THE PERCEIVED AND NORMATIVE ORTHODONTIC TREATMENT NEED OF A GROUP OF SOUTH AFRICAN CHILDREN

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A thesis submitted in fulfilment of the requirements for the degree of Master of Science Dentistry in the Department of Orthodontics, Faculty of Dentistry, University of the Western Cape.

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Keywords

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Aesthetic component

Abstract

The perceived and normative orthodontic treatment need of a group of South African children.

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Introduction:

Improvement of aesthetics is often the reason patients seek orthodontic treatment. The ability to accurately assess aesthetic treatment need from the viewpoint of the patient is necessary. The threshold for orthodontic treatment is not constant in all countries and no previous attempts to determine this threshold has been made in South Africa. By ensuring that patient's perceptions of treatment need are incorporated into the index chosen to assess perceived need, accurate data can be obtained. Determining perceived need from the patient's viewpoint is important, and understanding its relationship with perceived need according to the professional, as well as normative need can facilitate better patient communication and management of expectations.

Aims:

There were three main aims of this study. First, South African children's perceptions of treatment need according to the Aesthetic Component (AC) of the Index of Orthodontic Treatment Need (IOTN) was assessed to determine if they were similar to those of the dentists who established the threshold, or if the threshold of the grading system should be altered to better suit laypeople's opinions. Second, the newly established threshold could then be used to determine the perceived needs for orthodontic treatment, and compare them to the normative need of the population. Finally, factors that may influence the perceived needs of the patients such as gender, ethnicity and socio-economic position could be investigated.

Methodology:

A cross-sectional study on 317 children aged between 11 and 14 years was done. 43.8% were male and 56.2 % were female. The sample was chosen from five schools in the Lekwa District of Mpumalanga using a multi-stage sampling technique. The study population comprised of four groups based on ethnicity; Asian (3%), black (74%), coloured (6%) and white (17%). The socio-economic position (SEP) was determined by Principal Component Analysis of household assets. Societal perceived, subjective perceived and self-perceived needs were assessed using a questionnaire and the child-rated AC of the IOTN. An intra-oral examination was conducted using the AC of the IOTN to assess objective perceived need and the modified Dental Health Component (DHC) of the IOTN to assess normative treatment need.

Results:

Treatment threshold was determined to be grade 3 of the AC of the IOTN according to societal perceived need of the group of South African children, and was confirmed by self-perceived need. Subjective perceived need for treatment was assessed using the AC grade participants felt best reflected their aesthetic impairment, and was found to be 20.2%, compared to actual self-perceived need of 38.5%. The latter was deduced by comparing the child-rated AC (subjective perceived need) to their perception of treatment need of that grade (societal perceived need). The objective perceived need measured by the examiner-rated AC was 60%. Definite need for orthodontic treatment based on the modified DHC of the IOTN was 41.2%. No significant difference between societal perceived or self-perceived need and gender or socio-economic position was found. White children have lower societal perceived treatment need regarding others' aesthetic impairment.

Conclusion:

The treatment threshold grade should be lowered to better represent the societal perceived and self-perceived need of the South African population. Normative need was higher than perceived needs from the patients' point of view (subjective

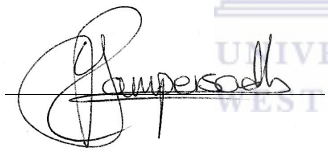
perceived and self-perceived need), but lower than the perceived need from the professional's point of view (objective perceived need). Ethnicity was found to have an influence on societal perceived need.

November 2015

Declaration

I declare that *The perceived and normative orthodontic treatment need of a group of South African children* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Full Name: Yuvthi Rampersadh Date: November 2015

Signed: 

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List of Abbreviations

AC	Aesthetic Component
BASCD	British Association for the Study of Community Dentistry
CI	Confidence Interval
DAI	Dental Aesthetic Index
DHC	Dental Health Component
DOE	Department of Education
FDI	Fédération Dentaire Internationale
ICON	Index of Complexity, Outcome and Need
IOTN	Index of Orthodontic Treatment Need
OASIS	Oral Aesthetic Subjective Impact Scale
OI	Occlusal Index of Summers
OR	Odds Ratio
PCA	Principal Component Analysis
SEP	Socio-economic position
WHO	World Health Organisation

Definitions of terms

Normative need

The need for orthodontic treatment based on dental health impairment as determined by the examiner using the modified Dental Health Component of the Index of Orthodontic Treatment Need.

Objective perceived need

The need for orthodontic treatment based on aesthetic impairment as determined by the examiner using the Aesthetic Component of the Index of Orthodontic Treatment Need (examiner-rated AC).

Societal perceived need

The need for orthodontic treatment based on the aesthetic impairments depicted by the Aesthetic Component of the Index of Orthodontic Treatment Need. It represents societies view on need of treatment for each grade of the Aesthetic Component.

Subjective perceived need

The need for orthodontic treatment based on the aesthetic impairment as determined by the child using the Aesthetic Component of the Index of Orthodontic Treatment Need. It is the grade of the Aesthetic Component the child chose to represent his/her own dentition (child-rated AC).

Self-perceived need

The actual need for orthodontic treatment felt by the child and is determined by comparing the child's subjective perceived need for treatment with the child's societal perceived need for treatment.

Chapter 1: Introduction

One of the main motivating factors for patients seeking orthodontic treatment is to improve their appearance aesthetically. For this reason, one needs to realise the importance of aesthetic parameters in assessing treatment need (Brook and Shaw, 1989). Different people view aesthetic impairment very differently and it is important to get a valid representation of society's perceptions regarding when treatment is necessary (Jenny, 1975).

The Aesthetic Component (AC) of the Index of Orthodontic Treatment Need (IOTN) is one of the indices available to clinicians that allow for the assessment of treatment need on the basis of aesthetics. A major problem, however, is that the threshold at which treatment is needed may vary between geographical and socio-demographic populations, as societal expectations are not equal in all countries and economic subsets (Borzabadi-Farahani, 2011; Hamdan *et al,* 2007; Hunt *et al,* 2002; Stenvik *et al,* 1997; Jenny, 1975). This being said, the threshold is yet to be determined among South African population groups.

Professionals have determined the current grading system, which categorises the "treatment need" for this index, but it has been criticised for not truly reflecting the views of the patient (Hunt *et al,* 2002; Richmond *et al,* 1995).

When one assesses treatment need, although the demand may be greatly driven by aesthetic considerations, one cannot detract from the prevalence of normative need of the patients. When the data is used to motivate for publicly funded health care, normative need plays a big role in justifying treatment, differentiating those who will need treatment from those who will not. The modified Dental Health Component (DHC) of the IOTN will be used in this study to measure normative need.

This study aimed to

- assess whether South African children perceive treatment need similarly to the dentists who developed the Aesthetic Component grading or if the threshold should be altered to better suit our patients' needs.
- establish the need for orthodontic treatment based on the new threshold of the AC of the IOTN found in this study, and assess the proportion of the population which is in definite need of orthodontic treatment based on the modified DHC of the IOTN and compare that to the perceived needs of the population
- identify demographic factors that influence the perceived needs of the patients such as gender, ethnicity and socio-economic position.

Chapter 2: Literature review

2. Introduction

Mutilation and removal of teeth to satisfy socio-cultural expectations has been around since early times. The socio-cultural needs met by a Brazilian or African native who have filed their teeth to sharp points is vastly similar to those of a westernized adolescent who has four teeth surgically removed to reposition and straighten the remaining teeth. This desire, more of a need, to satisfy cultural norms is not a trivial pursuit and it is considered culturally valid to make attempts to seek orthodontic treatment in instances where teeth do not naturally meet socially expected norms (Jenny, 1975).

Orthodontics in the 21st century differs from the past - more emphasis is being placed on dental and facial appearance, with patients playing a bigger role in treatment planning than before (Proffit *et al*, 2007). Over three decades ago, recognition was given to the importance of assessing the aesthetic impairment of a patient's malocclusion (Prahl-Andersen, 1978).

Malocclusion, being a deviation from the norm, is associated with a large degree of subjectivity and distortion regarding how treatment need is perceived (Borzabadi-Farahani, 2011). Today, the desire for treatment has moved away from the improved functionality needs as determined by the dentist and is driven by the patient's demand (Špalj *et al,* 2014; Grzywacz, 2003). The literature reflects this shift in focus from a biophysical concern to a more patient-centered concern regarding malocclusion and its management. This may be in part due to the fact that more studies are showing there is an association between malocclusion or orthodontic treatment need and poor health-related quality of life. However, this association between orthodontic treatment need and poor health-related quality of life is a moderate one, at best (Liu *et al*, 2009).

Much controversy exists around the subject of whether or not malocclusion and its treatment affects quality of life. A meta-analysis of the data on such research

studies conducted by Zhang *et al* in 2006 concluded the lack of a concise answer to this question even though it is generally accepted that patients seek orthodontic treatment because of the psychological as well as social and physical effects of their malocclusion.

A longitudinal study by Shaw *et al* (2007) may put the psychosocial benefits of orthodontic treatment into dispute. The study conducted on 337 follow-up patients after twenty years from initial assessment showed that participants with a prior need for orthodontic treatment at age 11-12 who obtained the required treatment had better tooth alignment and satisfaction. However, when self-esteem was compared, it was found that orthodontic treatment had little positive impact on psychological health and quality of life at age 30-31. The researchers concluded that lack of orthodontic treatment when there was need for it, did not lead to psychological difficulties in later life. It is important to note that in their study, Shaw *et al* themselves determined the orthodontic treatment need based on normative parameters. Self-perceived treatment need that is not met might have a different outcome.

It has been confirmed by cross-sectional investigations that children with a professionally determined need for treatment do not have a worse psychosocial quality of life than those who are not considered in need of treatment by professionals. However in the same study it was demonstrated that when treatment need was determined on a more consumer-based approach by establishing the children's concern with their malocclusion, the children with a need for treatment did have a worse quality of life (Kok *et al*, 2004). Further studies need to be done in this regard to determine the long-term effect of unmet self-perceived need, as the literature suggests that it does has a negative effect on patient quality of life.

The main motivating factor for seeking orthodontic treatment is the improvement of appearance (Al-Zubair *et al*, 2015; Samsonyanová and Broukal, 2014; Trivedi *et al,* 2011; Grzywacz, 2003). Thus it is no longer accurate to solely measure

objective need, the need as determined by the professional, when allocating resources for orthodontic care, as doing so will not accurately reflect the demand. Due to the paradigm shift toward patient-centered care in dental clinical practice and particularly in orthodontics, it is important to acknowledge both the clinicians' need for establishing a rationale for treatment interventions and the patients' evaluation regarding what is necessary treatment (Vig *et al*, 1999). A system based on normative need alone will lead to wasted resources on the one side or denial of treatment on the other (de Oliveira *et al,* 2008; Tsakos, 2008). Patients' perceptions of orthodontic treatment need should not be underestimated (Shue-Te Yeh *et al,* 2000).

Patients' concerns do not always coincide with those of the clinicians (Siddiqui *et al,* 2014; de Oliveira *et al,* 2008; Shue-Te Yeh *et al*, 2000) and this causes difficulty in determining treatment need according to indices, as occlusal indices by definition and purpose are available to define treatment need from a clinician's point of view (Trivedi *et al,* 2011; Väkiparta *et al,* 2005) and not from that of the patient. At the end of the day, it is the patient who needs to be satisfied with the improvement in aesthetics and function resulting from their orthodontic treatment (Shue-Te Yeh *et al,* 2000).

In order to attain a successful treatment outcome from any aesthetic treatment, the health provider and patient should reciprocally agree on the severity of the presenting complaint or condition for which treatment is sought (Siddiqui *et al,* 2014; Špalj *et al,* 2014). Without this congruency of opinions, there will be suboptimal understanding and communication between the parties and this may lead to poor compliance levels from these patients. Increasing patients' confidence in the practitioner, allowing for better explanation of treatment options and creating mutual understanding are a few benefits to orthodontic practice as a result of being able to discuss a patient's condition with them. Self-esteem plays an important role in self-perception of impairment and treatment need (Siddiqui *et al*, 2014).

When assessing the perceived treatment need from the view of the patient, it is of utmost importance to ensure that the treatment need assessment tool in use is in fact valid. An index is considered valid if it accurately measures what it purports to (Beglin *et al,* 2001).

Appreciating the importance of patients' perceptions of treatment need in no way detracts from the importance of professional referral for treatment. Irrespective of the fact that in some cases there is a conflict of opinion between professional and patient, there will be times in which the professional opinion of the specialist will be requested by the patient themselves (Tsakos, 2008). It is merely highlighting that it would be prudent to encourage that both normative professional and perceived patient needs be assessed before treatment planning (Khan and Fida, 2008). Although significant correlations have been noted in young adults between self-perceived and normative treatment need assessments, there still exists a considerable difference between the two and both needs should be addressed in the treatment plan (Oshagh *et al*, 2011). Understanding self-perception of malocclusion and assessing it, as well as assessing normative needs for orthodontic treatment, and comparing the two for a given population are crucial issues in modern orthodontic practice (Aikins *et al*, 2012). Furthermore, using indices to determine where treatment is needed is useful when priority needs to be given to those in most need due to lack of resources. The use of indices can also prevent potential over-treatment (Hamdan *et al*, 2007; Birkeland *et al,* 1996).

2.1. The qualities of an ideal index

Indices used in an epidemiological setting will differ considerably from those used in a clinical setting where detail is of importance (Burden *et al*, 2001). The ideal characteristics would be an index that is objective, valid and reliable when used by general dental practitioners (Cardoso *et al,* 2011; Beglin *et al*, 2001; Burden *et al*, 2001). It is advantageous if the index has a short training time (Burden *et al,* 2001) and reduced time of application, especially when population studies are being carried out (Cardoso *et al*, 2011).

In order for orthodontic treatment to become an integral part of any health care system, basic information on the treatment need is required (Ngom *et al*, 2007). Different methods of funding orthodontic care exist in different countries, but where publicly funded orthodontic care needs to be made available, reliable population data is paramount to a successful health care service. Many indices were developed with the purpose of categorising the severity of malocclusion and the need for treatment to ensure that, in areas where resources are limited, those patients with the highest need for treatment are prioritised. The orthodontic component used in oral health surveys should aim to clearly identify those individuals who have a definite need for orthodontic treatment (Burden *et al,* 2001).

Other benefits of a treatment need index include: ensuring priority for treatment is given to those with the highest need; safeguarding against overtreatment; and providing a platform on which important and constructive discussion about treatment for both functional and aesthetic benefit can be had between the orthodontist and the patient (Birkeland *et al,* 1996).

2.2. The Index of Orthodontic Treatment Need

The IOTN is an occlusal index that is gaining popularity worldwide, and is the most frequently used index amongst European countries (Hamdan *et al*, 2007). An orthodontic treatment need index is an index which is used in the prioritisation of treatment need as it has a grading system dependent on the severity of the malocclusion recorded (Borzabadi-Farahani, 2011). The Index of Orthodontic Treatment need is unique in that it comprises two separate components; the Dental Health Component (DHC) and the Aesthetic Component (AC) (Khasim *et al*, 2013; Cardoso *et al*, 2011; Hamdan *et al*, 2007; Richmond *et al,* 1995; Brook and Shaw, 1989), thus the assessment of treatment need purely based on aesthetic need is possible. The two components are independent of each other and the one that quantifies the most need takes precedence (Beglin *et al*, 2001). A health professional must assess the DHC limiting it to measure normative need, however

the AC has the benefit of professional as well as layperson assessment (Khasim *et al*, 2013; Kok *et al*, 2004).

2.2.1. **The Dental Health Component**

The original DHC is a hierarchal 5-grade index with 30 sub-categories as shown in Figure 1 (Burden *et al*, 2001). The assessment of malocclusion is made on 5 traits, namely: missing teeth; overjet; crossbite; displacement of contact points; and overbite (Cardoso *et al,* 2011).

Figure 1: The DHC of the IOTN (Burden *et al*, 2001)

Grade 5 ***(Need treatment)***
5.h Extensive hypodontia with restorative implications (more than1 tooth missing in any quadrant) requiring pre-restorative orthodontics.
5.i Impeded eruption of teeth (except for third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause.
5.a Increased overjet greater than 9 mm.
5.m Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties.
5.p Defects of cleft lip and palate and other cranio-facial anomalies.
5.s Submerged deciduous teeth.

Grade 4 ***(Need treatment)***
4.h Less extensive hypondontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis.
4.a Increased overjet greater than 6 mm but less than or equal to 9 mm.
4.b Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties.
4.m Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties.
4.c Anterior or posterior crossbites with greater than 2 mm discrepancy between retruded contact position and intercuspal position.
4.l Posterior lingual crossbite with no functional occlusal contact in one or both buccal segments.
4.d Severe contact point displacements greater than 4 mm.
4.e Extreme lateral or anterior open bites greater than 4 mm.
4.f Increased and complete overbite with gingival or palatal trauma.
4.t Partially erupted teeth, tipped and impacted against adjacent teeth.
4.x Presence of supernumerary teeth.

Grade 3 ***(Borderline need)***
3.a Increased overjet greater than 3.5 mm but less than or equal to 6 mm with incompetent lips.
3.b Reverse overjet greater than 1 mm but less than or equal to 3.5 mm.
3.c Anterior or posterior crossbites with greater than 1 mm but less than or equal to 2 mm discrepancy between retruded contact position and intercuspal position.
3.d Contact point displacements greater than 2 mm but less than or equal to 4 mm.
3.e Lateral or anterior open bite greater than 2 mm but less than or equal to 4 mm.
3.f Deep overbite complete on gingival or palatal tissues but no trauma.

Grade 2 ***(Little need)***
2.a Increased overjet greater than 3.5 mm but less than or equal to 6 mm with competent lips.
2.b Reverse overjet greater than 0 mm but less than or equal to 1 mm.
2.c Anterior or posterior crossbite with less than or equal to 1 mm discrepancy between retruded contact position and intercuspal position.
2.d Contact point displacements greater than 1 mm but less than or equal to 2 mm.
2.e Anterior or posterior openbite greater than 1 mm but less than or equal to 2 mm.
2.f Increased overbite greater than or equal 3.5 mm without gingival contact.
2.g Prenormal or postnormal occlusions with no other anomalies includes up to half a unit discrepancy.

Grade 1 ***(No Need)***
1. Extremely minor malocclusions including contact point displacements less than 1 mm.

Although this index offers great detail with respect to severity of malocclusion and has been used in numerous surveys in the past, the complexity of the index meant that it could not be utilised reliably without lengthy training periods. Besides the long training period, concern was raised about the reliability of non-specialists conducting the complex original DHC and these factors motivated the

British Association for the Study of Community Dentistry (BASCD) to formulate a less complicated, more practical index that could be implemented in their National Oral Health surveys conducted every 4 years (Burden *et al*, 2001). The concern regarding non-specialists' ability to reliably and validly utilise the original DHC of the IOTN was echoed by Cardoso *et al* (2011), when they suggested that evaluation of reliability and validity studies should be conducted on general dentists as well.

2.2.2. **The modified IOTN**

The modified IOTN was developed by a committee in Britain under instruction from the BASCD, whose sole purpose was to formulate a method of determining orthodontic treatment need that was reliable and practical to implement in a national children's dental health survey (Burden *et al*, 2001).

Due to the fact that the DHC of the IOTN is based on the worst occlusal trait, it ignores the possibility of a number of lesser occlusal irregularities leading to a more complex occlusal pattern (Souames *et al*, 2006). As the DHC does not accurately gauge complexity of treatment required (de Oliveira, 2003), it is not beneficial to record the dental anomaly that places the patient into a certain treatment group (Burden *et al*, 2001).

The modified DHC (Figure 2), which records only those malocclusions that result in definite need for treatment, could be simplified such that it comprises only two categories (i.e. 'definite need for treatment' and 'no definite need for treatment') with no sub-categories (Burden *et al*, 2001).

This modified index appears to overcome reliability and training problems that other past indices experience. Results show it has great potential to be used in epidemiological studies where the goal is to establish the level of orthodontic treatment need in a population (Burden *et al,* 2001).

Figure 2: The modified DHC of the IOTN (Burden *et al*, 2001)

Definite need for orthodontic treatment
If any one of the occlusal anomalies below is present, there is a definite need for orthodontic treatment. (In brackets, for information and comparison, are given the sub-categories from the original Dental Health component of IOTN).
The acronym "MOCDO" is used as an aide memoire: Missing teeth, Overjet, Crossbites, Displacement of contact points (crowding), Overbite

M Hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis. (4h, 5h)

Impeded eruption of teeth (5i). Presence of supernumerary teeth (4x), and retained deciduous teeth (5s)

O Increased overjet greater than 6mm. (4a, 5a)

Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties. (5m, 4b)

Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties. (4m)

C Anterior or posterior crossbites with greater than 2 mm discrepancy between retruded contact position and intercuspal position. (4c)

D Contact point displacements greater than 4 mm. (4d)

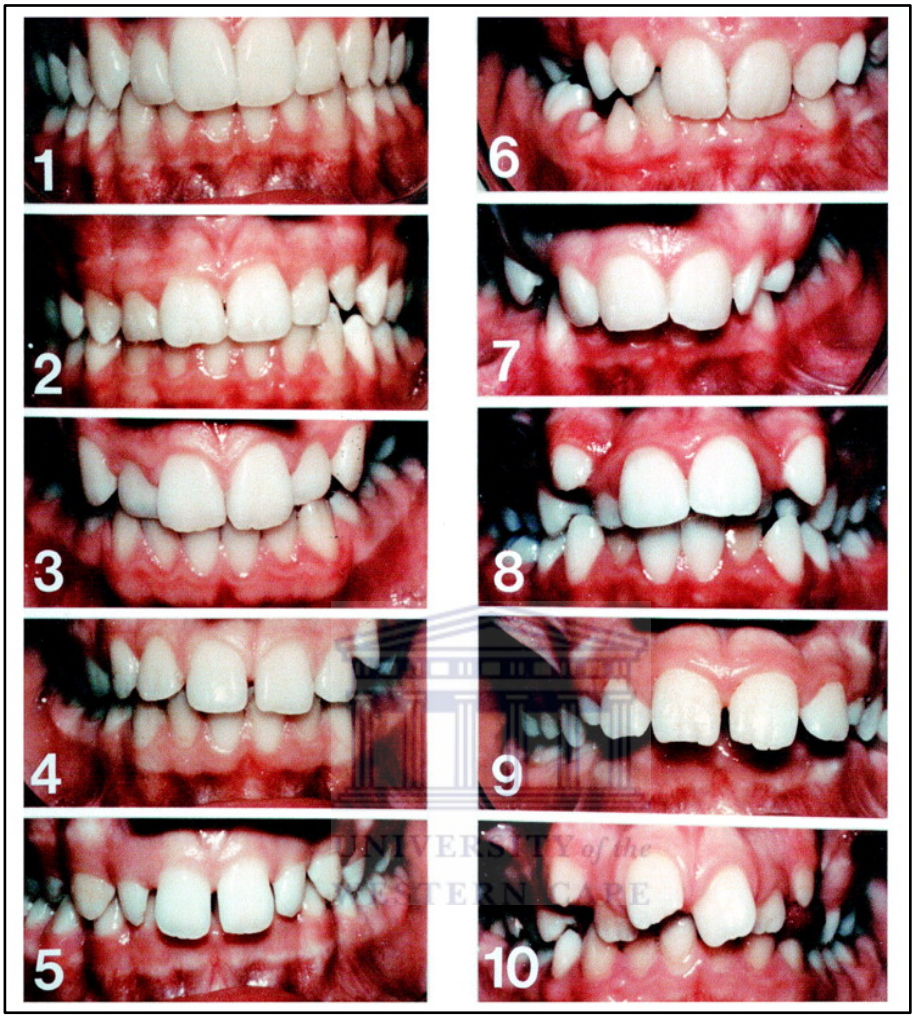
O Lateral or anterior open bites greater than 4 mm. (4e)

Deep overbite with gingival or palatal trauma. (4f)

2.2.3. **The Aesthetic Component**

The Aesthetic Component (AC) is a picture scale of ten intraoral photographs, as shown in Figure 3, taken from a frontal view showing mainly anterior teeth (Brook and Shaw, 1989; Evans and Shaw, 1987). The photographs were arranged according to how they were rated with regard to their attractiveness by a panel of 6 non-dental judges (Brook and Shaw, 1989). According to a study by Padisar *et al* (2009), most individuals seek treatment based on the aesthetics of the anterior segment of their dental arch. The pictures range from grade 1, the most attractive (Photo 1) to grade 10, the least attractive dentition (Photo 10) (Trivedi *et al*, 2011; Hunt *et al*, 2002).

Figure 3: The AC of the IOTN (Brook and Shaw, 1989)



The proposed applications of the AC according to Stenvik *et al* (1997) are both to assist the orthodontist in determining treatment priority, and in research related to psychological aspects of malocclusion. During its development, Evans and Shaw (1987) found it to be a suitable and reliable standardised scale able to rate dental attractiveness and assist in treatment priority determination. It was also considered for use, inter alia, as a tool in patient counselling, so a credible impression of a subject's dental attractiveness could be attained.

The modified AC according to Burden *et al* (2001) records only grades 8 and above on the AC as falling into the 'definite need for treatment' category.

It is important to note that the AC can be either examiner-rated, in which case the assessment is done by the healthcare professional and this reflects the objective perceived need, or it can be rated by the patient (Khasim *et al,* 2013; Aikins *et al*, 2012; Khan and Fida, 2008; Kok *et al,* 2004; Shue-Te Yeh *et al*, 2000) reflecting the subjective perceived need.

The literature is not always consistent with these definitions and AC rated by the examiner has also been referred to as reflecting normative need in some studies (Kolawole *et al,* 2013; Padisar *et al*, 2009; Ngom, 2007; Kok *et al,* 2004; Mandall *et al,* 2000).

2.2.4. **Other modifications**

Various researchers have modified the IOTN for specific purposes over the course of its use. It has been modified for specific ethnic groups due to the fact that the conventional AC appears to be directed toward Caucasian malocclusions (Khasim *et al*, 2013; Psiwa, 2004).

It has been modified in mixed dentition studies on the success of interceptive orthodontics by recording any crossbite with lateral shift as well as crossbites of primary molars and canines, and not recording overjets and overbites if incisors were not fully erupted (Väkiparta *et al,* 2005).

2.2.5. **Bias of operator rated AC and its effect on the reliability of the IOTN**

It could be argued that the AC as rated by the examiner, compared to the DHC, is extremely biased and that the reliability of the overall index may be increased if the AC was removed. Souames *et al* (2006) stated that fewer children were judged as requiring treatment by the examiner-rated AC than the DHC and suggested it was an unnecessary part of the IOTN and could be removed. This ideology, when tested using the modified IOTN as suggested Burden *et al,* was found to be contradicted. Burden *et al* (2001) suggested it best not to remove the AC of the IOTN when using the modified IOTN, as this would then decrease the sensitivity

of the index to detect need for treatment in the cases based on aesthetic impairment without dental health impairment, which previous studies showed occurred in 2% of cases. Burden *et al* therefore concluded that the overall reliability of the modified IOTN including the DHC and AC was good and that the AC should be retained to ensure recognition of treatment need in this small percentage of the study population.

2.2.6. **Child-rated AC compared to examiner-rated AC**

Orthodontist- or examiner-rated AC and child-rated AC correlation and associations have been analysed in many previous studies.

In 2004, Kerosuo *et al* found a statistically significant, albeit low, correlation between the two ratings of the AC, even though subjects consistently rated themselves more favourably than the examiner rated them. Similarly, Abu Alhaija *et al* (2005) found a weak but significant correlation even though the majority of the students rated their teeth more attractive than the examiner. In contrast, Grzywacz (2003) found that more than a quarter of the children rated their AC at one grade above the examiner, therefore more critically.

Aikins *et al* (2012) and Siddiqui *et al* (2014) found a statistically significant difference between patient perception and orthodontists' perception of the AC of the IOTN. In the study by Siddiqui et al (2014), 121 patients at pre-treatment orthodontic level were asked to assess their AC and this was compared to the AC grading as determined by the orthodontist. The orthodontist perceived fewer patients to be in the 'no need for treatment' category than was perceived by the patients themselves. Aikins *et al* (2012) had similar findings and concluded that in order for effective orthodontic care, due to the variance between self-perception and professional assessment of aesthetics, both need to be taken into consideration. Although a difference between orthodontist and layperson ratings of aesthetic impairment is usually present, there has been high agreement within each group (Vig *et al*, 1999).

In studies where there is a significant correlation between AC as rated by the examiner and subject, the relationship is found between AC grading categories and not individual grades (Kolawole *et al,* 2013; Trivedi *et al,* 2011; Grzywacz, 2003) which increases the chance of there being a correlation.

2.2.7. **AC compared to DHC**

When analysed by the health professional, the AC and DHC have been shown to have a significant relationship, a significant difference was found between normative and perceived needs (Padisar *et al*, 2009). However, others find weak to moderate controversial and diverse associations between the two components of the IOTN (Oshagh *et al,* 2011; Špalj *et al,* 2010). When examiner-rated AC is compared to normative orthodontic treatment need as measured by the DHC, irrespective of patient's age, orthodontists tend to rate the dentition as more aesthetically pleasing than the normative need would suggest (Siddiqui *et al,* 2014; Kolawole *et al,* 2013; Dogan *et al,* 2010; Ngom *et al,* 2007; Souames *et al,* 2006). The same is true for patient-rated AC compared to DHC (Siddiqui *et al,* 2014; Ngom *et al,* 2007; Otuyemi and Kolawole, 2005; Birkeland *et al,* 1996).

The differentiation and comparison of perceived needs of the patient with normative need has implications regarding services available to a patient, as treatment need is usually determined by clinical examination (de Oliveira *et al*, 2008). These associations are of importance to orthodontists in publicly funded health care systems as they allow for the establishment of methods to be put in place that can effectively measure treatment need accurately (Kerosuo *et al,* 2004). The success of treatment care should be assessed on the basis of whether it meets the expectations of both parties, and not just those of the clinician (Vig *et al,* 1999).

The Padisar *et al* study, which was done in 2009 on a group of 343 individuals with a mean age of 18 years who had applied for orthodontic treatment, found that there was in fact a significant relationship between AC and DHC components of the IOTN, suggesting this index has a high specificity. There was no significant

relationship found between perceived needs and the different class of malocclusions. The same study also found that most of the individuals considered themselves to fall in the region of grades 1 to 4 on the AC scale, and specialists confirmed this. This implies that even though the AC grade of 4 or lower may currently fall in the category of not needing treatment, the majority of individuals seeking treatment in fact fall into this group. This brings about the question of whether or not the treatment threshold determined for the AC of the IOTN is in fact validated against lay opinion.

2.3. The treatment need threshold of the AC of the IOTN

During the initial development of the AC of the IOTN, the definition of specific ranges determining treatment need or a lack thereof were not established, as the goal was to create a mathematical model defining combinations of gradings which could be altered according to the specific target population (Brook and Shaw, 1989). An occlusal index usually has a cut-off point, and the lowest value at which treatment is advocated usually determines the cut-off point (Borzabadi-Farahani, 2011; Winnier *et al*, 2011). Below the cut-off point, the malocclusion is considered too minor to warrant treatment (Beglin *et al*, 2001). The threshold grade is the grade that must be exceeded before the cut-off point is reached and treatment need is considered in varying degrees of necessity.

In 1995 the subjective opinions of 74 dentists (44 orthodontists and 30 non-orthodontists) were used as the 'gold standard' to validate the cut-off point and the values representing the different grades of orthodontic treatment need based on the AC of the IOTN in England. Even though there was a moderate spread in each of the gradings, the validation exercise by the professionals yielded 3 proposed treatment categories: grades 1 to 4 – 'no to slight treatment need'; grades 5 to 7 – 'moderate treatment need', and grades 8 to 10 – 'definite/great need for treatment', thus making grade 4 the accepted threshold grade (Richmond *et al*, 1995).

Validation of the index by professionals in different countries in which the index is used has been advocated, as the cut-off points may vary dramatically based on social perception and economy of the country (Borzabadi-Farahani, 2011; Stenvik *et al,* 1997). Malocclusion is a condition which usually needs treatment over a lengthy period and may come with a substantial price tag, therefore it is beneficial that the treatment need categories can be adjusted in order for a higher cut-off point to be implemented. In this way, limited resources can be distributed sparingly to those in most need of treatment (Beglin *et al*, 2001).

It could be argued that there is an inherent shortcoming with using professional opinion to validate an aesthetic ranking scale as studies show professional opinion is in many instances more critical than that of the layperson (Siddiqui *et al,* 2014; Khasim *et al,* 2013; Aikins *et al,* 2012; Abu Alhaija *et al,* 2005; Kerosuo *et al,* 2004; Birkeland *et al,* 1996). Dental professionals, due to their training and experience, are likely to take a more critical view of any deviation from normal occlusion (Prahl-Andersen, 1978). This is supported by studies that demonstrate orthodontists rate children's aesthetics more critically than the children rate themselves (Ghijselings *et al,* 2014; Sharma and Sharma, 2014; Khasim *et al,* 2013; Ngom *et al,* 2007; Otuyemi and Kolawole, 2005; Kok *et al*, 2004). Winnier *et al* confirmed this in 2011, when they concluded that almost sixteen percent (15.8%) of the children, according to the child-rated AC placed themselves in the 'need for treatment' category grades, whereas almost 10 percentage points more (25.6%) were defined to be in the same category by dentists examining them using the AC.

There is evidence that at times the perceived need of the patient, the AC ranking of their parent and the AC ranking of the dentist have all been in harmony (Hamdan *et al*, 2007). However, it can be concluded that using the opinions of specialists as the gold standard may result in the biased views of a small few and not accurately reflect the views of society as a whole (Hamdan *et al*, 2007; Hunt *et al*, 2002).

Discrepancies have been found between the potential patients' and the professionals' opinion of malocclusion and treatment need. The self-perception of the patient may be more important and differ from the professional judgement of the orthodontist. Prahl-Anderson (1978) addressed the issue of 'Subjective Symptoms', which is the ideology that due to the development of malocclusion to a large extent being of a slow nature, most patients adapt over time to their condition and rarely are functional disturbances found. Thus if the orthodontist identifies a problem and it is not recognised by the patient as a problem, then the defect, irrespective of its severity from the professional's point of view, has little significance for the patient apart from the problem with aesthetics (Prahl-Anderson, 1978).

2.4. Prior attempts to validate the AC against lay opinion

Four prior published studies were found that have attempted to validate the threshold of treatment of the AC of the IOTN against lay opinion (Stenvik *et al,* 1997; Hunt *et al,* 2002; Hamdan *et al,* 2007; Svedström-Oristo *et al*, 2009). Some suggest that, as currently graded, the AC does not reflect the public's opinion on treatment need. The methods used and the results are discussed below in detail along with critiques of methods engaged.

2.4.1. **Stenvik *et al***

In 1997, a study was conducted in Norway, to validate the AC to match the socio-cultural standard of the Norwegian children (mean age = 11.6yrs), parents and young adults. This was regarded as important so as to reflect the societal perspective regarding dental aesthetics when the AC scale was used to advise patients on treatment need, as opposed to the perspective of the dental professionals who graded the index.

The method used was to show all participants the 10 photographs in order, and asking them to evaluate each picture based on a 4-point scale according to whether the aesthetics were perceived as very good, acceptable, not good or

unattractive. The categories for aesthetic acceptability were ranked A to D and were associated with whether or not the teeth needed to be treated. Only category 'D – unattractive' qualified for treatment.

The cut-off point of the AC scale for each subject was determined to be the point at which the child first chose category D. Progressiveness of the scale was assessed by whether or not any picture after the cut-off point was considered to be in category A, B or C and therefore representing no treatment. Mean cut-off points were calculated for each group and differences were analysed.

The results showed that the scale was progressive with the only exception being AC photograph 9. Young adults and parents rated the photographs similarly but the children were less critical, having a mean cut-off point 5.6, representing grade 4 as the treatment threshold grade. Grades 1 to 4 of the scale were considered to need treatment by less than 25% of all three samples. More than 90% of the young adults and parents felt grade 7 and above required treatment. Greatest variance amongst the groups was found between grades 5 and 6 as only half the children thought they represented treatment need, yet over 70% of parents and young adults thought treatment was necessary. No significant differences were seen between sexes in either group.

It was concluded that the Norwegian laypeople's assessment of treatment need did not differ from British professional opinion.

Some bias could have been elicited by presenting the scale in order, however it could be argued that this was omitted by assessing the progressiveness of the scale.

2.4.2. **Hunt *et al***

In 2002, Hunt *et al* conducted a study aimed at determining the treatment threshold grade of the AC of the IOTN as determined by laypeople and comparing it to the currently suggested threshold of grade 4. The study group consisted of

two hundred and fifteen social science students, either in their first or second year of university, a mean age of 20.3 years. This age group was considered to be sufficiently mature to make judgements on the impact that dental aesthetics has on social acceptability, self-esteem and self-confidence. They were asked to complete a questionnaire to determine the point at which they would like to receive orthodontic treatment.

The IOTN scale of 10 pictures, in the correct order was projected onto a 15 by 10 metre lecture screen. The purpose of the AC was explained and they were told to record the grade at which they would seek treatment if the photograph represented their own dentition. They were also asked to rate the attractiveness of their own dentition from very unattractive to very attractive, and the importance of having straight teeth from very unimportant to very important.

The results were that 42% of the sample selected grade 4 as the grade at which they would seek treatment. In addition to representing the percentage of the sample that selected a particular grade, they also represented the cumulative percentage of the grades prior to the selected grade and deduced that by grade 4, 74% of the population had reported that they would seek treatment and this cumulative percentage rose to 95.8 by grade 5.

Almost one third (31%) felt it necessary to seek orthodontic treatment by grade 3 using the cumulative percentage, but it was decided more reasonable to determine the threshold at a point where the majority felt treatment was necessary. Evidence was therefore in favour of moving the threshold for treatment from the currently accepted norm of grade 4 to grade 3, so as to re-categorise the AC treatment need category for 'no/slight need' to be from grade 1 to 3, and not grade 1 to 4 to more accurately reflect the society's aesthetic expectations.

The students' previous orthodontic experience or lack thereof, and annual dental attendance rate were assessed to determine if they affected the threshold chosen and the only variable that influenced the cut-off point picture selected by the

research group was frequency of dental attendance. Those who attended the dentist regularly chose a cut off point closer to the attractive end of the spectrum than those who attended less frequently, implying frequent dental attenders were more critical of aesthetic impairment. No influence of gender on threshold chosen was apparent. There was no significant relationship found between the participant's rating of the attractiveness of their own teeth and the choice of threshold grade.

The fact that the AC scale was given to the group in order and they were asked to pick a particular point raises concern in that they were unable to rearrange the pictures if there was a picture after the selected grade, which in their opinion might not require treatment. The fact that every picture thereafter automatically required treatment seems a fair assumption to make but it remains open to interpretation as the order of the pictures was presented to the participants. Studies have shown that laypeople may not absolutely agree with the pre-determined scale (Sehowa, 2011; Hamdan *et al,* 2007; Stenvik *et al,* 1997).

2.4.3. **Hamdan *et al***

In 2007, a study aimed at comparing rankings of dental aesthetics and the threshold at which orthodontic treatment is needed, between patients, parents and dentists was conducted.

The opinions of 100 patients aged 11-22, only 5 of which were adults (18 years and over), their parents and 23 non-orthodontic specialist dentists were investigated by exposing them to the 10 pictures of the AC of the IOTN printed on equal size rectangular photograph paper with a Velcro strip attached to the back. They were placed in a paper envelope in no particular order. The subjects were asked to arrange them in order of most attractive to least attractive on a numbered cardboard by attaching them to Velcro strips on the board.

The subjects were then presented with the AC of the IOTN in sequence and asked to identify the cut-off point between no treatment need and treatment need.

It was found that AC grades 1 to 4 and 10 were identically ranked compared to the original AC scale, AC grades 5 and 6 were both given a median rank of 6 and AC grades 7 and 8 were both given a median rank of 7. Grade 9 of the AC was given a median rank of 8 and thus median rank 9 was left empty. The ordering of the AC grades resulted in the researchers suggesting that the AC scale could be modified to only incorporate eight and not ten grades as the pictures reflecting grades 5 and 6 were found to have little significant difference as the case with the pictures for grades 7 and 8.

The median cut-off point for females was grade 3 whereas for males it was grade 2, but the difference was not found to be statistically significant and the data was then pooled. The median cut-off point for dentists was grade 3, for patients grade 2.5 and for parents grade 2. No significant difference between the cut-off grades between these groups was found.

The researchers came to the same conclusion as Hunt *et al* (2002) that grade 4 of the AC of the IOTN should be included in the 'need for treatment' category. In the study the mean threshold value was actually found to be 2.5 but since there are no half grades, they rounded it up to grade 3.

This study allowed for the ranking of the AC scale, as well as the threshold for treatment to be determined by the laypeople, and even though the threshold was deduced using the AC in its original order, the fact that in this instance there was no significant difference in the AC ranking of the children compared to the original AC ranking mitigates any argument that the threshold was determined using the original ranking of the AC scale and not that determined by laypeople.

2.4.4. **Svedström-Oristo *et al***

The aim of this study, carried out in 2009, on a group of young Finnish adults aged between 16 and 25 years of age was to define the grade in the AC of the IOTN which would subjectively and objectively differentiate an aesthetically acceptable occlusion from one that was not considered acceptable.

The researchers used a semi-structured questionnaire and a clinical examination that was carried out by two orthodontists. The questionnaire was designed to gather information on satisfaction with one's own dental appearance, and where dissatisfied, reasons were sought. Of interest, the participants were asked to assess their own dental appearance on a ten grade visual analog scale that was anchored on each side by the first and last picture grades of the AC scale. Information of previous or current orthodontic treatment history was also sought.

There were 3 study groups and the AC grade of each participant was recorded by both examiners in study group 2 and by one of the examiners in study group 1 and 3.

Receiver-operator characteristic curves were used to establish the cut off point of the AC that would accurately reflect the relationship between the subjective child-rated AC grades and the objective examiner-rated AC grades, with the participants' satisfaction of dental appearance. The conclusion was that grade 3 of the IOTN was the optimal cut-off grade as it met the definition laid out by the researchers as being the point on the curve closest to the top left corner.

This method could be criticised as not being a true validation of the AC scale by laypeople due to the fact that only 2 of the AC grade pictures were shown. There was also inconsistency in the number of examiners assessing the study groups.

2.5. Comparing the IOTN and Dental Aesthetic Index

There are many occlusal indices in use at present that can measure level of need for orthodontic treatment of a population or the severity of malocclusion (which is more commonly used in a clinical setting). Indices such as the IOTN and the Dental Aesthetic Index (DAI) are able to rank malocclusion according to the need for orthodontic treatment and are useful in oral health surveys (Cardoso *et al*, 2011).

2.5.1. **The DAI**

The DAI is a scoring index in which different malocclusions are given different weighting and all the values are added up to reach the DAI score (Borzabadi-Farahani, 2011; Cardoso *et al*, 2011). It is the index that was adopted by the World Health Organisation (WHO) in their manual on Oral Health Surveys in its 4th edition, however appears to be omitted in their latest 5th edition (WHO, 1997; WHO, 2013). There are 10 malocclusions assessed; missing teeth, incisal segment crowding, incisal segment spacing, diastema, largest anterior maxillary irregularity, largest anterior mandibular irregularity, anterior maxillary overjet, anterior mandibular overjet, vertical anterior open bite and antero-posterior molar relationship. The DAI score is then categorised into 4 treatment need categories. If the score is less than 25 there is normal occlusion or minor malocclusion and no/slight treatment need. A score between 26 and 30 indicates a definite malocclusion and treatment is elective. A score of 31 to 35 indicates severe malocclusion for which treatment is highly desirable, and a score over 36 concludes there is a very severe or handicapping malocclusion, which warrants mandatory treatment (Borzabadi-Farahani, 2011; Jenny and Cons, 1996).

The possible limitations of the DAI which the IOTN does not have is that it fails to measure posterior crossbites, impacted teeth and deep overbites, and does not consider the impact of missing molar teeth. The DAI and the IOTN fail to measure midline maxillary-mandibular discrepancy (Borzabadi-Farahani, 2011).

Shue-Te Yeh *et al* (2000) found there to be statistically significant correlations between both components of the IOTN and the DAI, and both indices were capable of identifying malocclusal traits. They found the strongest association between the DAI and the AC of the IOTN. The AC was shown to have a stronger association to subjective questions relating to appearance and speech than the DHC or the DAI, however it was still a weak association. It was concluded that the IOTN was more accurate in assessment of patients' perception of aesthetics and treatment need, and the cut-off points were in line with those previously determined (Shue-Te Yeh *et al*, 2000).

In a study done by Beglin *et al* in 2001, which investigated the reliability and validity of 3 occlusal indices including the DAI, the Handicapping Labiolingual Deviation with the California Modification and the IOTN, it was found that all three indices had a very reliable overall accuracy, with the IOTN topping the bunch at 98%.

Cardoso *et al* also performed a study comparing the DAI and the IOTN. In this more recent study, done in 2011, they concluded that both indices are highly reproducible and reliable, however there was a big problem with high false positive rate compared to the gold standard – a panel of 3 Brazilian orthodontic professors with a minimum of ten years of clinical experience. The sensitivity (true positive) of an index is important because it prevents people with the problem from being disregarded. Cardoso *et al* found the sensitivity of the DHC of the IOTN to be 100% and the DAI 91%. Unfortunately both indices showed low specificity (true negative). This implies treatment need may be lower than the data suggests when using the DHC of the IOTN and the DAI.

The overall accuracy of the IOTN was 67%, higher than the 61% accuracy of the DAI obtained in the same study. These figures were significantly lower than studies done previously by American or English orthodontists, but were comparable to those attained in another study, as noted by Cardoso *et al*. The DHC of the IOTN had an advantage over the DAI in that it took considerably less time to perform as a result of the fact that only the worst occlusal feature was recorded by the DHC of the IOTN whereas all occlusal irregularities had to be noted to correctly calculate the final DAI score. As mentioned under the qualities of an ideal index, a reduction in implementation time can be an important factor in studies done on a large population (Cardoso *et al*, 2011). It must be noted however that the AC was not measured in the aforementioned study and may increase examination time of the IOTN if included.

2.6. Disadvantages and limitations of the IOTN

The one major practical disadvantage of the IOTN is that it requires the use of a specially designed ruler, and it is not easily found. The measuring instrument used in the DAI that is an easily accessible periodontal probe (Cardoso *et al*, 2011).

The IOTN is an index of treatment need and cannot be used to assess complexity and outcome of treatment (de Oliveira, 2003). A study done by Borzabadi-Farahani and Borzabadi-Farahani in 2011 shows that based on the good level of agreement and strong association between the DHC of the IOTN and the Index of Complexity, Outcome and Need (ICON), the ICON would be a good substitute for the DHC of the IOTN in instances that require the assessment of complexity of treatment. Assessing the need for orthodontic treatment using the modified DHC of the IOTN does not allow one to rank malocclusion across the entire spectrum of severity ranging from those with no or little need, to those with very great need and thus does not allow for the modified IOTN to be used as an administrative tool under graded insurance or public funded schemes (Burden *et al*, 2001).

It has been suggested that there needs to be an assessment of the person's readiness to cooperate or their motivation to receive the required treatment (Kok *et al*, 2004). The IOTN does not include any quality of life measure. Kok *et al* (2004) found that the AC of the IOTN has definite limitations in reflecting a child's motivation and concern for orthodontic treatment and suggested that a quality of life measure should be included to supplement the IOTN to identify patients with a clear psychosocial need for treatment. They did point out however that although a quality of life measure was proven better than the AC of the IOTN at predicting orthodontic concern, it is not known whether this correlates to good prediction of treatment uptake.

In a later study done in 2008, Khan and Fida found an inverse association present between the AC of the IOTN and the psychosocial well-being of the adults in

their study, and thus found that the AC could be considered an effective tool in assessing the psychosocial impact of dental aesthetics, but still recommended pairing it with a psychometric scale in order to assess orthodontic-related quality of life impacts caused by malocclusion. The need for reinforcement of the IOTN by oral health-related quality of life measures was expressed by de Oliveira *et al* and Tsakos in 2008, and again by Ghijselings *et al* in 2014, in order to accurately predict or explain a patient's perceived need for treatment.

A poor agreement of AC score determined from photographs when compared to clinically recorded AC or AC recorded from models has also been demonstrated (Buchanan *et al*, 1994).

The AC of the IOTN was based on photographs of Caucasian twelve year olds and has been stated as being referenced to this group and not other ethnic groups. Vig *et al* (1999) found that the AC did not function as efficiently amongst groups that differed significantly with regards to culturally accepted norms from this reference group.

2.7. Advantages of the IOTN

A distinct advantage of the AC of the IOTN compared to virtually all other indices is its ability to measure perceived need for orthodontic treatment when allowing the patient to assess their own AC (Khasim *et al*, 2013; Kok *et al*, 2004).

There has been a proven reliability over time using this index. In 1998, Tarvit and Freer conducted a study to assess the reliability of multiple indices over time, including the DAI and the IOTN. There was significant reduction in severity with the DAI, insignificant reduction in severity over time using the AC of the IOTN and the DHC showed stability over the period. Cooper *et al* (2000) conducted a longitudinal study on children at 11-15 years and then 19 years to determine the reliability of both components of the IOTN. The DHC was reliable and the AC showed improvement over time. This is of significant importance if the

possibility of treatment is dependent on a waiting list, which could be several years long, as is the case in the public sector in South Africa.

The index has been shown to be very time efficient, taking 1 to 2 minutes to perform the assessment of malocclusal traits based on the IOTN (Ovsenik and Primožič, 2007) and is suitable for large groups and thus ideal for population screening (Sharma and Sharma, 2014; Tang and So, 1995).

It has been proven that the DHC of the index has a high intra-examiner reliability (Sharma and Sharma, 2014).

2.8. Factors that influence the need for orthodontic treatment

Socio-economic factors, including the increasing removal of financial barriers, striving up the social ladder, and social change with regard to public attitudes towards available dental health care, are affecting the perceived need and demand for orthodontic treatment (Jenny, 1975).

Mandall *et al,* in 2005, found that consumer-based socio-dental information (Utility and Oral Aesthetic Subjective Impact Scale (OASIS) values) did not accurately predict future use of orthodontic services, however examiner-rated IOTN and child-rated AC adequately did.

Mandall *et al* (2005) concluded that children who have been teased about their teeth and those who perceived their dental aesthetics to be poor were more likely to receive orthodontic treatment. Besides the more obvious association between severity and perceived need, studies show factors such as gender, ethnicity, socio-economic backgrounds and age play a role in perceived need of orthodontic treatment (Aikins *et al*, 2012; Ngom *et al,* 2005; Abu Alhaija *et al*, 2005). Psychosocial status of individuals also plays a role in perceived treatment need (Kolawole *et al*, 2013).

2.8.1. **Gender**

Girls perceived a need for treatment more frequently than boys, contributing almost 66% of the total children that perceived a need for orthodontic treatment (Grzywacz, 2003). In a study by Abu Alhaija *et al* in 2005, although double (6 versus 3 percent) the number of males rated their dental aesthetics at a grade which fell into the definite need for treatment category based on aesthetic impairment, more females than males wanted to have their teeth straightened. Studies done on older age samples also show a predilection of females to perceive greater treatment need than males (Al-Zubair *et al*, 2015). Other studies found there to be no significant difference in perceived orthodontic treatment need between genders (Aikins *et al,* 2012; Oshagh *et al*, 2011; Špalj *et al,* 2010). Men were found to have slightly less perceived need for orthodontic treatment when compared with women, however, the difference was found to be statistically insignificant by Padisar *et al* (2009).

On the contrary, there is a significant difference in normative need between genders. Studies have shown men have a higher normative need for orthodontic treatment than women (Aikins *et al,* 2012; Dias and Gleiser, 2009; Padisar *et al*, 2009). One study found men to have a slightly lower, but not significantly different, normative need than woman (Oshagh *et al*, 2011).

2.8.2. **Ethnicity**

Studies show differences in perceived need for orthodontic treatment can vary between ethnic groups as much as thirty percent (Ngom *et al*, 2007). Ngom *et al* (2005) found that Caucasian lay judges perceived the majority of 98 images presented to them of African adolescents' and adults' anterior dentitions to be less attractive than the African lay judges.

Josefsson *et al* displayed differences in self-perceived need for orthodontic treatment amongst people originating from different geographic backgrounds in a study in 2009. Validating the AC of the IOTN in different ethnic groups would be useful (Aikins *et al*, 2012).

South Africans are generally divided into four main ethnic population groups – black, white, coloured and Asian. The classification process was done at birth and was the direct result of The Population Registration Act, which was in effect between 1950 and 1991 under order of the government. The classification, based on considerations such as family background, cultural acceptance and appearance, resulted in a largely arbitrary separation of the population.

Black people, who make up a large portion of the population, are descendants of the Bantu-speaking Africans who entered South Africa from the North centuries ago.

Most white South Africans are descendants of the European settlers who began to migrate to South Africa about 360 years ago. They originated from Great Britain, Germany and the Netherlands.

The coloured population is made up of many mixed-ethnicity combinations but originally referred to descendants of the Khoisan (Khoikhoi and San) peoples, slaves imported from Madagascar, Malaysian and Indonesian by the Dutch, Europeans and Bantu-speaking Africans.

The population group of Asians is largely made up of South Africans of Indian descent, who were classified under apartheid as Asian, however does include smaller groups such as the Chinese. Most Indians were brought to the country as indentured labourers in the mid-19 century, and a few later as immigrant traders to what was then the Natal colony. The majority of Asians live in Kwa-Zulu Natal but a substantial group resides in Gauteng and to a lesser extent in Limpopo and Mpumalanga (Bundy *et al*, 2015).

2.8.3. **Socio-economic position**

Some studies assess socio-economic position broadly according to the notion that public school attendees are usually of a lower socio-economic position than

private school attendees who are usually inhabitants of high socio-economic positioned households (Badran *et al*, 2014; Mandall *et al,* 2000).

It has been found that greater normative and perceived treatment needs have been seen among low socio-economic position groups compared to high position groups (Badran *et al,* 2014). Similarly, Dogan *et al* (2010) found family income significantly correlated with the objective orthodontic treatment need as assessed by the orthodontist. They noticed as the family income increased the AC grades given to those subjects were approaching a more aesthetic occlusion. This suggests a lesser need for orthodontic treatment.

Socio-economic backgrounds influence perceived needs because education about, and access to, available treatment vary in different socio-economic groups.

It is not easy to acquire accurate information regarding household income and expenditure to assess socio-economic position in a timely and cost-efficient manner and it is becoming increasingly routine to employ Principal Component Analysis (PCA) using asset data to create socio-economic position indices. Since it has been concluded in previous studies that only the principal component be analysed to assess socio-economic positions, the higher socio-economic positions are indicated by a positive score and as this score decreases so does the socio-economic position (Vyas and Kumaranayake, 2006).

2.8.4. **Influence of age**

Orthodontic treatment is usually initiated around 12 years of age (Birkeland *et al,* 1996). At this age a child is very likely to have all, or almost all of their anterior teeth fully erupted and is more likely to have not yet begun orthodontic therapy (Kok *et al*, 2004). Psychologically, 12 year olds are in the final cognitive developmental stage known as the formal operational stage of development according to the widely accepted Piaget's Theory of Cognitive development. They are therefore capable of deductive reasoning and can successfully interpret and answer questions posed to them (Kail and Cavanaugh, 2015). The

characteristics reflected in the AC pictures are those characteristics exhibited in children who are in the stage of early permanent dentition, which is roughly age 11 to 14 (Sharma and Sharma, 2014). For these reasons, a target group of 12 year olds is attractive for research regarding orthodontic treatment need.

With advancing age, there seems to be an increase in incidence and number of anomalies suggesting severity of malocclusion will increase with age due to lack of early intervention (Sharma and Sharma, 2014; Dias and Gleiser, 2009); however studies show that 17 year olds perceive their dental aesthetics as more attractive than younger children in the 13 year old group (Abu Alhaija *et al,* 2005).

Alternatively, young adults may have higher expectations with regard to aesthetics than children and have higher treatment outcome expectations (Bos *et al,* 2003), however they may be less willing to undergo treatment. This suggests that even though their perceived need may be higher than children, they may not necessarily follow through with treatment. Implications with the difference between young adults and children in some studies shows findings in studies done on one age group cannot be generalised to include the other, however other studies conclude there are similar findings regarding children and young adults (Oshagh *et al*, 2011).

With developments in interceptive orthodontics it could be argued that it may seem prudent to assess treatment need at earlier age groups. Studies found that children would benefit greatly from early treatment by improvement of the presenting malocclusion and reduction in need for succeeding treatment, and in most cases if no treatment was present at the earlier assessments then treatment need remained nil at later assessments (Väkiparta *et al*, 2005; Al Nimri and Richardson, 2000).

2.9. Need for orthodontic treatment in South Africa and neighbouring countries

Zietsman identified the need for prevalence of malocclusion studies to be conducted in South Africa as far back as 1976. He did not have any treatment priority index at his disposal but used Angles Classification. For this reason, the total treatment need percentages based on his subjective approach are recorded. In a preliminary report in 1976 he noted a total treatment need of 73.5% among the white population and in his conclusion he noted that there was a large variation between his finding of treatment need and other studies indicated a lack of standardisation regarding the method with which treatment need was assessed.

A study was conducted in 1981 by Hirschowitz *et al* that assessed oral health in 402 urban black school children from Soweto. Malocclusion was scored using a simplified Angles method to determine whether is was present or not. As only gross anomalies of neutrocclusion (Class 1), distocclusion (Class 2) and mesiocclusion (Class 3) were scored as positive, the data has been included as definite need in Table 1. Class 1 malocclusion was commonest and present in 8.8%, Class 2 present in 1.3% and Class 3 in 1%. Malocclusion was therefore concluded as rare as it was only present in 11.1% of the study group.

De Mûelenaere and Viljoen (1987) did not determine chronological age but used dental age to divide the rural study population. The age categories were determined according to the stage of dentition and ranged between Dental Age II (late primary dentition) to Dental Age VI (permanent dentition). In their subsequent study on the urban population, they did measure chronological age finding the mean to be 14.4 years with a deviation of 1.2 years either way (de Mûelenaere *et al,* 1992).

From July 1999 to June 2002, a National Oral Health survey was conducted which aimed to assess the status of malocclusion in the process of collecting data on the prevalence of dental caries, periodontal disease, edentulousness and dental fluorosis. From this study, it was found that 32.3% of the study population

presented with definitive need for orthodontic treatment according to the DAI. Of the malocclusions observed, maxillary and mandibular irregularities accounted for 59.5 and 53.1 percent respectively followed by crowding (35.8%), spacing (22.1%) and diastema (17.2%) (Van Wyk and Van Wyk, 2004). This was the highest definite treatment need recorded using an index.

In 2003, Drummond undertook a national research project in the form of a dissertation. The study was conducted in seven of the nine provinces in South Africa. His findings were later summarised in 2005 in an article. In the National Oral Health survey and the studies by Hlongwa & du Plessis (2005) and Van Wyk and Drummond (2005), the DAI was used to evaluate malocclusion. There was a shift from the Occlusal Index of Summers. DAI scores over 26 were used to calculate total treatment need, of which definite treatment need (severe or handicapping malocclusion) was represented by those scores above 36. Drummond found that 31% of the South African children examined presented with severe or handicapping occlusions. He also found malocclusion was significantly associated with the different provinces of South Africa, different population groups, different dentition stages and gender, but not with location type or employment status of parents.

There is limited data available regarding perceived need for treatment in South Africa. In a study required for completion of her specialist qualification, conducted in Limpopo province in 2011, Sehowa concluded that the perceived needs of orthodontic treatment, according to the children, was 9%, of which 5.5% fell into the definite need for treatment category of AC grade 8 to 10. The most commonly selected AC grade chosen by the children to reflect their own dental aesthetics was AC grade 1 with 255 of the 403 children choosing this grade. Thereafter grades 2, 3 and 4 were chosen most frequently. The children were asked to reorder the randomised AC pictures and rank them according to attractiveness. She found that the agreement between the ranking established and the original ordering was very good with almost 100% agreement. But the discrepancy came in at a point in the grading that may affect the treatment need

categories, as grades 7 and 9 were reversed. This difference affects the current treatment need categories of the AC of the IOTN as grade 7 is currently considered to fall into the borderline need for treatment whereas grade 8, 9 and 10 fall into the definite need for treatment. The normative need and perceived threshold of treatment need according to the children were not explored in this study.

The change in preference of index used is evident from Table 1, developing from Angle Classification, Occlusal Index of Summers (OI), Fédération Dentaire Internationale (FDI) adopted methods, moving to the DAI, and more recently the IOTN.

Table 1: Need for orthodontic treatment in South Africa and neighbouring countries

Researcher/s and the year of study publication	Ethnic group	Age	Total need (%)	Definite need (%)	Index used	Country of study
Zietsman, 1976	White	14	73.5	-	Angle Classifi-cation	South Africa (Pretoria, Gauteng)
Zietsman, 1979	White	14	-	63.0	Angle Classifi-cation	South Africa (Pretoria, Gauteng)
	Black	12-14	25.0	-		South Africa
	Coloured	14	47.0	-		
	Indian	14	49.0	-		

Researcher/s and the year of study publication	**Ethnic group**	**Age**	**Total need (%)**	**Definite need (%)**	**Index used**	**Country of study**
Hirschowitz *et al,* 1981	Black (urban)	12	-	11.1	Similar to Angle Classifi-cation	South Africa (Soweto, Gauteng)
Kotze *et al,* 1983	White	11-12	78.0	-	OI	South Africa (Defence Force)
Swanepoel, 1985	Black	14	79.8	29.8	FDI adopted Method	South Africa (Pretoria, Gauteng)
Van Wyk *et al,* 1985	Coloured	12-13	40.0	23.0	OI	South Africa (Pretoria, Gauteng)
de Mûelenaere and Viljoen, 1987	Black (rural)	-	17.0	5.0	OI	South Africa (Venda, Limpopo)
de Mûelenaere *et al,* 1992	Black (urban)	13-15	28.0	12.0	OI	South Africa (Venda, Limpopo)
Volschenk *et al*, 1993	Black	12	17.1	6.7	OI	Swaziland

Researcher/s and the year of study publication	**Ethnic group**	**Age**	**Total need (%)**	**Definite need (%)**	**Index used**	**Country of study**
National Children's Oral Health Survey (Van Wyk and Van Wyk, 2004)	Multi-ethnic (Asian, Black, Coloured and White)	12	-	32.3	DAI	South Africa
Hlongwa and du Plessis, 2005	Black	12	47.0	27.0	DAI	South Africa (Mankweng, Limpopo)
Van Wyk and Drummond, 2005	Asian	12	54.6	21.0	DAI	South Africa
	Black	12	49.1	14.8		
	Coloured	12	62.0	23.0		
	White	12	56.9	19.5		
Sehowa, 2011	-	13-16	9.0	5.5	Child-rated AC of IOTN (Perceiv-ed need)	South Africa (Capricorn District, Limpopo)

The assessment of orthodontic treatment need has greatly evolved in the South African context and as the literature shows, there is a new interest developing regarding perceived orthodontic treatment need. From Table 1, it can be seen that definite orthodontic treatment need in South Africa and neighbouring countries has ranged from 5 to 32.3% over a number of studies and varies amongst different age groups, ethnicities and socio-economic positions.

2.10. Need for orthodontic treatment in other countries based on IOTN

Table 2 shows a summary of studies conducted in other countries utilising the IOTN in its conventional form. A discussion of salient points of the studies follows.

Table 2: Need for orthodontic treatment in other countries based on the IOTN

Researcher/s and the year of study publication	Age	Grade	Self perceived AC (%)	Examiner-rated AC (%)	DHC grade 4-5 (%)	Country
Birkeland *et al,* 1996	10.6 (mean)	5-7 8-10	13.5 9.0	21.7 7.7	26.1	Norway
Mugonzibwa *et al*, 2004	9-18	8-10	-	11.0	22.0	Tanzania
Abu Alhaija *et al*, 2005	13 and 17	1-4 5-7 8-10	91.0 5.0 4.0	56.0 34.0 10.0	-	Jordan
Otuyemi and Kolawole, 2005	7-21	1-4 5-7 8-10	54.0 25.0 21.0	30.0 29.0 51.0	50.0	Nigeria
Souames *et al,* 2006	9-12	1-4 5-7 8-10	- - -	75.0 18.0 7.0	21.3	France
Ngom *et al,* 2007	12-13	1-4 5-7 8-10	86.2 10.7 3.2	69.6 21.7 8.7	42.6	Senegal
Dias and Gleiser, 2009	9-12	8-10	-	11.3	34.2	Brazil

Researcher/s and the year of study publication	Age	Grade	Self perceived AC (%)	Examiner-rated AC (%)	DHC grade 4-5 (%)	Country
Svedström-Oristo *et al*, 2009	16-25	1-4 5-7 8-10	- - -	84.0 15.0 2.0	-	Finland
Watanabe *et al,* 2009	11-14	8-10	-	10.4	34.1	Japan
Borzabadi-Farahani and Borzabadi-Farahani, 2011	11-14	1-4 5-7 8-10	- - -	46.0 36.1 17.9	36.1	Iran
Puertes-Fernández *et al*, 2011	12	5-7 8-10	- -	16.9 13.7	18.1	Western Sahara
Soni *et al,* 2011	12-15	1-4 5-7 8-10	- - -	60.3 23.0 16.7	30.8	India (Special needs children)
Aikins *et al,* 2012	12-18	1-4 5-7 8-10	82.5 11.0 6.5	64.9 17.5 17.6	-	Nigeria
Singh and Sharma, 2014	12-15		-	-	46.3	Nepal
Al-Zubair *et al,* 2015	University students	1-4 5-7 8-10	96.4 0.6 3.0	- - -	-	Yemen

Mugonzibwa *et al* (2004) used a pre-structured questionnaire to determine self-perceived need for orthodontic treatment. 38% of the group felt they required orthodontic treatment according to the question, "Do you need orthodontic treatment?". All 11% of the children in the study who were considered in the definite need for treatment category according to the AC also had a DHC of grade 4-5; however an additional 11% had definite need according to the DHC alone. The parents' education level and employment status had no influence on the self-perceived treatment need. The AC of the IOTN was used to determine only objective perceived need. Children who were dissatisfied with the arrangement and appearance of their teeth were found to have higher clinical AC scores and thus it was confirmed that the AC was a useful tool to establish treatment need. Mugonzibwa *et al* concluded that the grades of 8 to 10 of the AC and 4 to 5 of the DHC could be given first priority to orthodontic treatment in Tanzania based on the children's point of view.

Abu Alhaija *et al* (2005) noticed that as the objective perceived need for orthodontic treatment increased, the factors influencing subjective perceived need varied. Younger children who were rated by the examiner as having no need often rated their teeth more critically. In the borderline need group, gender and rural/urban living influenced children's perceived need. Whereas no factors were found to influence the definite need group and they perceived their need similarly to the examiner.

Otuyemi and Kolawole (2005) conducted a study to investigate the perceptions of 100 children and their parents of orthodontic treatment need and to compare those observations with the treatment need as determined by the orthodontist using the IOTN. The sample comprised first time attendees at the Orthodontic unit of a teaching hospital. The children and their parent assessed the AC of the child, and the orthodontist recorded the AC and DHC of each child. The children tended to rate themselves as more attractive than their parent or the orthodontist rated them. The researchers concluded there was a strong relationship between the AC of the child and that of other dental assessors. They also found that the AC of the IOTN

was highly comparable to the DHC and therefore the two could be used independently to assess orthodontic treatment need.

The first French survey to use the IOTN was conducted in 2006 by Souames *et al*.

In 2009, Dias and Gleiser investigated the orthodontic treatment need of a group of 9 to 12 year old Brazilian schoolchildren. Definite treatment need was recorded in 11.3% by the AC and 34.2% by the DHC, however, only 9.8% of the participants were considered in definite need of treatment category according to both the components of the IOTN. The significant difference in AC and DHC scores in this study was attributed to the fact that the two components measure various distinct characteristics and are not both affected by the same malocclusions.

It is worthwhile to note that in the study conducted by Puertes-Fernández (2011), none of the children in the population where the study group was chosen had been orthodontically treated. This allowed for a true reflection of orthodontic treatment need compared to most epidemiological studies in which children that have been orthodontically treated fall into the exclusion criteria of the study (Singh and Sharma, 2014; Trivedi *et al,* 2011; Watanabe *et al,* 2009; Souames *et al*, 2006; Mandall *et al,* 2000). This is a justifiable exclusion criteria in cases where the aim is to determine unmet orthodontic treatment need as assessed by Špalj *et al* in 2014 and therefore will not affect the prevalence statistics in the chosen study population.

The study conducted by Al-Zubair *et al* (2015) assessed subjective perceived need only and did not include an examination thus no objective perceived or normative need figures are available. 41.8% felt that they should receive orthodontic treatment according to the questionnaire. This is in stark comparison to the 3.6% who assessed their aesthetic impairment as falling above the currently accepted threshold of grade 4.

The definite treatment need based on dental health found in these studies is relatively higher than that found in the South African and nearby country studies. Furthermore the manner in which perceived treatment need is assessed differs vastly, from direct methods by utilising questions which ask if the responder considers themselves to be in need of treatment, to more indirect methods in which the responder is asked to assess their own AC and then deduction of need is made using the treatment need categories.

Chapter 3: Research design and methodology

3. Introduction

In the previous chapter, patients' and professionals' perceptions and normative needs assessment was discussed; the notion of thresholds in the determination of these needs, in particular, the threshold of the IOTN was examined; and previous studies regarding these issues were explored. In this chapter, the research design and methodology of this study will be explained.

3.1. Aims

The aims of the study were to

- assess whether South African children perceive treatment need similarly to the dentists who developed the Aesthetic Component grading or if the threshold should be altered to better suit our patients' needs.
- establish the need for orthodontic treatment based on the new threshold grade of the AC of the IOTN established in the first aim, and assess the proportion of the population which is in definite need of orthodontic treatment based on the modified DHC of the IOTN and compare that to the perceived needs of the population
- identify demographic factors that influence the perceived needs of the patients such as gender, ethnicity and socio-economic position.

3.2. Research hypotheses

The null hypotheses to be tested were:

- the perceived orthodontic treatment need threshold as determined by South African children does not differ from the threshold already established
- the normative and perceived needs do not differ
- demographic factors such as gender, ethnicity and socio-economic background do not affect perceived needs of South African children.

3.3. Study design

This research was conducted as a cross sectional study. It comprised of two questionnaires and an intra-oral examination using the AC of the IOTN and the modified DHC of the IOTN. The first questionnaire was constructed for the caregiver of the primary research participants which were the children, and was to attain socio-economic information that the children may not have known (Appendix 1). The second was constructed for the children to fill in themselves on the day of examinations (Appendix 2).

3.4. Sampling technique

A multi-stage cluster sampling technique was used as described by the World Health Organisation (2013) in their manual on basic methods in oral health surveys. Lekwa District was selected as the primary sampling unit. It was chosen because there is currently no access to orthodontic services in this district, and therefore it is of importance to establish whether the need for orthodontic treatment in this area would warrant motivation for an orthodontist to be employed in this District.

The secondary sampling unit was the schools, which were selected from the predetermined sample population. A list of schools in the area was obtained from a senior dentist in Standerton Hospital who manages the oral health school screenings conducted in the vicinity. Schools were selected based on the ethnic majorities primarily found in those schools. Grades 6 and 7 were chosen as the tertiary sampling unit, as this was the age group targeted for this study. All children in those grades were invited to participate; however the study sample included only those who consented.

Originally a stratified random sampling technique was planned. The participants within the schools would have been divided based on ethnicity and gender and then a random sample from the strata could have been attained. This would have resulted in a more representative sampling strategy but it was not possible to

attain information regarding ethnicity and gender prior to attaining caregiver's consent, hence this technique was not achievable, and a multi-stage cluster technique was implemented.

3.5. Sample population

The sample population included school children and their caregivers in Standerton and Morgenzon, which belong to Lekwa local municipality in Mpumalanga.

3.6. Sample size

The sample size minimum was calculated as 260. The whole population figure of 10-14 year olds in the area was estimated from data accessed from the 2011 census. Standerton, Lekwa Local Municipality, Gert Sibande District, Mpumalanga was said to have a total population of 43 966 (Frith, 2011). According to Stats SA, 9.1% of the population of Lekwa municipality is between the ages of 10-14 years. Using a total population size of 800 ((9.1% of 43966)/5yrs) and a Confidence Interval (CI) of 5%, the sample size minimum was 260 children if a confidence level of 95% was sought. The minimum number from each population group necessary to get a demographic representation aimed for was 84% black (*n*=218), 12% white (*n*=31), 3% coloured (*n*=8) and 1% Asian (*n*=3).

3.7. Exclusion criteria

Any child for whom caregiver consent was not attained was excluded.

Any child who declined to participate on the day of data collection was excluded.

Any child who was currently undergoing or had received orthodontic treatment was excluded from the clinical examination but was invited to complete the questionnaire.

3.8. Calibration of the examiner

The examiner was trained and calibrated in the use of the IOTN before data collection began. It is of vital importance in the attainment of valid data (Cardoso *et al,* 2011). The examiner was calibrated against two independent orthodontic specialists on the 04 of October 2014. The examiner did the measurements independently from the specialists on 20 study models. The models were chosen at random and the results were filled into a table for analysis. The results of the Kappa statistic between the examiner and the specialists were 0.625 and 0.6923, both categorised as substantial agreement based on the suggested interpretation by Landis and Koch (1977). Studies show high examiner reliability and agreement between information obtained on study models and clinically using the DHC of the IOTN (Buchanan *et al,* 1994).

3.9. Intra-examiner reliability

The intra-examiner reliability was calculated according to the Kappa statistic and was found to be almost perfect, more specifically 0.848 for the AC and 1.000 for the DHC. Every tenth participant was re-examined to determine the reliability of the examiner and the two measurements were compared. A total of 39 children were re-examined, approximately 11.5% of the total sample of 339 that were screened. There was one examiner who conducted all the examinations.

3.10. Ethics approval and consent

A research proposal was sent to the Senate Research Committee of the University of the Western Cape and approval to carry out this study was granted in August 2014 (Appendix 3).

Prior to data collection, the Department of Education (DoE) was contacted for permission to carry out the research in primary schools in the Lekwa District (Standerton area); thereafter the selected schools were contacted for consent. It was discovered from the email communications with the DoE that subsequent to them publishing the research manual, which initially stated that they should be

contacted for permission to carry out any study done in a school, they took the decision not to be involved in approval of health related research and that the research manual pertained to research on education and not health matters. They advised that the researcher proceed to contact the parents or guardians of the children for consent directly without any involvement by the DoE (Appendix 4).

The principals were contacted for appointments at which the aims and research procedure were explained to them. They were then requested to complete a consent form allowing the researcher to approach children and their caregivers to participate (Appendix 5).

Thereafter the class lists for grades were obtained from the schools depending on the average age of children in the grades. Detailed consent and questionnaire forms in the language/s of their preference (English/Zulu/Afrikaans) were sent to each caregiver marked with a unique research participant number (Appendix 6). Only children whose caregiver's consent was obtained were invited to participate in the study and approached on the day of data collection.

All children were informed verbally, prior to handing out the questionnaires, that they could withdraw from the study at any time. The children were asked to consent themselves before the questionnaire was filled. This is keeping in line with the direction that future legislation is heading, namely s71 of the National Health Act, which when implemented will make it mandatory to receive consent from children alongside their parents' in all health research no matter the risk category (Strode *et al,* 2010). Children requiring dental treatment for any condition diagnosed during the examination were referred to Standerton Hospital Dental Department for further management. 829 caregivers were invited to participate, of which 349 responded positively, resulting in an overall consent rate of 42% (See Table 4 on page 55). No child declined to participate once caregiver's consent was obtained.

3.11. Research instruments

3.11.1. **Caregiver's Questionnaire**

The Caregiver's Questionnaire aimed at retrieving socio-economic information. The employment status of the caregiver, receipt of a social grant, education level, location of dental services and questions regarding certain household assets and amenities was included (Appendix 1).

3.11.2. **Student's Questionnaire**

Every child was asked to complete the questionnaire, which included demographic information, one question regarding their self-assessed AC grading and another regarding their opinion on treatment need based on the pictures used in the AC of the IOTN (Appendix 2).

3.11.3. **AC of IOTN**

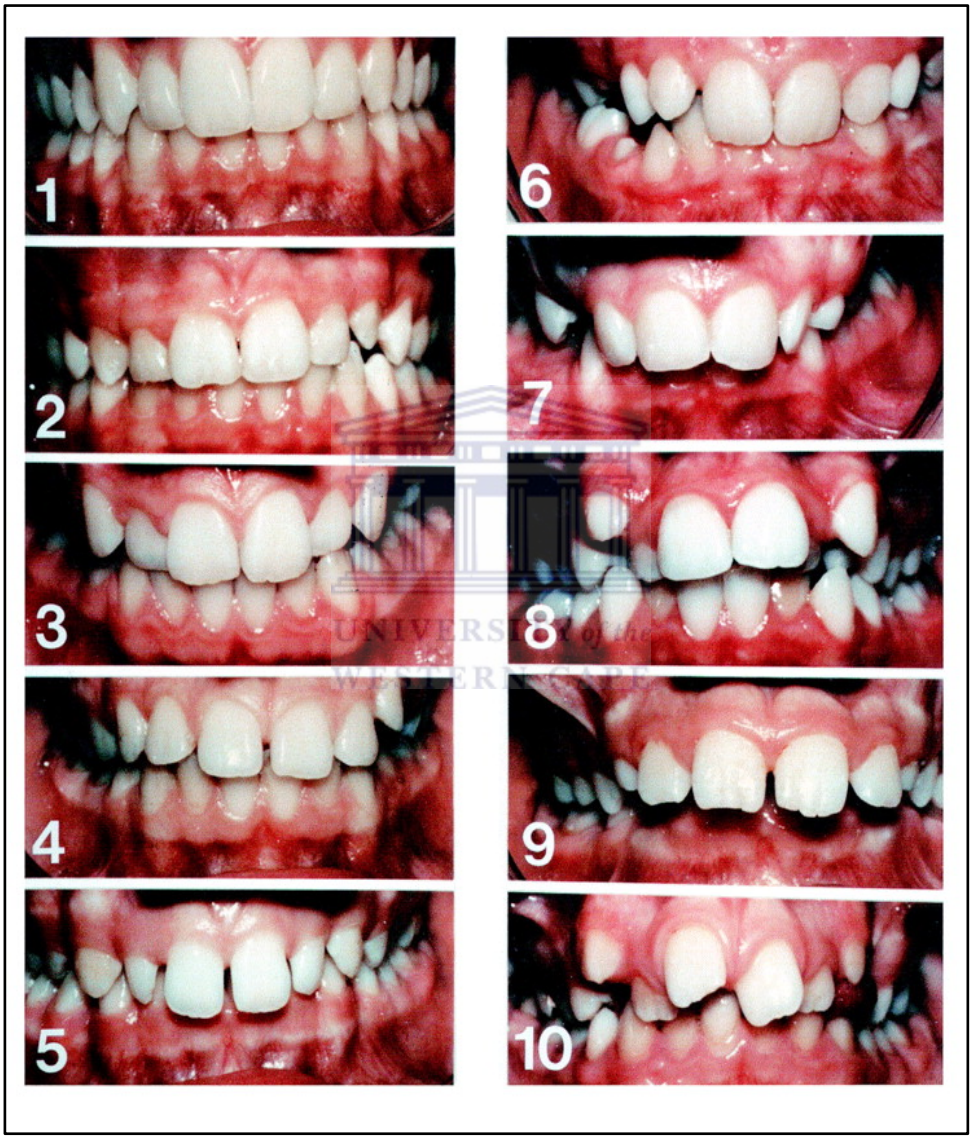
The AC of the IOTN consists of a ten-point scale illustrated by a series of photographs, rated for attractiveness by a lay panel, and which were selected as being equidistantly spaced through the range of grades.

In their questionnaire, the children were asked to rate their own dentition according to the AC pictures, which were re-ordered, to attain the subjective perceived need for orthodontic treatment.

The examiner, using the AC as pictured in Figure 3, also rated the dental aesthetics of the child during the clinical examination to attain the objective perceived need for treatment. This was assessed after the normative need was examined, using the DHC. The children were requested to bite on their back teeth and smile for assessment of the AC by the examiner to determine the objective perceived treatment need.

The AC was used as a guide to pick a grade, which most closely resembled the overall level of aesthetic impairment of the dentition, as opposed to the specific character traits represented by the picture.

Figure 3: The AC of the IOTN (Brooke and Shaw, 1989)



What needed to be established, besides the child-rated and examiner-rated AC grades, to reach the aims of the study, was the grade on the scale that was considered by the children to represent the threshold at which treatment is required. Previous studies, as discussed in Chapter 2, suggest that gender,

ethnicity and socio-economic backgrounds are amongst the factors that may affect the way children perceive attractiveness of dentition and thus impact the perceived need for treatment and in turn, the threshold established if determined by laypeople. Collection of data regarding these possibly associated factors was sought to offer insight into the role, or lack thereof, they might have on views of different groups.

The images presented to the children were not in order as they appear in the original AC picture scale and the children were asked to state which pictures they felt represented occlusions which in their opinion required orthodontic treatment and which they considered to not require orthodontic treatment. The rationale was to establish which pictures represented a dental attractiveness value that the children perceived to need treatment. It would then be possible to analyse the data and rank the pictures according to these societal perceptions of treatment need ranging from those the fewest children perceived to be in need of treatment to those the most believed were in need of treatment. From there, it would be possible to establish a treatment need threshold as determined by the unbiased opinion of the majority of the children based on the societal perceptions of need.

The following code was selected at random and the pictures were re-organised and presented to the children in the order below (Table 3 and Figure 4). The children were not exposed to the correctly ordered AC at any time during the study to prevent persuasion of their opinions regarding severity of impairment or treatment need.

Table 3: Code used to re-order the AC of the IOTN

1	2	3	4	5	6	7	8	9	10
F	A	D	J	H	I	G	C	B	E

Figure 4: The re-ordered AC of IOTN

3.11.4. **The modified DHC of the IOTN**

The normative orthodontic treatment need was assessed once the children had completed their questionnaires. Children were asked to stand in front of the examiner, and the natural light was used to examine the dentition. They were requested to open their mouth so the assessment of dental health could be done.

For the purpose of this research project, it was essential to distinguish those individuals who had a definite normative need for treatment from those who had borderline or no need for treatment. As this was the goal, the use of the modified DHC as described by Burden *et al* (2001), shown in Figure 2, fulfilled the requirements of a normative needs assessment index. The study population therefore fell into one of the two groups based on this modified DHC, either 'no definite need for treatment' or 'definite need for treatment'.

However, given that one of the aims is to establish the threshold grade of the AC of the IOTN index and another is to compare the relationship between factors and the perceived needs for orthodontic treatment, the original AC of the IOTN was used to record all 10 grades to ensure data and analysis was thorough. For this reason, the modified AC of the IOTN, as described by Burden *et al* (2001), was not used to determine subjective (child-rated AC) or objective (examiner-rated AC) perceived needs.

Disposable wooden spatulas were utilised where necessary to aid in cheek retraction. The examiner, directly from clinical examination, calculated normative need and objective perceived need and no radiographs, previously written records, study models or casts were used.

The intra-oral examination was conducted according to the modified DHC of the IOTN as described by Burden *et al* (2001), which is a 2-grade scale.

0. No definite need for orthodontic treatment
1. Definite need for orthodontic treatment

Each participant was examined for specific conditions and if one was found, a "1" was recorded and no further conditions were sought.

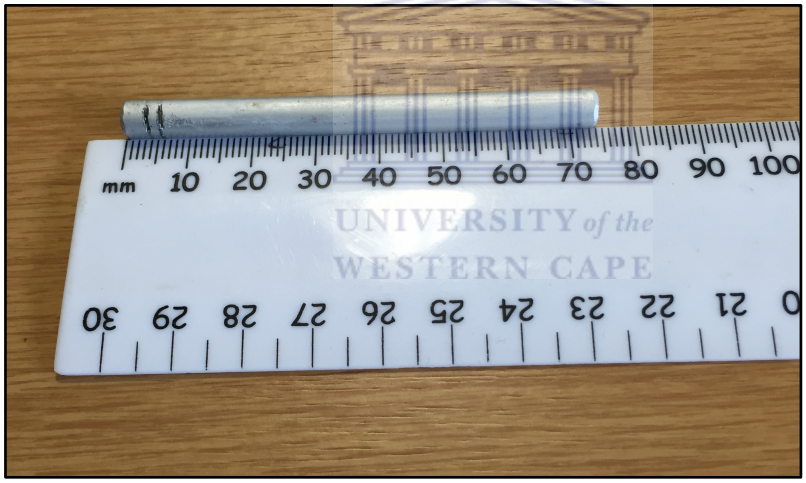
Each participant was examined according to the following conditions:

1. Missing teeth
    i. Any teeth missing due to traumatic loss or congenital absence, if orthodontic treatment was required to open or close the space, were recorded
    ii. Any teeth which were erupting ectopically were recorded
    iii. Any teeth, which were impacted, including any space required for the future eruption of a tooth that was less than 4mm between teeth present, were recorded.
    iv. The presence of supernumery teeth and retained deciduous teeth was recorded.
2. Overjet
    i. Increased and reverse overjets were measured using the modified DHC ruler.
    ii. Measurement was done to the labial surface of the most prominent incisor.
    iii. Increased overjets exceeding 6mm were recorded
    iv. Reverse overjets in which all 4 maxillary incisors were in lingual occlusion were recorded if they were greater than 4mm without masticatory or speech difficulties, or greater than 1mm with masticatory or speech difficulties.
3. Crossbite/s
    i. Any anterior or posterior crossbite with more than 2mm discrepancy between intercuspal and retruded contact positions were recorded.
4. Displacement of contact point/s
    i. This was determined according to crowding of permanent teeth only.
    ii. If the measurement between the contact points of the two most crowded teeth was more than 4mm, then it was recorded.

5. Overbite
    i. Any deep overbite causing gingival or palatal traumatic injury was recorded.
    ii. Any anterior or lateral open bite greater than 4mm was recorded

A modified ruler was used to conduct the DHC component of the intra-oral examination (Figure 5). The ruler was marked at 4mm and 6mm points. During development of the modified DHC, a sterilisable, modified DHC ruler was created to measure overjets, crowding and open bites intra-orally, which is much easier to understand than the ruler used for the original DHC (Burden *et al,* 2001).

Figure 5: Constructed stainless steel modified DHC ruler



A problem arose in acquiring these rulers, as this is not a commonly used index in South Africa, and the rulers were not available via local dental suppliers, so they had to be made from stainless steel rods with a handsaw and then the indentations were made clearer with a permanent marker. They had to be re-marked with the marker after each sterilisation. This method was labour intensive and if the modified DHC of the IOTN is to be used in future studies, on a larger scale, it may be worthwhile for this issue to be addressed and a company sourced to produce the rulers. It may be of even greater benefit to purchase disposable rulers should future studies' budgets allow for this. The limitation with using a periodontal probe, as is done with the DAI, is that the 4mm marking is absent on

the conventional Williams probe, and is required to measure both missing teeth spacing or reverse overjet without impaired functions. If a UNC-15 probe is sourced it may omit this problem as that probe is marked at every millimeter. A dental assistant who did not take part in the examination recorded the observations and information obtained from the clinical examinations carried out by the examiner.

3.12. Infection control

The examiner used a mask and gloves at all times and infection control protocol was strictly adhered to at all times. There were 20 stainless steel rulers that were cold-sterilised with Steri-101 cold sterilant and autoclaved before being re-used.

3.13. Data collection

Appointments were set up on Monday 15 September 2014 with the principals of the schools that were originally chosen for the study. Consent was obtained from only one of the principals seen that day. Due to a lack of enthusiasm from some schools and some delays in attaining approval from the school boards, it was decided that an attempt would be made to contact more schools than was originally planned. With the demographic target groups in mind, 3 additional schools were chosen. All three principals consented. Later, two of the original schools, which were unavailable when first contacted, consented to participate, one on condition that data collection occurred in January 2015. One of the problems experienced was the hesitance of the principals at certain facilities to participate.

Table 4: Consent obtained from principals, caregivers and children

School's name	Principal's consent	Caregiver's consent	Children's consent and data collection	School's consent (%)
Azalea Combined School	30/09/2014	14/10/2014	16/10/2014	45/90 = 50
Laerskool Jeukrag	15/09/2014	13/10/2014	22-24/10/2014	141/195 = 72
Laerskool Standerton	19/11/2014	06/02/2015	19/02/2015	49/247 = 20
Morgenzon Landbou Akademie	20/10/2014	28/10/2014	10/11/2014	16/51 = 31
Standerton Primary School	31/10/2014	05/11/2014	06/11/2014	60/172 = 35
Stanwest Primary	30/09/2014	14/10/2014	29/10/2014	38/74 = 51
Total consent				349/829 = 42

Data collection occurred on the dates chosen by the Principals of the schools. Uniquely stamped questionnaires, which were pre-assigned to children according to their caregiver's research participants number were handed out. The children were informed that this was a voluntary study and they could choose to not participate. It was explained to the children that they would be required to answer the questionnaire and when they had completed it, they could line up for the intraoral examination. They were encouraged to ask questions if anything was unclear, however they were requested not to discuss the questionnaire with the other children.

A small proportion of children struggled with understanding what was required of them in Questions 5 and 6 (Appendix 2). Those who raised their concerns were addressed on the spot, and once issues were discussed and explained, the children

went on to answer the questionnaire without any further confusion. It may assist in future studies to take note that it would be beneficial to place the picture scale on the same page as the questions pertaining to it, to assist the children in filling out the questionnaire without having to turn the page back and forth between each entry.

3.14. Data analysis

The database was created using Microsoft Excel and statistical analysis of the data was carried out using the Program R for Windows and MacOS (R Core Team, 2014).

The quantitative information from the questionnaires and examinations was tabulated in an Excel spreadsheet. Data was entered into the spreadsheet on the day of collection. In order to minimise errors in data capturing, every entry was re-checked once entered and a random spot check of 10 entries was done daily after each collection session.

The frequency distribution of all variables was calculated. The p-values were considered statistically significant (*) when they were equal to or less than 0.05. Confidence Intervals (CI) of 95% were used when calculating upper and lower means. Pairwise comparison using the McNemar test was used to determine agreement of the ordering of the AC. Agreement between examiner- and child-rated AC was assessed using Pearson's Correlation Co-efficient. Principal Component Analysis was used to determine the socio-economic position of the households to which the children belong. Odds Ratio (OR) was used to assess the relationship between subjective and self-perceived need. Differences in perceived needs based on gender, ethnicity and socio-economic position were analyzed by means of Chi-squared test, and, where confirmation was needed, ANOVA was done.

3.15. Data editing

The data was cleaned prior to statistical analysis. Participants for whom large blocks of data were incomplete were omitted from the analysis. In certain variables there were isolated missing values. These participants were not omitted; consequently the total number of observations of some variables may be smaller than the overall total number of retained participants.

3.16. Possible limitations and gaps in the data

As a main aim was to determine if the perceived treatment needs of the children matched the grading system, which was predetermined by professionals, no attempt was made to assess the satisfaction or dissatisfaction of appearance or to find psychosocial reasons for why the need was felt. Based on the age of the study sample chosen, drawing conclusions of this nature may have been difficult for their maturity level as shown in previous studies. Hunt *et al* (2002) chose a sample with a mean age of 20.3 years so they were considered sufficiently mature to draw sensible conclusions regarding the influence of dental aesthetics on their social acceptability, self-confidence and self-esteem. So if this is attempted in future research, careful consideration of sample age needs to occur.

When assessing examiner-rated treatment need, the children who were currently receiving orthodontic treatment were excluded, as it could not be discerned accurately if the objective perceived AC or normative DHC rating of the child pre-treatment would have placed the child into the treatment need category. This could lead to an underestimation of true treatment need in the group (Puertes-Fernández *et al*, 2011).

Only children who obtained parental consent, and gave their own assent participated in the study.

The AC of the IOTN does not represent all forms of malocclusion. In a study in 1996 by Trottman and Elsbach, white children were found to have Class II

malocclusion more frequently than black children who, in comparison, commonly presented with Class III malocclusion. Furthermore, they found that black children were twice as likely to suffer from anterior crossbites than white children. De Mûelenaere *et al* (1998) suggested that minor adjustments to the index used, such as representing bimaxillary protrusion, would better suit the black South African population.

Although the minimum number per demographic group was obtained, the total numbers for some groups were too small to draw definite conclusions and should be considered as suggestive with further investigation being required.

Chapter 4: Results

4. Introduction

In the previous chapter, the methodology to collect the data, and the rationale for tools chosen was explained. In this chapter the actual sample, its characteristics and the results will be presented, followed by the analysed data in regard to the aims of the study. The findings compared to present literature will be discussed in Chapter 5.

4.1. Sample size

829 children and their caregivers were approached for consent to participate in this study of which 349 returned positive consent.

The total number of children screened on the days of data collection was 339 out of the 349 who had received their caregiver's consent. 5 children whose caregiver consent was received prior to the day of examination were absent from their respective schools and 1 had transferred to another school were therefore not included in the sample. A further 4 children were currently undergoing orthodontic treatment and these 4 were excluded from the clinical examination but completed the questionnaires. After all entries with significant missing information were removed, 317 from an original total of 349 children whose caregivers had consented were used in this study. This was above the minimum required sample size of 260 as explained in Chapter 3. In each population group, the minimum required number to provide a demographically representative sample group was exceeded, but in the case of the two minority groups seen in the area, namely Asian and coloured, the actual number obtained was relatively small.

4.2. Demographic information obtained

The first part of the Student's Questionnaire comprised questions related to demographics. The demographics of the study population were as follows.

4.2.1. **Age**

The age distribution of the children ranged from 11-14 years and is summarised below in Table 5. This was due to the fact that Grade 6 and Grade 7 children were targeted for this study.

The majority of the children (38.5%) were 12 years of age, followed closely by 13 year olds who accounted for 31.5% of the sample, 11 year olds made up 24.6% and 14 year olds made up the smallest proportion (3.5%) of the sample. 6 children failed to fill in their age.

Table 5: Age distribution of sample

Age	Total (*n*)	Total (%)
Not recorded	6	1.9
11	78	24.6
12	122	38.5
13	100	31.5
14	11	3.5
Total	317	100

4.2.2. **Gender**

Of the 317 children, 139 (43.8%) were male. 178 children (56.2%), the majority of the sample, were female. The gender distribution with mean age per gender is given in Table 6.

Table 6: Gender distribution of sample

Gender	Total (*n*)	Total (%)	Mean age (SD)
Male	139	43.8	12.26 (0.9)
Female	178	56.2	12.05 (0.8)
Total	317	100	

4.2.3. **Population groups**

The total study population of 317 was comprised of the 4 population groups in South Africa. The population distribution with mean age per population group is given in Table 7.

Black children accounted for most of the study population (74%) followed by white (17%), coloured (6%) and Asians/other made up the smallest group of 3% of the total sample size. Asians/other group consisted of those children who selected 'Asian' as well as 4 children selecting the option 'other'. The children who chose the option 'other' were offered the opportunity to specify, and all 4 children took this. The specifications given were 'Muslim' (1 child), 'Hindu' (1 child) and 'Indian' (2 children), hence the amalgamation of the 'Asian' and 'Other' groups for analyses.

Table 7: Population distribution of sample

Ethnic group	Male	Female	Total (*n*)	Total (%)	Mean age (SD)
Asian/Other	6	4	10	3	11.6 (0.7)
Black	103	130	233	74	12.2 (0.8)
Coloured	5	15	20	6	12.3 (1.0)
White	25	29	54	17	11.9 (0.8)
Total	139	178	317	100	

4.2.4. **Frequency of dental visits**

The children were asked how frequently they attended a dentist on average per year. They were given three options: zero times per year; one to two times per year; or more than 2 times per year. The results are presented per frequency in Table 8. The majority of the sample does not visit a dentist at all, with just over 40% visiting a dentist 1 to 2 times per year. Only 13.6% visit a dentist at the 'recommended' (albeit debatable) interval of 6 months.

Table 8: Frequency of dental visits annually

Frequency of visits	Total (*n*)	Total (%)
None	146	46.0
1-2 times per year	128	40.4
More than 2 times per year	43	13.6
Total	317	100

4.3. Socio-economic information

The following statistics were obtained from the Caregiver's Questionnaire. The socio-economic position of participants was viewed as important to investigate possible correlations between children's perceived needs for orthodontic treatment and the socio-economic position of their household.

4.3.1. **Employment status**

35.3 % of the caregivers who returned the questionnaire were unemployed.

4.3.2. **Social grant**

28.3 % of the households were receiving a minimum of one social grant.

4.3.3. **Education level**

The average distribution of education level for the sample was investigated (Table 9). The caregiver's were asked to select the highest education level held in their household. In instances where more than one education level was selected, the highest was used for analysis.

A large proportion of caregivers (41.3%) were educated up to Grade 12/Matric level. Only one caregiver had no formal education. 44.2% of the sample had a caregiver in the household who had obtained training at a tertiary institution, 83 caregivers in the form of a diploma and 57 caregivers in the form of a degree, 38 of whom had a postgraduate degree. This sample comprised of a high proportion

of well-educated individuals, even though 28% were receiving government subsidies in the form of a grant and 35% were unemployed.

Table 9: Average distribution of highest education level of household

Education level	Frequency (*n*)	Frequency (%)
No formal education	1	0.3
Below Grade 9	14	4.4
Grade 9	13	4.1
Grade 12/Matric	131	41.3
Diploma	83	26.2
Undergraduate degree	19	6.0
Postgraduate degree	38	12.0
Other	18	5.7
Total	317	100

4.3.4. **Dental treatment source**

46.4% receive their dental treatment from the public sector, 49.8% from private dental services and the rest of the questionnaires were either incomplete or responded to with a comment. 7 caregivers left the question blank. 6 caregivers replied none or not applicable, and one replied both public and private.

Although slightly more of the sample sourced dental treatment in the private sector (49.8%), a significant proportion (46.4%) relied on the public sector for dental treatment. Six caregivers claimed to not receive any dental treatment; the education levels of these caregivers were Grade 12 or higher. Lack of education is therefore unlikely to be the reason for their not receiving dental treatment, and one could make the assumption that treatment was most likely not required in these cases. There is data confirming lower risk of dental health problems in higher educated individuals (Timis and Danila, 2005; Paulander *et al,* 2003).

4.3.5. **Socio-economic position**

Multiple assets and household amenities were assessed in the Caregiver's Questionnaire to ensure a collection of variables could be encapsulated into one linear function of the original variables. One caregiver failed to answer the questionnaire completely and thus a total sample size of 316 individuals was used. Application of principal components program with yes or no data, referred to as dichotomous variables, as was attained from the Caregiver's Questionnaire, is not ideal. In order to analyse socio-economic position all indicators of wealth were added and the variables were coded 1 for yes and 0 for no. The correlation between the main principal component and total positive answers (yes) for question 5 of the Caregiver's Questionnaire was found to be 0.998 which is near enough to optimality and hence question 5 of the Caregiver's Questionnaire was used for PCA (Principal Component Analysis) of socio-economic position of the households. The socio-economic position was said to heighten with an increase in total assets hence 0 is the lowest socio-economic position and 6 is the highest.

The socio-economic position of the sample, as determined by PCA of household assets, was spread out with a predilection toward the higher end of the spectrum with 25.3% of the sample in a low socio-economic position (SEP 0-2), 26.6% in an average socio-economic position (SEP 3-4), and 48.1% in a high socio-economic position (SEP 5-6). From the data summarised in Table 10, it can be deduced that almost half the sample have a relatively high socio-economic position being 5 or 6 compared to the other 51.9% who have a low to average socio-economic position of 1 to 4.

Table 10: Socio-economic position of sample

Socio-economic Position	0	1	2	3	4	5	6
Total (*n)*	7	63	10	31	53	75	77
Total (%)	2.2	19.9	3.2	9.8	16.8	23.7	24.4

4.4. Assessment of aesthetics

4.4.1. Child-rated AC

The AC (Aesthetic Component) grades as chosen by the children to demonstrate their self-perceived level of aesthetic impairment, and thus their subjective perceived treatment need, is summarised in Table 11. Self-perceived level of aesthetic impairment does not equate to self-perceived need for treatment, and to avoid confusion, the former shall be referred to as child-rated AC, which is the variable used to measure the subjective perceived need for treatment. It was attained from Question 6 of the Student's Questionnaire: "What letter picture do you think looks most like your teeth?". 11 children (3.5%) did not select a grade, as they were unable to pick one that represented their dentition.

The most frequently chosen picture was A, which is AC grade 2. 41% of children chose this grade, followed by almost 20% choosing grade 1 and 16% and 5% for grades 3 and 4 respectively. The majority of children picked a grade from 1-3.

Table 11: Child-rated AC

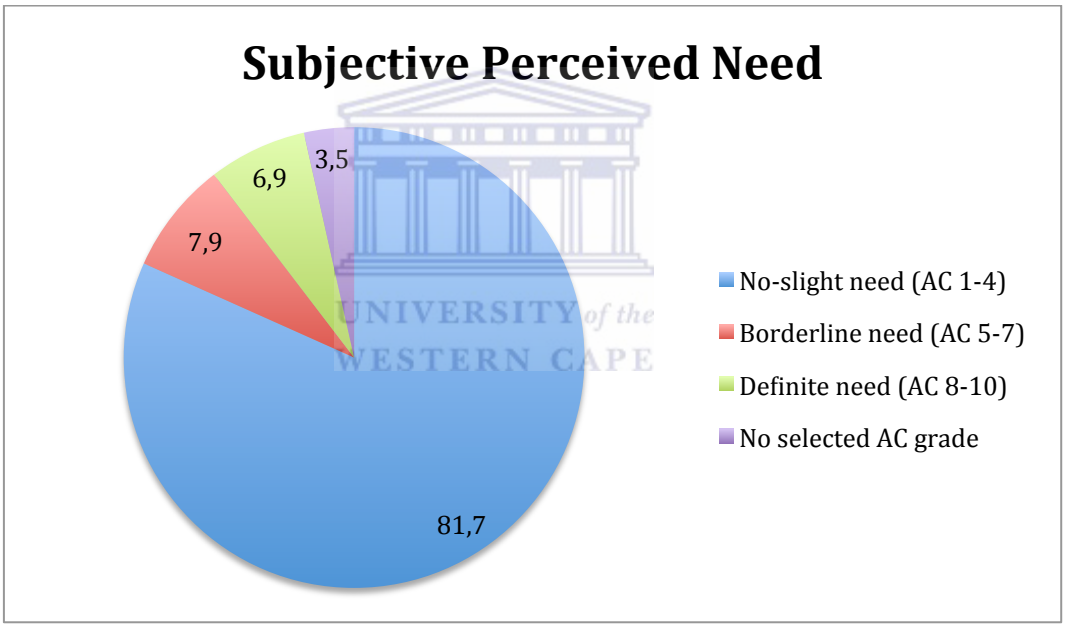
Picture code	F	A	D	J	H	I	G	C	B	E	Not recorded	Total
AC grade	1	2	3	4	5	6	7	8	9	10		
Total (*n*)	63	129	50	17	10	12	3	13	7	2	11	317
Total (%)	19.9	40.7	15.8	5.4	3.2	3.8	0.9	4.1	2.2	0.6	3.5	100

According to the currently used treatment need categories; using the child-rated AC scores, 81.7% (*n*=259) of children would fall into the "no to slight need for treatment" category, having chosen a grade below 5. 7.9% (*n*=25) chose either grade 5, 6 or 7, which would be regarded as "borderline need for treatment". 6.9% (*n*=22) chose grade 8 or over to represent their own dentitions aesthetic

impairment, placing them in the "definite need for treatment" category. The proportion of the sample falling into each treatment need category, based on subjective perceived need, and determined by currently accepted categorisation of AC grades is depicted in Figure 6.

14.8% (*n*=47) were rated grade 5 or higher and represent those in need of treatment based on the current treatment need threshold of grade 4. 20.2% (*n*=64) were given an AC grade including or above 4.

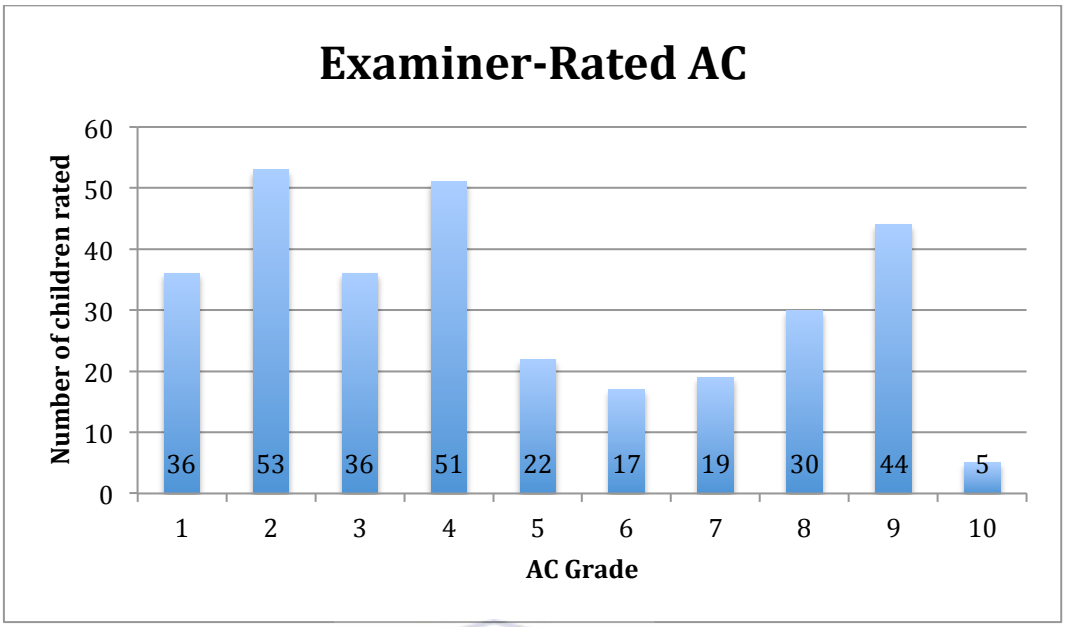
Figure 6: Subjective perceived need based on the currently used treatment need categories



4.4.2. **Examiner-rated AC**

The AC grade as awarded by the dentist, assessing the child's dental aesthetic appearance, is represented in the bar graph below (Figure 7). This is the objective opinion of the examiner based on the AC of the IOTN. There are 313 participants in total, which were examined. The 4 missing participants out of the 317 are due to the fact that 4 children were undergoing orthodontic treatment at the time of the examination and were excluded from the clinical examination.

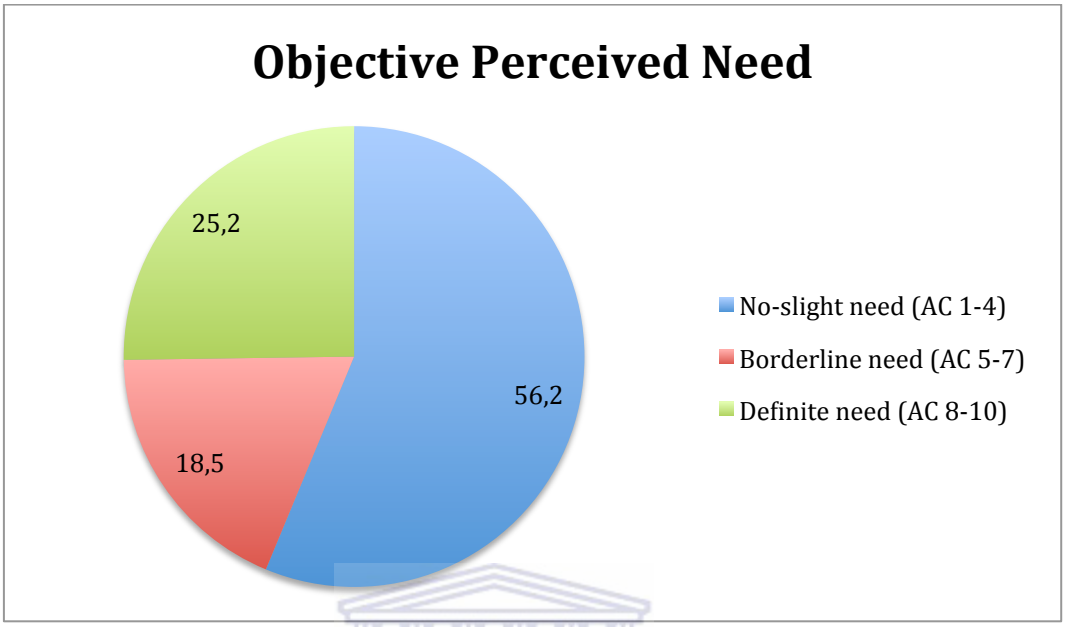
Figure 7: Examiner-rated AC



According to the currently used treatment need categories; using the examiner-rated AC scores, 56.2% (*n*=176) of children would fall into the "no to slight need for treatment" category of grades 1-4. 18.5% (*n*=58) were rated grades 5-7 which would be regarded as "borderline need for treatment". 25.2% (*n*=79) were rated as in "definite need for treatment" being grade 8 or over. The proportion of the sample falling into each treatment need category, based on objective perceived need, and determined by currently accepted categorisation of AC grades is depicted in Figure 8.

43.8% (*n*=137) were rated grade 5 or higher and represent those in need of treatment based on the current treatment need threshold of grade 4. 60.1 % (*n*=188) were given an AC grade including or above 4.

Figure 8: Objective perceived need based on the currently used treatment need categories



4.5. Assessment of dental health

4.5.1. DHC

The modified DHC (Dental Health Component) was used to assess the children for missing teeth, overjets, crossbites, displacement of contact points or overbites in that order. A grade of 0 or 1 was awarded based on the dental clinical examination conducted. If the child had any occlusal trait, which met the criteria explained according to the modified DHC examination, then that child was regarded as in need of treatment on the basis of dental health (DHC=1) and the examination was terminated at that point.

This is the objective opinion of the examiner with regard to the child's need for orthodontic treatment based on the modified DHC of the IOTN and represents the normative need of the population studied. Care should be taken to not confuse it with the AC grade awarded by the examiner, which reflects the objective perceived need for treatment. Similarly to the examiner-rated AC, there are 313

entries due to the fact that 4 children were currently undergoing orthodontic treatment at the time of the examination.

41.2% of the children were in definite need of orthodontic treatment based on the results of Table 12. This method reflects only those children whose dental health status warrants they receive highest priority to orthodontic services. The result is comparable to a conventional DHC grade 4 or 5.

Table 12: Normative level of treatment need based on the modified Dental Health Component

	No normative need	**Normative need**	**Total**
Total (*n*)	184	129	313
Total (%)	58.8	41.2	100

4.6. Establishing the threshold of societal perceived treatment need

To assess how South African children perceive treatment need, one needs to understand the societal perceptions of treatment need and evaluate the point of the AC scale at which children perceive treatment as necessary.

4.6.1. Societal perceived treatment need

The ten grades of the AC of the IOTN were presented to the children in the mixed order described in Chapter 3. The children were asked to decide whether or not orthodontics was required to correct the impairment shown in each picture. This data was collected from Question 5 of the Student's Questionnaire, which stated, "Looking at the pictures, choose whether you think the teeth in the picture need to be fixed using braces". The response to each picture coded A-J was either yes or no. The pictures were then decoded back to their AC grade of 1 to 10 before data analysis proceeded.

If the child answered no, it meant the child did not consider that particular grade to require orthodontic treatment, hence there was no perception of treatment need for that specific AC grade. All the children who answered yes for a specific picture made up the percentage of the population who felt treatment was necessary at that grade of the AC. This percentage of the population was taken as the societal perceived need of the group for each grade of the AC. The societal perceived need for orthodontic treatment, as based on the child's perception of the aesthetic impairment pictured in the re-ordered aesthetic scale, is summarised in Table 13 below. The last two rows of the table indicate the lower and upper limits of a 95% Confidence Interval (CI) for the true proportion of children who perceive treatment need at a given AC grade.

Table 13: Societal perceived treatment need based on aesthetic impairment

Picture code	F	A	D	J	H	I	G	C	B	E
AC grade	1	2	3	4	5	6	7	8	9	10
Mean of societal perceived need (%)	14.8	21.1	50.8	65.6	75.7	77.6	75.1	85.5	79.2	85.2
Lower limit (CI=95%)	10.4	16.6	45.3	**60.4**	71	73	70.3	81.6	74.7	81.3
Upper limit (CI=95%)	18.7	25.6	56.3	70.8	80.4	82.2	79.8	89.4	83.6	89.1

4.6.2. **The threshold for treatment need determined by the children**

The threshold for treatment need is the last grade in the AC scale, which children feel treatment is not yet required. Once the threshold grade is passed, the children then feel treatment is required for the represented aesthetic impairment. In order to determine the threshold grade of South African children based on societal perceived need, one needs to find the point of the AC scale at which the majority of the children feel treatment is necessary. One grade below that will be the

threshold grade. To ascertain the most prudent point on the scale where the majority of children perceive treatment need, the lower 95% CI was used. Using the lower mean value in Table 13, it can be said with 95% confidence that more than half (60.4%) of the children feel that the aesthetic impairment depicted by grade 4 requires orthodontic treatment. Therefore, grade 3 is the last grade in the AC scale at which children do not perceive treatment need. This makes grade 3 the new threshold of treatment need found in this study, according to the societal perceptions of South African children.

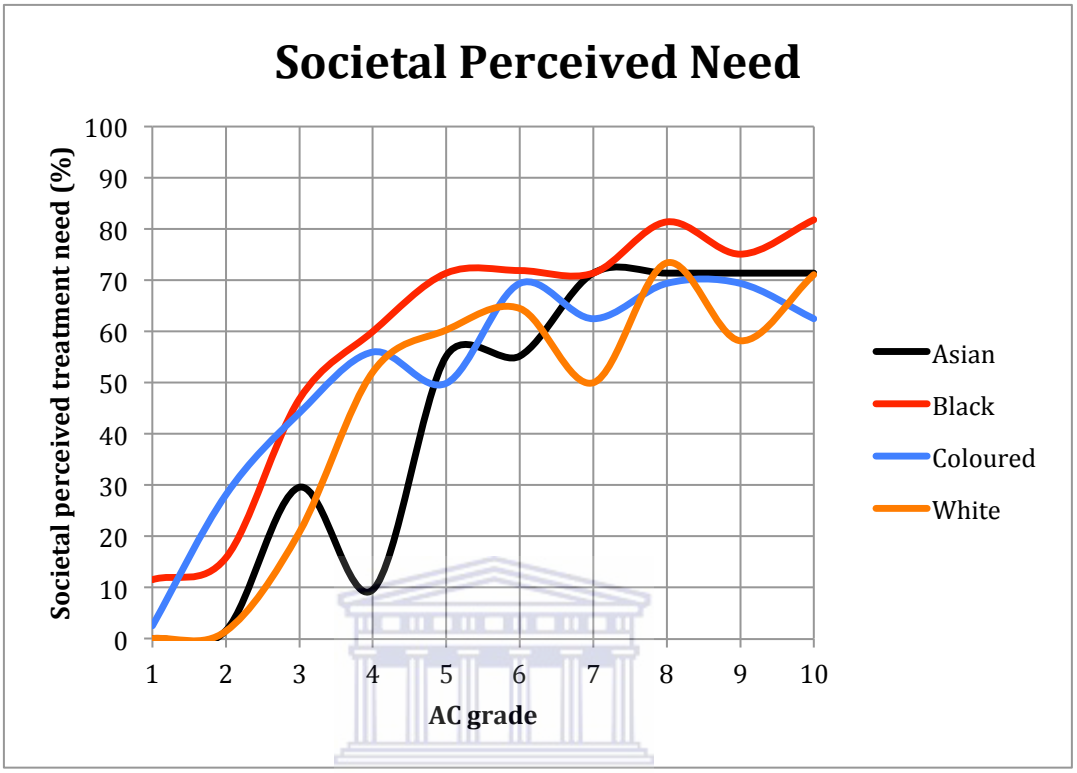
4.6.3. **The threshold of treatment need of ethnic groups**

The societal perceptions of the ethnic groups were examined to assess whether the threshold grade of 3 was applicable to all ethnicities. The percentage of the each ethnic group, which felt treatment was necessary at the stipulated AC grade, was tabulated (Table 14) and then the lower 95 CI from the table was placed into a trend line to facilitate comparison of threshold grades of the ethnic groups (Figure 9). In Figure 9, the three lines representing the black, coloured and white groups all cross to above the 50% horizontal gridline before grade 4. The Asian line crosses over 50% before grade 5.

Table 14: Treatment threshold perceptions of ethnic groups

AC grade		1	2	3	4	5	6	7	8	9	10
Asian	Mean	20.0	30.0	60.0	40.0	80.0	80.0	90.0	90.0	90.0	90.0
	Lower	0.0	1.6	29.6	9.6	**55.2**	55.2	71.4	71.4	71.4	71.4
	Upper	44.8	58.4	90.4	70.4	100	100	100	100	100	100
Black	Mean	16.3	21.0	53.2	66.1	76.8	77.3	76.8	85.8	80.3	86.3
	Lower	11.6	15.8	46.8	**60.0**	71.4	71.9	71.4	81.4	75.1	81.8
	Upper	21.1	26.3	59.6	72.2	82.2	82.6	82.2	90.3	85.4	90.7
Coloured	Mean	20.0	50.0	65.0	75.0	70.0	85.0	80.0	85.0	85.0	80.0
	Lower	2.5	28.1	44.1	**56.0**	49.9	69.4	62.5	69.4	69.4	62.5
	Upper	37.5	71.9	85.9	94.0	90.1	100	97.5	100	100	97.5
White	Mean	5.6	9.3	33.3	64.8	72.2	75.9	63.0	83.3	70.4	81.5
	Lower	0.0	1.5	20.8	**52.1**	60.3	64.5	50.1	73.4	58.2	71.1
	Upper	11.7	17.0	45.9	77.6	84.2	87.3	75.8	93.3	82.5	91.8

Figure 9: Societal perceived need by ethnic group using lower limit of 95% CI



4.6.4. Agreement with the ordering of the AC of the IOTN

The AC scale order based on societal perceived treatment need is reflected below. Pairwise comparisons of the societal perceived need using the McNemar test was conducted to establish the order of the AC pictures so that they would accurately reflect the treatment need perceptions of laypeople.

The ordering of pictures by the children almost perfectly reflects the professionally predetermined AC scale order with the exception of the picture for AC grade 8. The children in this study consider AC grade 8 to represent the worst aesthetic impairment. The results show it was considered to need treatment by the highest percentage of children compared to any other grade. Although the pictures for grades 5, 6 and 7 are not exactly in numerical order, there is no statistically significant difference between the grades.

The results are summarised in the following ordering of AC grade pictures:

F<A<D<J<G=H=I=B<E=C or 1<2<3<4<7=5=6=9<10=8

4.7. Perceived needs and how they compare to the normative need

Now that the new threshold grade that is established by laypeople of South Africa has been found in this study, the objective and subjective perceived needs, for orthodontic treatment, based on this threshold grade can be determined. The assessment of the proportion of children that have a normative need for treatment can then be compared to the perceived needs of the population. Since according to societal perceptions, treatment is considered to be necessary by the majority from grade 4 of the AC, the grades 4 and above will be used to determine treatment need based on aesthetic impairment.

4.7.1. Objective perceived need based on new threshold grade of 3

The objective perceived need is the need for orthodontic treatment as determined by the examiner-rated AC of the IOTN. Figure 7 shows the distribution of AC grades given by the examiner. 188 children (60.1%) were given an AC grade, by the examiner, equal to or above grade 4. According to the AC, these children need orthodontic treatment based on the new threshold as found in this study, which regards grade 4 to be in need of orthodontic treatment.

4.7.2. Subjective perceived need based on new threshold grade of 3

The subjective perceived need is the need for orthodontic treatment as determined by the child-rated AC of the IOTN. According to the new AC threshold grade of 3, 64 children (20.2%) rated their own aesthetic impairment at a grade equal to or above 4 (Table 11). Thus, based on child-rated AC, the subjective perceived treatment need is 20%. However, the actual self-perceived need for treatment (38.5%) is discussed below.

4.7.3. **Self-perceived need**

It must be acknowledged that the child-rated AC of the IOTN, although reflective of the child's perceived aesthetic impairment, may not reflect the self-perceived need for treatment, as self-perceived need is idiosyncratic. This is the rationale for assessing self-perceived need as follows.

Self-perceived need was analysed using Question 5 and 6 of the Student's Questionnaire (Appendix 2). In Question 5, the perceived need for treatment for each AC picture grade was attained from the children. The follow up Question 6 was how they perceived their own dentition's aesthetic level (Table 11). Based on these two responses, by comparing the grade selected by the child in Question 6 (as representing his/her perceived level of aesthetics) and whether or not that particular child had answered yes for the corresponding grade in Question 5, the self-perceived need of each child was deduced. Table 15 indicates the percentage of children who felt they required orthodontic treatment based on this method.

This method ensured that an unbiased answer was attained from the children, one that was not influenced or suggested by the direct question of whether they feel they need braces. By asking children directly if they feel they require orthodontic treatment, one might receive an answer that is tainted by many other considerations made on the part of the children at that point in time.

The results from Table 15 suggest that in the opinion of laypeople, as the perceived levels of aesthetic impairment increase, seen in column 1, so do the actual self-perceived needs for treatment, seen in column 4. This finding suggests that the AC of the IOTN, which is used to determine subjective perceived treatment need, to some extent, does reflect actual self-perceived treatment need.

Another observation to draw from Table 15 is that at grade 3, 50% of children believe they have an aesthetic impairment that requires treatment and 50% believe they do not require treatment. Therefore at grade 4 onwards, the majority of children perceive they need treatment for their aesthetic impairment according to

self-perceived treatment need, making grade 3 the threshold for self-perceived treatment need. This also confirms the threshold of grade 3 determined by the societal perceived needs of the children.

Table 15: Self-perceived need for orthodontic treatment

Child-rated AC grade	Total	No need for treatment (*n*)	Need for treatment (*n*)	Proportion with need for treatment (%)
1	63	51	12	19.0
2	129	99	30	23.3
3	50	25	25	50.0
4	17	7	10	58.8
5	10	3	7	70.0
6	12	1	11	91.7
7	3	1	2	66.7
8	13	0	13	100
9	7	1	6	85.7
10	2	0	2	100
Total	306	188	118	

4.7.4. Understanding the difference between subjective and self-perceived need

A major concern is that 67 (12+30+25) children of the 317 (21%) have rated their aesthetic impairment at grades 1 to 3 (no subjective perceived need), a level below the threshold, yet feel that their aesthetic impairment requires treatment (self-perceived need). They account for 27.7% (67/242) of the children without subjective perceived need. Although these figures are not alarmingly high, when considered as a percentage of total self-perceived need, this amounts to 57% (67/118), over half the children. More than half the children who have a self-perceived need for treatment chose AC grades that fall below the new threshold,

found in this study, to reflect their dentition, even though it was lowered from the conventionally accepted threshold. In contradiction, only 6.9% (13/118) of the children who express a subjective perceived need for treatment do not exhibit a self-perceived need for treatment at their respective AC grade.

This highlights the low sensitivity (true positive rate) and high specificity (true negative rate) of the new threshold grade as calculated from the data below (Table 16).

51 of the participants with a self-perceived need for treatment selected an AC grade, which correlated with their subjective perceived need, indicating a true positive diagnosis. 13 of the participants who felt no self-perceived need for orthodontic treatment fell into the "need for treatment' category based on subjective perceived need, indicating a false positive diagnosis. 67 of the participants who felt a self-perceived need for orthodontic treatment fell into the 'no need for treatment category' based on subjective perceived need, indicating a false negative diagnosis. 175 (51+99+25) of the participants felt no self-perceived need for the selected AC grade, which correctly fell into the 'no need for treatment' category based on subjective perceived need, indicating a true negative diagnosis. This association between self-perceived need and subjective perceived need is given in Table 16.

Table 16: Association between subjective and self-perceived need

	Self-perceived need (*n*)	**No self-perceived need (*n*)**	**Total (*n*)**
Subjective perceived need (*n*)	[a]51	[b]13	64
No subjective perceived need (*n*)	[c]67	[d]175	242
Total (*n*)	118	188	

Sensitivity (true positive rate) = a / (a +c) = 51/118 = 43%
Specificity (true negative rate) = d/ (b + d) = 175/188 = 93%

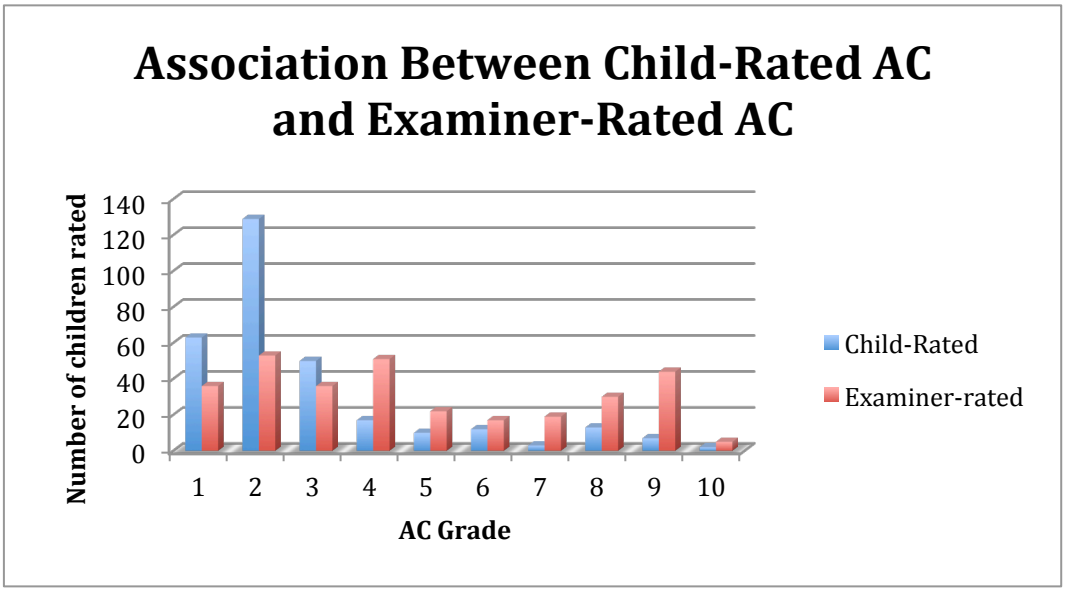
The sensitivity of 43% shows that 43% of the children with a self-perceived need would be correctly diagnosed as having a subjective perceived need (child-rated AC grade over threshold of 3) using the AC scale. The specificity of 93% shows that 93% of the children without a self-perceived need would be correctly diagnosed as not having any subjective perceived need (child-rated AC grade of 1-3) using the AC scale.

Children who have a subjective perceived need are ten times more likely to have a self-perceived need than children who don't have a subjective perceived need (OR = 10.24, p<0.0001*).

4.7.5. Subjective compared to objective perceived need

206 (65.8%) of the children rated their aesthetics more favourably than the examiner. 65 (20.7%) children chose the exact same grade as the examiner chose for them. 42 (13.4%) of the children rated their aesthetics less pleasing than the examiner did (Figure 10).

Figure 10: Association between child-rated AC and examiner-rated AC



It can be seen that children are more likely to rate themselves at the aesthetically pleasing spectrum of the scale. Only 22 children chose an AC grade of 8 or over to represent their aesthetic impairment. Of the 79 children rated by the examiner to be in the most critical need for treatment according to aesthetic impairment (AC ≥ 8), only 22.8% (18 children) rated their own aesthetics to be grades 8, 9 or 10 themselves. The remaining 4 children with a child-rated AC grade of 8 or over received an examiner-rated AC of less than 8.

Pearson correlation coefficient was used to determine correlation between the child-rated AC (subjective perceived need) and examiner-rated AC (objective perceived need). The Pearson correlation coefficient value achieved was 0.424, indicating moderate agreement, and this value is highly statistically significant ($p<0.001$*). This shows moderate agreement between subjective and objective perceived treatment need.

4.7.6. Self-perceived need compared to societal perceived need

Regarding the association between self-perceived and societal perceived treatment need, the two are compared in Table 17. This comparison will give insight into the differences or similarities between when children consider themselves to require orthodontic treatment (self-perceived need) and when they consider others to require orthodontic treatment (societal perceived need).

Table 17: Self-perceived need compared to societal perceived need

AC grade	**Self-perceived need (%)**	**Societal perceived need (%)**
1	19.0	14.8
2	23.3	21.1
3	50.0	50.8
4	58.8	65.6
5	70.0	75.7
6	91.7	77.6
7	66.7	75.1

AC grade	**Self-perceived need (%)**	**Societal perceived need (%)**
8	100	85.5
9	85.7	79.2
10	100	85.2

Although the self-perceived need for treatment threshold of grade 3 confirms the societal need for treatment threshold of grade 3, there are discrepancies between the two perceived needs. The results in Table 13 differ from Table 15, so it can be concluded that there is a difference between the perceived need for treatment of the society and the self-perceived need of the individuals at certain grades of the AC.

50 children feel their own aesthetic impairment ranks at grade 3 on the AC scale (child-rated AC). Half of them express a self-perceived need for treatment at this grade and the other half do not. This is similar to the 50.8% of society who express a societal perceived need at this grade.

However at grade 4, there is a difference between the self-perceived need and the societal perceived need of the children. 17 children rated their AC as grade 4, of which 58.8% feel needs treatment, yet 65.6% of society believes this grade requires treatment. So the self-perceived treatment need at this grade is lower than societal perceived need. Similarly, self-perceived need at grade 5 is lower than societal perceived need.

100% of the children who believe their dentition corresponds to grades 8 (n =13) or 10 (n =2) think they need treatment compared to 85% who feel there is a societal perceived need for treatment at that grade. Similarly, self-perceived need at grade 9 is higher than societal perceived need. This suggests that at higher grades of the AC, people are more critical of themselves, feeling treatment is more necessary for their perceived aesthetic impairment, than society is of that level of impairment.

Grades 3, 4 and 5 show there is a lower self-perceived need than societal perceived need at these grades. Grades 8, 9 and 10 show there is a higher self-perceived need than societal perceived need at these grades. So it is suggested, with the exception of grade 6 that at middle of the scale, self-perceived need is not determined as critically as societal perceived need, but at the ends of the scale, there is a higher self-perceived need than societal perceived need for treatment.

4.7.7. **Comparison of perceived and normative need**

41.2% of the children were in definite need of orthodontic treatment based on the modified DHC of the IOTN. This normative need as measured by the examiner is higher than both the subjective assessment of perceived treatment need, based on child-rated AC using the new threshold grade of 3 (20.2%), and the actual self-perceived need (38.5%). The objective perceived need for treatment, based on the examiner-rated AC at the new threshold grade of 3, was 60%.

Of the three forms of perceived need (subjective, objective and self-perceived), objective perceived need was the only perceived need that was higher than the normative need.

4.8. Association between societal perceived and self-perceived need and demographic factors

Data was collected in order to investigate potential associations between perceived need and gender, ethnicity and socio-economic position. Possible associations were investigated between societal perceived need and self-perceived need for each factor.

Subjective perceived need, which in essence, is the aesthetic impairment level felt by the child, was not chosen to be investigated for its association with the demographic factors, as it does not accurately reflect a need perceived by the child in all instances. This was demonstrated when subjective perceived need was compared to self-perceived need. Subjective perceived need is merely a reflection

of the aesthetic impairment level the child thinks best represents their dentition and it is limited to being used as part of the treatment need index. For this reason no association was sought between subjective perceived need and possible associated factors.

Objective perceived need was not assessed as the aim was not to assess whether demographic factors were associated with the perceived needs of the examiner, but whether they were associated with the perceived needs of the child.

4.8.1. Association between societal perceived and self-perceived treatment need and gender

No statistically significant difference was found between the societal perceived treatment need (p=0.24) or self-perceived treatment need (p=1) of males and females.

4.8.2. Association between societal perceived and self-perceived treatment need with ethnic groups

The association between perceived need for treatment and ethnic groups was investigated using both societal perceived need and self-perceived need.

Societal perceived need and ethnic groups

The societal perceived treatment need was assessed based on how many pictures of the AC the children felt needed treatment (Question 5). It was not assessed in the same manner as when the threshold for treatment need was being determined because that offered us a total percentage of the population with a societal perceived need at each grade of the AC. It has already been seen that the children agree with the ordering of the AC scale and that as the AC grade increases, the societal perceived need for treatment increases. In order to assess the association between societal perceived need and demographic factors, the societal perceived need was not calculated at each AC grade but rather as a total of the whole AC scale.

The total perceived need of the 10 AC pictures for each child was assessed using the data collected from Question 5, however 11 categories of data were analysed as there was 1 child who felt that none of the pictures represented a dentition which required treatment hence the 'None' column in Table 18. It stands to reason, that the lower the number of total images the children perceived to need treatment the lower their societal perceived need for treatment was, in other words, the less critical the children were of the aesthetic impairments of others.

Table 18: Association between societal perceived need and ethnic groups

Frequency of children with a total number of AC pictures for which they perceive treatment need (*n*)												
	None	1	2	3	4	5	6	7	8	9	All	Total
Asian	0	0	1	0	1	0	1	3	2	2	0	10
Black	1	2	6	7	21	28	41	51	56	19	1	233
Coloured	0	1	2	0	0	0	2	3	7	5	0	20
White	0	5	1	1	3	11	13	13	7	0	0	54

Chi-squared = 48.5777, df = 30, p= 0.01735*

Given the variation in the sample sizes of the ethnic groups, the percentage of the group that felt none (0) to all (10) pictures required treatment is presented in Table 19.

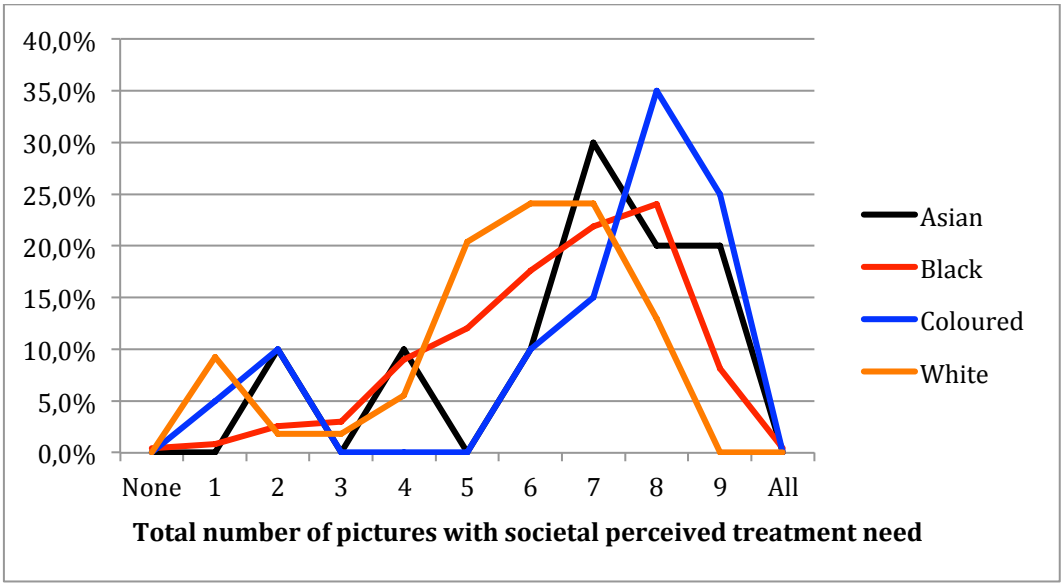
Table 19: Proportion of the group with a total number of pictures perceived to need treatment

Proportion of group which perceive treatment need for the given number of total pictures (%)												
	0	1	2	3	4	5	6	7	8	9	All	
Asian	0,0	0,0	10,0	0,0	10,0	0,0	10,0	30,0	20,0	20,0	0,0	100
Black	0,4	0,9	2,6	3,0	9,0	12,0	17,6	21,9	24,0	8,2	0,4	100

Proportion of group which perceive treatment need for the given number of total pictures (%)												
Coloured	0,0	5,0	10,0	0,0	0,0	0,0	10,0	15,0	35,0	25,0	0,0	100
White	0,0	9,3	1,9	1,9	5,6	20,4	24,1	24,1	13,0	0,0	0,0	100

To make it easier to see the differences in the proportions of the ethnic groups that perceived treatment need for a given number of total pictures, the data from Table 19 was displayed in the form of a line graph. From the table as well as the figure, it is evident that the white group had lower total numbers of pictures with societal perceived need than the other groups, peaking around 5 to 7 pictures out of 10. The orange line representing the white group is situated more to the left of the x-axis than the other three groups. The coloured and black groups appear the most critical, with their lines situated more to the right of the x-axis, and peaking around 8 out of 10 pictures.

Figure 11: Proportion of the group with a total number of pictures perceived to need treatment



Due to the statistically significant difference found between the various ethnic groups' societal perceived need for treatment, the weighted mean of total pictures requiring treatment, per ethnic group was calculated (Table 20). This was done in order to facilitate the interpretation of the differences between the groups.

Table 20: Calculation of the weighted mean of societal perceived treatment per ethnic group

	Total number of pictures for which treatment is perceived multiplied by frequency											
Group	0	1	2	3	4	5	6	7	8	9	All	Mean
Asian	0	0	2	0	4	0	6	21	16	18	0	6.70
Black	1	2	12	21	84	14	24	35	44	17	10	6.40
Coloured	0	1	4	0	0	0	12	21	56	45	0	6.95
White	0	5	2	3	12	55	78	91	56	0	0	5.59

From Table 20, it can be seen that the weighted mean out of 10, for total pictures said to require treatment per ethnic group for Asian, black and coloured was 6.70, 6.40, and 6.95 respectively. The weighted mean for the white group was significantly lower, at 5.59 out of 10.

Although a highly statistically significant p-value was found for the data in Table 18 (p= 0.01735*), the small frequencies led to the possibility of the p-value being inaccurate. As the white weighted mean was found to be relatively low, confirmation by Analysis of Variance (ANOVA) summary was carried out. ANOVA was done on the group means (Table 20) to confirm the original Chi-squared results that showed a statistically significant difference between societal perceived need in different ethnic groups (Table 18). The p-value attained from the ANOVA (p=0.0142*) confirms that the statistical differences found between the ethnic groups' societal perceived need are significant despite the small frequencies analysed.

Thus regarding societal perceived need, the white group had a lower mean than the other 3 ethnic groups. This statistically significant difference implies white children, due to their lower societal perceived need, are found to perceive treatment need of others less critically than the other ethnic groups.

Self-perceived need and ethnic groups

In the Asian, black and white ethnic groups, the percentage of self-perceived need for treatment of each group, is 40, 37 and 33% respectively (Table 21). The coloured group showed a relatively high self-perceived need for treatment as 65% of these children feel the grade which best represents their dental aesthetics is in need of orthodontic treatment. This is suggestive that coloured children have a higher critical attitude toward their own dental aesthetics compared to the other 3 ethnic groups. However this difference is not considered statistically significant (p=0.08).

Table 21: Association between self-perceived treatment need and ethnicity

	Self perceived need (*n*)	**No self-perceived need (*n*)**	**Self-perceived need (%)**
Asian	4	6	40
Black	84	141	37
Coloured	13	7	65
White	17	34	33

Chi-squared = 6.6411, df = 3, p= 0.08426

4.8.3. Association between societal perceived and self-perceived treatment need and SEP

The effect of SEP (socio-economic position) on societal perceived need as well as self-perceived need was investigated.

The correlation co-efficient of -0.076 shows virtually zero correlation between societal perceived treatment need and SEP. Similarly there was no statistically

significant correlation between self-perceived need for treatment and SEP found (p=0.3246). Thus it can be concluded that no associations between perceived needs of the children and socio-economic position was found.

4.8.4. **Association between societal perceived and self-perceived treatment need and dental visits**

The relationship between societal perceived need for treatment based on aesthetic impairment and frequency of dental visits was explored and no statistically significant relationship was found except at AC grade 2, 9 and 10. However, at grades 9 and 10, the relationship was counter-intuitive, with more dental visits resulting in less societal perceived need for treatment. At grade 2, the relationship showed those who visited the dentist 2 or more times per year had the most critical viewpoint on treatment need.

The weighted mean of societal perceived need for each frequency of dental visits was explored and again no significant relationship was found (p=0.248). Due to these facts, that statistically significant differences were found at only 3 of the 10 grades and these differences were not consistent with one another, it can be concluded that there was no significant relationship overall between number of dental visits and societal perceived treatment need in this study.

However, a statistically significant relationship was noted when self-perceived need was investigated in relation to dental visits per year. It was found that the children who visited the dentist 2 times or more per year had a statistically significant, lower, self-perceived need for orthodontic treatment than those who visited the dentist annually or not at all (p=0.02*).

Chapter 5: Discussion

5. Introduction

In the previous chapter, the results were presented and the analysis of the data was described. In this chapter, the results will be discussed and the findings will be compared to reviewed literature.

5.1. Establishing the threshold of societal perceived treatment need

5.1.1. The threshold for treatment need determined by the children

As explained in Chapter 2, a threshold grade is the level that must be exceeded for a cut-off point to be reached which then denotes treatment need above that cut-off.

The AC (Aesthetic Component) of the IOTN's treatment need grading system as determined by a panel of professional judges in the study in 1995 by Richmond *et al*, is the currently used system by professionals. The threshold grade of 4 established from that study meant that grade 1-4 represents the 'no-slight need for treatment' category, and only once the threshold grade of 4 was exceeded, was treatment need for aesthetic impairment considered by the professional. From the definition of a threshold grade, the threshold grade was deduced for this study population as seen in the Table 13. The lowest grade at which the majority (more than 50%) of patients perceive treatment need was used to determine the point at which treatment should be considered for aesthetic impairment. The threshold grade was then assigned below this grade.

The results obtained in this study show that the majority of children feel treatment need begins at grade 4 of the AC of the IOTN. This means the treatment threshold grade of the AC is grade 3 according to the societal and self-perceived needs of the children in this study. A threshold of grade 3 lies below the currently accepted treatment threshold of professionals, grade 4. The data suggests that the current threshold of the AC of grade 4 should be lowered to grade 3, in order to

better reflect the opinions of our society regarding the point at which treatment becomes necessary. Regarding the threshold for treatment need as felt by the children in this study, it is apparent that the perceived need of laypeople for orthodontic treatment takes a more critical view than the threshold that is currently in use.

One prior study, done in Norway, found an agreement between laypeople and British professionals regarding the threshold grade of 4 (Stenvik *et al,* 1997). A threshold grade of 3, as determined by laypeople, found in various other countries such as the United Kingdom (Hunt *et al*, 2002), Jordan (Hamdan *et al*, 2007) and Finland (Svedström-Oristo *et al*, 2009) is in agreement with the findings in this study. This reaffirms that the threshold of treatment need as determined by laypeople should be established in each country in which it is used.

The results show that grade 3 (cut-off point between grades 3 and 4) is the threshold grade agreed on by all ethnic groups in this study except the Asian group, who demonstrate a higher threshold for perceived treatment need at grade 4. However due to the small size of this group (n = 10) it must be noted that this evidence is only suggestive and must be followed up with further investigation of larger sample groups to confirm the suggested difference. A similar conclusion, where all sample groups except one agreed on a threshold, was found in another study. A small group of 24 participants also regarded the threshold to be higher at grade 4, however they differed from the rest of their sample in self-perceived treatment need and not in ethnicity (Svedström-Oristo, 2009).

5.1.2. **Agreement with the ordering of the AC of the IOTN**

The group almost perfectly agreed with the order of the pictures however it should be noted that there was no statistically significant difference in the societal perceived need for treatment of grade 5, 6, and 7 which is a concern. It could be that the differences in malocclusion represented by those 3 picture grades is too small to be noticed by a layperson, in which case the scale could be condensed to incorporate only 1 of those 3 pictures. Condensing the AC to 8 pictures by

combining grade 5 with 6 and grade 7 with 8 was suggested previously (Hamdan *et al,* 2007). Condensing the current scale will allow one to incorporate new pictures that reflect the local concerns with malocclusion that our population may experience such as Class III malocclusions and anterior open bites and diastemas (de Mûelenaere *et al*, 1998; Trottman and Elsbach, 1996). This could further enhance the applicability of the AC in the South African context.

5.2. Perceived needs and how they compare to the normative need

5.2.1. **Objective perceived need**

The highest treatment need deduced was the objective perceived need, as the examiner rated 60% of the children as exhibiting aesthetic impairment of AC grade 4 or higher. This is total orthodontic treatment need and not only the definite need as it includes AC grades 4-7. This is a high objective perceived need but there are other studies with high results. Borzabadi-Farahani and Borzabadi-Farahani (2011) found objective perceived treatment need at 54%. Otuyemi and Kolawole (2005) found objective perceived treatment need to be 80%. In both studies, treatment need based on aesthetics was defined, using a threshold grade of 4, as AC grade 5 and above. Otuyemi and Kolawole did not aim to assess the orthodontic treatment need in the population, and the high figure attained in their study could be due to the fact that their sample was taken from hospital-referred patients with varying degrees of malocclusion who were seeking orthodontic treatment.

Definite objective perceived orthodontic treatment need found in this study, if taken as grades 8-10, according to the treatment categories suggested, would be 6.9%, which is similar to the 7% found in France (Souames *et al,* 2006). Sehowa found a definite need for treatment of 5.5% determined in her assessment of perceived need in South Africa (2011). However Sehowa investigated subjective perceived need only and there is no data available on objective perceived need in other South African studies. The objective perceived need found in this study is

lower than recently found in children of a similar age group from many countries including Nigeria, (Aikins *et al,* 2012), India (Soni *et al,* 2011), Western Sahara (Puertes-Fernández *et al,* 2011), Brazil (Dias and Gleiser, 2009), Japan (Watanabe *et al,* 2009) and Senegal (Ngom *et al,* 2007).

5.2.2. **Subjective perceived need**

11 children (3.5%) were unable to select an AC grade to represent their dentition. This is similar to the 3.5% (14 children) who could not pick a grade to resemble their own dentition in the 2011 study by Sehowa.

40% of the sample chose grade 2 to represent their dentition. Khan and Fida (2008) also found the majority of their sample (35%) chose AC grade 2. 242 children (76.3%) picked an AC grade below the new threshold to represent their dentition. This finding, that the majority of children perceive their dental aesthetics to be situated at the attractive end of the spectrum, specifically between grades 1 and 4, has not been contradicted (Al-Zubair *et al,* 2015; Aikins *et al,* 2012; Sehowa, 2011; Padisar *et al,* 2009; Ngom *et al,* 2007; Otuyemi and Kolawole, 2005; Abu Alhaija *et al,* 2005; Grzywacz, 2003). The least frequently chosen grade was 10, which corresponds to the same finding in Sehowa's (2011) study.

Subjective perceived need, as determined by the child-rated AC, was 20.2% when the new threshold grade of 3 was used. This is significantly higher than found by Sehowa, who used the currently accepted treatment threshold of grade 4 and found total subjective treatment need (AC grade including and above 5) to be 9%. Irrespective, had she used a threshold for South African children suggested in this study, of grade 3 (AC grade including and above 4), the subjective perceived treatment need found would still be lower (13.6%) than found in this study.

5.2.3. **Self-perceived need**

Actual self-perceived need for treatment was 38.5%. The self-perceived need found in this study is comparable to that found by Mugonzibwa *et al*, 2004 where 38% said they felt they required orthodontic treatment.

5.2.4. **Understanding the difference between subjective and self-perceived need**

The new threshold, found in this study, attempts to better reflect the views of laypeople but it is not without it's problems. It does have a high specificity, but even though the likelihood of the lack of self-perceived need being correctly diagnosed is high, the low sensitivity shows there are still patients with undiagnosed self-perceived need when the threshold is implemented. This implies the overall subjective perceived need, as measured by the child-rated AC, will be lower than the true self-perceived need of the population. That being said, when the odds ratio of 10.24, ($p<0.0001$) shows that children with a subjective perceived need for treatment were ten times more likely to have a self-perceived need for treatment than children without a subjective perceived need for treatment. This supports the usefulness of assessing the child-rated AC (subjective perceived need), as it is a good indicator of children with a self-perceived need.

The discrepancy between subjective perceived need as determined by the child-rated AC and the self-perceived need found in this study was 18.3%. This is considerably lower than the discrepancies found in other studies. Al-Zubair *et al* (2015) obtained results with a discrepancy of 38.2%, Winnier *et al* (2011) 34.2%, Abu Alhaija *et al* (2005) 36% and Grzywacz (2003) 52.3%. This implies the lowering of the threshold grade may have a large impact on the accuracy of subjective perceived need determination, as the discrepancy between subjective perceived and self-perceived need would be higher (23.7%) if the conventional threshold of grade 4 was used, but still much less that the other studies mentioned.

5.2.5. **Subjective compared to objective assessment of aesthetics**

There was a moderate correlation, found in this study, between subjective (child-rated) and objective (examiner-rated) perceived treatment need when assessed by the AC. This correlation was found despite the fact that more children rated their aesthetics less critically than the examiner did in this study, as found by other authors (Ghijselings *et al,* 2014; Ngom *et al,* 2007; Kok *et al,* 2004). 65 children (20.7%) chose the exact same grade as the examiner chose for them. Psiwa and Kok *et al,* who conducted their studies in 2004, noted a similar correlation, although the correlation in their studies was found using treatment need categories and not individual grades. The fact that a moderate correlation was found using grades and not categories enhances the correlation strength found in this study.

Despite the moderate correlation between subjective perceived need and objective perceived need found in this study, the discrepancy of treatment need according to the AC grades, between child and examiner, found in this study affirms the need for a tool like the AC to be implemented when aesthetic impairment is assessed. It allows the clinician to interpret the subjective treatment need as perceived by the patients, and in comparing that to their own objective assessment, achieve a better understanding of the perceived need of the patient and importantly manage the patient's expectations.

5.2.6. **Self-perceived need compared to societal perceived need**

The majority of the AC scale shows that at the middle portion of the scale (grades 3 to 7) self-perceived need is less critical than societal perceived need whereas at either end of the scale, self-perceived need is more critical than societal perceived need. Grades 1 and 2 of the AC show marginally higher (2 to 4%), thus more critical, self-perceived treatment need than societal perceived need. The reasons as to why children who rate their aesthetics at the attractive end of the scale, feel there is a need for treatment for themselves (self-perceived need) yet they wouldn't consider the same need for others (societal perceived need) are not understood. Maybe these reasons should be further investigated due to the fact

that a large proportion of the group selected grade 1 or 2 of the AC to represent their dental aesthetics.

5.2.7. **Normative need**

The normative need as determined by the modified Dental Health Component of the IOTN showed 41.2% of the children examined in this study were in definite need of orthodontic treatment. This is higher than all previous studies conducted in South Africa and neighbouring countries have found (Hlongwa and du Plessis, 2005; Van Wyk and Drummond, 2005; Volschenk *et al*, 1993; de Mûelenaere *et al,* 1992; de Mûelenaere and Viljoen, 1987; Swanepoel, 1985; Van Wyk *et al,* 1985; Hirschowitz *et al,* 1981). None of these studies used the IOTN to determine treatment need and the difference in indexes used may attribute to the discrepancy in normative need assessed. Furthermore, due to a lack of comprehensive dental services in the area of this study, high extraction rates as well as environmental factors may contribute to higher prevalence of malocclusion (de Mûelenaere *et al*, 1992) thereby resulting in higher normative need.

Only 1.26% of this sample was currently undergoing orthodontic treatment, which is very low compared to other countries like Croatia where about 28 - 40% of the children undergo orthodontic treatment (Špalj *et al*, 2014; Špalj *et al,* 2010) and Spain where treatment is conducted on 23.5% of 12 year olds (Manzanera *et al*, 2009). The low figure of current or past orthodontic treatment found in this study is comparable to treatment levels noted in Tanzania, elsewhere in South Africa, and in France. In 2004, Mugonzibwa examined 400 Tanzanian children aged 9 to 18 and none of them were undergoing, or had a history of, orthodontic treatment. In 2005, Hlongwa & du Plessis also found no previous or current orthodontic treatment in a total of 313 South African children from 5 schools in Mankweng, Limpopo. Souames *et al* (2006), found 2.4% of their 531 9 to 12 year old French sample were undergoing orthodontic treatment. The low rates of treatment and the high normative treatment rates found in this study indicate a high rate of

untreated malocclusion in this area of South Africa. There appears to be a need for orthodontic services in this area based on normative need for treatment.

5.2.8. **Comparison of perceived and normative need**

41.2% have definite normative need for orthodontic treatment and this is higher than the 20.2% subjective perceived need as assessed using the new treatment threshold of grade 3, and 38.5% actual self-perceived need, but lower than the objective perceived need of 60% using the new threshold. The notion that clinicians are more critical of patients' aesthetics than patients themselves, as supported by numerous studies (Ghijselings *et al,* 2014; Sharma and Sharma, 2014; Khasim *et al,* 2013; Ngom *et al,* 2007; Otuyemi and Kolawole, 2005; Kok *et al*, 2004), is evident in these results.

5.3. Association between societal perceived and self-perceived need and demographic factors

From this study it can be concluded that gender, and socio-economic position have no statistically significant relation to societal perceived need or self-perceived need. This is similar to findings in other studies (Al-Zubair *et al,* 2015; Kerosuo *et al,* 2004).

Interestingly, there was an association between gender and self-perceived treatment need by Svedström-Oristo *et al* (2009), they found that when subjects expressed a self-perceived treatment need, gender had an effect in that females were more dissatisfied with their appearance than males, unlike the results found in this study. However they found no statistically significant difference between the genders of individuals who did not express a self-perceived need, which is in agreement with this study.

Regarding ethnicity, the white population had a slightly lower weighted mean of societal perceived need. This finding suggests the white population is less critical of the aesthetic impairments of others. However, no difference was found

between ethnic groups regarding self-perceived need for treatment. Ethnicity has an effect on perceived need due to differences in acceptable facial appearances and what is or is not deemed acceptable amongst different ethnic groups (Aikins *et al*, 2012).

An incidental finding of a statistically significant relationship was noted between self-perceived need for orthodontic treatment and a frequency of 2 or more visits per year. The increased frequency of visits is related to a lower self-perceived need for orthodontic treatment. The reasons for this remain unclear.

Chapter 6: Conclusion and recommendations

The treatment threshold grade of the AC of the IOTN should be lowered to better represent the societal and self-perceived needs of the South African population. Treatment need is perceived as necessary for grade 4 and above of the AC scale, by the majority of children in this study, and the currently accepted threshold grade should therefore be lowered from grade 4 to grade 3 to better reflect the views of South African children.

Normative need is higher than perceived needs from the patients' point of view (subjective and self-perceived need), but lower than the perceived need from the examiner's point of view (objective perceived need). Dental professionals rate the aesthetics of the children more critically than children themselves. It is important for professionals to understand that the need for treatment need as perceived by them may not be regarded in the same manner as by the patients.

Children with a subjective perceived need for treatment are 10 times more likely to have a self-perceived need for treatment than those without a subjective perceived need. This reinforces the reliability of the AC to accurately predict self-perceived need even though it actually measures subjective perceived need. The AC can therefore be used to assess these discrepancies in patient's and professional's perceptions of treatment need so that they can be addressed.

Given there is a normative need of 41.2%, a self-perceived need of 38,5%, a current or past treatment rate of 1.26%, and a relatively high socio-economic position of this sample, it is evident that orthodontic services in this area are required.

No relationship was established between societal or self-perceived need and either gender or socio-economic position. There was a statistically significant relationship found between ethnicity and societal perceived need, but not self-

perceived need. The white population seems less critical of the aesthetic impairments of others.

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Appendix 1: Caregiver's Questionnaire

Caregiver Questionnaire

This questionnaire is part of a research project being conducted by Dr Yuvthi Rampersadh. All information you give is confidential. Do you give consent to be part of the study?

Yes ☐ No ☐

---

1. **Are you currently employed?**

Yes	
No	

2. **Do you have access to any social grant?**

Yes	
No	

3. **What is the highest education level in your household?**

No formal education	
Below Grade 9	
Grade 12/ Matric	
Diploma	
Undergraduate degree	
Postgraduate degree	
Other (Please specify)	

4. **Do you receive family dental treatment from the public sector or from a private dentist?**

Public	
Private	

5. **Tick which of the following household amenities you possess?**

Electricity	
Radio	
Television	
Refrigerator	
Car	
Bicycle	
Telephone	

6. Which best describes your household water supply?

Piped into home	
Piped into yard, plot/compound/Piped outside compound	
Well, spring inside/covered well	
Well or spring outside/open well	
Bottled water/ Covered or open spring/River	
Other (Please specify)	

7. What sanitation facilities do you have at your home?

Toilet to sewer/flush toilet	
Toilet to open space or river	
Latrine to sewer	
Latrine no connection	
Traditional latrine/ pit/ ventilated improved pit latrine	
No facility/and bush or field	

8. What type of flooring material do you have in your home?

Earth or sand	
Wood planks / and reed or bamboo	
Polished wood and parquet	
Vinyl and sheet tiles	
Ceramic tiles/ and brick	
Cement	
Carpet	
Other (please specify)	

Thank you for your participation.

Dr Yuvthi Rampersadh
Researcher
Dentist
Standerton Hospital
Mpumalanga DoH
3412510@myuwc.ac.za
(017) 719 9600

Prof Angela Harris
Supervisor
HoD of Orthodontics
University of the Western Cape
ampharris@uwc.ac.za
(021) 937 3105/6

Dr Rob Barrie
Co-Supervisor
Community Dentistry
University of the Western Cape
rbarrie@uwc.ac.za
(021) 937 3000

RESEARCH PARTICIPANT NUMBER:

Appendix 2: Student's Questionnaire

Student Questionnaire

This questionnaire is part of a research project being conducted by Dr Yuvthi Rampersadh. All information you give is confidential. Do you want to be part of the study and have a check-up?

Yes ☐ No ☐

---

1. What gender are you?

Male	
Female	
Other (please specify)	

2. How old are you?

11 years	
12 years	
13 years	
Other (please specify)	

3. What group do you belong to?

Black	
Asian	
Coloured	
White	
Other (please specify)	
Do not wish to disclose	

4. How often do you visit the dentist?

0x /year	
1-2x/year	
More than 2x/year	

5. Looking at the pictures, choose whether you think the teeth in the picture need to be fixed using braces.

Picture	Yes	No
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		

6. What letter picture do you think looks most like your teeth? _____

RESEARCH PATICIPANT NUMBER:

Thank you for your participation.

To be completed by the Dentist
Orthodontic Treatment Need based on AC: _____
Orthodontic Treatment Need based on modified DHC: _____

Appendix 3: Senate Research Committee Approval

Office of the Deputy Dean
Postgraduate Studies and Research
Faculty of Dentistry & WHO Collaborating Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 29th August 2014

For Attention: Dr Y Rampersadh
Department of Orthodontics
Faculty of Dentistry
Tygerberg Campus

Dear Dr Rampersadh

STUDY PROJECT: The perceived and normative orthodontic treatment need of a group of South African children

PROJECT REGISTRATION NUMBER: 14/7/18

ETHICS: Approved

At a meeting of the Senate Research Committee held on Friday 29th August 2014 the above-mentioned project was approved. This project is therefore now registered and you can proceed with the study. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

Professor Sudeshni Naidoo

Tel -27-21-937 3148 (w); Fax -27-21-931 2287 e-mail: suenaidoo@uwc.ac.za

Appendix 4: Department of Education letter

education
DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

Private Bag X 11341
Nelspruit 1200
Government Boulevard
Riverside Park
Building 5
Mpumalanga Province
Republic of South Africa

Litiko leTemfundvo Umnyango we Fundo Departement van Onderwys Ndzawulo ya Dyondzo

Enquiries: Mr AH Baloyi
Tel: 0137665476

Dr. Yuvthi Rampersadh (Dentist)
University of Western Cape
Cape Town

Dear Doctor Rampersadh

Re: YOUR APPLICATION TO CONDUCT RESEARCH IN OUR SCHOOLS-MEDICAL RESEARCH FOCUS

Your application to conduct research was received and it is acknowledged. Note that as a department we promote research studies which seek to promote teaching and learning. While the department promotes healthy life styles to both learners and staff it does not approve research which concerns the health of learners. Studies of this nature require the consent and approval of parents of learners involved. The researcher should therefore communicate and seek permission from parents and guardians of the learners directly.

I trust that you will find this in order

Kind regards

Mr. HA Baloyi
Chief Education Specialist
Research Unit

Appendix 5: Consent forms of School Principals

School Principal Consent Form

The perceived and normative orthodontic treatment need of a group of South African children.

Schools Name: Laerskool Jeugkraal

I, G.A. Marais, give consent for you to approach learners in Grade 6 & 7 to participate in the research project: The perceived and normative orthodontic treatment need of a group of South African children. (Project Number: 14/7/18)

I have read the Letter of invitation explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- Grade 6 & 7 learners will be invited to participate and that permission will be sought from their parents and the learners themselves.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The learners' names will not be used and individual learners will not be identifiable in any written reports about the study. The learners' and their parents' information will be correlated by way of randomised research participant numbers.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty, however once the questionnaires have been completed and collected and the intra-oral examination has been completed, I cannot recall the consent. This is because there will be no way to trace their information back to them.
- A report of the findings will be made available to my school and me and may be published.
- I may seek further information on the project from Dr Yuvthi Rampersadh on 0177199600 (Ext 2264)

G.A. Marais
Principal's Name

Principal's Signature

15/09/2014.
Date

Please contact me on 0177199600 (Ext 2264) when this form is complete and I can collect it from your school.

School Principal Consent Form

The perceived and normative orthodontic treatment need of a group of South African children.

Schools Name: Azalea Combined School

I, P.H. Wienand, give consent for you to approach learners in Grade 6 & 7 to participate in the research project: The perceived and normative orthodontic treatment need of a group of South African children. (Project Number: 14/7/18)

I have read the Letter of invitation explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- Grade 6 & 7 learners will be invited to participate and that permission will be sought from their parents and the learners themselves.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The learners' names will not be used and individual learners will not be identifiable in any written reports about the study. The learners' and their parents' information will be correlated by way of randomised research participant numbers.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty, however once the questionnaires have been completed and collected and the intra-oral examination has been completed, I cannot recall the consent. This is because there will be no way to trace their information back to them.
- A report of the findings will be made available to my school and me and may be published.
- I may seek further information on the project from Dr Yuvthi Rampersadh on 0177199600 (Ext 2264)

P.H. Wienand
Principal's Name

Principal's Signature

30.09.14
Date

MPUMALANGA EDUCATION DEPT.
AZALEA COMBINED SCHOOL
30 SEP 2014
P.O. BOX 712, STANDERTON 2430

Please contact me on 0177199600 (Ext 2264) when this form is complete and I can collect it from your school.

School Principal Consent Form

The perceived and normative orthodontic treatment need of a group of South African children.

Schools Name: Stanwest Combined School

I, Mr Mathebula, give consent for you to approach learners in Grade 6 & 7 to participate in the research project: The perceived and normative orthodontic treatment need of a group of South African children. (Project Number: 14/7/18)

I have read the Letter of invitation explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- Grade 6 & 7 learners will be invited to participate and that permission will be sought from their parents and the learners themselves.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The learners' names will not be used and individual learners will not be identifiable in any written reports about the study. The learners' and their parents' information will be correlated by way of randomised research participant numbers.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty, however once the questionnaires have been completed and collected and the intra-oral examination has been completed, I cannot recall the consent. This is because there will be no way to trace their information back to them.
- A report of the findings will be made available to my school and me and may be published.
- I may seek further information on the project from Dr Yuvthi Rampersadh on 0177199600 (Ext 2264)

THEMBA MATHEBULA
Principal's Name

Principal's Signature

30/09/2014
Date

MPUMALANGA EDUCATION
DEPARTMENT
STANWEST COMBINED SCHOOL
1 JAN DE LANGE STREET
P O BOX 484
STANDERTON 2430
PHONE: 017-712 3171
FAX: 017-712 3027

Please contact me on 0177199600 (Ext 2264) when this form is complete and I can collect it from your school.

School Principal Consent Form

The perceived and normative orthodontic treatment need of a group of South African children.

Schools Name: Morgenzon Landbou Academie

I, Mr Wehmeyer, give consent for you to approach learners in Grade 6 & 7 to participate in the research project: The perceived and normative orthodontic treatment need of a group of South African children. (Project Number: 14/7/18)

I have read the Letter of invitation explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- Grade 6 & 7 learners will be invited to participate and that permission will be sought from their parents and the learners themselves.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The learners' names will not be used and individual learners will not be identifiable in any written reports about the study. The learners' and their parents' information will be correlated by way of randomised research participant numbers.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty, however once the questionnaires have been completed and collected and the intra-oral examination has been completed, I cannot recall the consent. This is because there will be no way to trace their information back to them.
- A report of the findings will be made available to my school and me and may be published.
- I may seek further information on the project from Dr Yuvthi Rampersadh on 0177199600 (Ext 2264)

A.M. WEHMEYER
Principal's Name

Principal's Signature

20 - 10 - 2014
Date

Please contact me on 0177199600 (Ext 2264) when this form is complete and I can collect it from your school.

MPUMALANGA EDUCATION DEPARTMENT
MORGENZON LANDBOU ACADEMIE
2014 -10- 20

School Principal Consent Form

The perceived and normative orthodontic treatment need of a group of South African children.

Schools Name: Standerton Primary

I, Mr Jonse Van Vuuren, give consent for you to approach learners in Grade 6 & 7 to participate in the research project: The perceived and normative orthodontic treatment need of a group of South African children. (Project Number: 14/7/18)

I have read the Letter of invitation explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- Grade 6 & 7 learners will be invited to participate and that permission will be sought from their parents and the learners themselves.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The learners' names will not be used and individual learners will not be identifiable in any written reports about the study. The learners' and their parents' information will be correlated by way of randomised research participant numbers.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty, however once the questionnaires have been completed and collected and the intra-oral examination has been completed, I cannot recall the consent. This is because there will be no way to trace their information back to them.
- A report of the findings will be made available to my school and me and may be published.
- I may seek further information on the project from Dr Yuvthi Rampersadh on 0177199600 (Ext 2264)

C J Jonse van Vuuren
Principal's Name

Principal's Signature

2014/10/31
Date

MPUMALANGA DEPARTMENT OF EDUCATION
STANDERTON PRIMARY
31 -10- 2014
TEL: 017-714-0006
P.O. BOX 294, STANDERTON, 2

Please contact me on 0177199600 (Ext 2264) when this form is complete and I can collect it from your school.

School Principal Consent Form

The perceived and normative orthodontic treatment need of a group of South African children.

Schools Name: Laerskool Standerton

I, C.C. Hamman, give consent for you to approach learners in Grade 6 & 7 to participate in the research project: The perceived and normative orthodontic treatment need of a group of South African children. (Project Number: 14/7/18)

I have read the Letter of invitation explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- Grade 6 & 7 learners will be invited to participate and that permission will be sought from their parents and the learners themselves.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The learners' names will not be used and individual learners will not be identifiable in any written reports about the study. The learners' and their parents' information will be correlated by way of randomised research participant numbers.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty, however once the questionnaires have been completed and collected and the intra-oral examination has been completed, I cannot recall the consent. This is because there will be no way to trace their information back to them.
- A report of the findings will be made available to my school and me and may be published.
- I may seek further information on the project from Dr Yuvthi Rampersadh on 0177199600 (Ext 2264)

C.C. Hamman
Principal's Name

Principal's Signature

14/11/19
Date

Laerskool Standerton
P.O. Box 196 Tel: 017 712 2345
2014 -11- 19
27 Paarl Street, Standerton 2430
Region: Gert Sibande
District Ermelo

Please contact me on 0177199600 (Ext 2264) when this form is complete and I can collect it from your school.

Appendix 6: Caregiver's information and consent forms

Caregiver information

Research Project: The perceived and normative orthodontic treatment need of a group of South African children.
Project Number: 14/7/18

Dear Caregiver,
I am a dentist at Standerton Hospital and a postgraduate student, studying part time at the University of the Western Cape. I am conducting research on Orthodontic treatment need under the supervision of Professor Angela Harris (Head of Department of Orthodontics) and co-supervision of Dr Rob Barrie (Community Dentist Specialist). The Principal of your child's school has agreed to the following research project to be conducted in the school should you consent to it. If you consent, you will be required to fill in an anonymous form regarding your current socioeconomic position.

What is the research about?

We are trying to find out what children in this area want and need treated with regards to their teeth. This will help dentists to better understand what the need for orthodontic treatment (straightening/moving teeth using wires) is in the area and may help to motivate for publicly funded treatment in the future.

Please note **no treatment** will be carried out based on this study and the questionnaire should be filled out as honestly as possible so that we get correct and useful information.

What is required of you and your child?

If you allow your child to participate in the research project, he/she will then need to fill in a questionnaire, which should not take more than 10 minutes to complete. The questionnaire consists of 6 short questions and I will be present throughout the process should they need to ask any questions or do not understand what is expected of them.

Then I will look at your child's teeth and assess his/her need for orthodontic treatment. This should not take more than 2 minutes.

All information collected will be treated in strictest confidence and neither the school nor individual learners will be identifiable in any reports that are written. Participants may withdraw from the study at any time without penalty prior to the collection of data. Once data has been collected it will be impossible to correlate the data given in by your child and thus impossible to withdraw it from our study. The role of the school is voluntary and the School Principal may decide to withdraw the school's participation at any time without penalty before the data has been combined with that from other schools.

Please complete the section below and return it to your child's teacher tomorrow with the completed caregiver questionnaire should you consent to the research study.

Many thanks,
Dr Yuvthi Rampersadh
Dentist
Standerton Hospital
0177199600 (Extension 2261/4)

Caregiver Consent Form

Child's Name: _____
Child's School: _____
Child's Grade: _____

I , Mr/Ms/Mrs _____ allow my child, _____ to participate in the research project carried out by Dr Yuvthi Rampersadh on the need for orthodontic treatment. I understand that the research is voluntary and no treatment will be carried out during the study but if necessary, children in need of dental treatment will be referred to Standerton Hospital for further management or referral. My child's information collected during the research will be confidential.

_____	_____	_____
Caregiver's Name	Signature	Date