.61 ± 4.95	0.99
Male	12	81.92 ± 4.98	
Female	7	82.06 ± 4.05	0.82
Female	12	82.20 ± 5.74	

In general the cephalic index of male for both age group is lower than the females. However the differences is not statistically significance ($p>0.05$). Age wise the elder group shows slight higher value than younger group in cephalic index. However the result is not statistically significant ($p>0.05$).

4.1.7 Head-Craniofacial Height Index (v-n x100/v-gn)

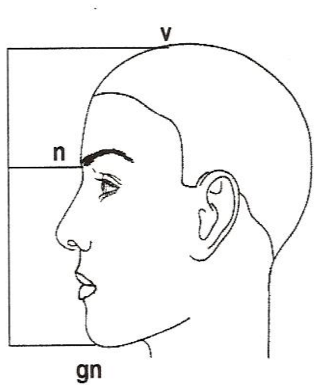


Table 4.1.7 Head-Craniofacial Height Index

Gender / Group	Age	Mean ± SD	p-value
Male	7	45.47 ± 4.59	0.98
Female	7	45.77 ± 3.10	
Male	12	45.57 ± 4.74	0.99
Female	12	45.83 ± 4.01	
Male	7	45.47 ± 4.59	0.99
Male	12	45.57 ± 4.74	
Female	7	45.77 ± 3.10	0.99
Female	12	45.83 ± 4.01	

In general the head-craniofacial height index between male and female shows almost no difference in both age group. However the findings is not statistically significance (p>0.05). Age wise, there is also almost no differences in this index in the age group of twelve and seven. However this differences were not statistically significant (p>0.05).

4.2 Face

There are seven (7) anthropometric measurements performed; face width (zy-zy), mandible width (go-go), face height (n-gn), upper face height (n-sto), mandible height (sto-gn), left maxillary depth (t-sn) and left mandibular depth (t-gn). Form these measurements, five (5) proportion indices are derived.

4.2.1 Face width (zy-zy)

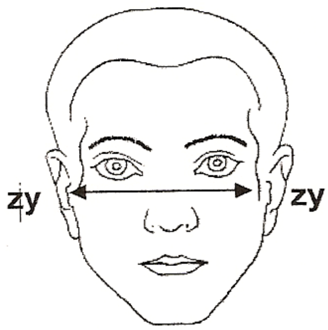


Table 4.2.1 Face width (zy-zy)

Gender / Group	Age	Mean ± SD	p-value
Male	7	116.72 ± 5.43	0.05
Female	7	113.12 ± 4.96	
Male	12	127.56 ± 8.34	0.88
Female	12	126.52 ± 8.48	
Male	7	116.72 ± 5.43	0.00
Male	12	127.56 ± 8.34	
Female	7	113.12 ± 4.96	0.00
Female	12	126.52 ± 8.48	

Widths for both male and female in 2 different age groups are showed in Table 4.2.1. Basically male in both age groups have a larger face width as compared to the female.however the differences is not statistically significant ($p>0.05$). The results also shows that the face width increases as the age increases and the difference is statistically significant ($p<0.05$).

4.2.2 Mandible width (go-go)

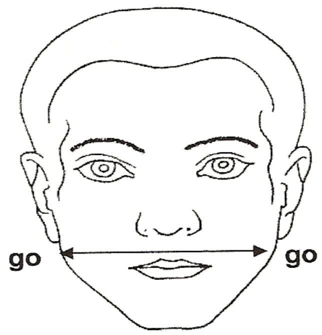


Table 4.2.2 Mandible width (go-go)

Gender / Group	Age	Mean ± SD	p-value
Male	7	94.08 ± 5.67	0.06
Female	7	90.82 ± 4.83	
Male	12	103.00 ± 7.45	0.01
Female	12	98.98 ± 7.65	
Male	7	94.08 ± 5.67	0.00
Male	12	103.00 ± 7.45	
Female	7	90.82 ± 4.83	0.00
Female	12	98.98 ± 7.65	

Based on the Table 4.2.2, the mean values for the mandible width are larger in male for both age groups. However the different only shows statistically significant in age group of 12 year old ($p<0.05$). Basically from the results, the mandible width is increase as the age increases and the difference is statistically significant for both gender ($p<0.05$).

4.2.3 Face height (n-gn)

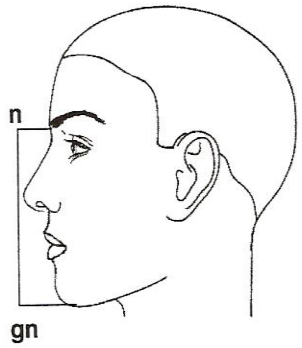


Table 4.2.3 Face Height (n-gn)

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	100.54 ± 6.03	0.04
Female	7	97.58 ± 3.90	
Male	12	110.80 ± 6.88	0.31
Female	12	108.83 ± 5.51	
Male	7	100.54 ± 6.03	0.00
Male	12	110.80 ± 6.88	
Female	7	97.58 ± 3.90	0.00
Female	12	108.83 ± 5.51	

The mean value for the face height is smaller in female as compared to male in the same age group. However the different is statistically significant only in age group of 7 year old ($p<0.05$). The face height is increases as the age increases and the difference is significant for both gender ($p<0.05$).

4.2.4. Upper face height (n-sto)

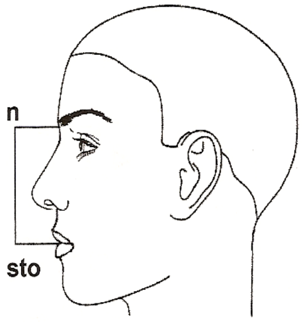


Table 4.2.4 Upper face height (n-sto)

Gender / Group	Age	Mean ± SD	p-value
Male	7	65.00 ± 4.67	0.24
Female	7	63.37 ± 3.40	
Male	12	72.10 ± 5.33	0.15
Female	12	70.26 ± 3.83	
Male	7	65.00 ± 4.67	0.00
Male	12	72.10 ± 5.33	
Female	7	63.37 ± 3.40	0.00
Female	12	70.26 ± 3.83	

For this parameter, the male has a higher upper face height than the female. However the differences are not significant in both age group ($p>0.05$). The face height increases as the age increases and the differences are statistically significant for both gender ($p<0.05$)

4.2.5. Mandible height (sto-gn)

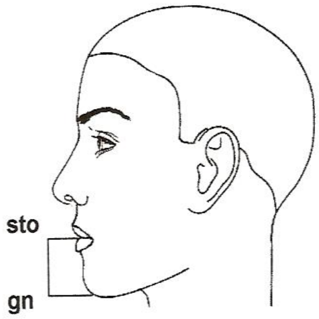


Table 4.2.5 Mandible height (sto-gn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	36.43± 2.94	0.63
Female	7	35.59± 35.59	
Male	12	41.55± 4.38	0.71
Female	12	40.80 ± 3.67	
Male	7	36.43± 2.94	0.00
Male	12	41.55± 4.38	
Female	7	35.59± 35.59	0.00
Female	12	40.80 ± 3.67	

As shown in Table 4.2.5., the mean value for mandible height is higher in male than female for both age group but the difference is not statistically significant ($p>0.05$). It is also found that the mandible height are increases as the age increases and the difference is statistically significant for both gender ($p<0.05$).

4.2.6. Left maxillary depth (t-sn)

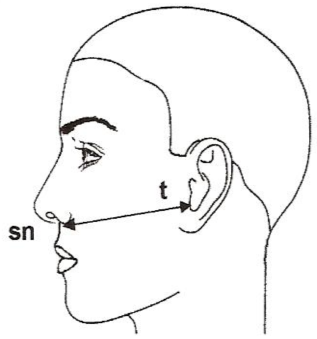


Table 4.2.6 Left maxillary depth (t-sn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	107.58 ± 4.38	0.07
Female	7	105.02 ± 4.66	
Male	12	119.08 ± 6.30	0.01
Female	12	115.99 ± 5.42	
Male	7	107.58 ± 4.38	0.00
Male	12	119.08 ± 6.30	
Female	7	105.02 ± 4.66	0.00
Female	12	115.99 ± 5.42	

As shown in the Table 4.2.6., the mean value for maxillary depth is larger in male than female for both age group but the difference is statistically significant only in the twelve years old ($p<0.05$). It is also found that the maxillary depth increases as the age increases and the results is significant in both gender ($p<0.05$)

4.2.7. Mandibular depth (t-gn), left

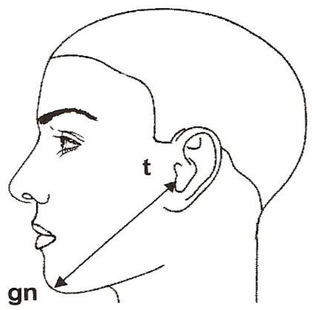


Table 4.2.7 Mandibular depth (t-gn), left

Gender / Group	Age	Mean ± SD	p-value
Male	7	115.28 ± 5.21	0.03
Female	7	111.86 ± 4.69	
Male	12	130.14 ± 7.18	0.01
Female	12	126.47 ± 7.25	
Male	7	115.28 ± 5.21	0.00
Male	12	130.14 ± 7.18	
Female	7	111.86 ± 4.69	0.00
Female	12	126.47 ± 7.25	
Male	7	115.28 ± 5.21	0.00
Female	12	126.47 ± 7.25	
Male	12	130.14 ± 7.18	0.00
Female	7	111.86 ± 4.69	

When measuring the mandibular depth, it has been found that the male has a larger mandibular depth than female for both age group and these findings were statistically significant ($p<0.05$). It is shown that the mandibular depth increases as the age increases and the difference is statistically significant for both genders ($p<0.05$).

4.2.8. Facial Index (n-gn x 100/zy-zy)

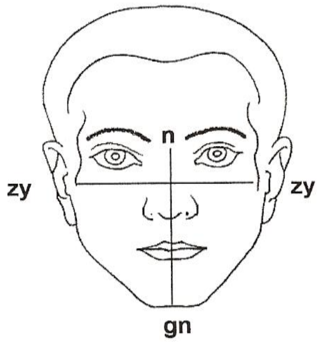


Table 4.2.8 Facial Index (n-gn x 100/zy-zy)

Gender / Group	Age	Mean ± SD	p-value
Male	7	86.22 ± 5.26	0.99
Female	7	86.39 ± 4.67	
Male	12	87.06 ± 5.71	0.89
Female	12	86.29 ± 5.92	
Male	7	86.22 ± 5.26	0.86
Male	12	87.06 ± 5.71	
Female	7	86.39 ± 4.67	1.00
Female	12	86.29 ± 5.92	

At age 7, the facial index mean value shows that there is almost no difference between male and female. At age 12 the index slightly larger in male as compared to the female. However these differences are not statistically significant ($p>0.05$).

In male, it has been shown that the mean increases as the age increases. Interestingly in female, the facial index decreases as the age increases. However these differences are not statistically significant ($p>0.05$).

4.2.9. Mandibular index (sto-gn x 100/go-go)

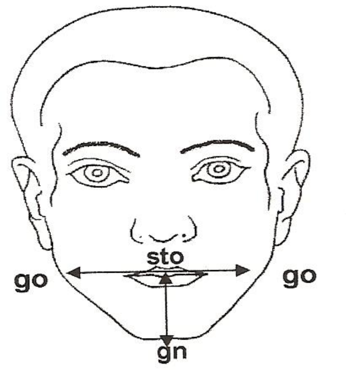


Table 4.2.9 Mandibular index (sto-gn x 100/go-go)

Gender / Group	Age	Mean ± SD	p-value
Male	7	38.78 ± 3.03	0.96
Female	7	39.32 ± 4.10	
Male	12	40.50 ± 4.81	0.68
Female	12	41.43 ± 4.49	
Male	7	38.78 ± 3.03	0.16
Male	12	40.50 ± 4.81	
Female	7	39.32 ± 4.10	0.06
Female	12	41.43 ± 4.49	

The mean value for mandibular index fort the female is higher results as compared to male in both age group but the differences are not statistically significant (p>0.05). It has been shown that the mandibular index increases as the age increases but statistically the differences are not significant (p>0.05).

4.2.10 Upper face-face height index (n-sto x 100/n-gn)

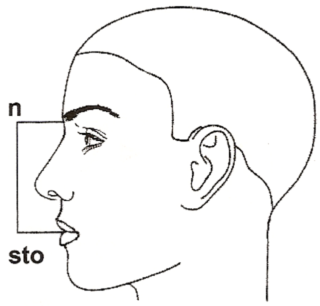


Table 4.2.10 Upper face-face height index (n-sto x 100/n-gn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	64.66 ± 2.81	0.94
Female	7	64.96 ± 2.68	
Male	12	65.08 ± 2.98	0.78
Female	12	64.98 ± 2.21	
Male	7	64.66 ± 2.81	0.86
Male	12	65.08 ± 2.98	
Female	7	64.96 ± 2.68	0.89
Female	12	64.98 ± 2.21	

At age 7, the upper face-face height index for the female is slightly larger than for the male but at the age of 12, male has achieved higher upper face-face height index. The index also increases as the age increases for both genders. However all these differences are not statistically significant ($p>0.05$).

4.2.11 Mandible-upper face height index sto-gn x 100/n-gn)

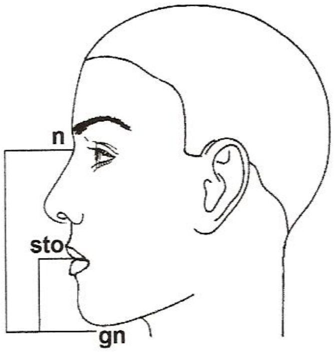


Table 4.2.11 Mandible-upper face height index (sto-gn x 100/n-gn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	36.24 ± 1.98	0.97
Female	7	36.46 ± 2.46	
Male	12	37.50 ± 3.14	1.00
Female	12	37.48 ± 2.65	
Male	7	36.24 ± 1.98	0.07
Male	12	37.50 ± 3.14	
Female	7	36.46 ± 2.46	0.20
Female	12	37.48 ± 2.65	

The mean of mandible-upper face height index is showed in Table 4.2.11. It was noted that the female in seven year old group has a larger index as compared to the male but as the male reached twelve years old they has a larger mandible-upper face height index than the female. However the differences is not statistically significant ($p>0.05$). There is a slight increase in the index as the age increases for both genders but the differences are not statistically significant ($p>0.05$)

4.2.12 Mandible-face width index (go-gox100/zy-zy)

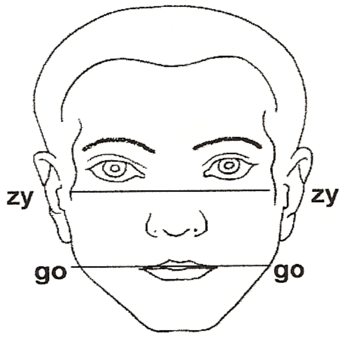


Table 4.2.12 Mandible-face width index (go-gox100/zy-zy)

Gender / Group	Age	Mean ± SD	p-value
Male	7	80.68 ± 4.69	0.97
Female	7	80.33 ± 3.65	
Male	12	80.81 ± 4.14	0.02
Female	12	78.31 ± 4.74	
Male	7	80.68 ± 4.69	0.99
Male	12	80.81 ± 4.14	
Female	7	80.33 ± 3.65	0.09
Female	12	78.31 ± 4.74	

Generally the male has a larger mandible-face width index than the female. However the difference is statistically significant only in age group of twelve ($p<0.05$). In female, the mandible-face width index decreases from 80.33% to 78.31% as the age increases. This change is not observed in male group, which the index increases slightly as the age increases. However, the differences are not statistically significant ($p>0.05$).

4.2.13 Middle-lower third face depth index (t-sn x 100/t-gn)

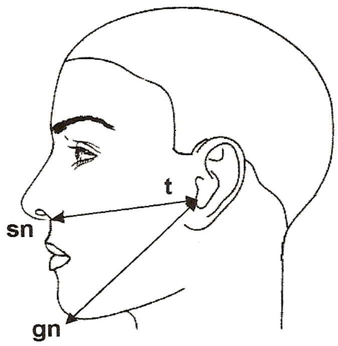


Table 4.2.13 Middle-lower third face depth index (t-sn x 100/t-gn)

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	93.37 ± 2.60	0.69
Female	7	93.90 ± 2.17	
Male	12	91.54 ± 2.46	0.94
Female	12	91.79 ± 2.47	
Male	7	93.37 ± 2.60	0.00
Male	12	91.54 ± 2.46	
Female	7	93.90 ± 2.17	0.00
Female	12	91.79 ± 2.47	
Male	7	93.37 ± 2.60	0.00
Female	12	91.79 ± 2.47	
Male	12	91.54 ± 2.46	0.00
Female	7	93.90 ± 2.17	

For the middle-lower third face depth index, female has a larger result for both age groups. However statistically the differences were not significant (p>0.05). The middle-lower third face depth index decrease slightly in both gender as the age increases and this finding is significant (p<0.05).

<u>4.3 Orbits</u>

In the orbit region, four anthropometric measurements are performed. These measurements are; intercanthal width (en-en), binocular width (ex-ex), left eye fissure length (ex-en) and left fissure height (ps-pi). Form these measurements, two proportions indices are derived, namely intercanthal index and eye fissure index.

4.3.1. Intercanthal width (en-en)

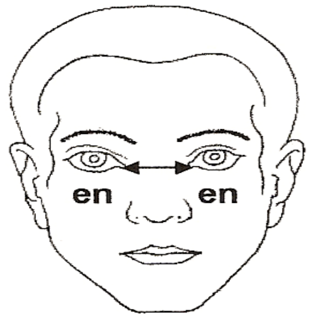


Table 4.3.1 Intercanthal width (en-en)

Gender / Group	Age	Mean ± SD	p-value
Male	7	32.41 ± 2.04	0.38
Female	7	31.70 ± 2.19	
Male	12	34.48 ± 2.13	0.54
Female	12	33.88 ± 2.54	
Male	7	32.41 ± 2.04	0.00
Male	12	34.48 ± 2.13	
Female	7	31.70 ± 2.19	0.00
Female	12	33.88 ± 2.54	

Table 4.3.1. shows that male has a larger intercanthal width than female for both age groups. However the difference is not statistically significant (p>0.05). The intercanthal width has significantly increases as the age increases both male and female. This difference is statistically significant in both gender(p<0.05).

4.3.2. Biocular width (ex-ex)

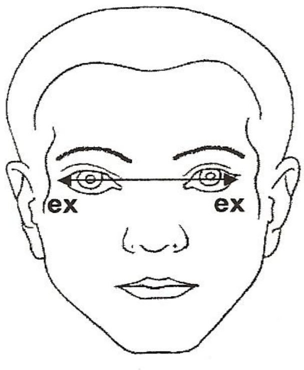


Table 4.3.2 Biocular width (ex-ex)

Gender / Group	Age	Mean ± SD	p-value
Male	7	92.74 ± 3.89	0.02
Female	7	89.74 ± 4.37	
Male	12	101.02 ± 4.00	0.15
Female	12	99.28 ± 4.21	
Male	7	92.74 ± 3.89	0.00
Male	12	101.02 ± 4.00	
Female	7	89.74 ± 4.37	0.00
Female	12	99.28 ± 4.21	
Male	7	92.74 ± 3.89	0.00
Female	12	99.28 ± 4.21	
Male	12	101.02 ± 4.00	0.00
Female	7	89.74 ± 4.37	

The means for biocular width is larger in the male as compared to the female in both age groups. However statistically the difference is only significant in age group of seven. The biocular width has significantly increases as the age increases in both male and female. Statistically the differences are significant for both gender ($p<0.05$).

4.3.3. Eye fissure length (ex-en), left

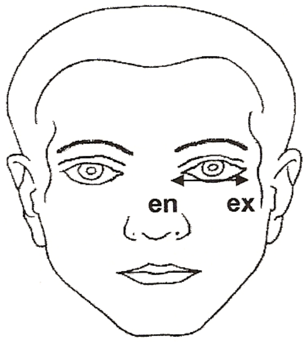


Table 4.3.3 Eye fissure length (ex-en), left

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	33.46 ± 1.88	0.15
Female	7	32.62 ± 2.01	
Male	12	35.89 ± 1.96	0.88
Female	12	35.60 ± 2.10	
Male	7	33.46 ± 1.88	0.00
Male	12	35.89 ± 1.96	
Female	7	32.62 ± 2.01	0.00
Female	12	35.60 ± 2.10	

Table 4.3.3. shows the result of eye fissure length and the data shows that the eye fissure length is slightly higher in male than female for both aged group. However statistically the differences are not significant ($p>0.05$). As the age increases the width also increases and the difference were significant in both male and female ($p<0.05$).

4.3.4. Eye fissure height (ps-pi), left

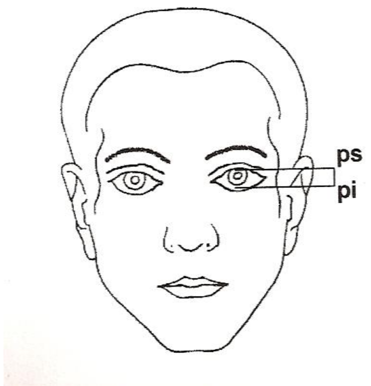


Table 4.3.4 Eye fissure height (ps-pi), left

Gender / Group	Age	Mean ± SD	p-value
Male	7	9.65 ± 0.83	0.99
Female	7	9.69 ± 0.98	
Male	12	8.9 ± 0.74	0.50
Female	12	9.1 ± 0.85	
Male	7	9.65 ± 0.83	0.00
Male	12	8.9 ± 0.74	
Female	7	9.69 ± 0.98	0.02
Female	12	9.1 ± 0.85	

For both age groups, male has slightly shorter in eye height than female, however the differences are not significant ($p>0.05$). Interestingly the findings shows that the eye fissure height decreases as the age increases for both gender and the difference is statistically significant($p<0.05$). Further analysis shows that for both gender the seven years old group has a higher height in eye fissure as compared to the aged group of twelve and the differences are significant ($p<0.05$).

4.3.5. Intercanthal index (en-en x 100/ex-ex)

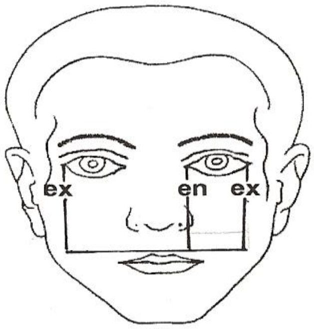


Table 4.3.5 Intercanthal index (en-en x 100/ex-ex)

Gender / Group	Age	Mean ± SD	p-value
Male	7	34.96 ± 1.82	0.77
Female	7	35.34 ± 2.02	
Male	12	34.14 ± 1.83	1.00
Female	12	34.13 ± 2.18	
Male	7	34.96 ± 1.82	0.16
Male	12	34.14 ± 1.83	
Female	7	35.34 ± 2.02	0.01
Female	12	34.13 ± 2.18	

The female shows a slightly greater mean value in intercanthal index as compared to the male in seven year old group. For the twelve year old group there is no difference in the mean value for the intercanthal index. However statistically the differences are not significant ($p>0.05$). The intercanthal index decreases as the age increases for both age group. Further analysis shows that the intercanthal index is lesser in twelve year old group as compared to the seven year old group. However statistically the differences only significant for the female ($p<0.05$).

4.3.6. Eye fissure index (ps-pi x 100/ex-en)

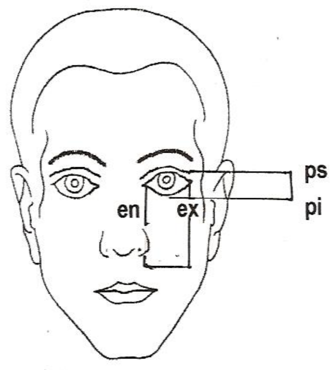


Table 4.3.6 Eye fissure index (ps-pi x 100/ex-en)

Gender / Group	Age	Mean ± SD	p-value
Male	7	28.89 ± 2.59	0.34
Female	7	29.78 ± 3.21	
Male	12	24.99 ± 2.01	0.31
Female	12	25.91 ± 2.73	
Male	7	28.89 ± 2.59	0.00
Male	12	24.99 ± 2.01	
Female	7	29.78 ± 3.21	0.00
Female	12	25.91 ± 2.73	

From the Table 4.3.6. it can be noted that the female has a greater eye fissure index as compared to the male in both aged group. However the difference is statistically not significant ($p>0.05$).

It is has been found that the eye fissure index is decreases from 28.89% to 24.99% in male and from 29.78% to 25.91% in female as the aged increases. The differences are statistically significant ($p<0.05$). l

4.4 Nose

Three anthropometric measurements are carried in the nose region, namely nose width (al-al), nose height (n-sn) and nasal tip protrusion (sn-prn). From these measurements four proportion indices are obtained; nasal index, nasal tip protrusion length -nose width index, nose-face height index and nose-face width index.

4.4.1 Nose width (al-al)

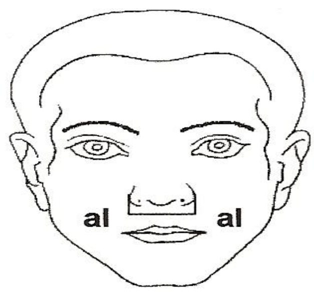


Table 4.4.1 Nose width (al-al)

Gender / Group	Age	Mean ± SD	p-value
Male	7	32.48 ± 1.52	0.21
Female	7	31.66 ± 1.71	
Male	12	36.13 ± 2.61	0.11
Female	12	35.18 ± 2.38	
Male	7	32.48 ± 1.52	0.00
Male	12	36.13 ± 2.61	
Female	7	31.66 ± 1.71	0.00
Female	12	35.18 ± 2.38	

The recorded mean value for nose width is higher in male in both age groups than female as shown in Table 4.4.1. However this differences are not statistically significant ($p>0.05$). The nose width increased significantly as the age increases and this finding is same for the both gender. The differences for this changes are statistically significant ($p<0.05$).

4.4.2 Nose height (n-sn)

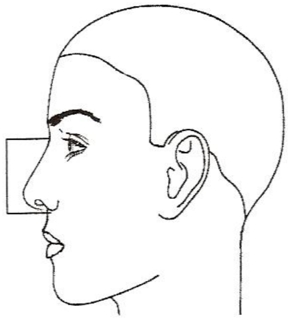


Table 4.4.2 Nose height (n-sn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	45.02 ± 3.20	0.88
Female	7	44.52 ± 2.52	
Male	12	50.96 ± 4.80	0.96
Female	12	51.29 ± 2.73	
Male	7	45.02 ± 3.20	0.00
Male	12	50.96 ± 4.80	
Female	7	44.52 ± 2.52	0.00
Female	12	51.29 ± 2.73	

For this parameter, the nose height is higher in male as compared to the female in seven year old group. For the twelve year old group it shows that the female has a higher nose width than male. The differences for these findings are not statistically significant ($p>0.05$). The nose height also increases significantly as the age increases and this occurred in both male and female ($p<0.05$).

4.4.3 Nasal tip protrusion (sn-prn)

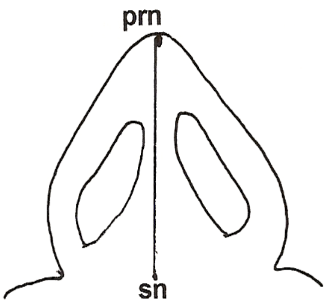


Table 4.4.3 Nasal tip protrusion (sn-prn)

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	11.90 ± 1.30	1.06
Female	7	11.88 ± 1.40	
Male	12	14.24 ± 2.30	0.89
Female	12	14.47 ± 1.25	
Male	7	11.90 ± 1.30	0.00
Male	12	14.24 ± 2.30	
Female	7	11.88 ± 1.40	0.00
Female	12	14.47 ± 1.25	

Table 4.4.3. shows that in 7 year old group the male has a larger nasal tip protrusion than female. On the other hand for the 12 year old group it has been shown that the female has a larger nasal tip protrusion than male. However the differences are not statistically significant ($p>0.05$). The nasal tip protrusion increases as the age increases for both male and female and this differences are statistically significant ($p<0.05$).

4.4.4 Nasal index (al-al x 100/n-sn)

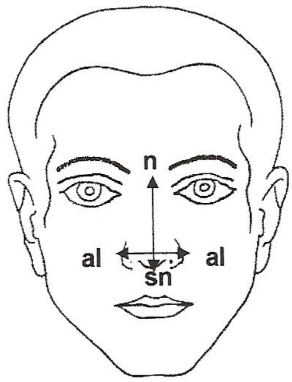


Table 4.4.4 Nasal index (al-al x 100/n-sn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	72.45 ± 5.67	0.79
Female	7	71.28 ± 4.80	
Male	12	71.51 ± 8.39	0.15
Female	12	68.82 ± 6.32	
Male	7	72.45 ± 5.67	0.88
Male	12	71.51 ± 8.39	
Female	7	71.28 ± 4.80	0.22
Female	12	68.82 ± 6.32	

Table 4.4.4. shows that the male generally has a larger nasal index than female for both aged groups. However the differences are not statistically significant ($p>0.05$). The nasal index decreases from 72.45% to 71.51% in male and from 71.28% to 68.82% in female as the aged increases but statistically the differences are not significant ($p>0.05$) for both genders.

4.4.5 Nasal tip protrusion-nose width index (sn-prn x 100/al-al)

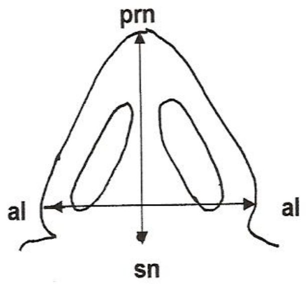


Table 4.4.5 Nasal tip protrusion length -nose width index (sn-prn x 100/al-al)

Gender / Group	Age	Mean ± SD	p-value
Male	7	36.69 ± 3.93	0.80
Female	7	37.54 ± 4.09	
Male	12	39.52 ± 6.57	0.26
Female	12	41.26 ± 3.95	
Male	7	36.69 ± 3.93	0.01
Male	12	39.52 ± 6.57	
Female	7	37.54 ± 4.09	0.00
Female	12	41.26 ± 3.95	

Generally the female has a greater nasal tip protrusion-nose width index than male in both 7 and 12 year old groups. However this differences are not significant ($p>0.05$). The index also increases as the age increases for both male and female and the differences are statistically significant ($p<0.05$).

4.4.6 Nose-face height index (n-sn x 100/n-gn)

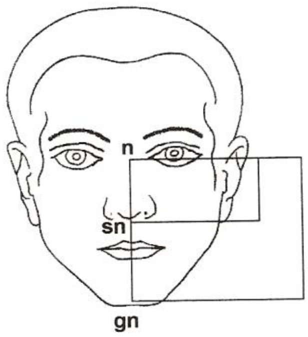


Table 4.4.6 Nose-face height index (n-sn x 100/n-gn)

Gender / Group	Age	Mean ± SD	p-value
Male	7	44.83 ± 2.75	0.39
Female	7	45.65 ± 2.46	
Male	12	45.94 ± 2.53	0.07
Female	12	47.19 ± 2.61	
Male	7	44.83 ± 2.75	0.14
Male	12	45.94 ± 2.53	
Female	7	45.65 ± 2.46	0.01
Female	12	47.19 ± 2.61	

For the nasal-face height index, females of both age groups have a greater index compared to male but the differences are not statistically significant ($p>0.05$). The index increases as the age increases from seven to twelve years but the differences only significant in female ($p<0.05$).

4.4.7 Nose-face width index (al-al x 100/zy-zy)

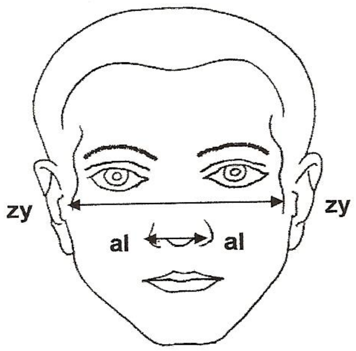


Table 4.4.7 Nose-face width index (al-al x 100/zy-zy)

Gender / Group	Age	Mean ± SD	p-value
Male	7	27.87 ± 2.75	0.97
Female	7	28.03 ± 2.46	
Male	12	28.40 ± 2.53	0.42
Female	12	28.24 ± 2.61	
Male	7	27.87 ± 2.75	0.46
Male	12	28.40 ± 2.53	
Female	7	28.03 ± 2.46	0.95
Female	12	28.24 ± 2.61	

Table 4.4.7. shows that the means of nose-face width index. For 7 year old group, female has a greater index than male. For 12 year old group the male has a greater index than female. However the differences are not statistically significant ($p>0.05$). The index also increases slightly as the age increases but the differences also not statistically significant ($p>0.05$)

4.5 Lips and mouth

In this region, three linear anthropometric measurements were performed; upper lip height (sn-sto), mouth width (h-ch) and lower lip height (sto-s). Three proportion indices are derived form these measurements; upper lip height-mouth index, lower – upper lip height index and mouth-face width index.

4.5.1 Upper lip height (sn-sto)

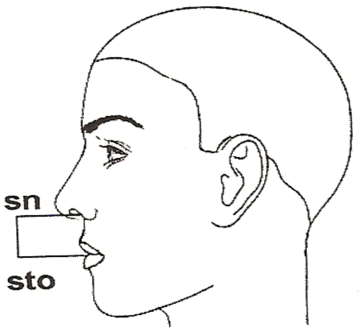


Table 4.5.1 Upper lip height (sn-sto)

Gender / Group	Age	Mean ± SD	p-value
Male	7	20.06 ± 1.10	0.00
Female	7	18.30 ± 1.71	
Male	12	21.39 ±1.60	0.00
Female	12	19.90 ± 1.63	
Male	7	20.06 ± 1.10	0.00
Male	12	21.39 ±1.60	
Female	7	18.30 ± 1.71	0.00
Female	12	19.90 ± 1.63	

Male has a greater upper lip height as compared to female in both age groups. The differences are statistically significant ($p<0.05$). The upper lip height increases slightly as the age increases for both male and female. The differences are statistically significant ($p<0.05$).

4.5.2 Mouth width (ch-ch)

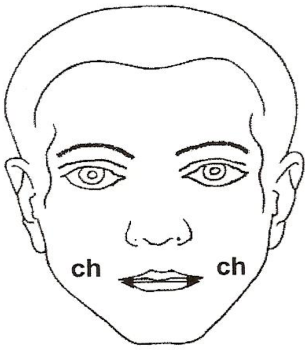


Table 4.5.2 Mouth width (ch-ch)

Gender / Group	Age	Mean ± SD	p-value
Male	7	39.75 ± 2.23	0.12
Female	7	38.57 ± 2.67	
Male	12	45.17 ± 2.72	0.17
Female	12	44.07 ± 2.94	
Male	7	39.75 ± 2.23	0.00
Male	12	45.17 ± 2.72	
Female	7	38.57 ± 2.67	0.00
Female	12	44.07 ± 2.94	

The mean for mouth width are generally larger in male as compared to female for both age groups. However statistically the differences are not significant ($p>0.05$). The mouth width increases as the age increases and it happened in both gender. Statistically the differences are significant ($p<0.05$).

4.5.3 Lower lip height (sto-sl)

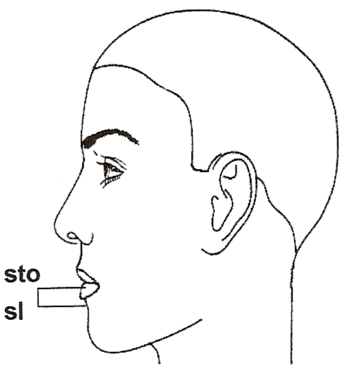


Table 4.5.3 Lower lip height (sto-sl)

Gender / Group	Age	Mean ± SD	p-value
Male	7	14.34 ± 1.35	0.59
Female	7	13.98 ± 1.38	
Male	12	16.45 ± 1.61	0.05
Female	12	15.73 ± 1.28	
Male	7	14.34 ± 1.35	0.00
Male	12	16.45 ± 1.61	
Female	7	13.98 ± 1.38	0.00
Female	12	15.73 ± 1.28	

The lower lip height result shown in Table 4.5.3. The lip height is higher in male in both age groups. However the differences are not statistically significant ($p>0.05$). It is shown that the lower lip height increases as the age increases for both male and female. The differences are statistically significant ($p<0.05$).

4.5.4 Upper lip height-mouth width index (sn-sto x 100/ch-ch)

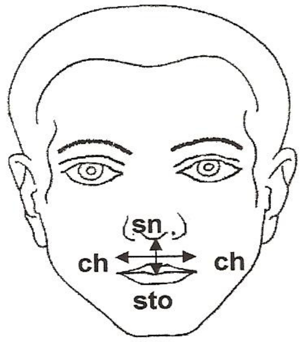


Table 4.5.4 Upper lip height-mouth width index (sn-sto x 100/ch-ch)

Gender / Group	Age	Mean ± SD	p-value
Male	7	50.60 ± 3.37	0.00
Female	7	47.61 ± 4.91	
Male	12	47.51 ± 4.38	0.04
Female	12	45.32 ± 4.47	
Male	7	50.60 ± 3.37	0.00
Male	12	47.51 ± 4.38	
Female	7	47.61 ± 4.91	0.04
Female	12	45.32 ± 4.47	

Generally the male has a greater upper lip height-mouth width index as compared to female in both age groups. The differences in these mean value are statistically are significant ($p<0.05$). The upper lip height-mouth width index decreases significantly ($p<0.05$) as the age increases from 50.60% to 47.51% in male and from 47.61% to 45.32% in female. Statistically these differences are significant.

4.5.5 Lower-upper lip height index (sto-sl x 100/sn-sto)

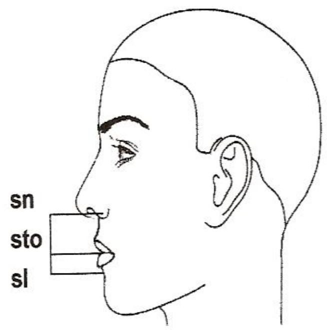


Table 4.5.5 Lower-upper lip height index (sto-sl x 100/sn-sto)

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	71.59 ± 6.97	0.00
Female	7	76.77 ± 7.95	
Male	12	77.37 ± 9.69	0.60
Female	12	79.34 ± 6.85	
Male	7	71.59 ± 6.97	0.00
Male	12	77.37 ± 9.69	
Female	7	76.77 ± 7.95	0.37
Female	12	79.34 ± 6.85	

Table 4.5.5. shows a mean value for lower-upper lip height index. Basically female has a greater index as compared to male in both age groups. However the differences is only significant in 7 year old group ($p<0.05$). Both male and female shows an increases in this index as the age increases. Interestingly the differences only significant in male ($p<0.05$).

4.5.6. Mouth-face width index (ch-ch x 100/zy-zy)

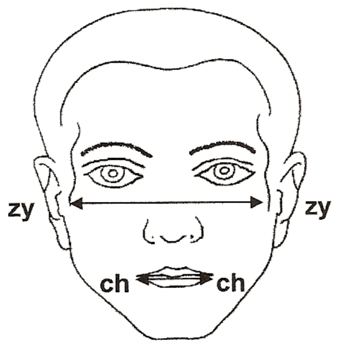


Table 4.5.6 Mouth-face width index (ch-ch x 100/zy-zy)

Gender / Group	**Age**	**Mean ± SD**	**p-value**
Male	7	34.12 ± 2.38	1.00
Female	7	34.11 ± 2.16	
Male	12	35.54 ± 3.02	0.57
Female	12	34.90 ± 2.28	
Male	7	34.12 ± 2.38	0.02
Male	12	35.54 ± 3.02	
Female	7	34.11 ± 2.16	0.38
Female	12	34.90 ± 2.28	

Table 4.5.6. shows a means for mouth-face width index. There are almost no different in this index for both female and male in both aged groups. However the differences are not statistically significant ($p>0.05$). The index shows a slight increases as the age increases but the difference is statistically significant ($p<0.05$) in male only.

Chapter 5 : Discussion

‘***The pursuit of truth and beauty is a sphere of activity in which are permitted to remain children all our lives’ … Albert Einstein.*** However growth and development never stops, beginning in the foetus and continuing throughout adult life.

Craniofacial growth is a complex interplay of structure and function and involves an interrelationship between all component parts. No part is independent or self contained. Changes in facial shape and form always take place as the face grows into adulthood. In general, human faces show much similarity and the presence of individual variation in facial characteristic is well recognized and gives a great clinical significant. This variability becomes clinically manifest in the individual size and shape of the adult craniofacial complex.

Enlow mentioned that the face of prepubertal boys and girls are essentially comparable. In females, facial development slows after age of 13 or the skeletal growth changes in the face slow and cease shortly after puberty. In males, facial development begins to be fully manifested at puberty and continues throughout the adolescent period and into early adulthood. It means that the face similarities that exist between sexes during childhood are altered markedly in the teen. (Enlow, 1980).

The growth from infant into an adult is characterised by increases in height and weight and also by changes in posture and proportions and by maturation of the skeleton and sex organs (Ranly, 1988).

A general feature of the facial development was a more or less marked forward rotation of the face including the two jaws but greater for the mandible (Bjo”rk & Skieller, 1972).

5.1 Craniofacial Anthropometric measurement analysis in Malaysian prepubertal Malay children of seven and twelve years old

Quantitative anthropometric measurements have been proven to be very useful in evaluation of post natal development in the craniofacial region (Farkas & Posnick, 1992). From the analyzed data in this cross sectional study, it shows that eighteen out of twenty two linear anthropometric measurement shows a significant increase ($p<0.05$) as the age increase in both gender. Head length (g-op) and head circumference (on-op) shows a significant increase in female only whereas the head height (v-n) increase in male.

Interestingly the eye fissure height (ex-en) shows a significant decrease as the age increase for both gender ($p<0.05$).

From seventeen proportion indices, it shows a significant decrease as the age increase for both gender in the middle-lower third face depth index (t-sn x 100/t-gn), eye fissure index (pHs-pi x 100/ex-en) and upper lip height-mouth width index (go-go x 100/ch-ch) whereas the proportion indices for the nasal tip protrusion-nose width index (sn-prn x 100/al-al) increases as the age increases in both gender ($p<0.05$).

Lower-upper lip height index (sto-sl x 100/sn-sto) and mouth-face width index (ch-ch x 100/zy-zy) shows a significant increase as the age increase only in male whereas the nose-face height index (n-sn x 100/n-gn) in female ($p<0.05$).

Intercanthal index (en-en x 100/ex-ex) shows a significant decrease as the age increase only in female ($p<0.05$).

Generally from the data analysis, the male has a larger measurement than female in both aged group. For the seven year old group, the mean value shows a significant different ($p<0.05$) only in head width (eu-eu), head length (g-op), face height (n-gn), mandibular depth (t-gn), binocular width(ex-ex) and upper lip height (sn-sto). The mean value for proportion indices shows a significant different ($p<0.05$) for upper lip height-mouth width index (sn-sto x 100/ch-ch) in male whereas female has a larger lower-upper lip height index (sto-sl x 100/sn-sto) and the result shows significant differences ($p<0.05$).

For twelve years old group, generally the male has a larger measurement and the linear anthropometric data analysis shows a significant different ($p<0.05$) in craniofacial height (v-gn), mandibular width (go-go), maxillary depth (t-sn), mandibular depth (t-gn) and upper lip height (sn-sto). For the proportion indices it shows a significant different in mandible-face width index (go-go x 100/zy-zy) and upper lip height-mouth width index (sn-sto x 100/ch-ch).

5.1.1 Head

The head region grows and functions in a three-dimensional manner. The cranial vault grows rapidly in the first year of life and with the velocity of the growth plateau in the following 5 years (Farkas & Posnick, 1992).

Grays Anatomy comments, the skull grows rapidly from birth to the seventh year, by which time the foramen magnum and petrous part of the temporals have reached their full size and the orbital cavities are only a little smaller than those of the adult. Growth is slow from the seventh year until the approach of puberty, when a second period of activity occurs; this results in an increase in all directions, but it is especially marked in the frontal and facial regions, where it is associated with the development of the air sinuses. (Behrents, 1985)

From the analyzed data of the healthy Malay prepubertal children it shows that the head width (eu-eu) had increased about 3.74mm in male and 6.52mm in female between seven and twelve years old and these finding is significant ($p<0.05$). The male shows a larger measurement compared to female by 3.86mm in seven years old group and 1.08mm in twelve years old group but the different only significant in seven years old ($p<0.05$). It shows that even though the male has a larger mean value but the female shows a rapid increase in head width. This mean value in both sexes revealed continuous growth of the head width. Furthermore many studies demonstrated that the head width followed the neural growth curve (Snodell et al, 1993). The cranium has grown rapidly before birth and continues to grow rapidly up to 1 year of age, accommodating the brain. By seven year old, the cranium has reached about 90% of its final volume and then the growth is increases slowly to maturity (Foster, 1990).

For the head length (g-op), male shows an increase about 3.90mm and female 10.32mm from seven to twelve years old. In seven years old group, male has a larger mean value compared to female by 5.86mm but there is almost no different in age group of twelve. In this region the female shows a rapid increase in head length compared to male. When compared to the Singapore Chinese population measured by Farkas in 1987, it shows that even though the male has a larger mean value in head length compared to female still female shows a rapid increase from six years to twelve years old (Farkas, 1994). The increase in head length might contribute by the continuous enlargement of the frontal air sinuses. Bjork's (1955) analysed 243 radiographs at age of 12 and 20 shows that the forward growth of the forehead at adolescence can indeed by the development of the brow ridges and the frontal sinuses. (Tanner, 1962)

Interestingly the male shows a rapid increase in head height(v-n), (8.38mm) compared to female (4.48mm) from seven to twelve years old. There is almost no different in comparison between female and male in seven years old and the different is about 4.06mm in twelve years old group, however both of these findings shows not significant different ($p>0.05$). From the result, it shows that the male and female has a same growth pattern in head height and male has been shown to have a rapid increase in height than female.

There is an increase about 17.8mm from seven to twelve years old in male and 11.54mm in female for the craniofacial height (v-n). Generally male has a larger value compared to female and the difference is about 7.96mm in seven years old but the different is not significant ($p>0.05$). However there was a significant different of 1.7mm in twelve years old group. Longitudinal studies of lateral skull radiographs by Yoong (1957) and Roche (1953) shows that the thickness of the bones rounds the top of the skull increases by 15% with spurt at adolescence, however their argument is the bone thickness solely not contribute to the increment, the acceleration of the brain itself must take into consideration (Tanner, 1962). The question arise, does it mean that the male has a larger cranial volume than female? The other possibility is that the female cranial volume increases gradually since at the age of twelve years old both sexes shows a minimal difference. As the finding is significant in age group of twelve it might also indicates that the growth differences in sexes has been started.

Head circumference (on-op) is the most frequently reported measurement in the medical literature. It has been used as an indicator of cranial volume and often used in the young infant as a rough measure of brain development. In this study the head circumference for the female shows an increase about 36.56mm and 25.02mm in male as they grow from seven to twelve years old but it only significant in female ($p<0.05$). The sex difference in head circumference varies from 16.84mm in seven year old group and 5.3mm in twelve years old group but the result shows no significant different ($p>0.05$). At 1 year old, the head circumference is approximately 87.5% of its adult size, whereas at 5 years old the head circumference increases to more than 90% of its adult size (Farkas, 1992). Form the data it shows that there is still increments occurs in growth between the age of seven and twelve and this indicate that the growth of the cranial volume still occurs. The data also indicates that the cranial volume growth occur more in female than male in this age group. The data also shows that the male head circumference is generally larger than female in both aged group.

From the analyzed data, it shows that there is almost no different in cephalic index between the gender and almost no increases from seven to twelve years old. Proportion wise there is no different in the head width in related to the head length for both aged group and the proportion also does not increase much from the age of seven to twelve years old.. Cephalic index was introduced by Anders Retzius (1843) where it defines the proportional quality of the head (Farkas, 1992). The cephalic index gives an idea either the head are bracycephalic (short wide head) or dolichocephalic (long-narrow head). When the cephalic index up to 74.9, the head considered dolicocephalic and if the index range between 75.0 and 79.9 it is called mesocephalic and when the range is between 80.0 to 84.9 then the head is considered brachycephalic (Farkas, 1994). From the data, both female and male in both age group considered having a brachycephalic head (mean value; 81.61 ± 4.95mm for seven years old male, 82.06 ± 4.05mm for seven years old female, 81.92 ± 4.98mm for twelve years old male and 82.20 ± 5.74mm for twelve years old female). The child in comparison to adult actually looks more brachycephalic. The bracycephalic type of head might due the brain, whereby the basicranium is precocious relative to facial development (Enlow & Hans, 1996).

As for the head craniofacial height index, there is almost no different in mean value for both aged group. The increases in mean from seven to twelve years old also very minimal and these finding is not statistically significant ($p>0.05$). It reflects that, proportion wise of the head craniofacial height index of male and female for both aged group actually is the same. The increment in the proportion from seven to twelve years old also shows no different for both genders. This data indicates that the mean value can be use for the both genders and for both aged groups

5.1.2 Face

The face is the most important part of the human body. It is often said that ***'beauty is in the eye of the beholder'*** (Margaret Hungerfold) however for a clinician or surgeon, facial beauty arises from symmetry, balanced and harmonious proportions.

The facial framework is identified horizontally or transversely by the width of the face and mandible, vertically by the facial heights and laterally by the depths of the maxilla and mandibular region (Farkas, 1992).

As in this study the transverse framework are indicated by the measurement of face width and mandibular width. The measurement of face height, upper face height, and mandibular height gives an idea of the facial framework vertically. The depth of maxilla and mandible shows a lateral framework of the face.

As what we expected the data analysed in this study shows that the transverse, vertical and depth of the facial framework increase significantly in both male and female subjects between seven and twelve years of age. This revealed that there is a continuous incremental growth changes during the pre pubertal period.

Thilander stated the facial skeleton increases in all dimensions during the post natal growth period. Facial growth has been reported to end first in width, then in length and finally in height (Thilander, 1995). However Hellman(1935) noted that the depth of the face increased the most, followed by height and width.

The growth rate of the face is highest at birth then fall sharply and reaches a pre pubertal minimum level some 2 years earlier in girls than in boys. The growth rate then increases to a peak at puberty, declining again and tailing off till growth ceases in late teenage (Foster TD, 1990). However many studies demonstrated that the growth does not cease but rather proceeds at a slower rate beyond the fifth decade (Behrents, 1985).

In this study it shows that the most means increases occurred in the mandibular depth and maxillary depth and followed with an increase in vertical and width measurement. This finding is consistent with Thilander statement that of all facial bones the mandible shows not only the largest amount of post natal growth but also the largest individual variation in morphology (Thilander,1995). The finding also consistent with Hellman observation where he said that the depth of the face increased the most followed by height and width.

Mandibular depth (t-gn), which also a measurement of the lower third face depth shows an increment of 14.86mm in males and 14.61mm in females, this increment is significant ($p<0.05$). In this study, the mandibular depth shows the largest measurement in the facial framework. The theory behind the growth of the mandibular depth is that the mandible grows forward and downward due to displacement of the whole bone. This creates the conditions for a simultaneous growth in the size of the bone in the opposite direction, including a lengthening of the basal arch at the condyle. Together with the backward and upward condylar growth, the ramus is relocated posteriorly. Deposition thus occur on the posterior margin of the ramus with simultaneous bone resoption along its anterior contours. At the same time the marked lengthening of the alveolar may also occasionally occur (Thilander, 1995). The mandibular depth reached 74.2% of its eventual adult size at one year old and reached 84.7% by five years old. The depth of the mandible reached its mature size in males at fifteen years old and in females at thirteen years old (Farkas,1992). From the findings, it shows that the male and female during pre pubertal period shows a same incremental in growth at this region.

The significant difference in sexes has been found, 3.42mm and 3.67mm in seven and twelve years old group respectively. The available data shows that there is a different of growth in this region between male and female.

The maxillary depth (t-sn) which is the measurement of the middle third face depth increased consistently with mandibular depth. The mean value increased by 11.5mm for males and 10.97mm for female from seven to twelve years old and it is statistically significant ($p<0.05$). The depth of maxilla approached 76.6% of its eventual adult size at one year old and increase to 85.5% at five years old. (Farkas 1992). The maxillary growth occurs in an antero-inferior direction. The bone deposition occurs on the tuberosity and at adjacent sutures. The alveolar base elongated during this period and as a result creating the space for posterior and late erupting teeth (Thilander, 1995). This reflect the reason of the increment in the maxillary depth because the subjects in this study is at the stage of mixed dentition (7 year old) and at the age of preparing to have fully permanent teeth.

The sexes differences in maxillary depth are about 2.56mm in seven years old group and by 3.09mm in twelve years group. However this differences is not significant ($p>0.05$). It explained that there is no different in the growth between sexes at this age groups.

The face width (zy-zy) is the measurement of bizygomatic diameter or it also represents the upper face width. The face width increased by mean of 10.84mm in male and 13.4mm in female between seven and twelve years old. The mean difference between genders in face width is 3.6mm in seven years old and only 1.04mm in twelve years old. However the result is not significant thus it explained that during this age group the growth at the facial width between male and female is same. Sex differences in zygomatic width of about 1mm have been found. (Nute & Moss, 2000). The zygomatic bone grow rapidly in the first year of life and the bizygomatic width is approximately 72% of its eventual adult size and increased 82.9% at the age of 5. The width of the face is mature at age of fifteen in boys and at thirteen years old in girls (Farkas, 1992). Farkas (1981) found the zygomatic width increased by about 7mm from six to ten years of age.

The growth of the zygomatic bone is consistent with the growth of maxillary bone. The enlargement of the maxillary sinuses also contributes to the transverse growth in facial region.

Generally male has a larger value in both age groups thus from this finding we can conclude that male has a larger facial width than female and the broader face in male may continue into adulthood.

Mandible width (go-go) is a bigonion diameter or lower face height, from the calculated data, there is an increase about 8.92mm in male and 8.16mm in female from age of seven and twelve years old and these increment shows a significant different ($p<0.05$).

Sex differences in about 3.26mm in age group of seven and 4.02mm in twelve years old group have been found and these mean is significant in age group of twelve. Sex differences in mandibular width of about 3mm have been found (Farkas, 1981) where it almost the same as in this study.

Although the mandibular width approached 80.2% of the eventual adult size at one year old and 93% complete by five years old, it does not mature until thirteen years old in male and twelve years old in female (Farkas, 1992).

Farkas (1981) found that the gonial width increased by 7mm from six to ten years of age. Initially the gonial width is less and as the result it proportionally changed more (Nute & Moss, 2000). It has been found that the width increases to be less than vertical changes (Snodell et al., 1993; Bishara et al., 1995). It also same in this study where the facial vertical mean is higher than the facial width.

As usual generally male has a larger value compared to female in both age groups. It explained why male has a more prominent jaw than female.

Face height (n-gn) is represented by measurement from nasion (point of nasal root) to gnathion (chin point). From the analyzed data, the increment of 10.6mm in male and 11.25mm in female from seven to twelve years old has been found. These findings were statistically significant ($p<0.05$). The face height showed a moderate level of development (mean 67.8% in both sexes) by age of one year and 83% of the eventual adult size by the age of five years. Face height reached full maturation in males at fifteen years and thirteen years in female (Farkas, 1992). The increase in vertical facial height is consistent with the growth of the maxillary and mandibular bone.

The sex difference in facial height varies from 2.96mm in seven years old group to 1.97mm in age group of twelve with males mean value larger than female in both age groups. This agrees with Snodell et al. (1993), who found the sex difference in facial height is about 1mm by measuring it from photograph. Since the increment of both sexes between ages seven and twelve years old is very small, the conclusion can be made that the most gender differences developed after the age of twelve year during the pubertal growth period.

The upper, middle and lower facial heights are highly independent variables. The upper anterior face height seems primarily correlated with growth changes in the cranial base while the dimensions of the lower face height seems to be dependent on muscle function, environmental factors as well as airway functional space and head posture (Thilander. 1995).

The measurement from nasion to the stomion represents the upper face height. It has been found that the upper face height increase significantly by 7.1mm in males and 6.89mm in female from seven years old to twelve years old. The developmental level of the upper face height is 67.3% complete by one year and increased to 82.2% of its adult level by five years old. This occurs for both sexes. The upper face height reached its mature size at fourteen years and at twelve years for female (Farkas, 1992). The vertical growth of the middle face occurs as the result of displacement of the maxilla antero-inferiorly to create space for an expansion of the nasal cavity and orbits. At the same time the vertical growth of the alveolar process is rapid during tooth eruption (Thilander, 1995). This explained the increase in growth of the middle face for both aged group.

Sex differences in upper face height of about 1.63mm in seven years old group and 1.84mm in twelve years old group with male generally have a larger mean value than female have been found in this study. However the differences are not significant statistically. Based on the finding we can conclude that for the vertical growth of the midface, the male and female shows a same growth pattern. The other explanation is that the gender differences might developed after the aged of twelve years during the pubertal growth spurt.

Mandible height (sto-gn) or also considered as lower third face height measured the lower vertical face anteriorly. The result shows a significant increase of 5.12mm in males and 5.21mm in females from seven to twelve years old. Generally male has a larger mean value than female and from the result there is not much different in increment for both genders.

The differences in sexes of the mandibular height are by 0.84mm in males and 0.75mm in females and these findings are not significant. It indicates that during pre pubertal period the vertical growth for both sexes is the same. Many studies shows that the lower vertical growth shows a significant different after the age of twelve (Snodell et al, 1993).

The facial index (n-gn x 100/zy-zy) shows a decrease in 0.1mm in female and increase about 0.84mm in males from seven to twelve years old age group. However this finding is not significant. The differences in sexes for the facial index almost the same but it is not significant. It means that proportion wise, there is no different between male and female.

The mandibular index (sto-gn x 100/go-go) shows an increase of 2.11mm for males and 1.77mm for females. The increases in index might due to the consistently increase of mandibular height and mandibular width. The differences in sexes were almost the same, 0.54mm and 0.93mm in seven and twelve years old respectively but the finding is not significant. It also shows that in this aged group the proportion of the mandibular height in relation to mandibular width of male and female is the same.

The upper face-face height index (n-sto x 100/n-gn) shows a minimally decrease in female by 0.38mm and increase by 0.42mm in males but the differences were not significant. The differences in sexes in this index also not significant and the differences were very small.

For the mandible-upper face height index (sto-gn x 100/n-gn), there is an increment by 1.02mm in females and 1.26mm in males form seven to twelve years. The increment is consistent with the increase in mandible height and upper face height. The differences in sexes is about 0.3mm with female larger than male and 0.5mm with male larger than female in seven years old and twelve years old group respectively. However this data is not significant.

Mandible-face width index(go-go x 100/zy-zy) shows a decrease by 2.02mm in female and increase by 0.13mm in males but the results is not significant. There is a significant difference in sexes in group of twelve of about 2.5mm with the male are larger than female. The larger mandibular width and face width in male than female might contribute to this. It shows that by the aged of twelve the the ratio of mandibular width to facial width is different between male and female and generally male shows a larger proportion than female. It other words, after the age of twelve the proportion at this region for the male and female is different.

Middle lower third face depth index (t-sn x 100/t-gn) shows a decrease by 2.11mm in females and 1.83mm in males but the results were not significant. The decrease in this index is related to the higher mean value in mandible than maxilla. The differences in sexes are significant of about 0.53mm and 0.25mm in age group of seven and twelve respectively. This finding shows that the proportion of the antero-posterior of the maxilla in relation to the mandible are different between male and female in both aged groups.

5.1.3 Orbits

The eyes play a major role in human communication. They have been often described as the *'window of the soul'* and perhaps the most capable part of the face to express human emotions.

Orbital measurements in children and orbital growth development have been reported by several authors (Juberg & Touchstone, 1975; Farkas, 1992; MacLachlan & Howland, 2002). It is accepted that the position of the eyes is relevant for the diagnosis of a large number of syndromes. Ocular adnexal changes and somatometric traits of the face such as epicanthus, telecanthus, flat nasal bridge, widely spaced eyebrows and blepharophimosis may create an illusory error in the identification of certain craniofacial syndromes. Therefore the normal value of the inner-canthal distance, outer canthal distance, interpupillary distance may help in the evaluation of telecanthus, ocular hypotelorism and hypertelorism (Evereklioglu, 2001). The studies in the orbital region in Chinese Taiwan children reveal that the inner canthal distance(en-en) is wider than the palpebral fissure length(ex-en) and this result is the reverse in Caucasian children. Form the finding they suggested it is not correct to diagnose hypertelorism in Chinese children in Taiwan base on the western data. They also suggested that the measurements should be adjusted with a normal standards specific for race (Wu et al,2000).

Form this study we establish our own data for the Malaysian children at age of seven and twelve and hope this normal mean value can help us in differentiate the hyper telorism from the normal eye position.

The intercanthal width (en-en) shows a significant increase by 2.07mm in males and by 2.18mm in females between seven and twelve years old. Intercanthal width mean value in males is larger than females in both age group and it is significant ($p<0.05$). The overall intercanthal distant in Chinese subjects in the Republic of Singapore are 34.4 ± 2.7 in male and 34.0 ± 2.3 in female 6 year old. The intercanthal width is 37.5 ± 2.8 in male and 35.6 ± 2.9 in female for 12 year old (Farkas, 1994) Our overall result was slightly lower than theirs; (for 7 year old male; 32.41 ± 2.04, 7 old female; 31.70 ± 2.19, for 12 year old male; 34.48 ± 2.13 and 12 year old female; 33.88 ± 2.54). In comparison with the data of 7 and 12 year old Caucasian North America children by Farkas, our mean value is slightly higher than their results (7 year old male; 30.2 ± 2.5; 7 year old female; 30.1 ± 1.9 and 12 year old male; 32.0 ± 2.1; 12 year old female; 31.6 ± 2.6).

The sexes different in intercanthal width are of 0.71mm and 0.6mm for seven years old and twelve years old group respectively. However the differences are not significant. From the growth pattern performed by Farkas, he found that the intercanthal width reached full maturation in males at eleven years old and in females at eight years of age (Farkas, 1992). The minimal differences indicate that the male and female shows a same growth pattern in intercanthal width and early maturation already occur by the age of 12 year old. Farkas concluded that the earlier maturation in this region is due to the intensive growth in the interorbital space in infancy and early childhood (Farkas, 1992).

For an eye fissure length (ex-en), the increment of 2.43mm in males and 2.98mm in female were observed and the increment is significant. Our study shows that the eye fissure length is wider than intercanthal width. In contrast with the Chinese children Taiwan it shows that the intercanthal width is wider than the eye fissure length and it causes the look of hypertelorim in their age group. Our finding is consistent with Caucasian children where they have a wider in eye fissure length than intercantal width (Farkas, 1994).

At the beginning of the fetal life the face shows a relative hypertelorism. This is related to the lateral position of the ocular cups during the embryonic period. However this relative hypertelorism progressively diminishes during foetal life leading to a decrease in inter canthal width to binocular distance ratio. This process continues after birth until adult age (Daniele et al 1998). The different in sexes of about 0.84mm and 0.29mm in even and twelve years of age respectively has been found in this study. However the results were not significant. The minimal different that occurs at the age of 12 between sexes indicate that the early maturation at this region already occur thus the male and female shows a same growth pattern.

The biocular width (ex-ex) is the measurement of a distant between the right and left outer commisure of the palpebral fissure. From the analyzed data it shows an increment of 8.28mm in males and by 9.54 in females from seven and twelve years of age. This finding is significant ($p<0.05$). Generally the male has a larger biocular width than female. The increment in the biocular width rise a question either the increment is due to the increase in intercanthal width or the palpebral fissure. From Farkas(1992) observation in 1 to 18 years old group it shows that the intercanthal width gaining 57.7% from its total growth increment from age 1 to 5 years old in contrast to the 16% of the total growth increment achieved in biocular width. The intercanthal width increases consistent with the growth in the interorbital spaces in infancy and early childhood. It shows that the continuous, gradual annual increment occurs in binocular width(84%) is greater than intercanthal width(43.7%) after 5 year old (Farkas 1992). From this finding we can conclude that the increases in binocular width at the age of seven and twelve are contribute much by the growth in palpebral fissure. We know that the development of the eye makes a major contribution to the induction of the orbit. Alternatively factors influencing the growth of the globe may influence the development of the orbit. Biometric study shows that the palpebral fissure developed more rapidly than the eye (Daniele, 1998). It shows that these inter related factors influences the growth in the orbital region.

The different in sexes in seven years old group is about 3mm and it is significant whereas there is no significant in twelve years old. The different in twelve year old group were only a fraction of a milimeter and this indicate by this age the growth pattern between sexes is almost the same.

Interestingly eye fissure height (ps-pi) shows a significant decrease in height by 0.59mm in female and by 0.75mm in males. It is a wonder why the eye fissure height decrease as the age increases. The eyes appear large in young child but appear smaller in proportion in adults. The young child appears to have a larger eye than adults because the orbit and its soft tissue matured earlier than the nasal and jaws (Enlow & Hans, 1996). Behrents (1985) mentioned that with age the thickness of eyelid is reduced due to deposit of lipid and the eyes also appears sunken with drooping bags and deep supraorbital creases. We can assume that since the orbital matured earlier than the nose and jaws so as the rest of the face increase in size the orbit shows a minimal increment and this reflect the size of the orbit looks smaller. Since the soft tissue around the orbit also matured early, does it mean that the decrease in fissure height indicate the early aging around the orbital soft tissue?

Generally female has a higher eye fissure height than male and a different of 0.04mm and 0.2mm were observed in seven and twelve years old age group but the differences were not significant. It shows that there is no different in eye fissure height of male and female at this age group.

Intercanthal index (en-en x 100/ex-ex) is the relationship of the intercantahal width to the biocular width and it gives a great influence in visual judgement of the proportions of the orbits. The male shows a decrease in intercanthal index but it is not significant. However female shows a significant decrease in intercanthal index. The decrease in intercanthal index might due to the early maturation of intercanthal width. It means that in this age group the increment for the intercanthal width is less than the length of the eye. From Farkas(1992) observation, the binocular width shows a continuous, gradual annual increment after 5 years old than intercanthal width. This explained the decreases in this proportion index. The female has a higher intercanthal index in seven years old group but as they reached twelve years old the male has a larger intercanthal index. This observation might be explained by the early maturation of female in intercanthal width than male.

Eye fissure index (ps-pi x 100/ex-en) shows a significant decrease by 3.9mm in males and by 3.87mm in females. The decrease in this index might due to the decrease in eye fissure height. Generally female has a larger in eye fissure height than male and this might due to the larger in eye fissure height compared to male. The sex’s differences in eye fissure index of 0.89mm and 0.92mm have been found in seven and twelve years old of age respectively but the finding is not significant.

5.1.4 Nose

The nose is the central focus and aesthetic unit of the face. It can be further subdivided into 5 subunit ;dorsum, side, tip, ala and soft triangles. The border of the subunit allow for scar camouflage when reconstructing nasal defects (Ridley, 1992).

The nasal growth plays an important contributor to changes in the overall facial profile. The nasal growth occurs mostly over the first five years of life and includes growth of the bony and cartilaginous regions. Peaks in growth occur coincide with the development of the nasal airway complex (Farkas, 1992).

The measurement of the nasal width is performed from the most lateral points of the nasal alae. The nasal width is proportional to the width of one eye at the nasal base (Ridley, 1992). However Epker and Fish (1986) stated that the normal alar base width is generally several millimetres wider than the intercanthal distance. Our finding is in agreement with his statement.

There is significant increase in nasal width in male by 3.65mm and 3.52mm in female. An increase in nasal size has been reported whereby Burke and Hughes-Lawson (1989) using stereophotogrammetry and Snodell et al. (1993) using lateral cephalometry showed a greater change in alar width. They concluded that the greater change in alar width is corresponding with the increase in intercanthal width due to orbital growth. However the sex difference in nasal width has generally been found to be quite small in pre pubertal period as the male nose being up to 1mm larger than female (Farkas, 1981; Nanda et al.,1990; Snodell et al.,1993). Our data also shows the same finding where the male has a larger nasal width than female. The differences in sexes shows almost the same finding with theirs where it is almost 1mm with male larger than female (0.82mm in seven years old group and 0.95mm in twelve years old group). However our data is not significant. It means that there is no different in alar base growth between male and female.

Nose height (n-sn) shows a significant increase of 5.94mm in male and 6.77mm in female from seven to twelve years old. By five years old the nose development approached about 76.9% from it eventual adult size. Early rapid growth of the nose height in males was observed between 1 to 4 years then between 11 and 12 years in females early rapid growth occurred between 1 and 4 years old (Farkas,1992). This observation might explain why the female has a greater increase in nose height than males. The increase in nose height is explained by Behrents(1985) study through cephalometric technique. He stated that the most anterior point on the nose continues to move forward and downward direction in all ages. The increases in nose height are also explained by the enlargement of nasal airway. He also shows that the males have a larger nose as compared to female. Our finding is in agreement with his finding.

The sex difference in nose height has been found about 0.5mm and 0.33 in seven years old group and twelve years old group respectively. However this finding was not significant. It shows that during this age group, the growth in nose height is the same between male and female.

Measurement of the nasal tip protrusion (sn-prn) shows a significant increase by 2.34mm in males and 2.59mm in females. Chaconas(1969) study the cephalometric radiographs and his finding shows that the tip of the nose grew forward with the anterior positioning of the nasal bone. He also demonstrated that the nose grew concomitantly with the maxilla and mandible. Farkas mentioned that the nasal tip protrusion did not mature in early age but at age of 16 in males and 14 years in female. It shows a smaller increment during pre pubertal period (Farkas,1992). The increment in nasal tip protrusion shows almost the same for both sexes and this might due to late growth at this region.

The sex difference in nasal tip protrusion in this study is very small by less than a mm for both age groups. This finding is consistent with Farkas study. However in this study the finding is not significant. It shows that during this period the growth between sexes at this region is the same.

Nasal index (al-al x 100/n-sn) shows a significant increase of 2.83mm in males and 3.72mm in females from seven to twelve years of age. The increase in nasal index might correlate with the increase in nose width and nose height. Generally male has a higher index than female. This finding is consistent with the larger mean value in nasal width and nasal height in male than female. The sex difference in nasal index of about 1.17mm and 2.69mm in seven and twelve years age group have been found. However the differences were not significant. It shows that the ratio of nasal width to nasal height in male is same as in female during this period of age.

The proportion of the nasal tip protrusion in relation to nose width index (sn-prn x 100/al-al) gives a significant increase of 2.83mm in males and 3.72mm in female. The female shows a higher increment in this proportion because in this study the female at age of twelve has a larger measurement as compared to male in the same age group. However the sex differences are not significant and this finding shows that the proportion between male and female at this region is the same.

Nose-face height index (n-sn x 100/n-gn) only shows a significant increase of 1.54mm in female. This might due to the constant increase in nose height and face height.

The remaining of the index, nose-face width index (al-al x 100/zy-zy) did not show any significant changes as the age increase from seven to twelve years old and differences in sexes also not significant.

5.1.5 Lips and mouth

The lips are contained within the lower third of the face. It is a dynamic and expressive aesthetic unit of the face. Fullness and strong definition of the philtrum are associated with youth whereas the loss of lip highlights and flatness are associated with aging (Ridley, 1992). From the data the analysis, it shows that the mean values in transverse growth shows the rapid increment than the vertical growth in the lips and mouth region. The vertical growth of lower lip is more than the upper lip.

The measurement of upper lip height (sn-sto) is taken from the base of columella to the stomion point of the labial fissure. The analyzed data shows a significant increase in upper lip height in both sexes (1.33mm for males and 1.6mm for females). There also a significant differences in sexes. It has been found the different in sexes of 1.76mm in seven years old and 1.49mm in twelve years of age. Generally the male has a larger mean value than female.

Proffit stated that although the vertical height of the lips rarely is considered an important part of the growth pattern but the height of the centre part of the lips (philtrum) trails behind the vertical height of the lower face. He further stated that the lips grow earlier in girls than boys. Alternatively Farkas found that the upper lip height achieved 82% of its eventual adult size and increase to 93% by age of five. To take the consideration of the age group in this study it explained the small increment in the upper lip height in both sexes.

The mouth width (ch-ch) shows a significant increase of 5.42mm in males and 5.5mm in females as they grow from seven to twelve years old. If we take the consideration that the mouth grew as the face grew, than the increment in mouth width at this study group are consistent with the increment in nose width as well as the facial width. However form this study it shows that there was no significant difference in sexes. Meaning that during this age group the male and female shows a same growth pattern in this region. Generally male shows a larger mouth width than female

Form the measurement of lower lip height (sto-sl); it has been found a significant increase of 2.11mm in males and 1.75mm in female as they grow from seven to twelve years of age. Interestingly we noted that the increment in lower lip height is slightly more than the upper lip height. Proffit demonstrated that the most vertical growth of the upper lip is achieved in females by age of 14 and the lower lip continues to grow vertically to age of 16. In males, growth of both upper and lower lips continues into the late teens with more growth of the lower lip (Proffit, 2003). This explained the more increment in male than in females in this study. Male shows a generally larger in lower lip height than female. However there are no significant differences when comparing the gender in both aged group.

Upper lip height-mouth width index (sn-sto x 100/ch-ch) shows a significant decrease in males (3.09mm) and females (2.29mm). The decrease in this index is explained by the significantly increase in mouth width compare to upper lip height. The sex differences in upper lip height-mouth width index vary from 2.99mm in seven years old group to 2.19mm in twelve years old group and the finding is significant. It shows that the proportion or the ratio of upper lip height to mouth width is different in this range of age group for both genders. It should alert us that further study need to be done in this region for each age group between seven to twelve and the age selection should be more widen.

The increase of lower-upper lip height index (sto-sl x 100/sn-sto) is significant in male only by 5.78mm from seven to twelve years old. The significant increase in male is explained by the larger lower lip height in male than female and constant increase in upper lip height in both sexes. There is a significant difference in sexes (5.18mm) at age group of seven. It shows that the different in proportion only occurs at the age of seven and by the age of twelve the proportion in this region is same for both genders. The upper lip height reached its eventual adult size by age of five and this contribute to the obvious different in seven years old group only.

The mouth-face width index (ch-ch x 100/zy-zy) shows a significant increase in male only (1.42mm from seven to twelve years old). The increase in this index is due to the obvious increase in mouth width than face width. The other parameter in mouth-face width index shows no significant different.

5.2 Limitation of this study

Anthropometry is a direct measurement that uses standard landmarks and instrumentation to compare populations. By anthropometric, the facial sizes and proportions are gain and the surgeon uses this data to reproduce cosmetically attractive proportion for their patients when performed reconstructive surgery. It is well accepted now that the standard measurement should not being applied to the whole race on the earth (Rogers, 1974).

In this study, the methodology was adapted from the study done by Hajnis et al (1994). However there still a human error when performing the measurement. Difficulty in identifying landmarks will result in poor repeatability and inconsistent measurements. As pointed out by Ward & Jamison (1991), the linear measurement of small magnitude leads to poor reliability because any given error would produce a greater percent deviation from the true distance. During the measurement, the high cooperation from the subjects is required. The use of high quality measurement tools also advisable. Contributing the difficulty in this study was the full cooperation from the subject in the age group of seven, they get bored and tired very easily.

Even though the subjects chosen were of convenient sample and included students from the selected primary school but the time constraints due to the tight school time table enables us only to select certain age group and small sample size.

The small samples size in this study contribute to the limitation in this study whereby it not representing the norms for the whole population in Malaysia. The other factors need to be considered when evaluate the changes in the growth pattern such as environmental, diet, genetic and socioeconomic.

It is best if this study can be extending further by doing the craniofacial measurement from birth to eighteen years old. By doing so, the percentile of growth pattern for the Malay population can be obtained. The norms measurement also can be readily available for this population.

Hoping in the future, this research field will developed further with more advanced measurement tools, more precise measurement environments and more representative sample of subjects. It would be nice if more researcher interested in this field despite of all the advanced technologies because up to now it been only a mission of a small number of researchers.

Chapter 6 : Conclusion

While there are many ways to approach craniofacial analysis, it is important that the technique used can be easily remembered and applied. By this way a routine systematic approach will be developed. This will help to maximize the evaluation of the subunit in question and minimizing the risk of overlooking other important abnormalities. Craniofacial anthropometric study has been shown to be useful in analyzing and determines the growth pattern.

Although new technologies are developed and available in our daily clinical practise, it has been proven that anthropometry offers a cheaper, non invasive, simple and provide a complete data set of the studied age group. Moreover the measurement taken is comparable between sexes.

The present study establishes the base value for various parameters in the craniofacial complex of the healthy Malay children at age of seven and twelve year old. Various dimensions of craniofacial region were measured. The analysis of the data does not simply indicate the differences in the measurements but also point out changes in growth patterns which will have a clinical significant.

This study reveals that as the age increase there also an increase in measurement for both sexes. We can conclude that both sexes grow during this period of age. Generally males have a larger mean value in most of the craniofacial region in both aged group whereas females appeared to have a greater degree of increment in craniofacial growth than did males in comparable age. In other words it means that the female shows a faster grows or more growth than males but female still at all times smaller than males during this period of age. We can say that males grew a smaller amount over the period examined however males were larger to begin with in pre pubertal period, grew more and were larger in early and late adulthood.

By the age of twelve years old, when comparison was made between sexes it shows that even though the differences were exists but the value were small. These indicate that male as well as female show a similar growth pattern among them. This finding is coincide with Enlow statement, he mentioned that in females, facial development slows after age of 13 and in males, facial development begins to be fully manifested at puberty and continues throughout the adolescent period and into early adulthood (Enlow, 1980).

In conclusion the craniofacial skeleton appears to grow in a remarkably constant fashion and certain area shows a highly significant different between males and females.

This study establishes the first normal set parameters of the craniofacial region in the seven and twelve years old in Malay population. As a result this normal value can be used for facial analysis, facial reference and also to specify patterns for craniofacial growth.

Appendix A

Table A-1 Linear measurement that shows significant increase in both sexes from 7 to 12 year old; $p<0.05$

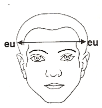
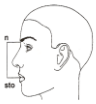
No	Landmark	Gender	Increment (mm)
1	Head width (eu-eu) 	Male Female	3.74 6.52
2	Craniofacial height (v-gn) 	Male Female	17.8 11.54
3	Face width (zy-zy) 	Male female	10.84 13.4
4	Mandible width (go-go) 	Male Female	8.92 8.16
5	Face height (n-gn) 	Male Female	10.6 11.25
6	Upper face height (n-sto) 	Male Female	7.1 6.89
7	Mandible height (sto-gn) 	Male Female	5.12 5.21

Table A-1 **Linear measurement that shows significant increase in both sexes from 7 to 12 year old; p<0.05 (continued)**

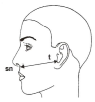
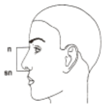
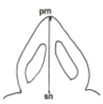
No	Landmark	Gender	Increment (mm)
8	Maxillary depth (t-sn) 	Male Female	11.5 10.97
9	Mandibular depth (t-gn) 	Male Female	14.86 14.61
10	Intercanthal width (en-en) 	Male Female	2.07 2.18
11	Biocular width (ex-ex) 	Male Female	8.28 9.54
12	Eye fissure length (ex-en) 	Male Female	2.43 2.98
13	Nose width (al-al) 	Male Female	3.65 3.52
14	Nose height (n-sn) 	Male Female	5.94 6.77
15	Nasal tip protrusion (sn-prn) 	Male Female	2.34 2.59
16	Upper lip height (sn-sto) 	Male Female	1.33 1.60

Table A-1 **Linear measurement that shows significant increase in both sexes from 7 to 12 year old; p<0.05 (continued)**

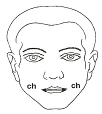
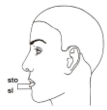
No	Landmark	Gender	Increment (mm)
17	Mouth width (ch-ch) 	Male Female	5.42 5.50
18	Lower lip height (sto-sl) 	Male Female	2.11 1.75

Table A-2 **Linear measurement that shows significant increase in female only from 7 to 12 year old**

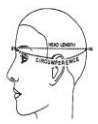
No	Landmark	Gender	Increment (mm)
1	Head length (g-op) 	Female	10.32
2	Head circumference (on-op) 	Female	36.56

Table A-3 **Linear measurement that shows significant increase in male only; p<0.05**

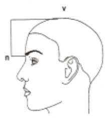
No	Landmark	Gender	Increment (mm)
1	Head height (v-n) 	Male	8.38

Table A-4 Linear measurement that shows significant decrease in both gender from 7 to 12 year old

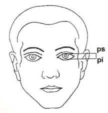
No	Landmark	Gender	Decreases (mm)
1	Eye fissure height (ps-pi) 	Male Female	0.59 0.75

Table A-5 Proportion indices that shows significant increase (p<0.05) from 7 to 12 year old for both sexes

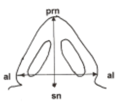
No	Landmark	Gender	Increment (mm)
1	Nasal tip protrusion-nose width index (sn-prn x 100/al-al) 	Male Female	2.83 3.72

Table A-6 Proportion indices that shows significant decrease (p<0.05) from 7 to 12 year old for both sexes

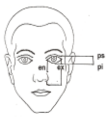
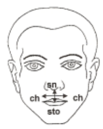
No	landmark	Gender	Decreases (mm)
1	Middle-lower face depth index (t-sn x 100/t-gn) 	Male Female	2.11 1.83
2	Eye fissure index (ps-pi x 100/ex-en) 	Male Female	3.9 3.87
3	Upper lip height-mouth width index (sn-sto x 100/ch-ch) 	Male Female	3.09 2.29

Table A-7 Proportion indices that shows significant increase from 7 to 12 year old in male only

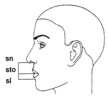
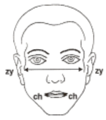
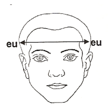
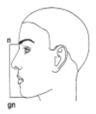
No	Landmark	Gender	Increment (mm)
1	Lower-upper lip index (sto-sl x 100/sn-sto) 	Male	5.78
2	Mouth-face width index (ch-ch x 100/zy-zy) 	Male	1.42

Table A-9 Proportion indices that shows significant increase from 7 to 12 year old in female only

No	Landmark	gender	Increment (mm)
1	Nose-face height index n-sn x 100/n-gn) 	Female	1.54

Table A-10 Linear measurement in aged group of 7 that shows a significant different ($p<0.05$) between sexes

No	Landmark	Differences in mean value (mm)
1	Head width (eu-eu) 	3.86
2	Head length (g-op) 	5.86
3	Face height (n-gn) 	2.96
4	Mandibular depth (t-gn) 	3.42
5	Biocular width (ex-ex) 	3.00
6	Upper lip height (sn-sto) 	1.76

All the measurement shows that male has a larger mean value than female

Table A-11 Proportion indices in aged group of 7 that shows a significant differences ($p<0.05$) between sexes

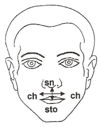
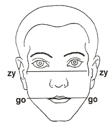
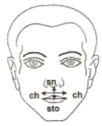
No	Landmark	Differences in mean value (mm)
1	Upper lip height-mouth width index (sn-sto x 100/ ch-ch) 	2.99, male larger than female
2	Lower-upper lip height index (sto-sl x 100/sn-sto) 	5.18, female larger than male

Table A-12 Linear measurement in aged group of 12 that shows a significant different ($p<0.05$) between sexes

No	Landmark	Differences in mean value (mm)
1	Craniofacial height (v-gn) 	7.96
2	Mandibular width (go-go) 	4.02
3	Maxillary depth (t-sn) 	3.09
4	Mandibular depth (t-gn) 	3.67
5	Upper lip height (sn-sto) 	1.49

All the measurement shows that male has a larger mean value than female

Table A-13 Proportion indices in aged group of 12 that shows a significant different ($p<0.05$) between sexes

No	Landmark	Differences in mean value (mm)
1	Mandible-face width index (go-go x 100/zy-zy) 	2.50
2	Upper lip height-mouth width index (sn-sto x 100/ ch-ch) 	2.19

All the measurement shows that male has a larger mean value than female

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