CHAPTER THREE

MATERIALS AND METHOD

3.5 ETHICAL APPROVAL

This study was approved by the research ethics committee of the Faculty of Dentistry, University of Malaya (Appendix 1).

3.6 PARTICIPATION INFORMATION SHEET AND INFORMED CONSENT

All subjects received detailed information about the research and signed a consent form to participate in the study (Appendix 2).

3.7 SUBJECTS IN THE STUDY

The subjects were 90 adults from 3 ethnic groups in Malaysia – Malays, Chinese and Indians (n=30 for each ethnic group). Their ages ranged from 20-57 years.

3.7.1 Facial skin measured

The forehead area was selected as being representative of the facial skin colour because the skin is exposed, sparsely covered with facial hair and easily probed as it is firmly bound to the frontal bone. Subjects who participated in the study were not wearing any make up, had healthy skin with no excessive facial hair and absence of skin conditions that would affect the skin tone and shade.

3.8 DEVICES USED FOR DATA COLLECTION

3.4.1 Spectrophotometer

The spectrophotometer used (Ocean Optics USB 4000, Florida USA) composed of a light generator, light analyzer, reflected light collector (probe), fibre optics, white calibrator, electric energy source, and ocean optics software (Spectra suit) (Figure 3.1).

The device was first connected to a personal computer. Before use, the device was calibrated. Calibration of the device was done following the information provided in the instruction manual. This procedure was performed before the final subject skin colour was recorded. (The calibration process was repeated before each subject skin was recorded).

The patient was seated comfortably in an upright position in a well lit room with fluorescent lighting. The tip of the measuring unit of the spectrophotometer (the probe light slit is an area of 2x2 mm) was put in contact with the forehead (Figure 3.2). Each single measurement was made one time for each person. The LED light of the spectrophotometer was switched on for 10 seconds for each recording. The reliability and consistency (repeatability) of the device recording was tested and approved before starting the work. Measurements were repeated 3 times consecutively for at least 7 subjects selected at random.

Figure 3.1 The spectrophotometer, digital camera and scanner used in the study.

Figure 3.2 Spectrophotometer probe location on the forehead of the face when recording of skin tone was made.

3.4.2 Digital camera

A digital camera was used in the study (Canon 450 D, Tokyo Japan). The camera with its tripod holder was placed in front of the seated patient. The lens level was set at 150 cm height. The subject was seated as for the spectrophotometer reading described in 3.4.1. The subject`s forehead was located at the same level of the lens using the adjustable mechanism of the chair. A sheet of paper of the appropriate thickness was placed in front of the subjects` face and the subject was asked to hold it. A rectangle measuring 4x3 cm was cut in the sheet of paper, and this was placed on the forehead of the subject (this represented the area of the forehead to be photographed). The distance between the camera and the area to be photographed was approximately 50 cm. The camera setting of the exposure was set as: 60 mm lens, ISO-400, exposure time of 1/20 sec. The lens was focused, before the exposed skin area was captured by the camera (Figure 3.3). The reliability of the camera recording was tested by capturing three frames per second consecutively for the same skin area.

Figure 3.3 The digital camera and subject position during recording of the skin tone.

3.4.3 Scanner

The scanner used was a Canon Lide 100 (Canon Inc., Vietnam) (Figure 3.4). In order to be used, the scanner was fixed in a custom-made stand holder, which consisted of a wooden base (30x30 cm) and a vertical aluminium stand (35x10 cm) fixed to the base of the jig (Figure 3.5).

The cover of the scanner was removed before it was used to record the skin shade. The screen of the scanner was then covered totally by a sheet of paper except for a rectangular window in the paper measuring 4x3 cm. This part of the exposed screen was then used for recording the forehead skin colour (Figure 3.6).

The patient was then seated comfortably in front of the scanner (held in the custom made jig on a table in front of patient). The base of the jig was then moved towards the subject until the forehead just lightly touched the scanner at the exposed area. The correct height of the subject`s forehead to the scanner was adjusted by adjusting the height of the subject`s chair (Figure 3.7).

A minimum resolution equal to 200 dpi was used to scan the forehead. The area was scanned with a lap time of 24 seconds. The reliability and consistency (repeatability) of the scanner record was tested and approved before starting the real record.

Figure 3.4 The scanner used in the study (with the cover in place).

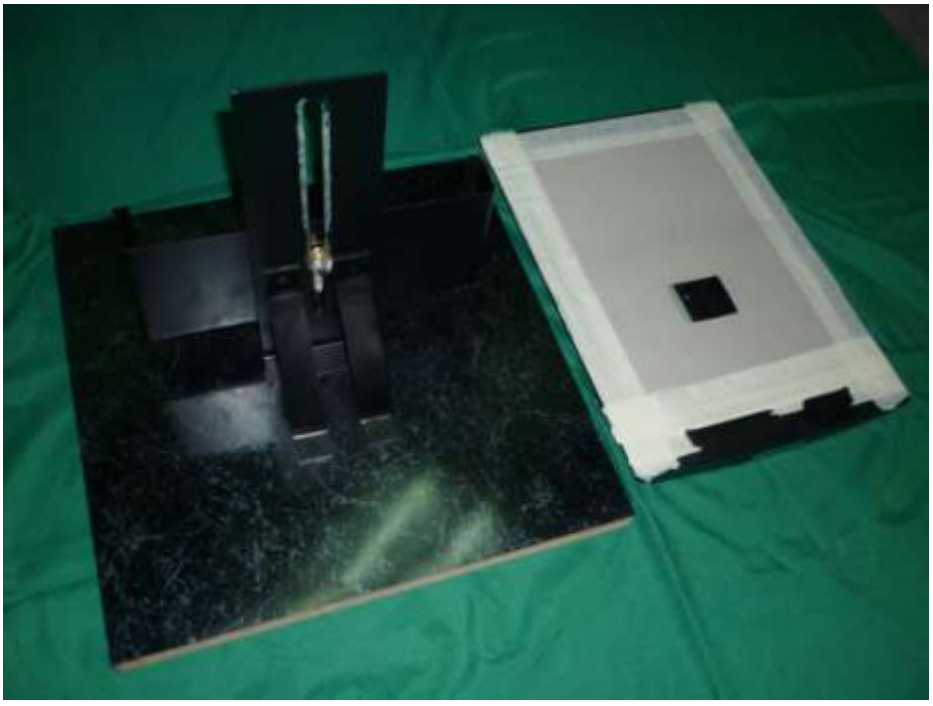


Figure 3.5 The scanner next to the custom made jig used to hold it during the process of recording the skin shade.

Figure 3.6 The scanner held vertically in the custom made jig with the cover removed.

Figure 3.7 The volunteer forehead position when the scanner was used to record the skin shade.

3.5 DATA CAPTURE AND SOFTWARE USED

The following softwares were used in the research:

1. Spectra suit software (Ocean optics) to display the data from the spectrophotometer.

2. Microsoft Office 2000 (Word, Power Point and Excel)

3. Adobe Photoshop (CS4).

4. Colours Average Calculator Software version 1 beta: which is a software designed by a software programmer to calculate the average LAB values of the whole pixels in the captured areas of the skin. This was done as follows:

Mean L = $(L_1+L_2+....+L_n)$ / total number (n),

Mean a = $(a_1 + a_2 +....+a_n)$ / total number (n),

Mean b = $(b_1 +b_2 +....+b_n)$ / total number (n) (Ahmed Laith, 2010).

3.5.1 Data from spectrophotometer

3.5.1.1 Computer software

The following softwares were used with the spectrophotometer: Spectra Suit Software (Ocean Optics) to display the recorded data by spectrophotometer, Microsoft Word, And Adobe Photoshop.

3.5.1.2 Data capture

The colour readings were copied from the Spectra Suit software and pasted and saved into a Word document file (Figure 3.8). The saved data were then converted into colour according to Lab values using Photoshop software (time consumed was about 3 min) (Figure 3.9).

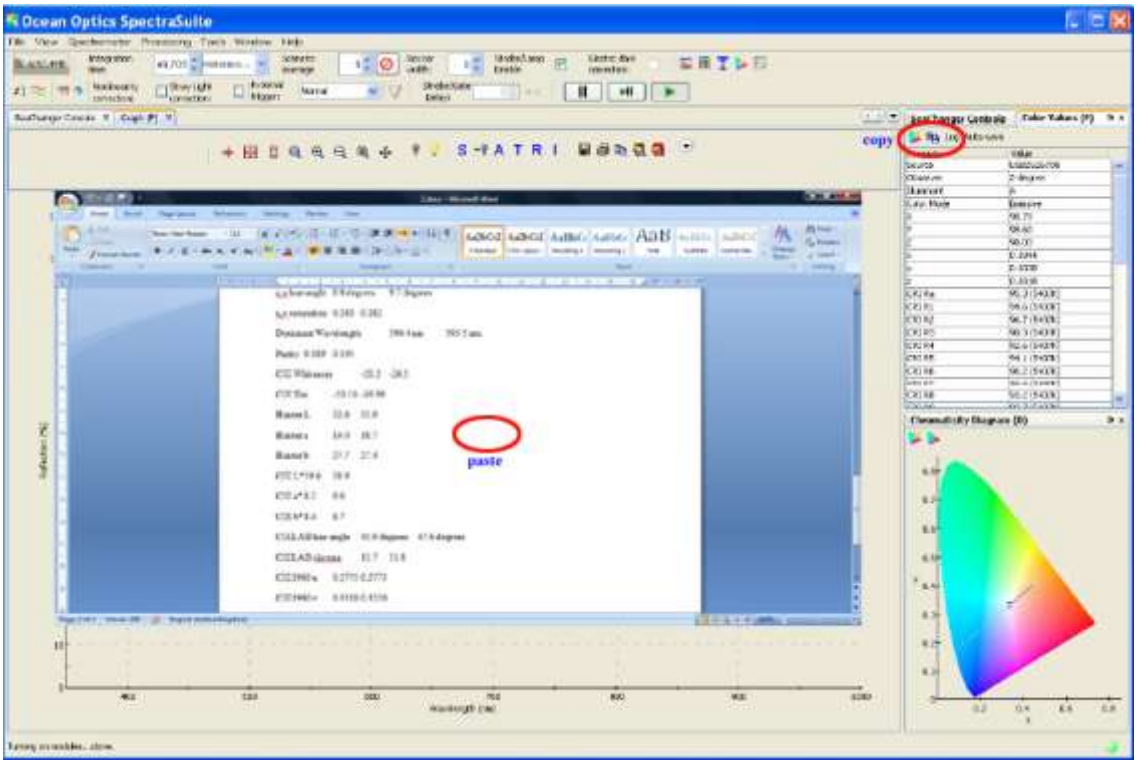


Figure 3.8 Copying and pasting of the Lab values from Spectra Suit to Microsoft Word.

Figure 3.9 Data transfer from Microsoft Word to Adobe Photoshop.

3.5.2 Data from digital camera

3.5.2.1 Computer software

The software used with the digital camera was Colours Average Calculator Software version 1 beta and Adobe Photoshop.

3.5.2.2 Data capture

The images recorded by the digital camera were saved as jpeg files using Adobe Photoshop software. Then the colour values of the images were converted into mean readings using (Image Colours Average Calculator Software). A reference number was given for each picture (time consumed is about 3 min) (Figure 3.10-11).

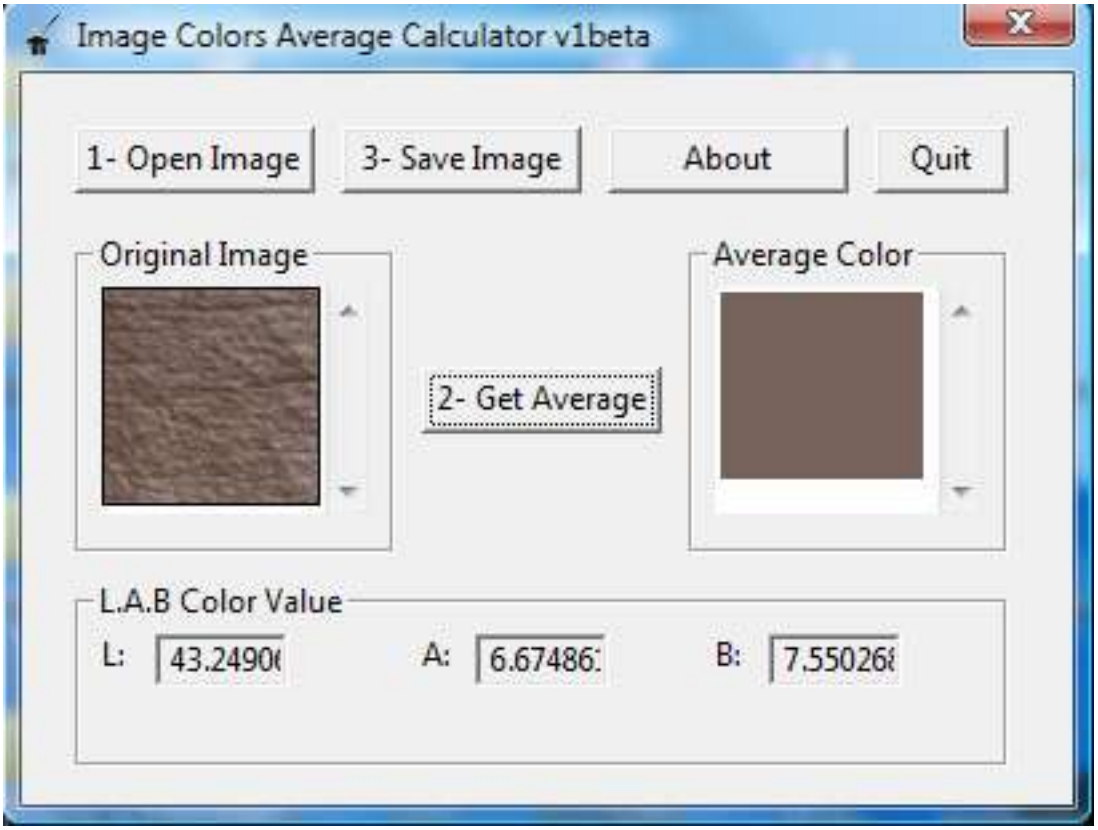


Figure 3.10 The image colour was converted to average colour values using Image Colour Average Calculator Software.

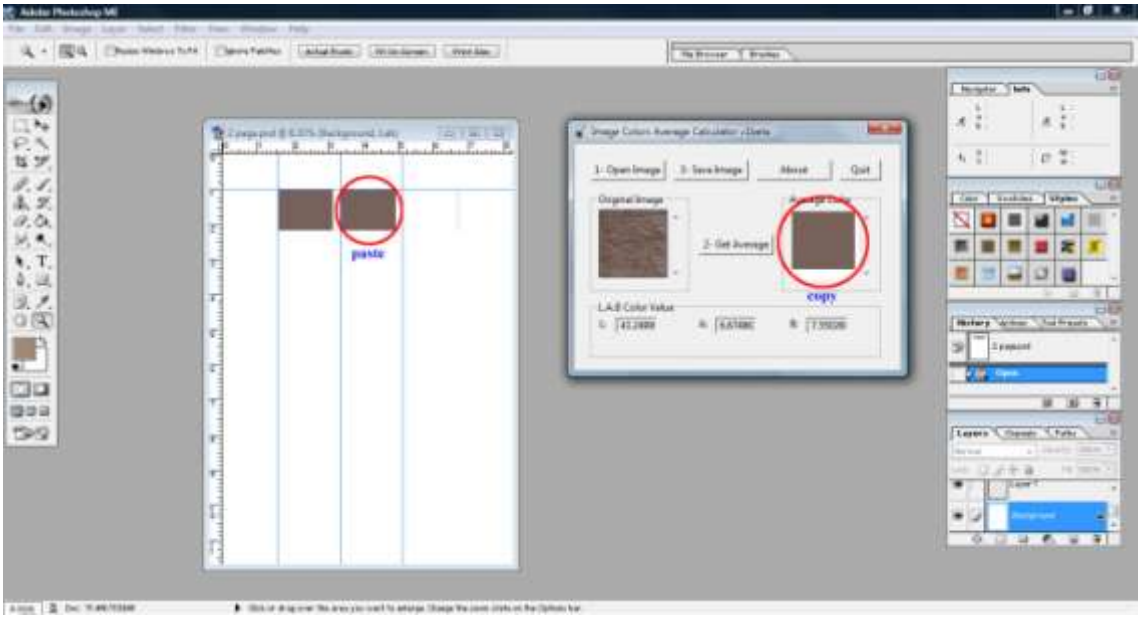


Figure 3.11 The average colour copied to Adobe Photoshop.

3.5.3 Data from flatbed scanner

3.5.3.1 Computer software

The computer software used was as stated in 3.5.2.1.

3.5.3.2 Manipulation of data

Manipulation of data from the scanner was the same as that described for the digital camera in 3.5.2.2.

3.6 PRINTING OF THE SKIN TAGS (SKIN SHADES)

3.6.1 Printing process

Using Adobe Photoshop, the skin shades for each subject obtained using the spectrophotometer, digital camera and scanner were arranged side by side as rectangles (Figure 3.12).

These colours were then printed on A4 matt texture paper (180g) as rectangles measuring 4x3 cm. The printer used was a Canon inkjet printer (Canon MP 970, Canon Inc., Thailand).

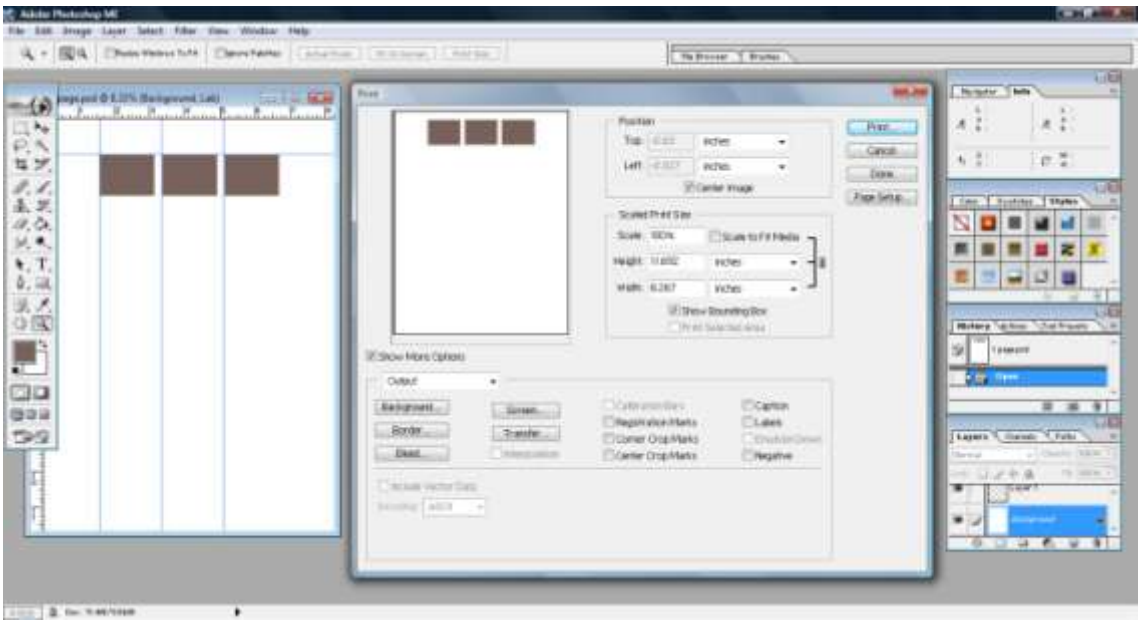


Figure 3.12 The shades for each individual subject obtained with the spectrophotometer, digital camera and scanner were arranged side by side in Adobe Photoshop.

3.7 METHOD OF VISUAL PERCEPTION IN ASSESSING MATCHING OF SKIN SHADE TO PRINTED TAGS

The printed colours were evaluated for matching to the subject skin by 4 assessors. Besides the researcher and the subjects themselves, 2 other independent assessors were involved in the assessment. The 2 other assessors were lecturers in the department of Prosthetic Dentistry, Faculty of Dentistry, University of Malaya. They each had more than 20 years' experience in clinical dentistry. All the assessors, including the subjects were healthy, with good vision and were not colour blind.

The subjects were assessed for matching of the printed tags to the shade of the forehead in the room where the skin tones were captured. This was to ensure that the same lighting conditions were used in the study.

During the visual assessment of the printed tags, the subjects were seated comfortably in a chair. Each subject held the printed tags to their forehead, and all the assessors were each given 1-2 minutes to complete the assessment (Figure 3.13). Although the assessors assessed the matching at the same time, each assessor carried out the assessment independently, and they were asked to assess the colour matching of each printed tag as: 1: poor, 2: fair, or 3: good.

The subject assessed the matching of the tags to their forehead shades using a hand-held mirror. They were also given 1-2 minutes to complete the evaluation.

Both of the two assessors and the subjects themselves were blind to the source of the data for the printed tags. Only the researcher knew the source of the data for the printed tags. All the responses were tabulated by the researcher.

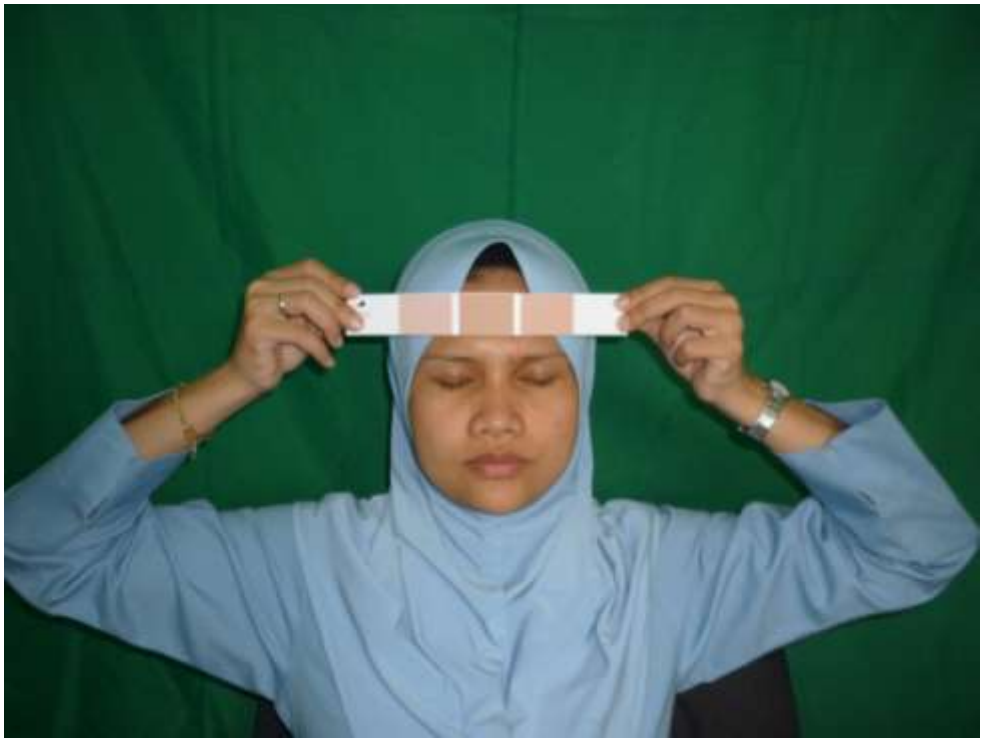


Figure 3.13 The printed skin tag was held closely to the forehead of the subject when colour matching was evaluated visually by assessors.

3.8 CLASSIFICATION OF SHADES ON THE SKIN TAGS

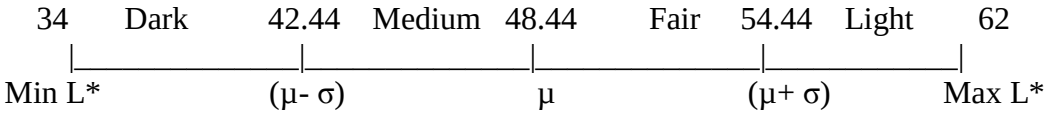
The classification of skin shades was made using the data obtained from the device which was rated by the assessors to be the best in reproducing the skin shade.

3.8.1 Determining the range of colours for classifying the skin colour

Once the device which gave the best skin matching was determined, data from the device was classified using the L* a* b* values, and grouped. As no standard method for skin colour classification was found in the literature, a system was created for this study using the concept of normal distribution, where a normal distribution was defined by two quantities, its arithmetic mean (μ) and its standard deviation (σ) (Bulman and Osborne, 2002). Hence 68% of the proportion of subjects in the study would fall in the interval μ± σ.

The method of classification of skin shade in the study was carried by creating a scale as follows:

The colours were classified using the L* values. The minimum and maximum L* values obtained from the device which gave the best skin colour reproduction for the 90 subjects were used as the extreme boundaries of the scale that was to be created. As the most important intervals along the scale would be the arithmetic mean (μ) and its standard deviation (σ), these were used as the intervals along the scale. Hence the scale had 5 intervals limited by the minimum and maximum L* values, the mean value (μ) and (μ± σ). Hence 4 groups of skin shades were created using these five limiting values.



These 4 groups were classified as:

1. Dark group: The L* values ranged between 34.0 and 42.44.
2. Medium group: The L* values ranged between 42.5 and 48.44.
3. Fair group: The L* values ranged between 48.50 and 54.44
4. Light group: The L* values ranged between 55.50 and 62.0.

3.9 DATA MANAGEMENT

3.9.1 Statistical analysis of the results

The L*a*b* values were normally distributed (Appendix 4, Figure 1-3). The following statistical tests were used to analyse the data; descriptive statistics, independent t- test analysis, paired t- test analysis, one way and two way ANOVA and Chi-square. The analysis included also the comparison of the reliability of each device in reproducing the skin colours. A statistical software SPSS version 17 was used for the analysis of the data.