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In vivo facial tissue depth study of Chinese-Americans in New York City

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IN VIVO FACIAL TISSUE DEPTH STUDY OF CHINESE-AMERICANS IN NEW YORK CITY

A Thesis

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Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

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by
Wing Nam Joyce Chan
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ABSTRACT

Facial tissue depth measurements are used to create forensic facial reconstructions to aid in human remains identification. Collection of such measurements began in the late nineteenth century with anatomists His, Kollman, and Welcker. Their results were used to bring the rich and famous back to life. In the 1970s, the technique of facial reconstruction was revitalized and incorporated into the forensic science field to aid in human identification. However, certain populations are extremely under-represented.

This study collected facial tissue depth information from the adult Chinese-American population in New York City. The study sample included 101 adult Chinese-Americans of varying weights and ages residing in New York City. Following the procedure outlined in Manhein et al. (2000), ultrasonic measurements were taken at 19 landmarks on the face. Previously used datasets to represent Chinese-American facial tissue depth (especially Miyasaka 1998; Ogawa 1960; Suzuki 1948) are compared to these data. This thesis examines how the Chinese-American facial tissue depth data compare with other Mongoloid, Manhein et al.'s (2000), and Kollman and Buchly's datasets. As expected, this dataset showed that facial tissue depths in Chinese-Americans were thicker than those of their Japanese counterparts (as represented in Suzuki 1948). In this dataset, statistical tests show that Body Mass Index (BMI) was the strongest determinant of facial tissue depth, while sex and age were the weakest.

The results of this study provide valuable facial tissue depth information for a previously under-represented population. Forensic facial reconstructions for Chinese-Americans using this dataset will be more accurate and will increase the chances of positive identification. Further

studies would need to be conducted in order to understand the relationship between age, sex, BMI, and facial tissue depth.

CHAPTER ONE: INTRODUCTION

Forensic anthropology has occupied a place in popular culture filled with intrigue and fascination over the years, especially with the increasing number of popular forensic television shows filling the airwaves today. Shows such as '*CSI*' and '*Bones*' have introduced the public to techniques that actual forensic anthropologists employ, including forensic facial reconstructions (the technique has been called by many different names, but for the duration of this thesis, I will refer to it as forensic facial reconstructions). Forensic facial reconstructions have been used as a means of identification since the nineteenth century. Anatomists and sculptors in the late nineteenth century were commissioned to verify skeletal remains of famous individuals. His (1895) and Kollman (1898) used facial reconstructions to confirm the skeletal remains of Bach and Dante, respectively. These early reconstructions produced favorable results and continued to stir public interest.

Reconstructions in the nineteenth and twentieth centuries produced by sculptors and anatomists were a source of public fascination and served to 'bring back to life' the faces of the rich and famous (Vanezis and Vanezis 2000:197). Facial reconstructions were not used for forensic purposes until the late 1920s in Britain and the 1940s in America. Americans use the tissue depth method, while the British use the anatomical method requiring the artist to sculpt each muscle onto the face. The technique was very unpopular in America for forensic purposes until the 1970s (Nafte 2000:134). It was only in 1970 that the validity and accuracy of facial reconstruction were put to the test by anthropologists (Snow et al. 1970). In 1979, a reevaluation of the technique was conducted, which reported a 70% success rate (Gatliff and Snow 1979:30). Modern forensic artists use techniques similar to those of their predecessors in the nineteenth century.

As the technique of facial reconstruction using tissue depth measurements grew in popularity, anthropologists began to collect data on different racial groups. Information still does not exist for many minority groups in America. The data available for tissue depth measurements of American groups mainly exist for American Negroids and Caucasoids. Somewhat less data are available for American Hispanics. Virtually no facial tissue depth measurement data are available for Mongoloid populations (other than Rhine's (1983) data for Native American populations). Mongoloids include Asian, Native American, and Eskimo populations. This under representation of Mongoloid populations inspired me to collect data for that population for my thesis.

Over eight million people live in the five boroughs of New York City. The five boroughs of New York City include Manhattan (New York County), Staten Island (Richmond County), Queens (Queens County), Brooklyn (Kings County), and the Bronx (Bronx County). According to the 2000 Census, there were 787,047, or 9.8%, Asians living in the five boroughs. Of these 361,531 are Chinese individuals (277,116 of which are foreign born). By 2005, the Asian population had increased to 11.6% or 922,978. The majority of the Asians in New York City live in Queens County (391,500), followed by Kings (185,818), and New York Counties (144,538).

Given the importance of facial tissue depth data for forensic purposes and the burgeoning population of ethnically Chinese individuals in America (especially in New York City), I set out to measure the facial tissue depth of 100 ethnically Chinese individuals in the summer of 2006 in New York City. The results of this study are reported and discussed in this thesis.

CHAPTER TWO: LITERATURE REVIEW

Forensic Facial Reconstruction

Before conducting this research, sufficient background information on facial reconstructions and facial tissue depths is necessary in order to understand the necessity of this project. Facial reconstructions are useful in forensic cases because they can be used to eliminate suspected individuals and they may support an identification of the victim in tandem with other evidence (Snow et al. 1970:226). As Miyasaka eloquently describes,

> "…the true value of facial reconstruction will be all the more displayed in the forensic science field, because all of the forensic anthropologists have honorable purposes of both establishing the personal origin of a skeletonized victim and relieving the victim's family and friends from mental anguish and sorrow." (1999:53)

Forensic artists use many techniques in their reconstructions. Caldwell divides facial reconstruction into four categories:

> "The repositioning and replacement of damaged or distorted soft tissues onto a skull; the use of photographic transparencies and drawings in an identikit-type system; the technique of graphic, photographic and video superimposition; and three-dimensional reconstruction of a face over the skull with modeling clay." (Caldwell 1986:229)

This thesis focuses on the three-dimensional method of reconstruction. In America, the "Depth System" is used to create reconstructions. This technique requires the artist/imager to create facial reconstructions using strategically placed skin depth markers (from previous facial tissue depth studies) and modeling clay to sculpt the face (Aulsebrook et al. 1996:100). The "Depth System" has clear limitations; the tissue data are only those from a specific landmark and are based on averages of a small sample. It is the job of the artist to look at the skull as the pattern and emphasize the idiosyncrasies in the skull (Rhine and Campbell 1980:857). Domaracki and Stephan (2006) suggest that there are ways to create more accurate reproductions from the tissue depth information. By using medians, artists can create "facial approximations" (faces that include many errors), and by using modes, artists can create "facial reconstructions" (exact representations) (2006:9). However, I believe that using modes will overlook the nuances of the population since the modes only resulted from collected data and not the entire population.

Before an imager begins a reconstruction, age, sex, and biological race (referring to race determined by skeletal remains) must be determined. Then, the skull and mandible are attached and mounted in the Frankfurt plane (a standard reference plane for the skull that passes through the porion and the orbitale) (Figure 1).

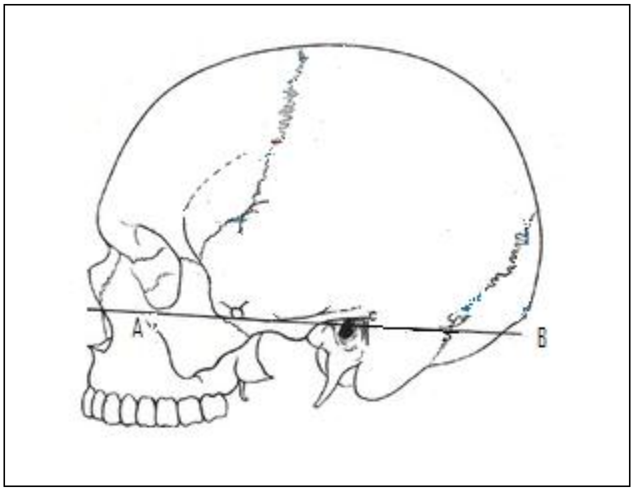

Figure 1 - Frankfurt plane (Line represents the Frankfurt Plane. Point A represents the orbitale and Point B represents the porion) (Adapted from *Gray's Anatomy* 1918).

Tissue depth markers are attached to between 18 to 32 landmarks on the face. Prosthetic eyes are then inserted in the orbits and facial contours are built up by filling in spaces between the markers with modeling clay. The soft features, such as the nose length and projection, mouth width, and ears are modeled by using standard proportions and anatomical features as reference points (Rathbun 1984:350).

History of Facial Tissue Depth Studies

The anatomist Welcker was one of the first people to be credited with using the technique that today is known as two-dimensional facial reconstruction. Welcker realized that in order to create accurate facial reconstructions, one must understand how the skin relates to the underlying bony surfaces. Welcker became the first person to conduct the documented research on facial tissue depth measurements in order to provide an accurate foundation for facial reconstructions. Welcker (1883) tested 13 Caucasoid male cadavers by inserting a thin blade at nine selected points in the midline of the face. Other anatomists, such as His and Kollman, conducted their own tissue depth studies on cadavers, each developing new techniques to collect his data. His used a sewing needle and rubber disc to mark the depth at each landmark. He collected information from 15 points from 24 male and four female Caucasoid cadavers (His 1895). Kollman and his sculptor Buchly used a soot covered needle to collect their data at 18 points from 21 male and four female Caucasoid cadavers (Kollman and Buchly 1898). Forensic artists used Kollman and Buchly's measurements as the standard for many years (Rhine 1998:171). As the years and technology progressed, new techniques were developed to collect facial tissue depth information. Researchers have used traditional methods employed by Kollman and Buchly on cadavers as well as MRIs and ultrasound on live subjects to collect their data.

His had realized that there were many factors that could influence an individual's facial tissue depth measurement. He noted that ethnicity played a large role in determining an individual’s tissue depth (His 1895). Kollman and Buchly (1898) recognized that fundamental differences existed in facial tissue depth between the sexes because of differences in skull morphology.

Noticeable differences exist in the face of males and females in the three major racial groups. While there may be more than three major racial groups, the three that are used in forensic anthropology are Mongoloid, Caucasoid, and Negroid. Age also affects tissue depth in everyone (Gatliff 1984:327). These differences between the sexes, ages, and racial groups create a need for representative samples from each group. The data that have been acquired by different researchers have been shown to be quite varied.

One inevitable problem that researchers who want to collect facial tissue depth information must face is the number and location of facial landmarks. His collected data from 15 points whereas Kollman and Buchly collected data from 18 points on the skull. Subsequent researchers have collected information from as few as 14 to many as 54 landmarks (Aulsebrook et al. 1996; George 1987). Imagers, artists, and anthropologists disagree as to the number of landmarks necessary to create the best reconstruction. There are certain points that researchers agree are unnecessary when creating a reconstruction. Data are rarely collected from anthropological points above the hairline (such as the vertex and the bregma) because they are not used in reconstructions; they likely will be covered by wigs or clay representing hair (Brown et al. 2004:2).

Most researchers obtain data from the traditional points established by Kollman and Buchly. Their points were the forehead, glabella, nasion, midnasal bone, rhinion, subnasale, midphiltrum, labiomental, mental tubercle, menton, supraorbital, infraorbital, zygomatic attachment, midmandible, zygomatic arch, midmasseter, gonion, and the supraglenoid (Kollman and Buchly 1898). Other commonly collected points include the supraglenoid, zygomatic attachment, supra canine, and sub canine (Manhein et al. 2000). Each researcher chooses at his or her discretion to add or subtract more landmarks based on his or her interests. This variation in the data sets has made comparisons among them nearly impossible for certain landmarks.

Traditional facial tissue depth measurements were obtained using cadavers and inserting either a thin blade or a needle into the soft portions of the face at selected points. In recent years, researchers have expanded their methods of data collection. Radiographs, cephalometric measurements, ultrasound, MRIs, and CT scans on live subjects have been used to take facial tissue depth measurements. Researchers often debate the accuracy of each of these techniques.

Because of certain limitations, such as access to equipment or a live sample, some researchers have resorted to the cadaver methods to obtain their data. In 1980, Rhine and Campbell published their findings of 59 normal weight adult Negroid cadavers in New Mexico. They offset some of the deformation created by the needle technique by leveling the skin by hand. To eliminate the degree of postmortem changes, they chose persons who had been deceased for less than 12 hours or who had only been refrigerated overnight. Rhine and Campbell discovered that faces of American Negroid females are as large or slightly less so than their male counterparts. Females in general have markedly thicker tissue in the regions beneath and lateral to the eye orbits (Rhine and Campbell 1980).

In 1948, Suzuki published the most commonly used data set on Mongoloids. In her study, Suzuki used 55 Japanese adult cadavers (males n=48; females n=7). Her study group consisted of individuals in various states of nourishment. She collected data from 23 points (Suzuki 1948). Subsequent researchers have discovered that Japanese measurements differ greatly from other racial groups. The Japanese faces show little similarity to both mixed racial origin groups in South

Africa and to those of American Negroids (Phillips and Smuts 1996:58; Rhine and Campbell 1980:852).

The most recent cadaver facial tissue study was conducted on Australian Caucasoid decedents. In 2006, Domaracki and Stephan published their study on 33 adult cadavers. Whereas Rhine and Campbell ensured that their cadavers were only embalmed for a short period or completely unembalmed, Domaracki and Stephan chose to have their subjects be embalmed for more than six months to ensure that the procedure had taken effect. They used the sooted needle method to collect their data (Domaracki and Stephan 2006).

Although cadavers have been the traditional subjects used for tissue depth measurements, some researchers have suggested that postmortem changes generate inaccurate results (Evison 2001:1). The positioning of a cadaver has also been noted to affect the results garnered from these studies. De Greef et al. have noticed a marked difference in the results of individuals in the supine versus the upright position (2005:1287). The supine position can lead to misalignment between the landmarks on the face and the actual landmarks of the skull, and the procedure itself can deform the soft tissue. Thus, cadavers have become an unreliable approximation for tissue depth information (Vanezis and Vanezis 2000:198).

With the advent of certain technologies, such as ultrasound and x-rays, it became possible to collect data from live subjects. The first available datasets from live subjects came from celphalometric measurements from radiographs. Generally, the radiographs were obtained with the patient’s consent in orthodontists’ offices or during medical procedures that required craniofacial x-rays. Orthodontics, cosmetic surgery, and cephalometric radiography are useful sources of soft tissue projections (George 1987:1306).

As technology continued to progress, ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT) scan facial tissue depth studies of live subjects became possible. Few MRI and CT scans studies exist since they are expensive procedures that have been shown to expose the subject to high levels of radiation. Facial tissue depth data from CT scans and MRIs have traditionally come from patients receiving medical treatment, which explains the small sample sizes in these studies. Recently, there has been only one notable tissue depth study using MRI. This study was conducted in 2002 on 60 northwest Indians (Sahni et al. 2002). Phillips and Smuts performed the most recent facial tissue depth study using CT scans. They used CT scans to measure facial tissue thickness in a mixed race population in South Africa in 1996. They collected data from 21 points (Phillips and Smuts 1996).

Most of the recent facial tissue depth surveys resulted from ultrasonography methods. Because of the portability and relative low cost of ultrasound equipment, many researchers have preferred to use this tool to take their measurements of tissue depth. They also believe that ultrasound is the most accurate method to collect tissue depth measurements because it is noninvasive and not harmful to the subjects allowing data collection from live subjects (Wilkinson 2004:132). Ultrasound measurements have also produced narrower ranges than the needle puncture method when collecting facial tissue depth data (Simpson and Henneberg 2002:130).

Ultrasound became commonly used on humans more than 30 years ago (Bullen et al. 1965). Use of ultrasound has increased because the technology has been refined and introduced into mainstream medical uses. The first ultrasound facial tissue thickness survey published in America was by Hodson et al. in 1985. They measured 50 American Caucasoid children. In 1993, Lebedinskaya et al. published one of the largest ultrasound facial tissue depth studies to date. Their survey included nearly 1,700 individuals from the former USSR, including Koreans (Lebedinskaya et al. 1993:183).

Aulsebrook et al. (1996) used cephalometric radiographics and ultrasound to measure the facial tissue depth of 55 adult male Zulus. They obtained the cephalometric radiographs from a dental office and chose to use ultrasonic probes to collect data from points that could not be seen on the radiographs. They performed a comprehensive survey that included data from 54 different landmarks (Aulsebrook et al. 1996).

In 2000, Manhein et al. published the dataset from their results of in vivo facial tissue depth measurements in American children and “normal weight” adults. Their study included American Caucasoids, Negroids, and Hispanics and totaled 515 children and 197 adults. They collected from 19 landmarks from the right side of the face. Their study was the first to contain published data on American Hispanics (Manhein et al. 2000).

El-Mehallawi and Soliman published their ultrasonic assessment of facial soft tissue thickness in adult Egyptians in 2001. They measured tissue depths of 17 landmarks on 204 Egyptians aged 20-35 years. The results from the survey showed marked facial tissue depth differences from other populations (El-Mehallawi and Soliman 2001).

DeGreef et al. (2006) conducted the most recent ultrasonic survey of facial soft tissue thickness, which consisted of 967 adult Caucasoid subjects of both sexes. Their study included subjects of varying age and Body Mass Index (BMI). They took measurements from 52 facial landmarks, many of which were used in previous studies (DeGreef et al. 2006).

Review of the literature has revealed a dearth of facial soft tissue depth studies of Mongoloid populations. The extant Mongoloid population data mostly resulted from cadaver studies, including a sample of six beheaded Chinese criminals (Birkner 1905), two Papuans

(Fischer 1905), 14 Papuans and Melanesians (Zeidler 1921), one Javanese and 13 Melanesians (Stadtmuller 1925), and lastly, the most well known Mongoloid dataset by Suzuki (1948). Caldwell (1986) reported that most artists and anthropologists use the Suzuki dataset when creating Mongoloid facial reconstructions. Another dataset commonly used for Japanese forensic facial reconstructions is the Ogawa dataset. The Ogawa dataset was formulated using radiographic cephalometry and came from 68 healthy Japanese individuals (males n=56, females n=12) ranging from 22 to 44 years of age. Certain forensic artists have expressed their preference for the Ogawa data because Suzuki's dataset has been shown to be remarkably thinner than any other datasets (Miyasaka 1999:56). Although there is a lack of facial soft tissue studies for Mongoloid populations, cephalometric standards exist for certain populations. Cephalometric norms exist for a Japanese population (Engel and Spolter 1981), Korean adults (Park et al. 1989), and southern Chinese and British Caucasoid children (Cooke and Wei 1989).

Changes in Facial Tissue Depth

Certain factors affect a person's facial tissue. As a person ages, changes in the facial tissue depth are expected. Researchers have suggested that as we age, tissue depth gradually decreases (Vanezis and Vanezis 2000:198). Japanese researchers have discovered that in comparison with adults, soft tissue thickness in Japanese girls is relatively greater than Japanese women, with the exception of certain points. They conclude that the upper facial region shows a marked decrease in soft tissue thickness in adults (Utsuno et al. 2005:106). However, since children grow at variable rates, growth trends or specific differences for age sets cannot be determined (Tyrrell et al. 1997:655). Because of this lack of growth trends, the use of statistical analysis has been difficult for determining whether facial tissue depth decreases with age. Ogawa (1960) reports that facial soft tissue measurements reach a peak at age 30 to 40 and gradually decrease in size after age 60. However, Suzuki and Sakai (1955) suggest that gnathion measurements increase in size with age.

Rhine and Campbell have stated that facial tissue depth is also clearly sexually dimorphic (1980:848). Researchers have discovered that males normally have thicker soft tissue than females, with the exception of the region beneath the eyes (Rhine and Campbell 1980:852). Males have thicker tissue depth than females because they have larger skulls and larger muscle attachments. Most studies show that at the majority of the facial points males have thicker tissues than females, especially at the brow, mouth, and jaw (Wilkinson 2004:145).

Facial tissue depth data can also be affected by nutritional status. The anatomist His (1895) was the first to study the effects of nourishment on facial tissue depth. He compared facial tissue depths of emaciated and well-nourished people and the results were published in 1895. Kollman and Buchly and others continued His’ work and studied the effects of nourishment on facial skin depth. They discovered that at most points, facial tissues were thinner in the emaciated groups. The only areas they discovered that showed minimal changes were at the nasal bridge and the eye area, stemming from lack of subcutaneous fat in those areas (Wilkinson 2004:141). Rhine added obesity as an indicator of nutrition status. In his 1984 study of American Caucasoid facial tissue depth, he had information for the emaciated, normal, and obese individuals (1984). The nutrition categories today are usually defined by Body Mass Index (BMI). BMI is calculated by weight (kg)/[height (m)]^2. The Center of Disease Control (CDC 2007) lists four categories of weight: underweight (BMI <18.5), normal (BMI 18.5-24.9), overweight (BMI 25.0-29.9), and obese (BMI >30.0) (CDC 2007).

Race in Physical Anthropology

Race issues came to the forefront of anthropology in the late nineteenth to early twentieth centuries in the form of raciology, or scientific racism. The idea of scientific racism included the idea, "…that humans were divided into a few, distinctive racial types each with its own fairly ingrained or even immutable characteristics and all arranged in a stable moral, social and intellectual hierarchy in which white Europeans were at the top" (Wade 2002:2). While some anthropologists subscribed to the ideas of scientific racism, others were adamantly opposed. Franz Boas denied the ideas that: "a) humans could be divided up systematically in this way, and b) that moral, social and intellectual capacities were linked in any significant way to race (as judged from appearance)" (Wade 2002:2). The idea of scientific racism gradually fell out of favor but not before it was used to justify the eugenics movements in America and abroad.

In the past, when the term race was used as a basis for scientific racism, the study of craniology was introduced as a means to differentiate between the different races. Charles Darwin suggested that brain size is directly correlated with intelligence: the larger skull, the larger the brain, and the more intelligent the individual (Corcos 1997:23). Darwin and colleagues tested their theories by measuring skulls of the living and weighing the brains of the dead. Darwin measured the cranial index (skull breadth divided by width) as a means for racial classification. If the cranial index was lower than 0.75, the skull was dolicocephalic (a long and narrow skull); if the cranial index was higher than 0.80, the skull was brachycephalic (short and broad skull). Those between 0.75-0.80 were termed mesocephalic. Scientists believed that dolicocephalic and brachycephalic individuals were from two different races, and that mesocephalic individuals were a hybrid between the two races. Scientists used the cranial index to justify the commonly held belief that

Caucasoids, or Europeans, were superior to Negroids or Indians since Caucasoids had larger skulls. It was later discovered that the shape of the skull is correlated to environmental factors, demonstrated by attributes such as the European and Asian populations slowly changing from being dolicocephalic to brachycephalic (Corcos 1997:24-26).

Race is still a hotly contested issue in anthropology. Many anthropologists believe the cultural categorization of race no longer exists. However, biological racial categories are still helpful in forensic anthropology. The three commonly used categories of biological racial classification by anthropologists (Mongoloid, Caucasoid, and Negroid) have been met with some animosity. Anthropologically, the Mongoloid category includes Asians, Eskimos, and Native Americans; the Caucasoid category includes Europeans, East Indians, North and East Africans, Arabs, and Mediterraneans. The Negroid category includes West and South Africans (Wilkinson 2004:84). Although the racial categories used by anthropologists are seemingly antiquated, they are helpful when creating a biological profile.

Other anthropologists have created their own multiple distinct groupings within each of these categories, more specifically identifying each racial group. Ripley (1899) split the European race into three races: Nordic, Alpine, and Mediterranean. Coon, Garn, and Birdsell (1950) divided races into six groups (“stocks”) that were subdivided into thirty races. Their definition of race was based on certain features that were specifically adapted for various environments.

Anthropologists who subscribe to the environmental adaptation theory explain certain physical features such as the high-arched nose of the Bedouin tribes as adjusting to humidify the dry desert air, melanin in dark-skinned peoples protecting them from harmful sunlight, etc. (Wilkinson 2004:82). Others have tried to delineate racial categories by dividing the races into certain blood-type frequencies and certain genetic frequencies (Molnar 1975:17). Anthropologists have also suggested that diet can affect facial types (Wilkinson 2004:83). Despite the multiple categories that exist for racial classification, there are no “average” or “normal” individuals for each so-called race; there is a wide range of variation within every population. Yet because of the variations that exist in the human population, the broad categories of Mongoloid, Negroid, and Caucasoid are still the best way to classify biological race for anthropological purposes. These categories encompass wide geographical ranges of people and hundreds of “races.” In today’s globalized society, geographic location has little bearing on “race.” Immigration and political unrest have displaced many individuals from their traditional home ranges.

Nonmetric Analysis of Race

Skeletal analysis can be used to infer the racial origins of an unidentified individual. As Brace eloquently explains, “Skeletal analysis provides no direct evidence for skin color, for example, but it does allow an accurate estimate of original geographical origins. African, eastern Asian, and European ancestry can be specified with a high degree of accuracy” (quoted in White 2000:374). The skull provides the most information about the biological race of the individual. Studies have suggested that race determination from the skull has an accuracy rate of 77-95% (when the mandible is not present, there is a lower rate of accuracy in identifying race) (Wilkinson 2004:84). It is almost impossible to determine race from a prepubescent skull. All subadult crania look similar since they all have short, wide faces, short, wide noses, and rounded chins (St. Hoyme and İşcan 1989:70). Some anthropologists have suggested the use of other postcranial elements to determine race, such as the pelvis, femur, and other long bones, but they have not been proven to be as accurate as the skull (Craig 1990; Dibennardo and Taylor 1983; İşcan and Cotton 1990).

The most frequently used skull features to determine race are the cranial form, sagittal outline, cranial sutures, nose form, nasal bone size, nasal bridge form, nasal profile, interorbital projection, nasal spine, nasal sill, incisor form, facial prognathism, alveolar prognathism, malar form, zygomaticomaxillary suture, palatal form, palatine suture, orbital form, mastoid form, mandible, chin projection, and chin form (Reichs 1998:300). These aforementioned features are more useful in determining race than others. Traits such as cranial form are not reliable for cranial race determination because they vary widely within the major racial groups and races. The most reliable traits to determine race are generally the nose area and the mouth.

Caucasoid skulls on average have a long to rounded shape with a narrow nasal aperture, depressed glabella (area between the eyes), moderate supraorbital ridges (brow ridges), blunt supraorbital margins (area above the brow), simple cranial sutures, prominent nasal spine, jutting of the frontonasal junction, sharp cheekbones, prominent frontal bones, large mastoid processes, mild or no prognathism, narrow interorbital distance, a steeper forehead with no sagittal plateau, an orthognatic profile, and a prominent chin. Caucasoid skulls are also classified as having square or rhombic orbits. Enlow used older racial classificatory terms to describe the Caucasoid skull; he described them as being more dolicocephalic shaped with a more protrusive upper face and a more retrusive lower face (Wilkinson 2004: 84). Caucasoids also tend to have reduced alveolar prognathism, which leads to dental crowding and smaller teeth that exhibit a noticeable overbite. Additionally, Caucasoids generally show a parabolic palate with a jagged suture (Reichs 1998:302).

Negroid skulls display a longer head shape with wide nasal aperture, high alveolar prognathism, more rising supraorbital ridge, sharp upper orbital margins, rounded glabella, low rounded nasal root, plain frontonasal junction, wide interorbital distance, a fuller, more rounded forehead, and flatter sagittal contour (Wilkinson 2004:86). The high alveolar prognathism means that teeth are rarely crowded and often have prone upper incisors. Negroids also show a hyperbolic palate with curved maxillary sutures (Reichs 1998:302-303). Negroids tend to have rounder and larger but fairly angular orbits (Reichs 1998:300). Finally, Negroids have a narrow ascending ramus in the mandible and a retreating chin (Burns 1999:38).

Mongoloid skulls show a round head shape with a medium-width nasal aperture, massive zygomatics (cheekbones), moderate prognathism, rounded orbital margins, absent brow ridges, short nasal spine, straight nasal profile, shovel-shaped upper incisors, wide face and flatter face (Wilkinson 2004:86). Enlow has said that Mongoloid skulls are brachycephalic, a less protrusive midface with a wider, shorter nasal airway, a more upright and bulbous forehead, and shallower orbits (Wilkinson 2004:87). Mongoloids have medium facial and alveolar prognathism (Reichs 1998:300). Mongoloids also have a more elliptic palate with a straighter suture and a more robust mastoid (Reichs 1998:302-303). The problem within the Mongoloid category is that Native Americans display certain distinct traits that are not displayed in their East Asian cousins with the same frequencies, which makes it hard to identify them as Mongoloid. Native Americans have very complex cranial sutures, usually with Wormian bones, but these bones are not always present in other Mongoloid populations (Burns 1999:38).

Certain postcranial attributes have been used as racial identifiers, such as the pelvis. The pelvis is generally used to determine the sex of individuals but certain studies measuring American Negroids, both living and dead, suggest that Negroids have narrower pelves than Caucasoids (St. Hoyme and İşcan 1989:76). The place and degree of anterior femoral curvature have also been used as a means of racial identification. Stewart, Walensky, and Gilbert discovered that American Negroid femora were straighter than American Caucasoids (St. Hoyme and İşcan 1989:80). Suchey and Katz have suggested that the pubic symphysis can reveal racial differences, but it has not been determined whether they can be used conclusively for racial identification (Brooks and Suchy 1990).

Differences between East Asian Populations

During World War II there arose a need to distinguish Chinese from Japanese because the former were American allies and the latter were enemies. To prevent confusion between the friends and the enemies, popular magazines such as *Time* and *Life* published a guide for the laypersons. During this time the U.S. Department of War published comic strips that detailed the physical differences between Japanese and Chinese. The comic strips noted that Japanese have different skin color and complexions along with stockier builds (Figure 2). This type of American propaganda was common throughout the war but then waned by the late 1940s. Most anthropologists today believe that the physical variations between Japanese and Chinese are very slight and fit within the realm of normal Mongoloid population variation. Differences between Chinese and Korean individuals are also minute and cannot be easily distinguished in the skeletal remains. Despite their minute differences, it is still necessary to have datasets for both populations to ensure an accurate portrayal of individuals from each respective population.

If the differences between Asian populations are so minute, can they even be detected by physical anthropologists who examine unidentified bones? Probably not. However, based on the geographical location where the bones were found, we can associate the bones to a racial population with relative confidence. Once a racial identification has been assigned, new data from the current research will help forensic artists to create a facial reconstruction of a Chinese person

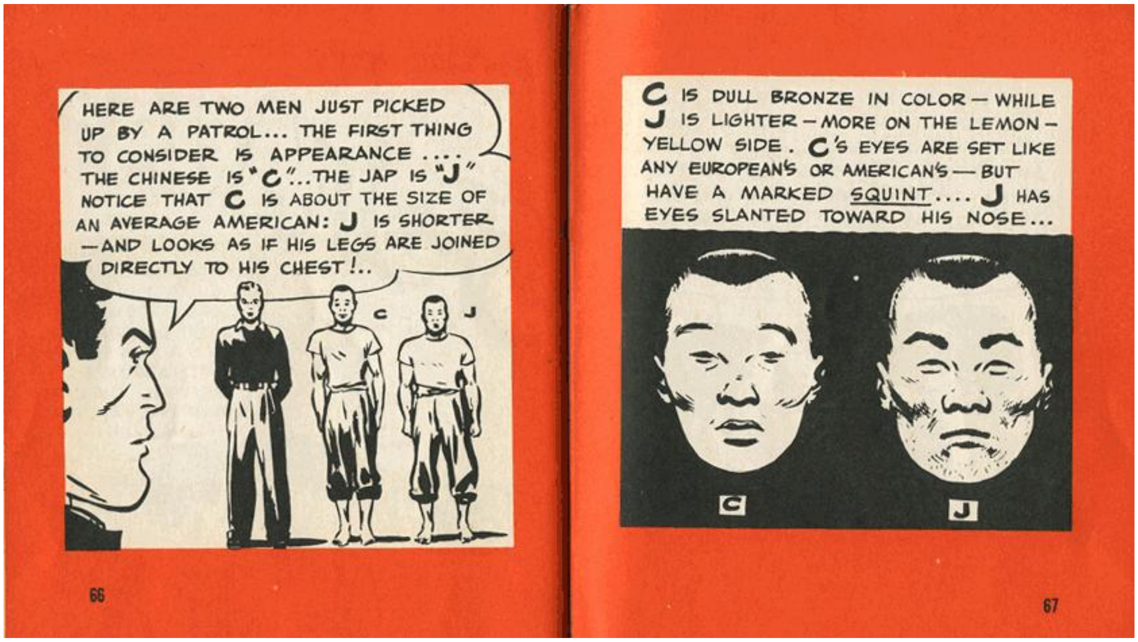

Figure 2 - WWII propaganda comic strip (United States Department of War, 1942).

that is more likely to be accurate and result in a positive identification than if a dataset for Japanese had been used.

After biological race has been determined for the individual, forensic artists can proceed with the creation of a facial reconstruction for forensic purposes.

CHAPTER THREE: FACIAL TISSUE DEPTH

The Project

Wilkinson (2004) described the different techniques used in creating forensic facial reconstructions. She included a discussion of the various facial tissue depth datasets to form a base for reconstructions. As mentioned previously, forensic artists choose the datasets and the number of points to use for their reconstructions (Wilkinson 2004). This subjectivity has made replication and standardization of the technique difficult. Despite these concerns, I decided to collect facial tissue depth data for the Chinese-American population of New York City using ultrasound because I believe this research would ultimately benefit the scientific community.

Ultrasound uses the reflection of ultrasonic waves to generate internal images. Ultrasonic waves are sound waves over the frequency of 20 kilo-cycles per second, beyond the range of human hearing (Whittingham 1962:1121). Ultrasound devices can produce one of two types of internal images: tissue configuration (B-scan mode) or tissue density changes (A-scan mode) (Borkan et al. 1982:307). This current project uses the B-scan mode. The ultrasound machine contains two main components, a probe and the machine that allows the operator to view the image on a monitor. The angulation of the probe is the most important aspect of taking accurate ultrasound images. The probe must be held at a 90º angle to the bone and the probe must maintain contact with the skin without creating a depression in the skin (Aulsebrook et al. 1996:92). Certain areas of the face can withstand more pressure than others. For example, the forehead requires greater pressure to distort the tissue depth measurement in comparison to the cheek, which requires very little.

Aulsebrook et al. (1996) suggest that the sites chosen as landmarks for ultrasonic measuring should meet certain requirements. The sites should be similar to those used by previous researchers to allow for comparison among datasets. If possible, landmarks should be over a bone or bony prominence (Aulsebrook et al. 1996:91).

Ultrasound machines can be difficult to operate, and adjustments must be made throughout data collection. The basic principles of ultrasound state that the higher the frequency of the sound, the higher the resolution image. The frequency is determined by the transducer and the range of frequency that it can emit. To supplement the frequency, the gain (the control to amplify the frequency) can be adjusted in every machine to see different points. At deeper points, such as the cheek region, the gain must be higher to see the underlying tissue and bone.

Research that uses live subjects is usually difficult to conduct because it requires active participation on the part of the subjects. Initially, the subjects were uncomfortable and tended to distort their facial features, which distort the measurements. After a minute or two, the subjects began to relax. Auslebrook et al. (1996) state that facial features must not be altered by postural strain or discomfort; if the subject is not maintaining his or her normal expression, the measurements will be distorted. They advise that the lower jaw should be relaxed; otherwise, the teeth will be held in occlusion and a strained unnatural look will result (Auslebrook et al. 1996:86).

This project's primary purpose is to provide a standard dataset for forensic artists to use to make facial reconstructions of the Chinese-American population. The data this project generates will allow a comparison with previously published datasets, such as Manhein et al.'s (2000) and Suzuki's (1948). This comparison will determine whether similar techniques will yield similar results among different races, or if previous studies of Mongoloids (Suzuki 1948; Ogawa 1960; Lebedinskaya et al. 1993; Miyasaka et al. 1998) correspond to my results. I have four hypotheses concerning this project. The first is that this dataset will uncover thinner facial measurements than that of Manhein et al.'s (2000), especially than those of the American Negroids. American Negroids from Manhein et al.'s (2000) study were found to have thicker facial tissue depths when compared to other studies. The second hypothesis is that the mean facial tissue depth will be thicker than that of Suzuki's (1948). The third hypothesis is that this dataset will be comparable to other contemporary Mongoloid datasets. The fourth hypothesis is that facial tissue depth will increase as a person ages but after a certain age (~35-45), facial tissue depths will start to decrease.

CHAPTER FOUR: MATERIALS AND METHODS

I used an Aloka SSD-500 OB/GYN system with a black and white monitor with an Aloka UST-5512-7.5 Mhz transducer. A Sony Video Graphic Thermal printer (UPP-890MD) that uses Sony thermal paper (UPP-110HD) was added to the system. The complete system was lightweight (< 25 lbs.) and portable, which allowed me to transport it to New York City easily.

The system is relatively easy to use, and the system's monitor is user friendly. The monitor displays the identification number for each subject, the date and time each measurement is taken, the ultrasound image for every point, and the measurement of each point in centimeters (displayed at the top of the viewing field). The tissue depth is measured to the nearest millimeter by the machine's internal calipers. The operator controls the calipers with a track ball, and the measurements are displayed directly on the screen. The operator measures tissue depth as the distance between the surface of the skin and the top of the bone.

Ms. Ginesse Listi trained me on the operation of the equipment and basic interpretation of the sonographic images. Ms. Kerry Weinberg also taught me how to interpret the images and to become consistent and comfortable using the machine.

I decided to use the same landmarks that Manhein et al. (2000) used in their study to facilitate a comparison between our datasets. Their study consisted of using 19 points across the human skull (Figure 3). For my study, I was able to collect in vivo tissue depth data from 101 Chinese-American adults in New York City, who ranged in age from 18 to 87.

I chose the subjects based upon their personal relationships with my family. Most of them were either friends of my parents or in my extended family. The data were collected when the subjects arrived at my house at scheduled times. The subjects were required to sign a consent form

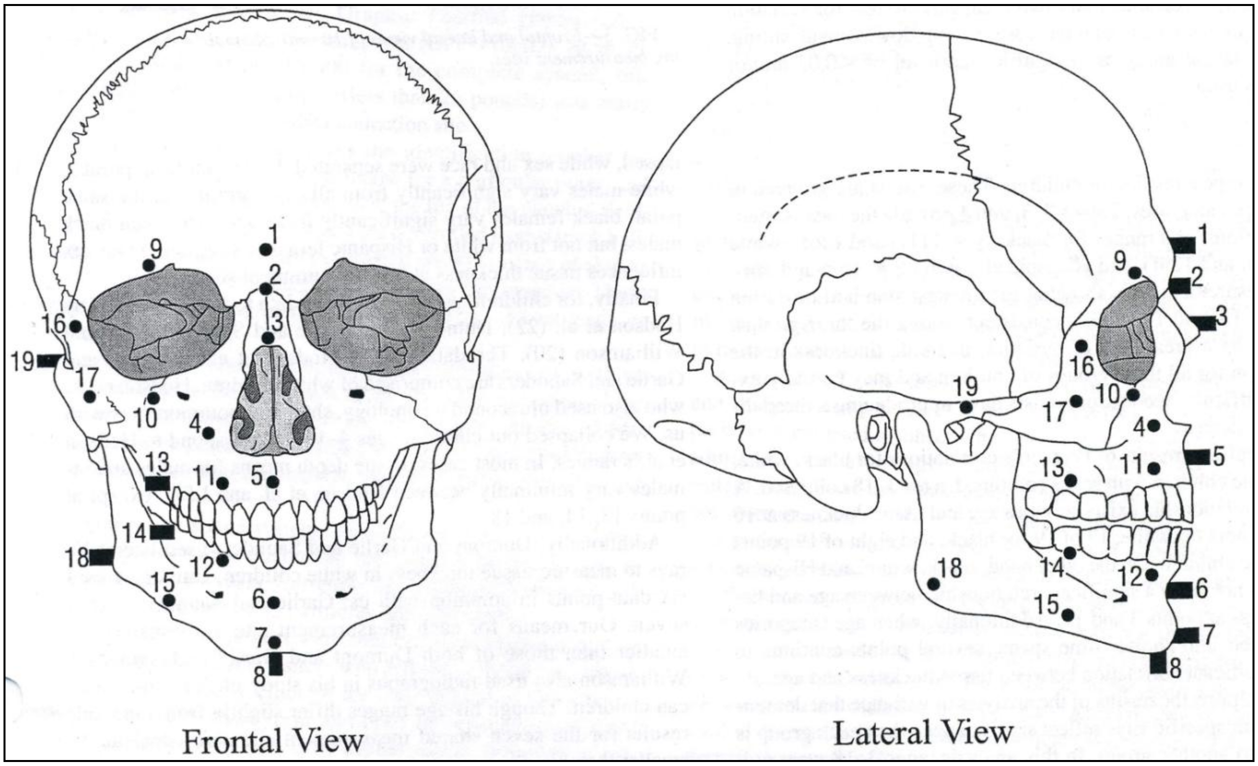

Figure 3 - The 19 points on the human skull this study uses as facial landmarks (courtesy of Manhein et al. 2000).

and fill out a brief biographical data sheet. The biographical datasheet collected information such as name, date of birth, country of birth, weight, height, greatest lip height, subject's race, mother and father's race, and additional information (Figure 4). Each subject was assigned a three-digit identification number to ensure his or her anonymity.

All the subjects were chosen from a pool of family friends since I was unsuccessful at soliciting strangers. Other people I approached were unwilling to take surveys or give out personal information to strangers. I tried to enlist the help of several Chinese-American run health centers but they were unwilling to help me because they thought their clientele would not allow me to ask personal questions or collect ultrasound data. Older Chinese-Americans that I approached often refused to volunteer for ultrasounds because of their suspicions about x-rays. They believed that ultrasound scanning might harm them and result in medical procedures that were detrimental

ID #______________

<u>In Vivo Facial Tissue Depth Measurements in the Chinese-American Population of New York City "Biographical Data Sheet"</u>

Participant's Information:
Date form completed (mm/dd/yyyy):____

Name (First, Last):____

Birthdate (mm/dd/yyyy):____

Country of Birth:____

Years in United States: ____

Height:____

Weight:____

Greatest Lip Height:____

Race:____

Contact Information:____

Family History:

Mother's Race:____

Location of Mother's Birth:____

Father's Race:____

Location of Father's Birth:____

Additional Information:

____
____
____
____

Figure 4 - Biographical data sheet

to their health. The older generations are also generally more skeptical about Western medicine. In fact, some family friends whom I have known since I was a little girl refused to be subjected to ultrasound scanning because they were skeptical that the procedure would not be harmful to them.

Many subjects were apprehensive to agree to ultrasound scanning and divulging personal data. Those who agreed to be measured were not very concerned or their fears were assuaged because of their close relationship to my family.

The subject was seated upright with a natural expression and asked if he or she would consent to be photographed. Many of the individuals were uncomfortable with being photographed and few subjects agreed. They worried that their identities would be stolen even though I assured them that I would not publicly release or publish their information. Yet many remained adamant against being photographed. I did not want to make my subjects uncomfortable so I continued my data collection without photographs.

To remain consistent, I followed the guidelines provided by Manhein et al. (2000) to pinpoint the exact locations for each landmark (Table 1). Each individual's location of landmarks differed based on his or her unique facial features. After weeks of practice, I was able to find the landmarks on each individual with relative ease. Figure 5 shows all the measurement locations I used.

The transducer was liberally coated with ultrasonic coupling gel, which was then lightly pressed to the subject's face at each measurement point. The transducer was placed on each point for three to five seconds. I had to be consistent and careful not to depress the skin at each point. The image was captured at each point with the measurements taken using internal calipers, then printed on thermal paper, and stored by individual case. Each printout consisted of images at two points. This resulted in ten continuous printed images in each case file (Figure 6).

The subjects received tissues, napkins, and wet napkins to clean the transducer gel from their faces. Between subjects, I cleaned the transducer with alcohol to ensure sanity. The subjects received no monetary compensation but in most cases, they were treated to various food items.

Table 1 - Point numbers and descriptions (Manhein et al. 2000)

1 Glabella	approximately 1 cm above and directly between the subject's eyebrows
2 Nasion	directly between eyes
3 End of nasals	palpating to determine where bone ends and cartilage begins
4 Lateral Nostril	approximately 0.5 cm to the right of the nostril
5 Mid-philtrum	centered between nose and mouth
6 Chin-lip fold	centered in fold of chin, below lips
7 Mental eminence	centered on forward-most projecting point of chin
8 Beneath chin	centered on inferior surface of mandible
9 Superior eye orbit	centered on eye, at level of eyebrow
10 Inferior eye orbit	centered on eye, where inferiorly bony margins lie
11 Supra canine	upper lip, lined up superiorly/inferiorly with lateral edge of nostril
12 Sub canine	lower lip, lined up superiorly/inferiorly with lateral edge of nostril
13 Supra M2	cheek region, lateral: lined up with bottom of nose; vertical: center of transducer lined up beneath lateral border of eye, measurement taken 0.5 cm to the left of center mark
14 Lower cheek	cheek region, lateral: lined up with mouth; vertical: same as 13
15 Mid mandible	inferior border of mandible, vertically lined up same as 13
16 Lateral eye orbit	lined up laterally with corner of the eye, on the bone
17 Zygomatic	lined up with the lateral border of the eye, on the zygomatic process
18 Gonion	found by palpating
19 Root of zygoma	anterior to and 0.5 cm superior to tragus
Greatest lip height	measured from superior most point of the upper lip to the inferior-most part of the lower lip

Manhein et al. stated that of their 19 landmark points, 13 were traditional points but the remaining six (points 4, 11, 12, 15, 16, 19) had rarely or never before been measured (2000:49). The lateral eye point (16) was often cited as being difficult to sculpt because of the lack of modern data for this landmark (Manhein et al. 2000:49). Certain points such as 13 and 14 have usually been useless for reconstructions (Manhein et al. 2000:49). The maximal variation in ultrasonic facial measurements comes from the cheek region (Utsuno et al. 2005:105).

Figure 5 - Facial landmarks where facial tissue depth was measured.

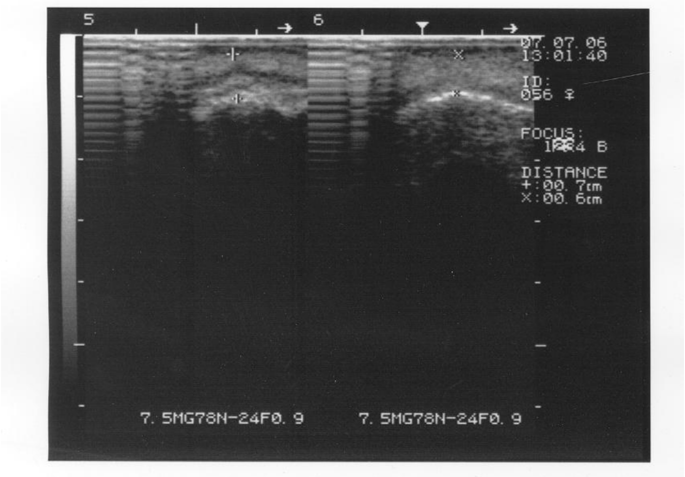

Figure 6 - An example of an ultrasound printout.

Following Manhein et al.'s (2000) protocol, I collected information from the 19 landmarks on the right side of the face. Manhein et al. chose to only collect data from the right side of the face because it was more time efficient than measuring both sides, especially when the subjects are restless children. During my data collection, some of my subjects, especially the older individuals, had a difficult time sitting still for all 19 points. Only using 19 points worked well for those individuals who had a difficult time sitting for points on both sides of the face. Although some facial asymmetry has been documented, variation has been minimal. I was able to collect facial tissue depth for both sides of the face in two individuals that I will use to compare the differences between the two sides.

Statistical Analysis

The measurements have been entered into Microsoft Excel spreadsheets and SPSS (a statistical software package) for statistical analysis. The mean, range, and standard deviation of the facial tissue depths were calculated for individuals of normal weight, using BMI for each age range and sex.

There were 101 individuals who participated in the study. Of the 101 individuals, only 67 individuals (38 females and 29 males) fit into the “normal” BMI range and will be subjected to statistical analysis. The data have been divided by age groups and sex. The data have been broken down into four age groups: 18-34, 35-45, 46-55, and over 56. These age categories are comparable to Manhein et al.’s (2000) age categories of adults of Caucasoid, Hispanic, and Negroid origins. Landmark measurement comparisons will be made between these data and Manhein et al.’s, Ogawa’s, Suzuki, and Kollman and Buchly’s datasets. Pearson’s correlations were calculated to test the statistical significance between each landmark, and age and BMI.

CHAPTER FIVE: RESULTS

Although I tried to obtain facial measurements from individuals of different ages, weights, and heights, most of the subjects fell into the normal BMI range (19-25). A subject's height might not have been as important as his or her weight because the height of individuals might be the least influential factor affecting facial soft tissue thickness (Aulsebrook et al. 1996:86). Few of my subjects fell into the emaciated categories (BMI<19). Several individuals fit into the obese/overweight categories (BMI>25). Comparisons between datasets will use measurements from individuals with normal BMI indices. Although some authors have not described their criteria for determining what a "normal" BMI is, I will assume that their range is similar to the one I use.

Tables 2 and 3 display the mean, standard deviation, and the range of facial tissue depths for normal females and males in each age group, respectively. The measurements generally fall within the same range for each age category, with the means of both sexes overlapping at most landmarks.

Tables 4 through 7 compare the means of my data for Chinese-Americans with the means of Manhein et al.'s (2000) American Caucasoid and Negroid adult groups. The measurements for American Caucasoid and Negroid females, with the exceptions of points 4 and 10, were thicker than Chinese-American females. Chinese-American males generally have thinner facial tissue depth than American Negroids and Caucasoids, with the exception of point 10 in some age ranges.

Table 8 compares my female dataset to other Mongoloid datasets as well as Kollman and Buchly's (1898) dataset for European Caucasoid females. Suzuki's dataset has always been thinner than other facial tissue depth datasets of other races and other Mongoloid groups and my dataset is no exception. Facial tissue depth for Chinese-American females is comparable to Lebedinskaya et

Table 2 – Facial tissue depth means (mm) for Chinese-American females

	Females aged 18-34 (N=10)			Females aged 35-45 (N=7)			Females aged 46-55 (N=9)			Females aged > 56 (N=11)		
Point Numbers/ Descriptions	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
1:glabella	4.30	0.95	3-6	3.86	0.90	3-5	4.22	0.67	3-5	4.36	1.12	2-6
2:nasion	4.10	1.45	2-6	2.86	0.38	2-3	3.33	1.66	2-7	3.27	0.90	2-5
3:end of nasals	1.90	0.32	1-2	1.71	0.76	1-3	1.33	0.50	1-2	1.91	0.54	1-3
4:lateral nostril	9.80	2.66	6-13	8.57	0.79	8-10	10.78	2.99	6-15	8.91	2.70	6-14
5:mid-philtrum	7.70	1.70	5-10	6.29	0.95	5-8	5.78	0.83	4-7	5.91	0.54	5-7
6:chin-lip fold	9.80	1.99	8-15	8.71	1.11	7-10	9.11	1.36	7-11	10.27	0.90	9-11
7:mental eminence	8.50	2.37	4-13	6.57	1.72	5-10	8.67	1.32	7-11	8.55	1.04	7-10
8:beneath chin	5.40	1.07	4-7	4.86	2.27	3-8	5.11	0.93	4-7	5.18	1.89	3-8
9:superior eye orbit	5.50	1.58	4-8	4.71	1.70	3-7	5.67	1.32	4-8	5.09	1.22	4-7
10:inferior eye orbit	7.70	2.58	5-14	7.29	2.43	4-11	7.22	2.54	5-11	7.45	1.97	5-12
11:supra canine	8.20	1.87	6-11	7.14	1.46	6-10	6.56	1.42	5-9	7.27	1.68	5-10
12:sub canine	9.30	1.83	6-12	7.29	1.89	5-10	8.00	1.32	7-10	8.82	1.89	6-12
13:supra M2	25.30	3.27	21-31	25.29	1.60	24-28	26.11	6.51	18-39	26.27	3.64	22-33
14:lower cheek	19.30	2.83	14-22	21.43	3.05	17-26	23.44	5.92	16-35	22.18	3.43	18-30
15:mid mandible	10.70	3.13	7-17	9.00	3.27	4-14	9.78	3.23	5-14	10.36	2.46	7-16
16:lateral eye orbit	4.50	1.18	3-7	4.00	0.82	3-5	4.56	1.13	3-7	5.09	1.30	3-7
17:zygomatic	7.60	1.35	6-10	7.86	1.77	6-10	8.11	2.47	4-12	8.18	1.89	6-11
18:gonion	12.90	3.03	9-19	11.86	4.38	9-20	11.00	2.12	8-15	11.45	3.14	6-18
19:root of zygoma	4.90	2.02	3-9	4.86	1.95	3-9	6.89	2.57	4-12	5.55	1.57	4-8

Table 3 – Facial tissue depth means (mm) for Chinese-American males

	Males aged 18-34 (N=9)			Males aged 35-45 (N=10*)			Males aged 46-55 (N=5)			Males aged > 56 (N=6)		
Point Numbers/Description	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
1:glabella	4.44	1.01	3-6	4.20	0.63	3-5	4.40	0.55	4-5	4.33	0.52	4-5
2:nasion	3.33	0.71	2-4	3.90	1.20	2-5	3.40	1.14	2-5	3.50	1.05	2-5
3:end of nasals	1.67	0.71	1-3	1.90	0.74	1-3	1.80	0.45	1-2	1.67	0.52	1-2
4:lateral nostril	8.89	1.45	7-11	9.20	3.22	5-14	8.80	1.92	6-11	8.50	2.17	6-11
5:mid-philtrum	7.67	1.94	4-10	8.10	1.60	6-10	6.60	1.14	5-8	7.17	1.17	6-9
6:chin-lip fold	9.56	1.33	8-12	9.50	1.64	7-11	8.40	0.89	7-9	9.33	2.25	8-13
7:mental eminence	7.56	1.13	6-10	7.44*	1.94	5-11	7.80	1.36	6-9	7.00	1.26	6-9
8:beneath chin	4.78	1.09	4-7	5.00*	1.41	3-7	5.60	2.48	3-9	5.17	2.48	3-10
9:superior eye orbit	4.33	1.22	3-6	4.60	0.84	4-6	4.80	1.30	4-7	4.67	1.03	4-6
10:inferior eye orbit	6.11	1.05	5-8	6.10	2.85	3-11	5.40	2.30	3-8	8.00	3.03	3-11
11:supra canine	8.78	2.64	5-14	8.00	1.94	5-12	7.80	2.17	5-10	7.83	1.60	5-9
12:sub canine	8.11	2.09	5-12	8.90	1.73	6-12	9.80	4.34	7-17	8.17	1.72	5-10
13:supra M2	24.78	2.94	20-30	27.30	5.33	20-38	25.40	5.37	20-32	23.17	2.04	20-26
14:lower cheek	19.78	3.31	13-25	19.50	3.10	16-26	20.00	4.95	14-26	19.00	2.28	15-21
15:mid mandible	8.11	2.52	4-13	9.40	4.27	5-20	8.00	1.87	7-11	9.67	2.42	7-14
16:lateral eye orbit	4.56	0.88	4-6	4.70	0.67	4-6	4.00	1.00	3-5	4.17	0.75	3-5
17:zygomatic	7.00	0.71	6-8	6.60	2.72	4-13	5.40	1.34	4-7	7.00	1.41	5-9
18:gonion	10.67	3.43	7-16	10.90	2.85	7-15	9.60	2.30	6-12	12.33	3.20	7-16
19:root of zygoma	6.44	1.42	4-9	6.90	2.28	3-10	6.60	1.82	4-9	6.67	3.33	2-11

* Indicates N=9, one individual had a full beard and points 7 and 8 were not collected for that individual

Table 4 – Chinese-American female facial tissue depth (mm) comparison with American Negroids (Manhein et al. 2000)

	18-34 Years Old			35-45 Years Old			46-55 Years Old		
	Chinese (N=10)	Negroids (N=18)	Difference	Chinese (N=7)	Negroids (N=21)	Difference	Chinese (N=9)	Negroids (N=5)	Difference
1:glabella	4.30	4.60	-0.30	3.86	4.50	-0.64	4.22	4.80	-0.58
2:nasion	4.10	6.00	-1.90	2.86	5.20	-2.34	3.33	6.00	-2.67
3:end of nasals	1.90	1.70	-0.20	1.71	1.50	0.21	1.33	2.00	-0.67
4:lateral nostril	9.80	8.40	1.40	8.57	8.40	0.17	10.78	8.40	2.38
5:mid-philtrum	7.70	9.20	-1.50	6.29	8.80	-2.51	5.78	8.20	-2.42
6:chin-lip fold	9.80	11.80	-2.00	8.71	11.70	-2.99	9.11	10.00	-0.89
7:mental eminence	8.50	10.80	-2.30	6.57	11.20	-4.63	8.67	10.80	-2.13
8:beneath chin	5.40	6.70	-0.70	4.86	6.40	-1.54	5.11	7.20	-2.09
9:superior eye orbit	5.50	6.10	-0.50	4.71	6.00	-1.29	5.67	5.80	-0.13
10:inferior eye orbit	7.70	6.20	1.50	7.29	6.90	0.39	7.22	5.80	1.42
11:supra canine	8.20	10.00	-1.80	7.14	9.60	-2.46	6.56	9.00	-2.44
12:sub canine	9.30	10.90	1.60	7.29	11.50	-4.21	8.00	12.40	-4.40
13:supra M2	25.30	26.60	1.30	25.29	26.80	-1.51	26.11	26.80	-0.69
14:lower cheek	19.30	21.70	-2.40	21.43	22.50	-1.07	23.44	21.20	2.24
15:mid mandible	10.70	12.60	-1.90	9.00	13.10	-4.10	9.78	13.40	-3.62
16:lateral eye orbit	4.50	5.00	-0.50	4.00	4.90	-0.90	4.56	4.80	-0.24
17:zygomatic	7.60	10.20	-2.60	7.86	9.80	-1.94	8.11	9.80	-1.69
18:gonion	12.90	17.00	-4.10	11.86	16.20	-4.34	11.00	14.80	-3.80
19:root of zygoma	4.90	6.40	-1.50	4.86	5.60	-0.74	6.89	6.00	0.89

Note: Manhein et al. (2000) did not have any data for individuals over the age of 55.

Table 5 – Chinese-American female facial tissue depth (mm) comparison with American Caucasoids (Manhein et al. 2000)

	18-34 Years Old			35-45 Years Old			46-55 Years Old			> 56 Years Old		
	Chinese (N=10)	Caucasoid (N=52)	Diff.	Chinese (N=7)	Caucasoid (N=15)	Diff.	Chinese (N=9)	Caucasoid (N=6)	Diff.	Chinese (N=11)	Caucasoid (N=9)	Diff.
1:glabella	4.30	4.80	-0.50	3.86	4.70	-0.84	4.22	4.80	-0.58	4.36	5.20	-0.84
2:nasion	4.10	5.50	-1.40	2.86	5.30	-2.44	3.33	6.20	-2.87	3.27	6.00	-2.73
3:end of nasals	1.90	1.80	0.10	1.71	1.60	0.11	1.33	1.80	-0.47	1.91	1.80	0.11
4:lateral nostril	9.80	8.60	1.20	8.57	8.00	0.57	10.78	10.80	-0.02	8.91	9.80	-0.89
5:mid-philtrum	7.70	9.10	-1.40	6.29	7.40	-1.11	5.78	8.00	-2.22	5.91	8.00	-2.09
6:chin-lip fold	9.80	10.30	-0.50	8.71	9.60	-0.89	9.11	9.80	-0.69	10.27	11.40	-1.13
7:mental eminence	8.50	9.20	-0.70	6.57	9.20	-2.63	8.67	10.70	-2.03	8.55	12.30	-3.75
8:beneath chin	5.40	6.00	-0.60	4.86	5.40	-0.54	5.11	6.70	-1.59	5.18	8.00	-2.82
9:superior eye orbit	5.50	5.70	-0.20	4.71	5.50	-0.79	5.67	6.50	-0.83	5.09	6.30	-1.21
10:inferior eye orbit	7.70	6.10	1.60	7.29	5.70	1.59	7.22	7.30	-0.08	7.45	7.00	0.45
11:supra canine	8.20	9.30	-1.10	7.14	7.80	-0.66	6.56	7.70	-1.14	7.27	8.00	-0.73
12:sub canine	9.30	9.40	-0.10	7.29	8.70	-1.41	8.00	9.00	-1.00	8.82	9.70	-0.88
13:supra M2	25.30	26.30	-1.00	25.29	25.10	0.19	26.11	27.20	-1.09	26.27	29.40	-3.13
14:lower cheek	19.30	23.40	-4.10	21.43	20.10	1.33	23.44	21.70	1.74	22.18	27.20	-5.02
15:mid mandible	10.70	13.70	-3.00	9.00	12.60	-3.60	9.78	13.00	-3.22	10.36	17.40	-7.04
16:lateral eye orbit	4.50	4.70	-0.20	4.00	4.30	-0.30	4.56	4.50	0.06	5.09	4.90	0.19
17:zygomatic	7.60	9.30	1.70	7.86	8.70	-0.84	8.11	10.20	-2.09	8.18	11.00	-2.82
18:gonion	12.90	17.40	4.50	11.86	15.30	-3.44	11.00	14.70	-3.70	11.45	16.90	-5.45
19:root of zygoma	4.90	7.40	-2.50	4.86	4.90	-0.04	6.89	6.00	0.89	5.55	7.40	-1.85

Table 6 – Chinese-American male facial tissue depth (mm) comparison with American Negroids (Manhein et al. 2000)

	18-34 Years Old			35-45 Years Old		
	Chinese (N=9)	Negroids (N=19)	Difference	Chinese (N=10)	Negroids (N=3)	Difference
1:glabella	4.44	5.20	-0.76	4.20	5.30	-1.10
2:nasion	3.33	6.60	-3.27	3.90	5.70	-1.80
3:end of nasals	1.67	2.20	-0.53	1.90	1.70	0.20
4:lateral nostril	8.89	9.20	-0.31	9.20	10.30	-1.10
5:mid-philtrum	7.67	13.00	-5.33	8.10	11.00	-2.90
6:chin-lip fold	9.56	12.70	-3.14	9.50	12.70	-3.20
7:mental eminence	7.56	12.10	-4.54	7.44	12.30	-4.86
8:beneath chin	4.78	8.80	-4.02	5.00	7.00	-2.00
9:superior eye orbit	4.33	6.40	-2.07	4.60	6.30	-1.70
10:inferior eye orbit	6.11	5.80	0.31	6.10	7.00	-0.90
11:supra canine	8.78	12.80	-4.02	8.00	10.30	-2.30
12:sub canine	8.11	14.40	-6.29	8.90	10.70	-1.80
13:supra M2	24.78	28.20	-3.42	27.30	27.30	0.00
14:lower cheek	19.78	24.50	-4.72	19.50	23.70	-4.20
15:mid mandible	8.11	14.10	-5.99	9.40	13.30	-3.90
16:lateral eye orbit	4.56	4.80	-0.24	4.70	3.70	1.00
17:zygomatic	7.00	8.40	-1.40	6.60	6.30	0.30
18:gonion	10.67	21.10	-10.43	10.90	20.70	-9.80
19:root of zygoma	6.44	7.40	-0.96	6.90	5.70	1.20

Note: Manhein et al. (2000) did not have any data for individuals over the age of 45.

Table 7 – Chinese-American male facial tissue depth (mm) comparison with American Caucasoids (Manhein et al. 2000)

	18-34 Years Old			35-45 Years Old			46-55 Years Old			> 56 Years Old		
	Chinese (N=9)	Caucasoid (N=28)	Diff.	Chinese (N=10)	Caucasoid (N=10)	Diff.	Chinese (N=6)	Caucasoid (N=5)	Diff.	Chinese (N=6)	Caucasoid (N=5)	Diff.
1:glabella	4.40	5.00	-0.60	4.20	5.50	-1.30	4.33	6.00	-1.67	4.33	5.60	-1.27
2:nasion	3.30	6.00	-2.70	3.90	6.40	-2.50	3.50	7.20	-3.70	3.50	6.60	-3.10
3:end of nasals	1.70	1.90	-0.20	1.90	2.40	-0.50	1.67	1.80	-0.13	1.67	2.00 ‡	-0.33
4:lateral nostril	8.90	7.50	1.40	9.20	9.80	-0.60	8.50	10.40	-1.90	8.50	10.80	-2.30
5:mid-philtrum	7.70	11.90	4.20	8.10	10.60	-2.50	7.17	8.00 †	-0.83	7.17	9.40	-2.23
6:chin-lip fold	9.60	11.10*	-1.50	9.50 ⁎	13.10	-3.60	9.33	11.60	-2.27	9.33	12.20	-2.87
7:mental eminence	7.60	10.00	-2.40	7.40 ⁎	12.00	-4.60	7.00	11.00	-4.00	7.00	11.80	-4.80
8:beneath chin	4.80	7.20*	-2.40	5.00	8.00	-3.00	5.17	7.20	-2.03	5.17	5.60	-0.43
9:superior eye orbit	4.30	5.30	-1.00	4.60	5.90	-1.30	4.67	7.70	-3.03	4.67	5.60	-0.93
10:inferior eye orbit	6.10	5.80	0.30	6.10	6.20	-0.10	8.00	6.80	1.20	8.00	5.00	3.00
11:supra canine	8.80	11.90*	-3.10	8.00	10.10	-2.10	7.83	10.00 †	-2.17	7.83	9.20	-1.37
12:sub canine	8.10	11.50	-3.40	8.90	10.20	-1.10	8.17	10.00	-1.83	8.17	11.80	-3.63
13:supra M2	24.80	28.50	-3.70	27.30	24.60	2.70	23.17	28.20	-5.03	23.17	23.60	-0.43
14:lower cheek	19.80	25.10	-5.30	19.50	21.10	-1.60	19.00	21.40	-2.40	19.00	20.60	-1.60
15:mid mandible	8.10	14.80	-6.70	9.40	15.60	-6.20	9.67	15.40	-5.73	9.67	11.40	-1.73
16:lateral eye orbit	4.60	4.20	0.40	4.70	4.30	0.40	4.17	5.40	-1.23	4.17	5.20	-1.03
17:zygomatic	7.00	7.80	-0.80	6.60	8.20	-1.60	7.00	8.20	-1.20	7.00	6.40	0.60
18:gonion	10.70	20.00	-9.30	10.90	19.60	-8.70	12.33	19.00	-6.67	12.33	14.00	-1.67
19:root of zygoma	6.40	7.80	-1.40	6.90	6.60	0.30	6.67	5.40	1.27	6.67	5.20	1.47

* Indicates N=27 (number excludes men with beards and mustaches).

⁎ Indicates N=9 (number excludes men with beards and mustaches).

† Indicates N=3 (number excludes men with beards and mustaches).

‡ Indicates N=4 (number excludes men with beards and mustaches).

Table 8 – Chinese-American female tissue depth (mm) comparison among different populations

Point Numbers/Description	Chinese (N=40) Mean	SD	Lebedinskaya et al. (1993) (Koreans) (N=91) Mean	SD	Suzuki (1948) (Japanese) (N=7) Mean	Kollman and Buchly (1898) (European Caucasoids) (N=8) Mean	Miyasaka et al. (1998) (Japanese) (N=12) Mean
1:glabella	4.18	0.90	5.40	0.88	3.20	4.25	5.06
2:nasion	3.35	1.25	4.40	0.89	3.40	4.50	5.55
3:end of nasals	1.73	0.55	2.90	0.35	1.60	2.00	1.99
4:lateral nostril	9.50	2.43	2.90	0.28			
5:mid-philtrum	6.43	1.28	9.60	1.13		10.00	11.89
6:chin-lip fold	9.45	1.50	11.10	1.16	8.50	10.00	12.71
7:mental eminence	8.13	1.76	11.10	1.71	5.30	10.00	11.96
8:beneath chin	5.10	1.50	6.50	1.12	2.80	6.25	6.56
9:superior eye orbit	5.15	1.44			3.60	5.25(l)	
10:inferior eye orbit	7.25	2.30			3.00	4.5(l)	
11:supra canine	7.30	1.73					
12:sub canine	8.40	1.78					
13:supra M2	25.75	3.91			12.30		
14:lower cheek	21.45	4.01			9.70		
15:mid mandible	10.00	2.92	14.60	2.83			
16:lateral eye orbit	4.55	1.15			4.70	7.75(l)	7.18
17:zygomatic	7.90	1.79			2.90	5.25	13.25
18:gonion	11.80	3.07	5.40	1.22	4.00	9.5(l)	
19:root of zygoma	5.48	2.14					

All measurements were taken on the right side of the face unless indicated with (l).

al.’s (1993) dataset of Koreans living in the former USSR, with the exception of points 4, 5, 15, and 18. For points 5 and 15, Chinese-American females exhibit thinner tissue than the Korean females in Lebedinskaya et al.’s (1993) study. Contrarily, they exhibit thicker tissue for points 4 and 18. In comparison to European Caucasoid females, Chinese-American females have thinner facial tissue depths. The exceptions to this are points 10, 17, and 18, at which Chinese-American females have thicker facial tissue depths. European females have much thicker tissue at points 5 and 10. Miyasaka et al.’s (1998) dataset for Japanese females that relied on cephalometry shows thicker tissue depth than my data for Chinese-Americans.

Table 9 compares facial tissue depths for Chinese-American males with Japanese males (Ogawa 1960; Miyasaka et al. 1998), Korean males (Lebedinskaya et al. 1993), and European Caucasoid males (Kollman and Buchly 1898). Korean males generally have thicker facial tissue depths, except for points 4 and 18 where Chinese-American males had noticeably thicker tissue. Chinese-American males have noticeably thinner tissue at points 5, 7, and 15. Generally, Chinese-American males have thicker facial tissue than Japanese males (Suzuki 1948). In comparison to Caucasoid European males, Chinese-American males have thinner facial tissue. The exceptions are points 10 and 17. Chinese-American males have tissue depth similar to Japanese males (Ogawa 1960) except that points 13 and 14 are thicker in the Chinese-Americans. However, Japanese males who were measured with cephalometry (Miyasaka et al. 1998) show much thicker tissue depths at all comparable points than the Chinese-Americans I measured with ultrasound.

Tables 10 through 13 show the correlations between the facial tissue depths and BMI and age. In the Pearson’s correlation between females and age (Table 10), points 5 and 14 are statistically significant. Point 5 is the mid-philtrum point, right below the nose, which would not seem to be as related to age as the other points would be. In the Pearson’s correlation between

Table 9 – Chinese-American male tissue depth (mm) comparison among different populations

Point Numbers/Description	Chinese (N=29*)		Lebedinskaya et al. (1993) (Koreans) (N=91)		Suzuki(1948) (Japanese) (N=48)	Kollman and Buchly (1898) (European Caucasoids) (N=45)	Ogawa (1960) (Japanese) (N=44)	Miyasaka et al. (1998) (Japanese) (N=56)
	Mean	SD	Mean	SD	Mean	Mean	Mean	Mean
1:glabella	4.34	0.72	5.10	0.80	3.80	4.75	3.61	5.94
2:nasion	3.57	1.02	4.50	0.79	4.10	5.00	3.87	6.91
3:end of nasals	1.79	0.62	2.80	0.31	2.20	2.00	2.01	2.41
4:lateral nostril	8.9	2.32	2.90	0.31				
5:mid-philtrum	7.59	1.59	11.10	1.44		11.50	10.18	13.5
6:chin-lip fold	9.31	1.61	11.30	1.34	10.50	10.00	8.72	13.12
7:mental eminence	7.43 *	1.45	10.60	1.85	6.20	10.25	10.84	12.91
8:beneath chin	5.07 *	1.78	6.30	1.17	4.80	6.00	4.5	7.51
9:superior eye orbit	4.62	1.02			4.50	5.75(l)	4.68	
10:inferior eye orbit	6.38	2.47			3.70	4.25(l)	5.72	
11:supra canine	8.28	2.03						
12:sub canine	8.66	2.39						
13:supra M2	25.41	4.35			14.50		18.02	
14:lower cheek	19.59	3.28			10.20		11.83	
15:mid mandible	8.86	3.13	12.80	3.43				
16:lateral eye orbit	4.45	0.83			5.40	6.75(l)	6.48	
17:zygomatic	6.55	1.84			4.40	4.25	5.28	7.48
18:gonion	10.93	3.05	4.60	0.96	6.80	10.5(l)	8.78	13.57
19:root of zygoma	6.66	2.18						

* Indicates N=28 (excludes individuals with beards and mustaches).

All measurements taken from the right side of the face unless indicated (l).

Table 10 – Pearson's Correlation between normal BMI Chinese-American females (N=38) and age

Point Numbers/ Descriptions	P-value	Pearson's Correlation
1:glabella	0.89	-0.023
2:nasion	0.393	-0.143
3:end of nasals	0.791	-0.044
4:lateral nostril	0.753	0.053
5:mid-philtrum	0.001	-0.0536(**)
6:chin-lip fold	0.352	0.155
7:mental eminence	0.534	0.104
8:beneath chin	0.636	-0.079
9:superior eye orbit	0.616	-0.084
10:inferior eye orbit	0.935	-0.014
11:supra canine	0.54	-0.103
12:sub canine	0.552	-0.099
13:supra M2	0.268	0.184
14:lower cheek	0.018	0.382(*)
15:mid mandible	0.865	-0.029
16:lateral eye orbit	0.266	0.185
17:zygomatic	0.467	0.122
18:gonion	0.321	-0.165
19:root of zygoma	0.274	0.182

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 11 – Pearson’s Correlation between normal BMI Chinese-American males (N=29) and age

Point Numbers/ Descriptions	P-value	Pearson's Correlation
1:glabella	0.644	-0.09
2:nasion	0.761	-0.059
3:end of nasals	0.772	-0.056
4:lateral nostril	0.775	-0.055
5:mid-philtrum	0.146	-0.277
6:chin-lip fold	0.455	-0.144
7:mental eminence	0.941	-0.015
8:beneath chin	0.592	0.106
9:superior eye orbit	0.543	0.118
10:inferior eye orbit	0.193	0.249
11:supra canine	0.55	-0.116
12:sub canine	0.631	0.093
13:supra M2	0.541	-0.118
14:lower cheek	0.482	-0.136
15:mid mandible	0.59	0.104
16:lateral eye orbit	0.17	-0.262
17:zygomatic	0.848	-0.037
18:gonion	0.49	0.134
19:root of zygoma	0.833	0.041

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 12 – Pearson's Correlation between Chinese-American females (N=53) and BMI

Point Numbers/ Descriptions	P-value	Pearson's Correlation
1:glabella	0.006	0.372(**)
2:nasion	0.237	0.165
3:end of nasals	0.971	0.005
4:lateral nostril	0.893	-0.019
5:mid-philtrum	0.761	0.043
6:chin-lip fold	0.028	0.302(*)
7:mental eminence	0.089	0.236
8:beneath chin	0.007	0.364(**)
9:superior eye orbit	<0.001	0.472(**)
10:inferior eye orbit	<0.001	0.511(**)
11:supra canine	0.686	0.057
12:sub canine	0.214	0.173
13:supra M2	0.005	0.379(**)
14:lower cheek	0.013	0.339(*)
15:mid mandible	0.006	0.371(**)
16:lateral eye orbit	0.023	0.311(*)
17:zygomatic	<0.001	0.485(**)
18:gonion	0.001	0.445(**)
19:root of zygoma	0.054	0.266

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 13 – Pearson's Correlation between Chinese-American males (N=48) and BMI

Point Numbers/ Descriptions	P-values	Pearson's Correlation
1:glabella	0.000	0.639(**)
2:nasion	0.237	-0.174
3:end of nasals	0.958	-0.008
4:lateral nostril	0.357	0.136
5:mid-philtrum	0.156	0.208
6:chin-lip fold	0.012	0.359(*)
7:mental eminence	0.000	0.500(**)
8:beneath chin	0.000	0.582(**)
9:superior eye orbit	0.000	0.579(**)
10:inferior eye orbit	0.022	0.331(*)
11:supra canine	0.126	0.224
12:sub canine	0.004	0.405(**)
13:supra M2	0.016	0.347(*)
14:lower cheek	0.000	0.528(**)
15:mid mandible	0.000	0.651(**)
16:lateral eye orbit	0.126	0.224
17:zygomatic	0.000	0.590(**)
18:gonion	0.000	0.641(**)
19:root of zygoma	0.104	-0.238

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

males and age (Table 11), none of the points is significantly correlated with age. The Pearson's correlation between females and BMI (Table 12) shows significant correlation at 11 of the 19 points. The Pearson's correlation between males and BMI (Table 13) has significant correlation to 12 of the 19 points.

Table 14 shows the Student's t-test analyzing the differences between sex and facial tissue depths at each landmark. Only three points, 1, 5, and 11, show significant differences in facial tissue depth between the sexes.

Table 15 shows the Student's t-test analyzing the differences between individuals aged over and under 35 and facial tissue depths at each landmark. This tests my hypothesis of facial tissue depth change in individuals after the age of 35. Only two points, 5 and 14, show significant differences between the ages.

Table 16 shows the difference in facial tissue depth measurements between the right and left side of the face. Only three of the twelve points showed any side differences. Point 14 showed the greatest difference, which happens to be in a region that shows maximal variation when using ultrasound (Utsuno et al. 2005:105).

Table 14 – Comparison of males (N=48) and females (N=53) at facial tissue depth landmarks by Student's t-test

Point Numbers/Descriptions	t	Sig. (2-tailed)
1:glabella	-2.058	0.042
2:nasion	-0.267	0.79
3:end of nasals	-0.152	0.879
4:lateral nostril	-0.146	0.885
5:mid-philtrum	-4.098	<0.001
6:chin-lip fold	0.232	0.817
7:mental eminence	0.457	0.648
8:beneath chin	-0.984	0.327
9:superior eye orbit	0.457	0.649
10:inferior eye orbit	1.781	0.078
11:supra canine	-2.477	0.015
12:sub canine	-1.225	0.224
13:supra M2	0.43	0.668
14:lower cheek	1.522	0.131
15:mid mandible	0.013	0.989
16:lateral eye orbit	-0.028	0.977
17:zygomatic	1.873	0.064
18:gonion	0.003	0.997
19:root of zygoma	-1.559	0.122

Table 15 – Comparison of subjects aged over (N=73) and under (N=23) 35 years old by Student's T-test

Point Numbers/Description	t	Sig. (2-tailed)
1:glabella	-0.079	0.938
2:nasion	-0.397	0.693
3:end of nasals	-1.163	0.248
4:lateral nostril	-0.102	0.919
5:mid-philtrum	-2.921	0.004
6:chin-lip fold	0.536	0.593
7:mental eminence	0.972	0.334
8:beneath chin	0.929	0.355
9:superior eye orbit	1.132	0.26
10:inferior eye orbit	0.708	0.481
11:supra canine	-2.091	0.039
12:sub canine	0.121	0.904
13:supra M2	1.43	0.156
14:lower cheek	1.988	0.05
15:mid mandible	1.376	0.172
16:lateral eye orbit	1.739	0.085
17:zygomatic	0.561	0.576
18:gonion	0.422	0.674
19:root of zygoma	-0.203	0.84

Table 16 – Example of tissue depth differences (mm) between the left and right side of face for one Chinese-American woman (Age 52)

	Female Number 002		
Point Numbers/ Descriptions	Right Side	Left Side	Difference
4:lateral nostril	6.00	6.00	0.00
9:superior eye orbit	5.00	5.00	0.00
10:inferior eye orbit	6.00	5.00	1.00
11:supra canine	5.00	5.00	0.00
12:sub canine	7.00	8.00	-1.00
13:supra M2	24.00	24.00	0.00
14:lower cheek	22.00	20.00	2.00
15:mid mandible	5.00	5.00	0.00
16:lateral eye orbit	3.00	3.00	0.00
17:zygomatic	5.00	5.00	0.00
18:gonion	8.00	8.00	0.00
19:root of zygoma	9.00	9.00	0.00

CHAPTER SIX: DISCUSSION

In America since the 1970s forensic artists have used facial tissue depth information to produce their facial reconstructions. Such information for many racial groups, especially East Asians still does not exist. This need led me to conduct my own study of facial tissue depths for Chinese-Americans. Suzuki's (1948) Japanese dataset was traditionally used to reconstruct individuals of Mongoloid (generally East Asian) descent. Some anthropologists question the validity of Suzuki's (1948) dataset because subsequent facial tissue depth studies of Japanese individuals have resulted in thicker facial tissue depths (Miyasaka et al. 1998; Ogawa 1960). One explanation for the discrepancy is that the researchers used different techniques to take their measurements. Suzuki (1948) used needles on cadavers while Miyasaka et al. (1998) used x-ray cephalometry on live subjects. Ogawa (1960) used embalmed cadavers as his subject group. Another difference in measurements can result from the position of the subjects. In Suzuki (1948) and Ogawa's (1960) data collection, the subjects were supine whereas in Miyasaka et al.'s (1998) data collection, the subjects were upright. Another possible component that can affect the difference between the datasets is the time period when the study was conducted. Suzuki's data were collected in the 1940s and Ogawa's were collected almost ten years later. There could also be secular changes that can attribute to larger individuals who fit in the "normal" range.

The current project has shown that there are differences in facial tissue depth measurements between my dataset and Suzuki (1948), Ogawa (1960), and Miyasaka et al.'s (1998). Some forensic artists maintain that Suzuki's dataset can be effectively applied to all East Asian populations because of perceived physical similarities among all East Asian peoples. However, there is a debate over whether there are physical differences between Chinese and Japanese populations that originated during WWII. Though the Chinese and Japanese share certain phenotypic traits, some argue that there is a clear physical distinction between individuals of each population that is only measurable in millimeters (*Life* 1941; *Time* 1941).

The results of the comparison between my datasets and other East Asian datasets were somewhat different than I expected. In my hypothesis, I suggested that my results should be comparable to those of other contemporary studies of Asian populations. In the comparison between Miyasaka et al.'s (1998) dataset on Japanese, my measurements were consistently smaller than their measurements. I can offer several possible reasons for the discrepancy. Differences in data collection techniques (x-ray cephalometry versus ultrasound) could account for the measurement differences. Another possible explanation is the sample itself. The average age of the Miyasaka et al. (1998) dataset is 29.5 for males and 26.4 for females, whereas the average age of both of my datasets is in the 40s (46.9 for females, 42.9 for males). Not only is Miyasaka et al.'s (1998) average age of subjects younger, their entire subject sample is more youthful, with the male sample ranging in age from 22 to 44 and the female sample ranging from 22 to 29 (Miyasaka et al. 1998). Because age has some role in facial tissue depths the different ages of our study groups make a direct comparison of results ambiguous.

Lebedinskaya et al.'s (1993) measurements of Koreans were generally thicker than mine with the exception of a couple of points. Because Lebedinskaya et al. (1993) also used ultrasound for their data collection, I expected our results to be the most similar. The differences between our datasets can most likely be attributed to the climate and ethnic group differences in our subject sample. The climates of Russia and New York City are very different and the environment has been suggested as playing a role in morphological changes in the human skeleton (Boas 1912). Lebedinskaya et al. (1993) did not specify the mean age of their subject group but they did remark that they only had subjects between the ages of 20 and 50, which means that the median age of my group is possibly older.

Comparisons between my data and Manhein et al.’s (2000) datasets yielded expected results. I hypothesized that my measurements would be smaller than Manhein et al.’s (2000) data on American Caucasoids and Negroids. While Manhein et al.’s (2000) data fell into a similar range as my own data, the observed means were generally greater than my data. One likely reason for the measurable differences is based on the physical differences between the racial groups. In general, Negroids and Caucasoids are more robust than Chinese. The more salient differences between the races are more in males than females. This corresponds to the broader physical differences among males of different races. Comparison can be difficult because of the lack of raw data available for Manhein et al.’s (2000) dataset. I believe the main reason for differences in our data was because of the fundamental differences in the bone structure of the three races.

The only points in my study that seem to be consistently thicker than Manhein et al.’s (2000) study are points 4 in females and 10 in both males and females. The only explanation I can offer to a greater measurement in point 10 is possibly due to the way the zygomatics are shaped in the Asian populations. A defining characteristic in Mongoloids is protruding zygomatics, which might influence how much facial tissue attaches to the inferior orbits. Further research must be done on differences in facial anatomy among different races before this issue can be resolved.

Because I have few subjects with widely varying BMI indices in each age category, the results might not be an accurate portrayal of the Chinese-American population. The normal BMI ranges span on average at least a 50-pound range, which is a large span that could affect my results. Because weight is a component that influences facial tissue depth at multiple points, my use of subjects with very different BMIs can skew an average drawn from all the subjects. The

BMI calculated for each individual was mostly based on self-reporting of weight and height. This self-reporting could be problematic if individuals who were on the fringes of the “normal” BMI range did not provide accurate data. I tried to determine if each individual was accurately reporting his or her height and weight based on visual confirmation and optional weighing. The height of the subjects was probably more accurate than weight because that is harder to embellish. Among female subjects it was more common to under-report weight than the male subjects, who sometimes reported a higher weight than they actually had. Many females desired to under-report their weight to fit into the idealized image of what a woman’s weight should be and males often over-reported weights to better fit the male ideals. I estimate that the female subjects would under-report 5-10 pounds on average, which would not place most people out of the “normal” BMI category.

My last hypothesis to test was that facial tissue depth decreases with age. I found no evidence of that in my results. In fact, this study found the opposite in Chinese-American females, with the female age group of 35-45 years having the smallest measurements and the other age groups having comparable measurements. In the males, there seemed to be no noticeable differences among age groups. When I conducted the Pearson’s correlation for the individuals and age, I found that for most points there was not a correlation between age and facial tissue depth. I also conducted a Student’s T-test to find a difference between individuals older and younger than 35 years old and facial tissue depth. The test showed only two points of significant differences between the age groups. This leads me to conclude there are very few significant differences as an individual ages in this population. Because individuals age differently, to determine a relationship between aging and facial tissue depth, it would be useful to perform a follow-up ultrasound scan for each individual in five years.

Manhein et al.'s (2000) findings of a statistically significant relationship between age and tissue depth is counter to my findings for Chinese-Americans. They found that using Pearson's correlation of facial tissue depth and age, points 4, 5, 11, 18, and 19 were not statistically significant in Caucasoids. In Negroids, points 5, 11, 18, and 19 were not statistically significant either. Overall, they had more points that were statistically correlated. Based on their results, they suggest that there is a significant relationship between tissue thickness and age at most points. From my dataset, I would agree that for most points, facial tissue depth is affected by age, but I am cautious about the extent of its influence.

In my study, BMI was the major determinant of facial tissue depth. It is somewhat intuitive that weight gain can be reflected in the face and thereby affect a person's facial tissue depth. Age does not affect facial tissue depth in my study, whereas in Manhein et al.'s (2000) study, they found the opposite. A reason for this discrepancy might be the aging pattern of Chinese-Americans versus American Caucasoids and Negroids. Based upon personal observation, older Chinese-American individuals can appear more youthful than their American counterparts. This more youthful appearance could result in facial tissue depth that resembles that of younger individuals. Because of the small number of individuals over age 60 whom I measured, I could not conduct statistical tests on this theory. This theory could also be applied to other Asian populations because they also seem to share the same youthful appearances in their 60s.

Perhaps the most interesting finding from this study is that there is little correlation between sex and facial tissue depths. Certain researchers have suggested that sex does not have a strong influence on facial tissue depth thickness (Stephan et al. 2005). Stephan et al. (2005) discovered that the variation within each sex was large but the variation between the sexes was small. They suggest that even though the means at each landmark may differ between the sexes, the ranges are generally the same or very similar. They suggest that the datasets for the two sexes should be combined because there appears to be little sexual dimorphism. My dataset supports this suggestion because multiple points show that there is no statistically significant correlation with sex. In order to evaluate this theory, larger study samples will be needed to confirm or to dispel it.

CHAPTER SEVEN: CONCLUSIONS

For over a century anthropologists and anatomists have performed facial tissue depth studies, but in recent years this research has been gaining popularity. However, certain ethnic groups in America have not been represented in this work. With this thesis, I attempt to contribute to the facial tissue depth data pool for facial reconstructions. I collected facial tissue depth measurements with an ultrasound machine from 101 Chinese adults living in New York City. New York City was the optimal location for this data collection because of the many Chinese-Americans who live there and because of my personal connections. My dataset of the facial tissue depths of Chinese-American adults yielded some expected and unexpected results.

My measurement range is comparable to Manhein et al.'s (2000) range. The means of most of my points are comparable to Manhein et al. (2000), Ogawa (1960) and Miyasaka et al. (1998). An unexpected result of my research is that although BMI and age influenced an individual's facial tissue depth, sex is not necessarily correlated to facial tissue thickness in Chinese-Americans. While age in other studies is significantly correlated to facial tissue depth, my findings did not support my hypothesis that as an individual ages, facial tissue depths will increase to a point and after a certain age, will decrease. My results show that the tissue thicknesses of individuals in all the age groups fall into similar ranges. A larger sample size and more research are necessary to better comprehend the significance of these findings.

This research can provide valuable information for forensic artists who create forensic facial reconstructions of Chinese-Americans. Information for this population has heretofore been unavailable and forensic artists have been using Suzuki's (1948) dataset for Japanese when they create facial reconstructions for suspected Chinese individuals. With this new dataset forensic artists can create accurate facial reconstructions for Chinese-Americans and this will increase the chances of a positive identification. Measurements of more individuals are needed to explore the full extent of the variance for each dependent variable.

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APPENDIX A: CONSENT FORM IN ENGLISH

1. Study Title: In Vivo Facial Tissue Depth Measurements in the Chinese-American Population of New York City

2. Performance Site: The Chan Residence

3. Investigators: The investigator listed below is available to answer questions about the research:

   M-F, 8:00 a.m. - 5:00 p.m.
   Joyce Chan
   (718)631-0340

4. Purpose of the Study: The purpose of this research project is to collect facial tissue depth measurements from individuals from the Chinese-American population of New York City for the purposes of aiding in forensic identification.

5. Subject Inclusion: Individuals, ages 18-90, who are from the Chinese-American population of New York City

6. Number of Subjects: 100

7. Study Procedures: Each subject will have ultrasound applied to the right side of the face at 19 specific landmarks. Also, each subject will have to complete a biographical data sheet. Questions on the data sheet will include, your birth date, height, weight, and race. The ultrasound procedure will take approximately 15 minutes to complete.

8. Benefits: There are no direct benefits to the individual subjects. However, information gained from the study may provide valuable information to forensic imagers when creating facial reconstructions.

9. Risks/Discomforts: Ultrasound poses no risk to the subject; however, individuals must be able to remain still while a gel-coated transducer is applied to the face for several 3-5 second periods. Subjects will receive sanitary wipes to clean their face after the procedure to wipe off the ultrasound gel.

10. Right to Refuse: Subjects may choose not to participate or to withdraw from the study at any time with no jeopardy to their relationship to the researcher or LSU or the LSU FACES Lab at the present time or in the future.

11. Privacy: The LSU Institutional Review Board (which oversees university research with human subjects) and the LSU FACES Lab may inspect and/or copy the study records.
    Results of the study may be published, but no names or identifying information will be included in

the publication.
Other than as set forth above, subject identity will remain confidential unless disclosure is legally compelled.

12. Financial Information: There is no cost to the subjects, nor is there any compensation for participating in the study.

13. Signatures:

The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of the consent form.

Subject Signature Date

The study subject has indicated to me that he/she is unable to read. I certify that I have read this consent form to the subject and explained that by completing the signature line above, the subject has agreed to participate.

Signature of Reader Date

APPENDIX B: CONSENT FORM IN CHINESE

1. 研究標題:紐約的中國美國人口人體臉部皮膚深度測量

2. 地點: 陳 住所和中國美國計劃委員會

3. 調**查員**: 調**查員列出以下時間回答關於研究的問題**:
M-F, 8:00 上午。- 5:00 p.m 。Joyce Chan (718)631-0340

4. 研究的目的:
這個研究計劃的目的將從紐約的中國美國人口的臉部皮膚深度測量的收集幫助法庭證明個人的身份。

5. 主題包含: 紐約的中國美國人口,年齡18-90

6. 主題的數字: 100

7. 研究程序:
各個主題將必須進行超聲波在右邊的臉19處測量和完成一張自傳資料表。問題將包括,
您的出生日期、高度、重量, 和種族。超聲波做法將需要大約15 分鐘完成。

8. 好處: 資訊被獲取可提供寶貴資料提供法庭研究臉孔重建。

9. 不方便之處: 將會接受右邊臉大致15分鐘無害健康的超聲波測量。
之後他們會將留在臉部的超聲波膠凝體衛生的清洗。

10. 有拒**絕權利**: 有權選擇不參與研究, 但沒有損害他們與研究員或LSU 或LSU
面孔實驗室的關係。

11. 保密性: 監督大學研究以人類主題) 的LSU 協會評論委員會(並且LSU
面孔實驗室也許檢**查並且**/或者複製研究紀**錄。**研究的結果也許被出版,
但名字或辨認資訊不會包括在出版物。除之外依照被指出以上,
附屬的身分將依然是機密除非法律上被強迫透露。

12. 財政資訊: 沒有費用對主題, 亦不是有任何報償為參加研究。

13. 簽名:
研究與我被談論並且所有我的問題被回答了。我也許指示另外的問題關於研究具體對調**查員。如果我有關於主題的權利或其它關心的問題**, 我能與羅伯特・C. Mathews,

協會評論委員會聯繫, (225) 578-8692。
我同意參加研究被描述上面和承認調**查員的義務提供我以同意形式的一個簽字的拷貝。**

接受研究者簽名 日期

接受研究者表明了對我, 他或她無法讀。我證明, 我解釋清楚這份研究表格,
接受研究者同意參與。

解釋員簽名 日期

VITA

Wing Nam Joyce Chan was born on August 16, 1983 in Hong Kong. She immigrated with her family to New York City in 1989. At a young age, her parents encouraged her to do well in school and she immersed herself into academia. Joyce graduated from Macalester College with a bachelors in anthropology in St. Paul, MN in December 2004, making her the first person in her family with a college degree. At Macalester, she was introduced to the world of anthropology. Anthropology enticed her with its unanswered questions and fascinating ideas. Feeling she still had much to learn, she decided to continue her education at Louisiana State University.

She hopes to graduate with her masters in anthropology in May 2007 from the LSU Department of Geography and Anthropology. During her time here, she had the wonderful opportunity to volunteer and work for the LSU FACES Lab, under the direction of Ms. Mary H. Manhein. Joyce plans to continue her education and obtain her Ph.D. at The Ohio State University after completing her degree at LSU.

There are still many questions that remain unanswered for Joyce and she will continue to embrace the field of anthropology.