

**TESTING OF THE PHILLIPS DENTAL AGE ESTIMATION TABLES ON A SAMPLE OF BLACK CHILDREN FROM MPUMALANGA, SOUTH AFRICA.**

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A research report submitted to the Faculty of Oral Pathology and Forensic Dentistry: University of the Western Cape in partial fulfillment of the requirements for the degree

of

Masters of Science in Forensic Dentistry

University of the Western Cape 2010

## DECLARATION

I, declare that this research report is my own work. It is submitted for the degree of Master of Science in Forensic Dentistry at the University of the Western Cape. It has not been submitted before for any degree or examination at this or any other university.

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## ABSTRACT

A number of dental age estimation methods have been developed over the years ranging from the frequently used age estimation of Demirjian *et al* (1973) and Moorrees *et al* (1965) to the less frequently used age estimation methods of Haavikko (1970) and Nolla (1960). Different dental age estimation methods have been used with variable success. These were developed using mainly children of Central and Northern European descent and white North Americans. The results of the above-mentioned dental age estimation methods, when used on South African children, show that the need for adaptation of these methods exists<sup>1</sup>. Phillips has thus developed a dental age estimation table for Nguni children of South Africa, to assist in correcting this discrepancy.

**OBJECTIVE:** To establish if the Phillips dental age estimation developed for Nguni children of South Africa is applicable to children in the region of Mpumalanga.



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**METHOD:** Cross sectional study using a stratified random sampling method involving 100 panoramic radiographs of black children up to the age of 14 years, in the region of Mpumalanga.

**CONCLUSION:** This study will determine if Phillips dental age estimation tables developed for South African Nguni children is applicable and accurate in estimating the age of black Mpumalanga children.

## ACKNOWLEDGEMENT

I would like say a hearty thank you to the Prof V.M.Phillips for his patience and guidance. To acknowledge Ms P.T.S. Mtshali for her valuable inputs and comments. I would also like to sincerely thank Mr. E.J. Mathonsi, Ms N.T. Nkosi and my family for their solid support. Last but not least a big thank you to my son, Mr. K.T. Mahlangu for his patience and understanding.



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## TABLE OF CONTENTS

## PAGE

DECLARATION	i
ABSTRACT	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENT	iv-v
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF GRAPHS	viii
LIST OF APPENDICES	ix
<b>CHAPTER 1: INTRODUCTION</b>	
1.1 Background and need	1-3
1.2 Aim of study	3
1.3 Objective of the study	3
1.4 Significance of the study	3-4
<b>CHAPTER 2: LITERATURE REVIEW</b>	
2.1 Dental age estimation	5
2.1.1 Tooth eruption	5-6
2.1.2 Tooth formation	6-11
2.1.3 Ethnicity vs. Tooth formation vs. Geographic location	11-13
<b>CHAPTER 3: MATERIALS AND METHODS</b>	
3.1 Study design	14
3.2 Study population	14
3.3 Sample selection	14-15
3.4 Tools	15-16
3.5 Procedure	16
3.6 Ethical consideration	17



<b>TABLE OF CONTENTS</b>	<b>PAGE</b>
<b>CHAPTER 4: RESULTS</b>	18-22
<b>CHAPTER 5: DISCUSSION</b>	23-25
<b>CHAPTER 6: CONCLUSION</b>	26
<b>REFERENCES</b>	27-28



UNIVERSITY *of the*  
WESTERN CAPE

## List of tables

page

**Table 1:** Dental age related table for Nguni children  
(SD in yrs) (n=236) 16

**Table 2:** The distribution table with sample number, gender,  
actual age in years, comparison of estimated age in years  
and deviation between Moorrees et al and Phillips method. 18

**Table 3:** % of overestimation of age with Moores et al method 20

**Table 4:** % of overestimation of age with Phillips method 21

**Table 5:** % of under-estimation of age with Moores et al method 21

**Table 6:** % of under-estimation of age with Phillips method 21



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## List of figures

page

**Fig 1:** Map of Mpumalanga, South Africa and surrounding regions

2

**Fig 2:** Different stages of tooth formation of the crown and root and apex of a mandibular permanent cuspid

8

**Fig 3:** Different stages of tooth formation of the crown and root and apex of a mandibular permanent cuspid

9

**Fig 4:** The explanation of the abbreviated stages of Tooth development

9

**Fig 5:** Diagram of the developmental stages as described by Demirjian *et al*<sup>6</sup>

11



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WESTERN CAPE



<b>List of graphs</b>	<b>page</b>
<b>Graph 1:</b> Actual age in years in relation to estimated ages in years using Moorrees <i>et al</i> and Phillips method.	19
<b>Graph 2:</b> Deviation of Moorrees <i>et al</i> and Phillips method, respectively	20



## Appendices

**Appendix 1:** Information sheet

**Appendix 2:** Consent form for service provider



# CHAPTER 1: INTRODUCTION

## 1.1 BACKGROUND&NEED

From time immemorial dental age estimation has always been seen as an important aspect in detecting and determining a person's age. It is documented that in Ancient Roman times, the eruption of the second molar tooth indicated that the male child was fit for service. Moreover in England, around 1883, the minimum age of criminal responsibility was 7years<sup>2</sup>. In most countries, age is still very important when it comes to social benefits, school attendance, employment, etc.

The different dental age estimation methods that are currently in use have been found by different authors to either vastly over estimate or under estimate the chronological ages of, especially, the juvenile population of the samples studied. Most authors conclude that population specific age estimation tables should be formulated in order to estimate as accurately as possible the individuals of that specific population. This led to the development of the Phillips age estimation table that is meant to be population-specific and has been specifically formulated for South African Nguni children<sup>3</sup>.

The current study will test the Phillips age estimation table on Nguni children who are born and reside in the Mpumalanga region and surrounding areas. The Mpumalanga region, where this study was conducted, is surrounded by Swaziland and Mozambique (Fig 1).

Due to the positive economic environment, South Africa is viewed as an African country that is most progressive compared to other African countries. This has led to the influx of African foreigners coming into South Africa by whatever means possible.

The downside to this is that large numbers of people from the poorer parts of the neighbouring countries cross over to South Africa, illegally, in the hope of finding financial relief<sup>4</sup>.

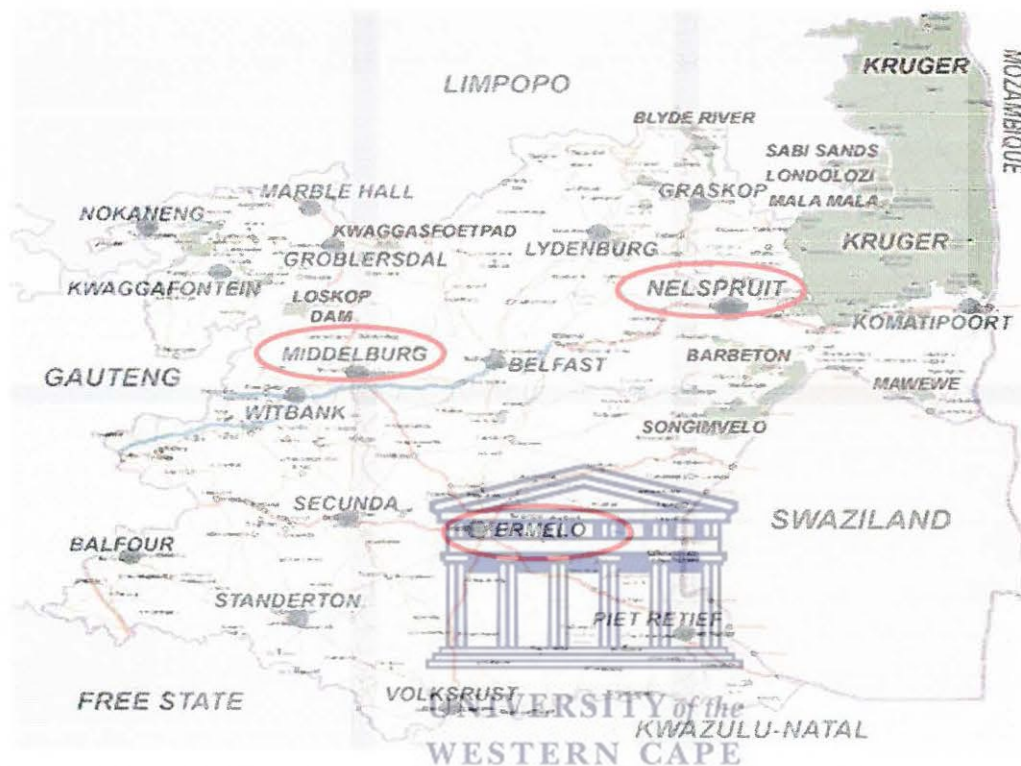


Fig 1: Map of Mpumalanga, South Africa and surrounding regions.

With the cross border migration on the increase, others manage to enter South Africa illegally but successfully while many others are not that fortunate. This has led to dead bodies being found along the border posts. In most cases, no form of identification documentation is found on the deceased and this propels the officials to use different means for identifying the body.

For those found alive, validation of the individual's age becomes imperative if no valid identification documents are found on the person.

What South African officials come across frequently are individuals who are caught crossing the border, claiming to be a certain age or foreigners who are already in the country whose genuine age is questionable but need to be confirmed because of criminal, civil, asylum or even social grant proceedings.

In living individuals, a combined examination finding in at least 3 different development systems need to be employed for accurate age estimation; dental age estimation is one of them. This is according to the recommendations of the Study Group on Forensic Age Diagnostics<sup>5</sup>.

## **1.2 AIM OF THE STUDY**

The aim of the study is to test the dental age estimation table that was developed for Nguni children by Phillips and if it is applicable to the dental age estimation of a sample of black children in Mpumalanga in relation to Moorrees et al method.

## **1.3 OBJECTIVES OF THE STUDY**

- To determine the applicability of the Phillips dental age estimation tables on black children in Mpumalanga
- To evaluate the accuracy of the Phillips age estimation tables on Mpumalanga children in relation to Moorrees et al method

## **1.4 SIGNIFICANCE OF THE STUDY**

- This study will assist in determining the applicability and accuracy of the newly developed Phillips dental age estimation tables for Nguni children of South Africa.
- The Phillips dental age estimation table, if applicable and accurate, will play a crucial and integral role in the field of forensic science.

- It will act as a scientific tool ( amongst other forensic identification tools) in the identification process of specifically, black children and juveniles who have been found dead or alive with no form of identification on them. In crime related cases, these tables can assist in determining if the offender is a child, juvenile or adult. These can also assist in determining the age in skeletal remains discovered in South Africa and its borders.



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## CHAPTER 2: LITERATURE REVIEW

### 2.1 DENTAL AGE ESTIMATION

Tooth development plays a vital role in determining tooth maturity and in turn, an estimation of the age of an individual. Dental age estimation tends to be preferred over other skeletal methods because of varying reasons. The dentition is part of three (3) other components used as developmental indicator. The other developmental indicators are secondary sex characteristics, stature or weight and bone development<sup>6</sup>.

Dental age estimation is preferred because teeth have been shown to be durable in archaeological context. They have minimal remodelling and the growth of permanent and deciduous teeth continue over the entire juvenile period. Compared to the development and mineralization of bone, development and mineralization of teeth is minimally affected by hormonal changes, diet or other extrinsic factors<sup>7</sup>.

In children and juveniles, the stages of calcification of the crowns and roots of the primary and permanent teeth, can be examined on a radiograph and the age can be determined by comparing the stage of development with the different published dental age estimation tables<sup>6</sup>. Normally, the deciduous teeth begin *in utero* at about 4 months and permanent teeth complete formation at about 25 years of age<sup>8</sup>.

The two broad methods used in dental age estimation are tooth eruption and tooth formation:

#### 2.1.1. Tooth eruption

With tooth eruption, the developing teeth move from the alveolar bone into the

oral cavity and eventually occlude with the opposing teeth of the opposing jaw. The progress of tooth eruption is easily influenced by the early loss of deciduous teeth, impaction or even lack of space in the dental arch.

The two most common methods used for tooth eruption are Schour and Massler (1941) and Uberlaker (1999). These methods and many others that use tooth eruption, rely on the fact that teeth will erupt in nature's prescribed format and sequence and also exfoliate in that manner. When tooth eruption methods are used, the importance of differentiating between alveolar emergence, gingival emergence or teeth reaching the occlusal plane must be made in order to guarantee some form of accuracy.

#### 2.1.2. Tooth formation.

Tooth formation is normally recommended over tooth eruption when estimating the age of an individual. This is because, with tooth formation, standards cover a continuum of maturation and also a longer period of time through childhood to adulthood<sup>9</sup>.

In the formation of a particular tooth, one observes a number of unique morphological stages; starting from cusp formation to the completion of calcification of the apex of the root. These morphological changes are often apparent on a panoramic radiograph. There are a number of dental age estimation methods that are based on tooth formation, that are currently in use. The most popular methods are Moorees et al (1963), Gustafson and Koch (1974) and Dermijian et al (1973).

The different methods and techniques used to estimate the actual age of an individual were developed over the years and modified accordingly. These methods differ between children and adults.



The most common methods used for dental age estimation in children may be divided into the Atlas approach and Scoring system approach<sup>7</sup>.

a. **Atlas approach**

During the process of tooth mineralization, the developing teeth will all share a unique structural change. This feature can be used to accurately estimate the actual age of an individual. The most common methods using this approach are:

- Tables of Schour and Massler<sup>10</sup>

These tables show +/-20 actual stages of tooth development from five (5) months in utero to 35 years of age. Using the panoramic radiograph of the child's dentition against these tables leads to the estimation of the child's actual age.

- Uberlaker<sup>11</sup>

Uberlaker tables are tables of Schour and Massler that have been updated and modified and include the dental data obtained from the non-white population.

- Moorrees et al<sup>6</sup>

This method is based on longitudinal radiographical studies of North American children of middle socio-economic class. It describes 13 (for cuspid) or 14 (for bicuspid) different stages of tooth development of each individual mandibular permanent and deciduous teeth (Figs 2 and 3, respectively). There are different formulated tables for both males and females. Each development stage of a tooth is compared with the formulated table to give an age estimation of that particular tooth. The teeth normally assessed on the panoramic radiograph are the seven (7) mandibular teeth. These teeth are analyzed (as explained above) and their scores averaged to determine the estimated age of the individual.



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Moorrees et al method has been found to be most useful in age estimation of individuals between the ages of 4 to 14 years. The explanation of the abbreviated stages of tooth development is shown in Fig 4.

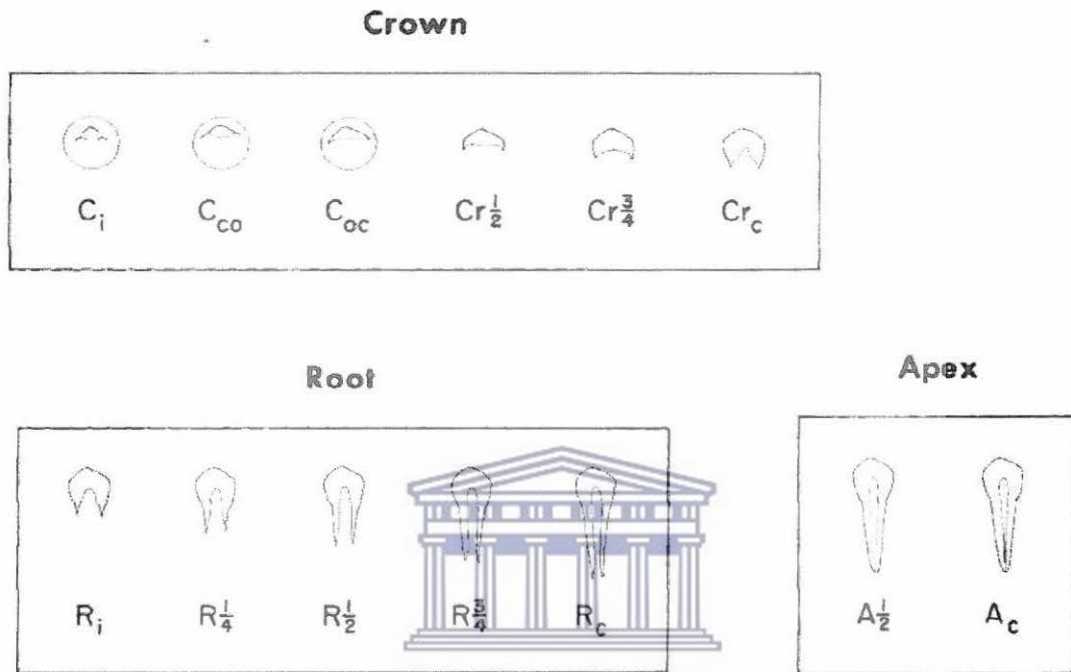


Fig 2: Different stages of tooth formation of the crown and root and apex of a mandibular permanent cuspid<sup>6</sup>

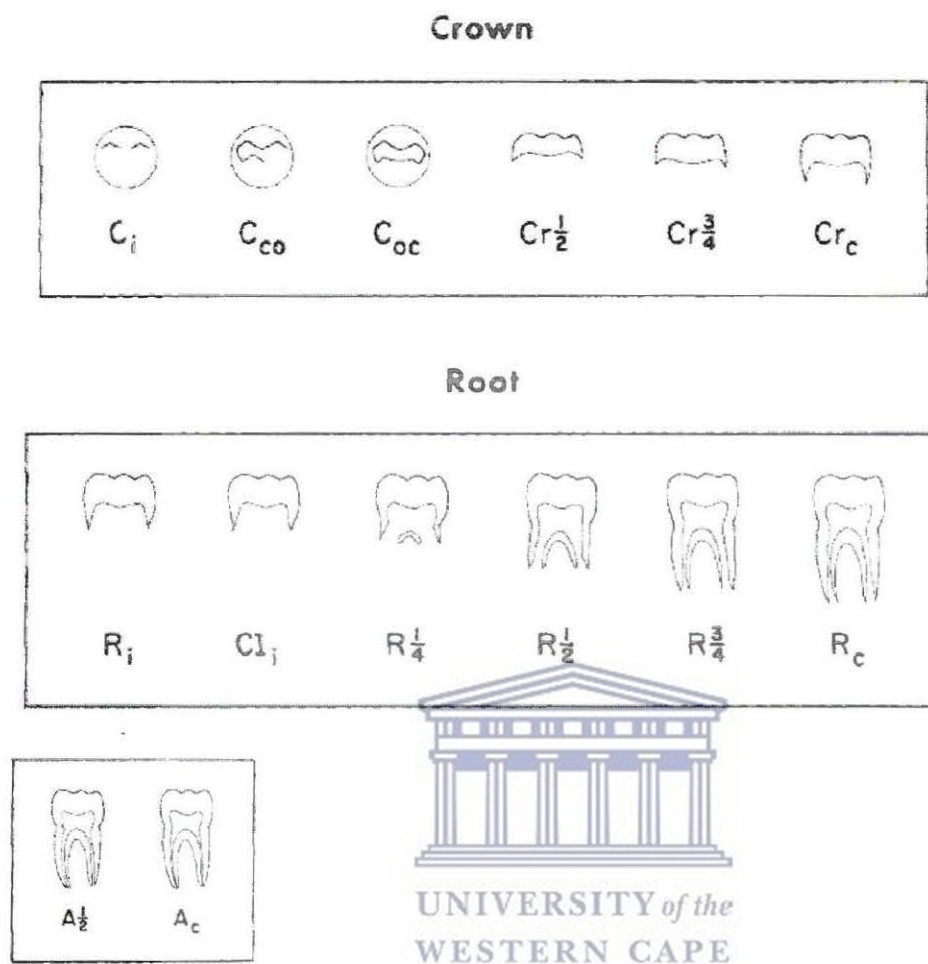


Fig 3: Different stages of tooth formation of the crown and root and apex of a mandibular permanent cuspid.<sup>6</sup>

C <sub>i</sub>	Cusp initiation
C <sub>co</sub>	Cusp coalescence
C <sub>oc</sub>	Cusp outline complete
Cr <sub>1/2</sub>	Crown half formed
Cr <sub>3/4</sub>	Crown three quarters formed
Cr <sub>c</sub>	Crown completely formed
R <sub>i</sub>	Root initiation
Cl <sub>i</sub>	Cleft initiation (molars only)
R <sub>1/4</sub>	Root one quarter formed
R <sub>1/2</sub>	Root half formed
R <sub>3/4</sub>	Root three quarters formed
R <sub>c</sub>	Root complete
A <sub>1/2</sub>	Apex one half complete
A <sub>c</sub>	Apex complete

Fig 4: The explanation of the abbreviated stages of tooth development<sup>3</sup>. 9

- Anderson et al<sup>12</sup>

It is a modified Moorrees *et al* method that also includes the third molars.

b. **Scoring system approach**

- Demirjian et al<sup>13</sup>

This is one of the frequently used dental age estimation method. It uses the development of teeth rather than the eruption process to estimate the age of a child. The study was conducted on French-Canadian children, using tooth development of the first seven lower left mandibular teeth. It distinguishes four (4) stages of crown formation and root development and classifies them as stages A-D and stages E-H. These stages primarily define the changes in shape of the developing tooth. Maturity scores were allocated to each of the teeth based on their developmental stage from A to H (Fig 5). The total of the maturity scores for the seven lower left mandibular teeth gives an overall maturity score that is in a table format. The maturity score table differs between males and females and is used for age estimation in children. For the assessment of third molar mineralization Demirjian's stage classification is the method most preferred, because it does not necessarily rely on root length estimation.

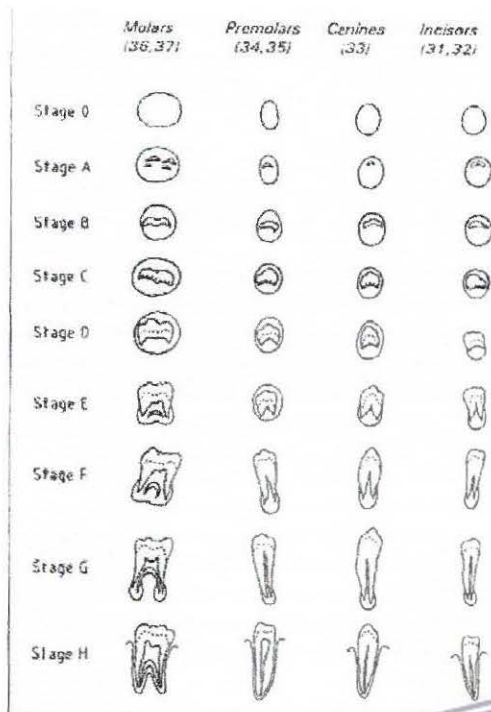


Fig 5. Diagram of the developmental stages as described by Demirjian *et al*<sup>13</sup>

- Willem *et al*<sup>14</sup>

A modification of the Demirjian method was derived where new maturity score tables for both males and females were formulated using a sample of white Belgian children. This method was formulated after a number of studies, conducted by several different individuals in different parts of the world, showed that the Demirjian *et al* method was consistently overestimating the actual ages of the children studied<sup>14</sup>

### 2.1.3 Ethnicity vs. Tooth formation vs. Geographic location

The development and mineralization of teeth is said to be minimally affected by hormonal changes, diet or other extrinsic factors<sup>7</sup>.

A number of studies have shown that ethnicity also plays a minimal role. A number of studies conducted show that an obvious difference in tooth formation between different ethnic groupings exists. This is most clearly seen in studies concentrating on the progress of the third molar formation.

In one study it was observed that black Africans were found to have mandibular third molars that mineralize 1.25 to 2.5 years earlier than their white American counterparts<sup>15</sup>. In yet another study, it was concluded that third molar eruption began at the age of 13 years in the investigated African subjects<sup>16</sup>.

The above could be due to ethnicity but the influence of geographic origin may also be playing a part. The role that geographic location plays in the rate of development of the teeth in children has not been sufficiently investigated. Reference studies that allude to the above are mostly available for children of European descent.

What has been proven is that socio-economic status does influence the process of skeletal maturity<sup>17</sup>. The lower the socio-economic status of the subject, the stronger the delay in skeletal development and that may lead to the under-estimation of the age of the individual studied<sup>18</sup>.

In another study evaluating black South African subjects against Japanese subjects, using the Demirjian method, it was found that the age estimates for the South African subjects were approx. 1-4 years higher than the Japanese subjects. In this particular study, the author concluded that the population differences observed was probably due to differences in palatal dimensions between the ethnic groups surveyed. The largest palatal dimensions were observed in Africans and the smallest in Mongoloids, with Caucasoids assuming the middle rank<sup>19</sup>.

Inadequate space in the maxillary crest causes delay in third molar eruption<sup>20</sup>. In turn, impacted third molar teeth mineralize later than teeth whose eruption has not been impeded<sup>21</sup>. This would explain why Caucasoid populations occupy the middle position in relative terms when it comes to wisdom tooth mineralization, while Mongoloid populations display a comparative delay and African populations a relative acceleration

Over the years, dental age estimation has become increasingly important in forensic dentistry in the identification of the dead and the living. The most favoured method in dental age estimation of children is Dermijian *et al* method and its results have shown varying success in each and every study conducted. The method, like most of the other methods discussed above, differs greatly depending on geographical area, ethnicity and gender. For example, a study conducted on Northern Turkish children, using the Dermijian age estimation method, concluded that this method was not suitable for the Northern Turkish children. The results showed that the Northern Turkish children were more advanced in their dental maturity than those used in Dermijian sample<sup>22</sup>. In yet another study conducted on Malay children, the results of the same method showed that Malay children were slower in their dental maturity than those used in the Demirjian sample<sup>23</sup>.

Results of a study conducted on South African children using Moorrees *et al* and Dermijian *et al* dental age estimation methods, showed that, Moorrees *et al* method underestimated the actual ages of the children whilst the Demirjian *et al* method overestimated the actual ages. The authors of this particular study concluded that there is a need to develop a dental age estimation table that will have specific standard of measurement in order to accurately estimate the chronological age of South African children<sup>1</sup>.

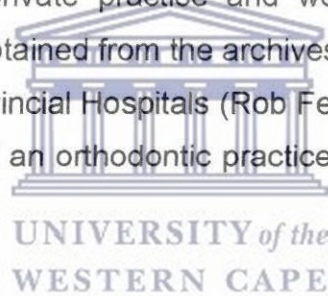
## CHAPTER 3: MATERIALS AND METHODS

### 3.1 STUDY DESIGN

This is a cross-sectional study, using a stratified random sampling method involving 100 panoramic radiographs of ethnically black children from Mpumalanga region.

### 3.2 STUDY POPULATION

A total of 100 panoramic radiographs of black children from the age of 4 to 13 years were examined. The panoramic radiographs were obtained from three (3) different dental institutions in the region of Mpumalanga. 66 panoramic radiographs were from a private practice and were radiographs of recently treated individuals. 8 were obtained from the archives in the X-Ray department of one of the Mpumalanga Provincial Hospitals (Rob Ferreira Hospital) and 26 were obtained from the records of an orthodontic practice. The sample was made up of 51 males and 49 females.



### 3.3 SAMPLE SELECTION

On each panoramic radiograph the sample number (1-100), the name, date of birth and gender of the child was clearly marked as well as the date on which the radiograph was taken. To determine the child's chronological age, the difference between date on the radiograph and the date of birth was calculated. The radiographs were checked for quality and presence of all seven left mandibular teeth. The radiographs were assessed under standardized conditions. The radiographs were viewed on an x-ray viewing box under reduced room lighting.

Only one (1) examiner estimated the dental age of each child.



- Inclusion criteria:
  - Conventional panoramic radiographs of black children of the Mpumalanga region up to the age of 14years.
  - No sign of pathological lesions.
  - Normal development of the dentition.
  
- Exclusion criteria:
  - Panoramic radiographs of children outside of Mpumalanga.
  - Panoramic radiographs of children who were not ethnically black.
  - Radiographs showing missing primary or secondary teeth.

### 3.4 TOOLS

Phillips formulated three (3) dental age estimation tables (based on Moorrees et al dental age estimation method) for South African children of different races. The first group was made up of 1006 coloured and white South African children from the Western Cape region termed the Tygerberg sample. The second group was South African Indian children from the region of Kwa Zulu Natal with 234 individuals. The third group was South African black children composed of 236 individuals from the Western Cape region and termed the Nguni sample. The results of his study found that 69.2% of the Nguni sample was within 1 year of the chronological age whilst the Moorrees et al on the same sample resulted in 13.8% falling within 1 year of chronological age<sup>3</sup>.

The need to further investigate the newly developed Phillips dental age estimation table by applying it to a population of black children outside the region of Western Cape and Kwa Zulu Natal exists. By investigating black South African children in different regions of S.A, one can compare its accuracy and applicability, in relation to the methods developed outside South Africa on subjects of European descent.

The table that was used for this study was the one developed by Phillips for the Nguni children (Table 1).

	I1	I2	C	Pm1	Pm2	M1	M2	M3
Fi								
F								
Ci								8.50 (0.88)
Cco								9.84 (1.18)
Coc					5.94		5.94	10.91 (1.30)
Cr1/2				6.03 (0.12)	6.45 (0.64)		6.50 (0.67)	11.30 (1.47)
Cr3/4			6.12 (0.01)	6.57 (0.73)	7.32 (1.54)		6.94 (1.04)	11.93 (1.43)
Cre		6.12	6.95 (0.71)	7.72 (1.93)	8.07 (1.64)		7.87 (0.90)	12.54 (1.02)
Ri	6.12 (0.01)	6.03 (0.12)	6.74 (0.40)	7.80 (1.30)	8.46 (0.82)		10.03 (1.65)	12.76 (0.98)
Cli							9.45 (1.31)	13.82 (1.55)
R1/4	6.14 (0.40)	6.52 (0.68)	8.44 (1.25)	8.97 (0.51)	9.98 (0.96)		10.27 (0.69)	14.45 (0.97)
R1/2	6.79 (0.87)	7.01 (0.97)	9.29 (0.68)	9.52 (0.32)	10.46 (1.18)	6.22 (0.34)	11.43 (1.39)	15.64 (0.91)
R3/4	7.24 (1.26)	6.94 (0.44)	10.71 (1.31)	10.50 (1.11)	11.22 (1.21)	7.21 (0.95)	12.24 (0.87)	15.78
Re	8.91 (1.14)	9.07 (0.88)	11.73 (1.42)	11.55 (1.31)	12.83 (1.29)	8.95 (0.87)	12.99 (1.29)	
A1/2	8.98 (1.01)	10.13 (1.21)	12.49 (1.26)	12.34 (1.07)	13.06 (1.37)	8.60 (1.05)	13.72 (1.01)	
Ac								

Table1: Dental age related table for Nguni children (SD in yrs) (n=236)<sup>3</sup>

### 3.5 PROCEDURE

Dental practices and Provincial Hospitals that had panoramic x-ray machines were contacted telephonically to request an appointment with the head of the dental clinic. Out of 7 dental practices and hospitals that were visited, three (3) agreed to assist. 1 x Orthodontic practice. 1 x Private practice. 1 x Provincial Hospital. The dental heads were given an information sheet ( Appendix1) and a verbal explanation was also given. All the questions and concerns that were raised by the dental heads were answered. A consent form for the use of their patient's radiographs was also given to them to sign. (Appendix 2).

### 3.6 ETHICAL CONSIDERATION

- Permission by the practitioners to use their patient's panoramic radiographs was given.
- Information sheet on what the study is about was given to each practitioner.
- Patient confidentiality was well maintained.



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## CHAPTER 4: RESULTS

After a thorough assessment of the 100 panoramic radiographs, a distribution table was constructed (Table 2)

SAMPLE NO	GENDER	ACTUAL AGE (years)	ESTIMATED AGE (years)		DEVIATION	
			MOORES ET AL	PHILLIPS	MOORES ET AL	PHILLIPS
1	F	4	7.1	9.1	3.1	5.1
2	F	5	5.5	7.4	0.5	2.4
3	F	5	6.5	7.8	1.5	2.8
4	M	5	5	5.8	0	0.8
5	M	6	6.8	8.5	0.8	2.5
6	M	6	5.6	7.6	-0.4	1.6
7	F	6	6.5	8.5	0.5	2.5
8	F	6	7	8.7	1	2.7

Table 2: The distribution table with sample number, gender, actual age in years, comparison of estimated age in years and deviation between Moorrees et al and Phillips method.

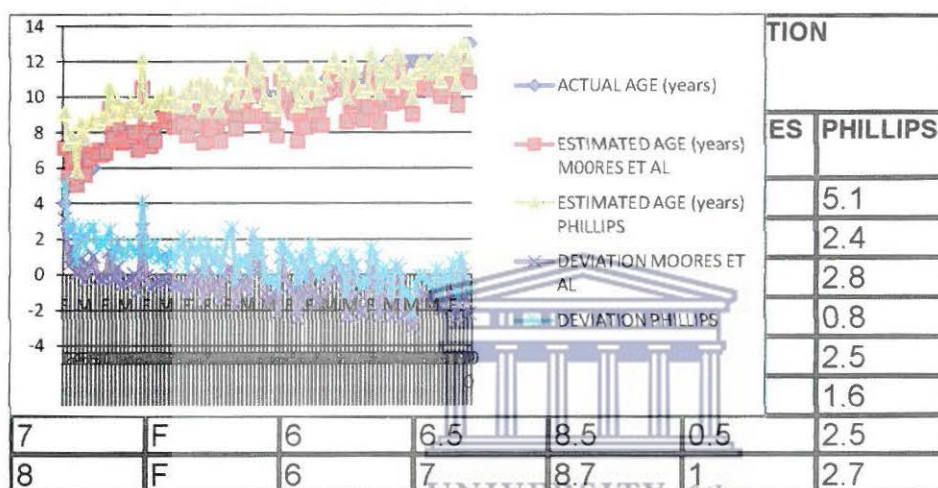
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The above table indicates:

- The **sample number** which is the numbering of the panoramic radiograph [1-100]
- The **gender** as indicated on the panoramic radiograph [M or F]
- The **actual/chronological age** which is calculated by subtracting the date of birth of an individual from the date on which the panoramic radiograph was taken.
- The **age estimation** as calculated using the methods of Moorrees et al and Phillips, respectively.
- The **deviation** is the difference between estimated age and actual age for the different methods used, i.e. Moores et al and Phillips method.

There were 49 female subjects and 51 male subjects in the sample assessed. The distribution table shows that the ages 5 -10 years are more likely to fall within the range of a year to the actual age of the subject when Moorrees et al method is used.

The table above shows that the ages 9-13 years are more likely to fall within the range of a year to the actual age of the subject when Phillips method is used.

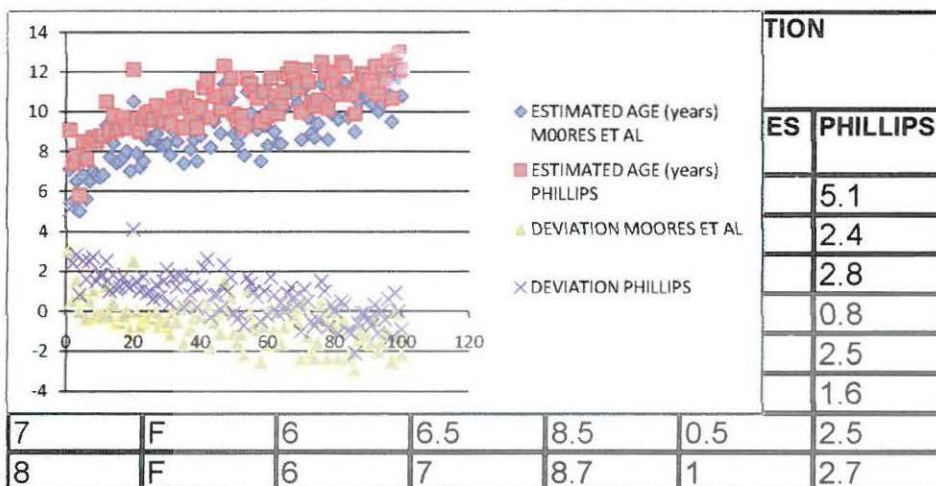


Graph 1: Actual age in years in relation to estimated ages in years using Moorrees et al and Phillips method.

The above graph highlights the relationship between actual age in years and estimated age in years.

With Moorrees et al method, the overestimation falls within a 2.5 year range, whilst the underestimation falls within a 3 year range.

With Phillips method, the overestimation is within a 2.7 year range, whilst the underestimation falls with 1.3 year range.



Graph 2: Deviation of Moorrees et al and Phillips method, respectively

The above indicates the deviations of both Moorrees et al and Phillips methods respectively.

It indicates that there is more negative deviation with Moorrees et al method than with Phillips. In essence, this means that Moorrees et al method under estimate more than does the Phillips method.

The deviation is between 2.7 to -1.3 for Phillips and between 2.5 to -3 for Moorrees et al. The range is much closer with the Phillips method than it is with the Moorrees et al method. This simply means that Phillips is accurate and closer to getting the 1year range between actual and estimated age.

GENDER	0-0.9 (yr)	1-1.9 (yr)	2-2.9 (yr)	>3 (yr)
Male(n=51)	14%	4%	-	-
Female(n=49)	20%	4%	2%	2%
<b>Total</b>	<b>34%</b>	<b>8%</b>	<b>2%</b>	<b>2%</b>

Table 3: % of over-estimation of age with Moories et al method

The females have a higher percentage of over estimation when using Moorrees et al method than their male counterpart.

<b>GENDER</b>	<b>0-0.9 (yr)</b>	<b>1-1.9 (yr)</b>	<b>2-2.9 (yr)</b>	<b>&gt;3yrs (yr)</b>
Male(n=51)	31%	27%	8%	-
Female(n=49)	22%	41%	12%	4%
<b>Total</b>	<b>53%</b>	<b>68%</b>	<b>20%</b>	<b>4%</b>

Table 4: % of over-estimation of age with Phillips method

The females have a higher percentage of over estimation when using Phillips method in relation to their male counterpart. At the range of 0-0.9, more males have a higher percentage.

<b>GENDER</b>	<b>0-(-0.9) (yr)</b>	<b>-1-(-1.9) (yr)</b>	<b>-2-(-2.9) (yr)</b>	<b>&gt;-3 (yr)</b>
Male(n=51)	43%	22%	12%	2%
Female(n=49)	37%	25%	12%	-
<b>Total</b>	<b>80%</b>	<b>47%</b>	<b>24%</b>	<b>2%</b>

Table 5: % of under-estimation of age with Moores et al method

The males have a higher percentage of under estimation when using Moorrees et al, in relation to their female counterpart. The percentages are higher overall meaning the bulk of the subjects' ages are under estimated with this method.

<b>GENDER</b>	<b>0-(-0.9) (yr)</b>	<b>-1-(-1.9) (yr)</b>	<b>-2-(-2.9) (yr)</b>	<b>&gt;-3yrs (yr)</b>
Male(n=51)	24%	10%	2%	-
Female(n=49)	16%	2%	-	-
<b>Total</b>	<b>40%</b>	<b>12%</b>	<b>2%</b>	<b>-</b>

Table 6: % of under-estimation of age with Phillips method

The males have a higher percentage of under-estimation when using Phillips method in relation to their female counterpart. The percentages are lower overall indicating that the bulk of the subjects' ages are less under estimated with this method.



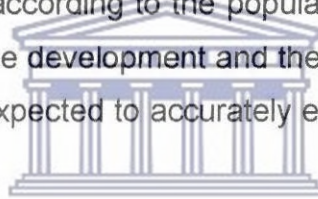
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## CHAPTER 5: DISCUSSION

The need to further investigate the Phillips dental age estimation table by applying it to a population of black children outside the region of Western Cape and Kwa Zulu Natal exists. This study is conducted to assess the accuracy and applicability of the Phillips tables for South African black children in Mpumalanga. By investigating black South African children in different regions of S.A one can compare its accuracy and applicability, in relation to the methods developed outside South Africa on subjects of white origin.

The numerous studies conducted on subjects who are of white origin and who resides outside South Africa, show that the dental age estimation methods need to be modified and adapted according to the population group it is measuring at the time. This necessitated the development and the testing of the Phillips dental age estimation table that is expected to accurately estimate the age of the Nguni children of South Africa.



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The age range of the sample studied was between 4 to 13 years. The result of this study indicates a consistent difference in the ages of tooth formation between the two (2) methods compared. When using Moorrees et al method, a high percentage of the sample was under estimated indicating that the Nguni children of Mpumalanga's tooth formation was slightly ahead of the children upon which the Moorrees et al method was formulated. This is in agreement with other authors.

The under estimation extends to 3years for Moorrees et al method whereas for Phillips method, it extends to a year, with a very low percentage extending to 1.3 years.

Over estimation for both Moorrees et al and Phillips methods is almost the same with over estimation of 2.7 and 2.5 respectively.

The ages by which the Moorrees et al method is at its most accurate are between 5 years and 10 years whereas with Phillips method the ages are between 9 years and 12 years. These ages are critical if one wants to determine the proper timing for initiation of orthodontic treatment

By root length completion (Rc) stage all teeth compared had a difference of at least one year in the age of attainment.

The differences in the attainment of tooth formation stages were lower in later stages of root development and remained within a year range, especially with Phillips method.

Percentage of age estimation within a 2 year range with Moorrees et al is 42%

Percentage of age estimation within a 2 year range with Phillips et al is 43%.

The Phillips method is slightly more accurate than the Moorrees et al method. The Phillips method need to be investigated on a much larger sample of Nguni children in order to conclusively prove that it a better population specific method for Nguni children. The results concur with the result obtained in the study that was conducted by Phillips and published in 2009<sup>3</sup>, where 69.2 % of Nguni sample that consisted of 236 children with the age range of 5 to 17 years, was estimated within 1 year of the actual age.

The decrease in the percentage may be due to the difference in the number of the Nguni samples investigated. It may also be due to the difference in the socio-economic environment of the samples investigated.

The difference of the percentages between the 2 methods may be due to the different ethnic groups investigated. It may also be due to considerable time gap between the 2 studies on the dental development of these children.

Age estimation, as previously mentioned, is established by assessing the developing teeth that have not attained root apex closure. Teeth that have reached the apex complete (Ac) stage were not used in estimating the age of the subject. This is due to the fact that the length of time that has passed to reach tooth maturity up to Ac is usually not known<sup>24</sup>.

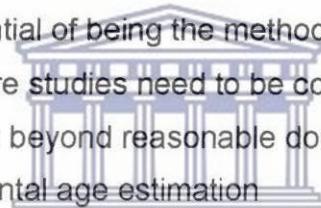
Attention is drawn to an obvious discrepancy on the result of the 4 year old, with deviation of 3.1 on Moorrees et al method and 5.1 on Phillips method. The contributing factor to this discrepancy is probably due to the examiner's error in scoring the tooth formation stages.



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## CHAPTER 5: CONCLUSION

There are differences in growth and development among populations and that has an effect on the dental age estimation methods. With the establishment of the Phillips table for Nguni children a way forward has been paved. In this study the Phillips tables have been shown to be slightly more accurate in determining the actual age of ethnically black children in the region of Mpumalanga the Moorrees et al method. The accuracy of the Phillips method is more pronounced between the ages of 9 to 13 years. Thus the Phillips method can be used in predicting the age for orthodontic treatment commencement. It can also be reliably used in estimation the age of the remains in conjunction with the other skeletal development indicators. These results are encouraging and show that the Phillips method has potential of being the method of choice when estimating the age of black children. More studies need to be conducted on a larger number of black children to determine beyond reasonable doubt the accuracy and reliability of this method of dental age estimation



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## APPENDIX 1

### INFORMATION SHEET

My name is Dr S.M. Mahlangu. I work as a dentist and I am doing my Masters in Forensic Dentistry at the University of Western Cape. I am conducting a study that aims to test the Phillips dental age estimation table developed for Nguni children of South Africa on a sample of black children-up to the age of 14years- in the region of Mpumalanga.

A number of dental age estimation methods have been developed over the years. These methods, however, used mainly children of European descent who are ethnically white. The results produced by these methods show that they are not fully applicable on ethnically black South African children. Thus Phillips dental age estimation tables were developed to correct the discrepancy.

The objectives of this study:

- To determine the applicability of the Phillips dental age estimation tables on black children in Mpumalanga
- To evaluate the accuracy of the Phillips age estimation tables on Mpumalanga children.



To successfully reach the above-mentioned objectives, I will need to obtain panoramic radiographs, of black children up to the age of 14 years. The service provider and the parent or guardian will need to grant me permission to use the radiographs of the child patient. There are no risks involved in the study. The information obtained from the panoramic radiographs will be confidential and used for research purposes only. Patient confidentiality is assured.

My details are as follows:

Tel: 013 756 2244 Fax: 013 756 2466 Mobile: 0768945601

E-mail: [sinomama@gmail.com](mailto:sinomama@gmail.com)

Thank you.

Dr S.M.Mahlangu(BDS)

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**APPENDIX 2**

**CONSENT FROM THE SERVICE PROVIDER**

I (name)..... service provider  
from (institution address)..... give  
my permission to Dr S.M. Mahlangu to utilize my patients' panoramic radiographs  
of children up to the age of 14years, for her study on "Testing the applicability of  
Phillips dental age estimation tables on a sample of Black children from  
Mpumalanga, South Africa."

I understand that patient confidentiality will be maintained and that there are no  
risks involved in the study.

Signed.....

Date.....



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