

288907



**UNIVERSITY OF THE WESTERN CAPE  
UNIVERSITEIT VAN WES-KAAPLAND**

**This book must be returned on or before the  
last date shown below.**

**Hierdie boek moet terugbesorg word voor of op  
die laaste datum hieronder aangegee.**

**NB: Telephonic renewals only between 17h00 – 22h00  
at issue desk 959 2946**

--	--	--

30001600253641





*Donated  
To The Library by*

**The late Prof M.H. Moola**

---

*Date*

**2014**

---

**A COMPARISON OF LAY AND PROFESSIONAL OPINION  
ON  
TREATMENT NEED AND TREATMENT  
OUTCOME**

**ISMAIL M. VALLY  
B.ChD (WESTERN CAPE)  
M. ORTH. RCS (EDIN)**

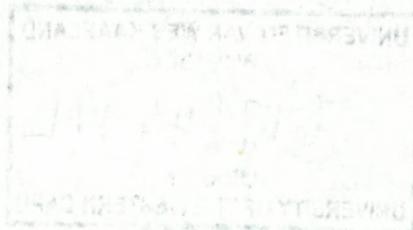
**Dissertation submitted in partial fulfilment  
for the degree of  
Magister in Scientia Dentali  
University of Wales**

## ACKNOWLEDGEMENTS

I would like to thank Professor M.L. Jones for giving me the opportunity to carry out this research within the Department, and I am also very grateful for his kind help and support.

I am indebted to Dr. S. Richmond, whose original ideas and knowledge provided a basis for this thesis. I thank him for his constructive criticism during the writing of the thesis. To this end I am also grateful to Dr F. Dunstan for his assistance in the initial planning stage and to Dr C. Daniels for statistical support during the final data analysis. Special thanks goes to participants who gave up their valuable time and to Mrs. C. Newton for assisting in the transfer of data for statistical analysis.

Finally, I would like to thank my dad, my wife and my three children for their support, tolerance and understanding throughout an eventful three year period.



OP 17-2-81

Handwritten signature  
17/2/81

OP 17-2-81

DEN (THE)

17-2-81

UNIVERSITEIT VAN WES-KAAPLAND  
BIBLIOTEK  
617.643 VAL  
LIBRARY  
UNIVERSITY OF THE WESTERN CAPE

OP 17-2-81

## DECLARATION

This work has not previously been accepted in substance for any degree, and is not being concurrently submitted in candidature for any other degree.

Signed ..... *Gracey* ..... Date  
18-8-97  
Dr Ismail M. Vally  
(Candidate)

Signed ..... *S. Richmond* ..... Date  
18/8/97  
Dr S. Richmond  
(Director of Studies)

This dissertation is being submitted in partial fulfilment of the requirements for the degree of M.Sc.D.

Signed ..... *Gracey* ..... Date  
18-8-97

This dissertation is the result of my own independent work/investigation, with the exception of the assistance of the acknowledged.

Signed ..... *Gracey* ..... Date  
18-8-97

I hereby give consent for my dissertation, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed ..... *Gracey* ..... Date  
18-8-97

## **INDEX**

- Chapter 1 :**           **Introduction**
- Chapter 2 :**           **Literature review**
- Part I**           **Concept of contemporary health in  
Orthodontics.**
- Part II**           **Lay persons perceptions of facial  
and dental attractiveness.**
- A.**           **Studies based on cine film.**
- B.**           **Studies based on questionnaires.**
- C.**           **Studies based on photographs.**
- D.**           **Studies based on study models.**
- Part III**           **Objective measures of facial and  
dental attractiveness.**
- A.**           **Diagnostic classification.**
- B.**           **Epidemiological data collection.**
- C.**           **Treatment complexity.**
- D.**           **Indices to record treatment need.**
- E.**           **Indices to record aesthetic impairment.**
- F.**           **Indices to record treatment standards.**
- Part IV**           **Patient and professional interactions.**
- A.**           **Comparison between lay and professional  
perceptions.**
- B.**           **Need and Demand.**

<b>Chapter 3 :</b>	<b>Aims and Objectives</b>
	<b>Hypotheses</b>
<b>Chapter 4 :</b>	<b>Materials and Method</b>
<b>Chapter 5 :</b>	<b>Results</b>
<b>Chapter 6 :</b>	<b>Discussion</b>
<b>Chapter 7 :</b>	<b>Conclusion</b>
<b>Chapter 8 :</b>	<b>Suggestions for future research</b>
<b>Chapter 9 :</b>	<b>Bibliography</b>
<b>Appendix 1</b>	<b>Detailed guidance and answer formats</b>
<b>Appendix 2</b>	<b>Questionnaire relating to personal details</b>
<b>Appendix 3</b>	<b>Box and Whisker plots</b>

## ABSTRACT

The psychological, social, and cultural aspects of facial and dental attractiveness is an integral part of health care. Lay persons perceptions of facial and dental attractiveness are influenced by many factors including age, gender, geographic location (nationally or international), ethnic status, employment status, cultural differences and social class will effect the social impact of the anomalies. In addition, the public response to dental anomalies will vary according to experience of good health or ill health of the individual, relatives and friends.

The perception of malocclusion is often seen differently between orthodontists, patients and lay public. The differing perceptions of patients and dental practitioners may influence the delivery of orthodontic care. It has been reported that 70% of orthodontic treatment is dentist induced and that orthodontic treatment may be undertaken without the patient or parents perceiving a problem with the teeth. (DHSS, Schanscheiff Report, 1986). The thresholds of entry and exit for orthodontic care may be different as perceived by orthodontists and lay persons. Orthodontists may pursue full alignment and perfect occlusion whereas lay persons may accept varying degrees of deviation from normal.

This current study has assessed and recorded the differences in opinions of professional orthodontists and lay persons on dento-facial aesthetics, orthodontic treatment need and orthodontic treatment outcome. The study was carried out at the Orthodontic Department, University of Wales, College of Medicine, School of Dentistry. The opinions of 56 lay persons (dental technicians, dental nurses and lay persons not involved in the clinical process) and 97 orthodontists was collected by recording judgements using various patient records as stimuli. For each set of records examined, each member of the panel indicated their opinion using Likert scales.

Judgements were made by assessments of 68 study casts in respect of:-

- \* the need for orthodontic treatment on dental health grounds.
- \* the need for orthodontic treatment on dental aesthetic grounds.
- \* deviation from normal occlusion.
- \* the decision whether to treat.

In addition, judgements were made on a sample of 50 pairs of outline facial profiles before and after treatment in respect of:

- \* deviation from normal facial aesthetics
- \* comparison of aesthetics pre-treatment and post-treatment.

Furthermore, assessments on 50 pairs of pre-treatment and post-treatment study casts in respect of:

- \* degree of improvement as a result of treatment.
- \* acceptability of result.

Orthodontists subjective judgements are more reliable than lay persons in their assessments of dental aesthetics, dental health and deviation from normal.

The level of agreement for the decision to recommend treatment is similar between orthodontists and lay groups ie. lay persons are as reliable as orthodontists in the decision to recommend treatment.

Orthodontists tend to recommend 10 - 12 % more treatment than lay persons.

The orthodontist group were more reliable than the lay group in assessing degree of improvement and assessment of outcome.

Orthodontists reject approximately 25% of cases deemed acceptable by the lay group.

Dental aesthetics appeared to be the most important feature in the assessment of treatment outcome by both orthodontists and lay groups.

CONQUEROR

**CHAPTER 1**

## INTRODUCTION

The introduction of the National Health Service in 1948 led to a considerable expansion of Orthodontic provision. Many hospitals now have a Consultant Orthodontist and there has been a noticeable increase in the Community Service. Figures from the Dental Practice Board show that the number of general dental practitioners carrying out orthodontic treatment has increased greatly, together with the total number of cases treated. In 1995/96, child item of service treatment costs totalled £ 95.6 million. Fifty three percent (53.1%) of this total was dominated by orthodontic treatment representing £50.756 million. In addition, a significant part of the fees for examination (£9.108 million equivalent to 9.5% of total) was in connection with orthodontic assessment. Overall, orthodontic treatment rose by 11.7% (approximately £5 million/year) compared to 1994/95.

The majority of orthodontic treatment in England and Wales is provided by the General Dental Service (80 percent), 12 percent in the Community Dental Service and 8 percent in the Hospital Dental Service (O'Brien, 1991). 68 Percent of Orthodontic treatment is undertaken by dentists with no orthodontic qualifications (Richmond et al., 1992). However, this expanding Orthodontic service finds itself in a more accountable age. All public services must be seen to be efficient. Prioritisation of provision has become topical in an environment of limited resources. Orthodontic indices have been developed as an aid to resource management.

The majority of orthodontists would agree that treatment efficiency and or effectiveness has increased following the introduction of more sophisticated appliance systems. In addition, the public have sought higher standards of care. However, due to the inequality of knowledge between the clinician and the public several questions are raised.

1. Is the profession supplying the type of orthodontic treatment the public want?

Are the treatment objectives of the orthodontist the same as those of the general public? The thresholds of entry and exit for orthodontic care may be different as perceived by orthodontists and lay persons. Orthodontists may pursue full alignment and perfect occlusion whereas lay persons may accept varying degrees of deviation from normal.

2. Does the clinician's opinion of a malocclusion specifically regarding aesthetics, dental health, deviation from normal occlusion, orthodontic treatment need and orthodontic treatment outcome coincide with that of a lay person?

3. Are professional standards for orthodontic treatment need, treatment outcome and dentofacial aesthetics meaningful to the public?

This study is an attempt to provide answers to the above questions by gaining opinions from lay people with regard to various malocclusions. In addition to determine whether lay persons suggest that certain malocclusions should be treated or not. Further, we will canvas opinions on the acceptability of outcome of treated cases. These findings will then be related to the opinions of orthodontists regarding the same malocclusions, for treatment need and acceptability of treatment outcome.

CONQUEROR

**CHAPTER 2**

## LITERATURE REVIEW

In Chapter 2 :

Part I briefly reviews the concept of contemporary health in orthodontics.

Part II constitutes a review of lay persons perceptions of facial and dental attractiveness and relevant studies utilising different modes of stimulation.

Part III describes objective measures of facial and dental attractiveness i.e. occlusal indices, the different types available, their development and applications.

Part IV reviews this information with specific interest paid to Patient and Professional interactions, comparing perceptions between these two groups and issues relating to need and demand.

## **PART 1.**

# **CONCEPT OF CONTEMPORARY ORTHODONTICS IN HEALTH**

The concept of health in today's society has been extended to encompass not merely the absence of disease and infirmity, but also a state of complete physical, mental and social well-being. Generally expressed, the aims of the orthodontic services are in accord with the contemporary health concept (Foster and Day 1974), the aim being to prevent and treat those dental anomalies which imply a threat to oral health or psycho-social well being.

The World Health Organisation (1962) includes malocclusion under the heading of Handicapping Dentofacial Anomaly, which is defined as an anomaly which causes disfigurement or which impedes function, and which requires treatment "if the disfigurement or functional defect is, or is likely to be an obstacle to the patient's physical or emotional well-being".

Salzmann (1968) defines a handicapping malocclusion as one which adversely affects aesthetics, function or speech. The dental profession recognises the elimination of physical lack of function and potential tissue destruction resulting from maloccluded teeth as the most legitimate basis for which orthodontic treatment should be provided. If mastication or speech functions are impaired or if there are gross traumatic defects or injuries, the need for orthodontic intervention is felt to be fully justified and often mandatory (National Centre for Health Statistics, 1967).

The British Dental Association Memorandum on Orthodontic Services (1954) and recently the Standing Dental Advisory Committee (1973) summarised and defined the aims of orthodontic treatment as being "to produce improved function by the

correction of irregularities and to create not only greater resistance to disease, but also to improve personal appearance, which latter will contribute to the mental as well as to the physical well being of the individual”.

## PART II

### LAY PERSONS PERCEPTIONS OF FACIAL AND DENTAL ATTRACTIVENESS

The main reasons for providing orthodontic treatment are, as stated previously, to improve oral health, oral function and personal appearance. The last of these, personal appearance, does not easily lend itself to objective assessment and the need for improvement depends to a large extent on the patient's own self-image. This is a very grey area, difficult to quantify and incorporate into any form of index of treatment need.

Studies by Albino et al (1981), in the field of social psychology, indicate that an unattractive physical appearance may result in a negative social response in the complex social interactions of today's society. Shaw (1980) makes the point that the role of the dento-facial complex in the overall self concept of physical appearance is uncertain. It is precisely this area that evokes the concern and need for orthodontic treatment.

Jenny (1975) stated that improvement in the physical function of the dentition was not the prime motivation for orthodontic treatment, and this has been supported recently by McNamara (1994). She stated that there were numerous social factors that formed the desire to achieve a culturally acceptable body image. These factors were the main initiating factors in forming a desire to seek treatment.

The dento-facial complex is thought to be involved in the self body image, but what constitutes a good dental form? Goochman (1975), showed that 99 percent of a sample of school children chose a picture of straight teeth as the one they would like most. Goochman also showed that the opinion of the arrangement of the teeth varied with age. It thus appears that body image may also vary with age.

Many different methodologies have formed the basis for studies, aimed at assessing the public's perception with regard to various malocclusions. Studies have used either photographs, questionnaires, cine-films or study models singly or in combination..

### **A. STUDIES BASED ON CINE-FILM**

The cine film was chosen as the medium for illustration because it was thought that this was the best way to present material so it would be equally familiar to lay and professional persons (Shaw, 1975). Results of the survey indicated that it was not possible to form a ranked order of malocclusions. For example a Class II Division I malocclusion and incisor imbrication were considered to be the most unacceptable whereas obvious Class 3 malocclusions were regarded as quite favourable. No marked gender or social class difference was noted.

This study concluded that orthodontists tended to freely recommend treatment, that it was necessary to determine the range of malocclusions acceptable to the individual and public. In addition, more research was required to clarify understanding of the importance of dental aesthetics.

### **B. STUDIES BASED ON QUESTIONNAIRES**

Questionnaires have been a popular method for assessing public opinion regarding tooth malalignment. This is due in part to the comparative ease with which a questionnaire based study can be administered. Patient and parent perceptions of malocclusions have been investigated and summarised in Tables 2.1, 2.2 and 2.3.

Lewit and Virolainen (1968) studied 129 adolescents in an attempt to identify factors motivating towards orthodontic treatment. The study suggested that if adolescent parental dependency needs were high, parental pressure tended to determine motivation for treatment. If the dependency need was low then perceived peer standards played a larger part in subjects with a strong desire for peer approval. The deviation from this generality was seen in the working class, low parental dependent subjects, who tended not to conform to the general orthodontic standard among those with high parental dependency.

TABLE 2.1 - *Studies on children's awareness of their own occlusion.*

	n	Age, yr	Method	Measurement Scales
Lewit & Virolainen 1968	129	12 - 14	"My teeth are crooked" "I have buck teeth"	4-point agreement scale
Horowitz et al. 1971	718	10 - 12	9 standardised facial drawings displaying various occlusal conditions	Depict drawing resembling own occlusion (self-image)
Graber & Lucker 1980	481	10 - 13	One question about straightness of teeth compared to "everybody's"	5-alternative rating scale positive, neutral, negative
Malmgren 1980	24 referred	10 - 14	"What do you think is wrong with your teeth?"	6 fixed choice alternatives
Shaw 1981a	200	9 - 12	a. Questions about presence of 10 maxillary and 10 mandibular anterior features  b. Dental photopanel including child's photo	a. Yes/no reply  b. Identification of own photo  Number of attempts.
Lindsay & Hodgkins 1983	40 referred	9 - 14	Questions about severity of 6 anterior occlusal traits.	10-point rating scale with indicators of treatment need at mid- and end points.
Espeland et al 1992	99	10-11	Questions about severity of 6 anterior occlusal traits	Identification of own photo Number of attempts
Helm et al. 1985	758 untreated screened at age 13-19 yr	28 - 34	Mailed questionnaires; Recalled awareness at adolescence: "At the time, did you have crooked teeth or did your teeth come together in the wrong way?"	4-alternative rating scale positive, neutral, negative

TABLE 2.2 - *Studies on parents' awareness of their child's occlusion*

	Number of Children	Age , year Children	Method	Measurement Scales
Luffingham & Campbell 1976	621	10 - 12	Mailed questionnaires: Questions about presence of 3 anterior traits	Yes/No reply
Malmgren 1980	24 referred	10 - 14	"What do you consider is wrong with your child's teeth?"	6 fixed choice alternatives
Malmgren 1980	147 referred	10 - 17	"Was it you who noticed your child's irregular teeth or did a dentist point it out?"	4 fixed choice alternatives
Shaw 1981 a	50	9 - 12	a. Questions about presence of 10 maxillary and 10 mandibular anterior features	a. Yes/no reply
			b. Dental photopanel including child's photo	b. Identification of child's photo Number of attempts
Lindsay & Hodgkins 1983	40	9 - 14	Questions about severity of 6 anterior occlusal traits	10-point rating scale with the indicators of treatment need at mid- and end points
Espeland et al 1992	99	10-11	Questions about severity of 6 anterior occlusal traits	Identification of child's photo Number of attempts

Lindsay and Hodgkins (1983) compared the reliability of parental and children's perceptions of malocclusion, with a panel of orthodontists. This study showed that parents and children do not estimate malocclusion reliably when tested against trained orthodontists. However, they were consistent in their own estimations. It was found that minimal and normal occlusions showed generally good agreement and this is supported by another study (Espeland, 1992).

Most studies indicate a moderate level of awareness between both children and their parents, ( Horowitz et al. 1971, Malmgren, 1980 Shaw 1981a, Espeland et al 1992)

and parents (Todd 1975, Luffingham & Campbell 1976, Shaw 1981a, Espeland 1992). A retrospective study revealed that less than half of the adults with recorded malocclusion at adolescence recalled that they had been aware of malocclusion (Helm et al. 1985).

In contrast to these studies, Graber & Lucker (1980), used questionnaires to assess their dental attractiveness and degree of self-satisfaction with their dental appearance in 481, 10-13 yr olds. The results suggested that children of this age group were capable of making objective aesthetic evaluations of their teeth, but there was a broad range of what was considered acceptable to the children. Only 96 children (20 per cent) in Graber and Lucker's study considered their teeth unattractive compared with (26.8 per cent) in Espeland's (1992) study. Based on children's response to one general question about straightness of own teeth, Graber and Lucker (1980) concluded that children were able to make fairly accurate self-evaluation of their malocclusion.

Malmgren (1980) reported a relatively high level of parental awareness. He found that parents were well aware of their child's malocclusion. The sample comprised, however, parents of children who had been referred for orthodontic treatment. Nevertheless, it was also reported that parents of referred children commonly stated that it was they themselves that initially noted the irregularity.

In a Scottish survey (Luffingham, 1976) it was revealed that, although 98 percent of the parents thought orthodontic treatment important, few parents recognised malocclusion in their own child. It was assumed that the impetus for seeking treatment largely came from the parents. This study showed that Glaswegian parents had a low recognition of malocclusions. Most would therefore depend on a general dental practitioner for advice.

The findings of Espeland (1992) might be most relevantly compared to those of the British study from which the photo-identification test was adapted (Shaw 1981a). The results revealed similarities in identification abilities among Welsh and Norwegian

children, as well as among the groups of parents. Although there existed a significant association between number of correct statements about occlusal traits given by the parents and their children, they did not necessarily recognise the same traits. Marked/severe overjet and spacing were the traits most often jointly recognised. The observation that mild/moderate irregularities usually were not stated as anomalies by either the child or the parent may imply that the professional criteria for deviations, or the concepts used, were not meaningful to them.

Overall, children and their parents seem to have limited ability in assessing their dentition. However, this observation may indicate that child and parental awareness may be underestimated if language-based measurements are used exclusively.

Ingervall (1974) published work based on Swedish 18 year olds. The aim was to determine prevalence of malocclusion, individual awareness of malocclusion and desire for treatment. The results showed that over 60 percent were thought to require treatment. Although a high percentage of these were aware of the malocclusion only 4 percent judged that they needed orthodontic treatment. The second survey by Ingervall, Mohlin and Thilander (1978) was based on Swedish men aged 21 - 54 years. Again the aim was to determine whether public awareness of their own malocclusion was matched by professional assessments. This survey reported that 76 percent were in need of treatment, 34 percent of the subjects were aware of mal-positioned teeth but only 3 percent desired orthodontic treatment.

These two similar surveys revealed that awareness of malocclusion amongst the general public correlated well with 'expert' opinion, but the desire for treatment fell short of the same mark!

In general, young adults are generally well aware of their dental arrangement, which is in agreement with other studies on adult Scandinavian populations (Helm et al. 1985, Horup et al. 1987, Salonen et al 1992). These studies did not include the subjects specification of actual traits. Again dissimilarities in methodology imply limitations in comparison of findings (Table 2.3).

Espeland (1992), observed no gender difference in level of awareness, whereas Salonen et al. (1992) found that women were more aware of their malocclusion. Furthermore, previous orthodontic treatment did not seem to affect level of awareness. The results of Ingervall et al. (1978) indicated that orthodontically treated individuals gave more accurate descriptions of their malocclusion traits, however the general occlusal status of the sample has to be considered when measurements of occlusal awareness are interpreted.

TABLE 2.3 - *Studies on adults' awareness of their own occlusion.*

	Sample	Age,yr	Method	Measurement Scales
Ingervall & Hedegard 1974	278 males (1) previously screened	18	Mailed questionnaires: 6 statements describing occlusion in each of four segments	Combination of yes/no neutral reply and preferred statement(s)
Ingervall et al 1978	389 males (2)	21 - 54	6 statements describing occlusion	Preferred statement(s)
Horup et al 1985	422	35 - 44	"Do you have any teeth that are out alignment?"	Yes/no reply
Helm et al 1985	758 untreated, screened at age 13-19yr	28 - 34	Mailed questionnaires: "Do you find that your teeth are irregular or come together in a wrong way?"	4 - alternative rating scale positive, neutral, negative
Salonen et al. 1992	250 with recorded malocclusion	>20	"Are you aware of any malocclusion and/or tooth malposition?"	Yes/no reply
Espeland et al 1991	80 previous orthodontic treatment	18.3	6 Questions describing their own occlusion. Identify their own occlusion amongst 18 photographs.	Yes/No reply

1. 16 % had received treatment with appliances
2. 9% had received treatment with appliances

Although obvious differences exist in occlusion between different age groups, comparisons of self-awareness are possible. Young adults demonstrate a higher level of awareness indicated by their descriptive skills as well as their abilities to identify their own dental photographs. Reports of previously orthodontically treated individuals have indicated that concern for certain malocclusion traits increase with

age (Gosney 1986). Furthermore, critical aesthetic evaluations of occlusal features in others, as well as negative feelings towards own dental appearance have been shown to increase with age in the childhood period (Shaw et al. 1975, Shaw 1981a, Davies, 1991).

Shaw et al (1979), using a questionnaire-based survey, attempted to determine expectations and the level of importance placed on orthodontic treatment in St. Louis, Missouri and South Wales. A striking similarity of response in the two differing populations was found. Both groups shared expectations of improved dental health, mastication and speech. Again the majority of recommendations for treatment came from within the dental profession in both groups although more so in South Wales. This correlated well with the Glasgow results of Luffingham (1976), and showed the trust of the public in the value of orthodontic treatment. It did not however, assess the demand in seeking treatment.

Linn (1966) and Samuels and Proshek (1973) showed that enthusiasm for the value of a satisfactory dental appearance at the time of the questionnaire did not correlate with seeking treatment. However, one criticism of these studies is that the participants were already having active treatment and therefore may have been biased.

One of the main contributions of Albino et al 1981, was to evaluate the contributions of both psychological and occlusal variables in the decision to seek orthodontic treatment.

They concluded that dento-facial aesthetics and self-perceptions of occlusal appearance, as well as attitudes towards malocclusion and orthodontic treatment, were important factors in the decision to obtain orthodontic treatment.

In 1965-66 the occurrence of malocclusion was recorded in the entire population of school children in a region of Denmark with no organised orthodontic care. Helm et al (1986) subsequently traced these individuals regarding their concern for dental appearance. Their results showed a close association between three variables; extreme maxillary overjet, reverse overjet, and maxillary crowding. Helm drew

attention to the complicated nature of the psychological mechanism involved in the perception of appearance. Helm concluded that orthodontic treatment should be prioritised towards malocclusions such as those with large maxillary overjets, reverse overjets, maxillary crowding and ectopic canines, i.e. those malocclusion that the lay person seemed most concerned about.

Gosney (1986) carried out another questionnaire-based survey to assess the influence of various occlusal anomalies and other factors upon the desire for orthodontic treatment. The author found that crowding and rotations and, to a lesser extent, spacing caused concern to the patient and even the associated presence of a large overjet did not conceal the effect of these traits. Thus it would seem that a moderately increased overjet alone is not a great source of dissatisfaction. Gosney also concluded that the desire for treatment usually came from within the patient and not from outside influences such as teasing.

Brown et al (1986) attempted to examine the association between psycho-social factors and degree of malocclusion in adolescents, to try to define the role of these factors in the acceptability of malocclusion and desire for treatment. The sample consisted of 13 year olds from a state and a private school. Brown also carried out a psychometric assessment of the acceptance of general physical appearance using aspects of the Piers-Harris Children's Self Concept Scale (Piers 1969). The impact of malocclusion on social and psychological well-being was assessed using the Social Acceptability scale of Occlusal conditions pioneered by Jenny et al (1980).

The author concluded that the more severe the malocclusion, the less acceptable the teeth were and the more likely the desire for treatment. Socio-economic status or ethnicity had no bearing on desire for treatment, but gender did, in that males were more likely to seek treatment. This last point is contentious however, although there was no mention of the possibility that the sample may have been biased in that the more severe malocclusions may have been present in the males in the sample.

### C. STUDIES BASED ON PHOTOGRAPHS

Photographs combined with a questionnaire to convey the results seem to be the most popular form of population assessment in this field. Sergl and Stodt (1970) concentrated on the aesthetics of a missing maxillary incisor. They were also more interested in the whole face aesthetics rather than just dental aesthetics.

The results showed that tooth position constituted a determining factor in the overall aesthetic impression of the face. Positional anomalies following the loss of an incisor might considerably reduce facial aesthetics. The worse variant scores were those where the result was asymmetrical, giving the impression that as long as the teeth are symmetrical they will be accepted by the lay person. Other important factors seem to be diastema free alignment and good axial inclination. The main theme of the results was that the degree of visible occlusal irregularity was an important factor in the desire for orthodontic treatment. However, some of the children with severe irregularities were satisfied with their teeth while others with negligible irregularities were dissatisfied. Thus the range of acceptable malocclusions varies between individuals and factors other than simple dental irregularities played a role in the child's self concept. Lastly, it was found that assessment of the teeth differed between children and professionals.

Shaw (1981) extended his work to see if dento-facial appearance had an influence on social attractiveness. Shaw used portrait photographs of two boys and two girls, modified so that, for each face, five different photographic versions were available. In each version the child's face was standardised, except that a different dental arrangement was demonstrated. The dental arrangements were: normal incisors, prominent incisors, missing maxillary left lateral incisor, severely crowded incisors and a unilateral cleft case.

The results offered clear cut support of the hypothesis that the photographs with normal dental appearance would be judged to be more socially attractive. Thus a dento-facial anomaly may be an important social handicap and hinder a child's social progress.

Shaw (1985) used the same experimental format and method except that photographs of children were replaced using photographs of adults. Again the hypotheses that the photographs with normal dental appearance would be judged to be more socially attractive over a range of personal characteristics was upheld.

Both of the above studies support the provision of an orthodontic service to eliminate social handicapping. However, they did not clarify exactly what aspect of dental appearance was socially unacceptable.

Earlier Shaw (1982) had studied another aspect of the social influence of the dental appearance, that of teacher expectations. Again the same format and methodology was used to produce the photographs. However, the results of this study showed that the original hypothesis that children's faces with normal dental appearance would gain preference with the teachers was not supported. Thus although a poor dental appearance is a social handicap, this study showed that it was not an educational handicap, in influencing teacher acceptance.

Two studies have been carried out using photographs to compare perceptions of occlusal conditions and attitudes towards orthodontic treatment. Cons et al (1983) studied perceptions of occlusal conditions in Australia, the German Democratic Republic (GDR) and the United States of America (USA). This study was an extension of the work carried out by Jenny et al (1980) developing the SASOC. The results of the survey in all three countries were remarkably similar in both students and adults, an argument that the authors used to confirm the reliability of the SASOC rating system.

The second bi-population survey was carried by Tulloch et al (1984). American and British populations were compared in Lexington, Kentucky and Cardiff, Wales respectively. In both communities 385, 11 to 12 year olds and 123 of their parents were interviewed regarding their views of dental aesthetics, treatment need, knowledge, and attitudes towards orthodontic treatment.

Again the results showed the attractiveness rating to be similar in both communities, as was the perceived need for treatment. The same can be said for the importance rating of straight teeth. More of the Cardiff respondents would sacrifice time and money to achieve straight teeth, but the Lexington parents were more willing to meet higher costs for treatment. The Lexington respondents had a greater knowledge of treatment and showed a greater experience of the orthodontic service. Thus, although the Lexington community showed a greater usage and understanding of orthodontics this did not lead to a higher valuation of dental aesthetics, treatment need and increased valuation of straight teeth.

Birte Prahl-Anderson (1979) incorporated not only intra-oral photographs, but also line drawings of facial profiles in her study. Subjects were asked to score the material, from normal, to abnormal and requiring treatment. A significant difference was found between professional and parental responses in 10 of the 11 profiles and in 7 of the 11 intra-oral photographs, with lay judgement tending towards the normal more often. Inter-professional assessments were close in all but one, an 'ugly duckling' example.

#### **D. STUDIES BASED ON STUDY MODELS**

Lindegard et al (1971) attempted to assess the demand for orthodontic treatment by showing study models of 8 different malocclusions, along with full face and profile photographs, to 10 orthodontists and 113 families. An evaluation of the indication for treatment was made using a seven degree rating scale. The hypothesis in this study was that treatment demand was related to socio-economic and other social variables.

The results showed that both groups, orthodontists and families, ranked the malocclusions in the same order, so that their evaluation of the need for treatment was identical. Families of higher socio-economic position expressed a higher demand for treatment than did those with known alcoholic problems linked to lower socio-economic position. Also those with personal experience of orthodontic treatment showed a higher demand.

A study by Davies (1991) combining a study model and questionnaire approach, attempted to ascertain the views of four groups of subjects regarding different aspects of malocclusion and the relative importance of different malocclusion traits. Information was collected based upon fifteen sets of study models, each model having a different malocclusion trait. Three groups of children were used corresponding to a pre-orthodontic, an orthodontic and a post-orthodontic age group. The survey was also presented to a group of general dental practitioners. The results showed general confirmation between all age groups with respect to their opinion of what is an aesthetic set of teeth, and what is unacceptable. There was general agreement that severe Class II div1, Class III and Class II div 2 were unacceptable. As the age increased the opinions of the subjects became more demanding and their standards higher. There was also good correlation between the opinions of the dentists and the groups of children.

A recent study by Birkeland (1996) combining a questionnaire and study model approach attempted to investigate and compare the opinions of both children and parents with an orthodontists assessment of treatment need and the childrens self esteem, which was measured by the global negative self-evaluation scale (GSE). This study found that the childrens own assessments of the aesthetic component of the Index of Treatment Need (IOTN) were closer to the attractive end of the scale than the orthodontists, that the childrens GSE scores were not correlated to components of IOTN and that some patients with great need do not express orthodontic concern, whereas others with near ideal occlusion express concern.

## SUMMARY

The psychological, social, and cultural aspects of facial and dental attractiveness is an integral part of health care. Since the term malocclusion as distinguished from normal variation is difficult to define, the extent to which an individual is labelled or labels himself as having a malformation requires a value judgement. Although not confirmed unanimously by studies done so far, it would still seem obvious that for a susceptible individual, the greater the aesthetic impairment, the greater the effect on that individuals socio-psychological well-being, the more the negative effect on that individuals body image and self esteem.

The lay persons perceptions of facial and dental attractiveness will be influenced by many factors including age, gender, geographic location (nationally or international), ethnic status, employment status, cultural differences and social class will effect the social impact of the anomalies. In addition, the public response to dental anomalies will vary according to experience of good health or ill health of the individual, relatives and friends.

Further, it has been demonstrated that persons with unattractive appearance may be disadvantaged in terms of third party assessment and interactions, and that this may affect their social skills. Furthermore, it has been shown that dental features do contribute towards a person's attractiveness. One might also expect that in addition to an effect on performance and social skills, social response has an influence on self esteem.

Even if it could be demonstrated that orthodontic treatment could permanently improve aesthetics both intraorally and facially, it needs to be demonstrated that this will have an effect on an individuals psycho-sociological well-being, or upon their interrelationships in society. These characteristics may not be influenced by aesthetics, or the early formative years may have an overriding effect on any subsequent improvement in psycho-sociological well-being.

Work in the field of dento-facial aesthetics and the desire for orthodontic treatment has attempted to address many questions, the prevalence of malocclusions, child and parental awareness of various malocclusion, demand for treatment and factors that determine the demand. However, the scientific information is inconclusive and all the previous studies have their limitations. Many studies have aimed to determine public opinion of malocclusion and demand for improvement but it appears that the studies have considered each malocclusion as a whole. They have not attempted to break down each malocclusion to individual components, in order to study more closely the factors that influence judgement by the public.

## **PART III**

# **OBJECTIVE MEASURES OF FACIAL AND DENTAL ATTRACTIVENESS**

### **Introduction**

An occlusal index may be used to record the various occlusal traits of a malocclusion in either numerical or categorical form.

The index may involve direct physical measurement (e.g. overjet), recognition of discrete morphological variations (e.g. crossbite or functional mandibular displacement), or taking the malocclusion as a whole and recording dental attractiveness.

Many indices have been developed for specific tasks although in practice most indices may be used for more than one purpose.

### **Requirements of an index**

Many authors (Draker, 1960 Summers, 1971 and Tang & Wei, 1991) have suggested that the following criteria must apply to any index; it should:-

- a). be valid and reliable i.e. should give a true measurement of the anomaly and the test should give consistent results in repeated trials. Many studies have used consensus of several experienced orthodontists in order to compare with the results of the index (Salzmann, 1968; Summers, 1971; Malmgren, 1980; Jenny et al., 1983). In general, the process of validation involves the comparison of a subjective measure against a more objective measure of the characteristic.
- b). be objective in nature and yield quantitative data which may be analysed.
- c). have the ability to be performed quickly, even by examiners without special instruction in orthodontic diagnosis.
- d). be possible to apply to either patients or dental casts.

- e). be acceptable to the profession and the public alike. Since participation is voluntary so an index must be acceptable to individuals being assessed and professionals applying it.
- f). should be valid during time i.e. the index should measure the basic orthodontic defect and not the symptom of a developmental change.
- g). be reproducible. The reproducibility of an index can readily be tested ie. observers must consistently obtain the same values for a series of test cases.
- h). Sensitivity. The index should be capable of providing a positive finding, when the individual being assessed has the anomaly being sought.
- i). Specificity. The index should be capable of giving a negative finding when the individual being assessed does not have the anomaly being sought.
- j). be acceptable to the cultural society norms. The index must be flexible to assess the individual needs, in line with cultural and society norms.
- k). be adaptable to the available resources. The index must be able to reflect need in a population which will match the expertise and resources available. To provide treatment to a worthwhile extent with long lasting effect.

## **TYPES OF INDICES**

### **A. Diagnostic classification**

These indices provide a description of a malocclusion which allows communication between personnel, enabling an adequate description of a malocclusion, without the necessity of referring to the patient or patient records. Angle's classification (Angle, 1899) is the best known example of this type. Since Angle's classification there have been many reports on its use, and many suggested modifications to overcome its shortcomings, Gardiner(1956). Another example includes Simons (1924) classification. However, more recently the British incisor classification (BS 4492, 1983) has become more popular and is often supported with other information regarding intra- and inter-arch relationships, allowing a full description of the occlusion.

The reliability of the Angle's classification has been questioned (Gravely and Johnson 1974, Salzman 1969, Jago 1974) because high intra and inter-examiner errors were

exhibited. The authors suggested that previous epidemiological studies showing differing distributions of malocclusions in various populations were mainly due to diagnostic standards rather than the differences between the communities. Isaacson et al (1975) further stated that Angle's classification has serious limitations because only the antero-posterior relationships of the teeth are considered and Case (1963) criticised Angle's classification stating that it disregarded the relationship of the teeth to the face.

## **B. Epidemiological data collection**

These indices have been developed to describe the prevalence of various occlusal traits within a population. The Epidemiological Registration of Malocclusion developed by Bjork Krebs and Solow (1963), Baume et al (1973) is such a system for recording occlusal traits.

The index developed by Bjork, Krebs and Solow (1963), formed the basic method for recording of malocclusions developed jointly by the WHO and the International Dental Federation (Bezroukov et al, 1979) and has been used to assess treatment need, although it was recommended that examinations should not be made on subjects in the mixed dentition stage of development because many problems at this stage are self correcting and the index over estimated the levels of treatment need.

Although these registration techniques were quite acceptable and most of the traits can be recorded with a high degree of precision, it has been stated that the index tends to be complex and time consuming, ( Helm et al 1975, Helm 1977). Other indices of this type score tooth alignment on stability for research purposes (Lau et al. 1984, Little 1975).

The prevalence of malocclusion may need to be recorded for several reasons:

- a) Planning of staff & financial resources (Stephens et al, 1985).
- b) Epidemiological research into the long term effects of malocclusion on dental health and socio-psychological well being (Shaw et al 1980).

- c) Possible aetiological factors acting on malocclusions on a geographical or community basis (Murray 1969). There is a need for accuracy in recording malocclusions over time, between communities and between examiners, if meaningful comparisons are to be made.
- d) Data for health care planning can be provided by epidemiologic surveys (Knox 1979, Holst & Rise 1986).

### **C. Treatment complexity**

The aim of these indices is to classify those cases in which treatment could be best undertaken within the range of competence of the non-specialist, the orthodontic specialist and a specialist interdisciplinary team (Working party on British orthodontic Standards, 2nd report, 1985). Further, the index should predict the difficulty of treatment (including where appropriate the appliance type), and to predict the treatment prognosis.

Several assessments have been developed (Gardiner, 1956; Foster and Walpole Day, 1974; Crabb and Rock, 1986; Haynes, 1973; Richmond, 1984 and Robertson et al, 1986, Stephens and Harradine 1988). Treatment complexity is related to the aetiology of the occlusal defects rather than to the defects themselves. For example, an increased overjet may be the result of proclination of the upper incisors, a skeletal discrepancy or a combination of both. These assessments assume that the designated practitioner is competent in delivering good quality care.

### **D. Indices to record treatment need**

In a health care system, establishment of treatment priority and criteria for allocation of public subsidies have to be based on scientific information. Several indices have been developed to categorise treatment according to urgency and need. Such an index should not only establish a priority of treatment for an individual according to the severity of the malocclusion and the functional disability, but also measure and evaluate the degree of aesthetic handicap associated with the malocclusion. Individuals with greatest treatment need can then be assigned priority when

orthodontic resources are limited, and when the availability of treatment is unevenly spread, to plan resources for both staff and facilities.

Similarly, individuals with little need for treatment can be safeguarded from potential risks of treatment (Shaw, 1988) and that a series of clearly defined levels of treatment need would be useful. By having such a classification system, and knowing the proportion of the population falling into each category, public dental health planners could select a workload which suits their goals and resources.

There are many indices that have been developed to undertake these tasks. Examples are Handicapping Labio-lingual deviation (Draker, 1960), Treatment Priority Index, TPI (Grainger, 1967), Occlusal Index (Summers, 1971, Handicapping Malocclusion Assessment record, HMAR (Salzmann, 1968), Index of Need of Orthodontic Treatment, INOT (Ingervall and Ronnermann, 1975), and the Swedish National Board for Health and Welfare Index (Linder-Aronson, 1974), Index of treatment need, IOTN, (Brook and Shaw 1989, Shaw and Richmond et al 1991), and the Need for orthodontic treatment index, NOTI (Norway 1990).

Several of these indices have attached importance to various occlusal traits to represent clinical opinion ie. to give each trait a weighting, then calculate an overall score (Salzmann, 1968; Summers, 1971; Grainger, 1967). The Treatment Priority and Occlusal Index have been weighted statistically by comparison to subjective assessments and others have been weighted according to the opinion of the authors (Draker, 1960; Salzmann, 1968). Correlation coefficients for examiner agreement for such indices have ranged from a Spearman correlation coefficient of 0.903 (Summers, 1971) to as low as 0.34 (Albino et al., 1978) in a community screening setting. The validity of such indices relies on acceptance of the author's weightings. Selection of these weightings represents the weakness in these assessments.

It has been pointed out that application of weightings to such diverse effects as TMJ dysfunction and rotated anterior teeth, in an attempt to define the need for each to be corrected, has to be subjective, no matter how objective the measurement of the traits

(Helm, 1977), and that orthodontists unaided subjective opinion may still be the best estimate of treatment need, although some suggest that such a subjective assessment has poor reliability (Foster, 1980). Subjective clinical opinion alone has agreement of about 80 per cent in most studies (Bowden and Davies, 1975; Helm et al., 1975) but the validity of such judgements depends upon the examiners' knowledge of the harmful effects of malocclusion. In addition, inexperienced examiners will find it difficult to apply such techniques.

The OI, TPI and HMAR use weighting systems which enable a score of severity to be calculated thus implying relative treatment priority. Only the OI had developed different scoring schemes and scoring forms for patients in different stages of dental development i.e. deciduous, mixed and permanent dentition. There have been several studies comparing the different indices (Albino et al, 1978, Banack et al 1972; and Jarvinen and Väättäjä 1987). It appears from these studies that the TPI is more reliable and more discriminating than the HMAR and Drakers Index. The Swedish Index however, was less time consuming than the HMAR, INOT and TPI.

Carlos & Ast (1966) concluded that HLDI (Draker 1960) could not distinguish between handicapping and non-handicapping malocclusions. Tang & Wei (1993) stated that the OI developed by Summers (1971) appeared to have the least amount of bias, is best correlated with clinical standards and has the highest validity during time. Ghafari et al (1989) longitudinally evaluated the TPI as a valid epidemiologic tool, but TPI values recorded in the transitional dentition does not predict the future severity of malocclusion.

The OI was more complicated to use than the TPI requiring more calculations and clerical time. The HMAR has an advantage in that subjective decisions are not as critical as only full cusp discrepancies are noted, if errors are made, they are not usually serious because the weighting system was applied only to the anterior segment and mostly for aesthetics.

Hermanson & Grewe (1970) tested the precision and bias of HMAR, OI, TPI. They concluded that the most precise and unbiased was the OI. Gray and Demirjian (1977) compared reproducibility & accuracy of HLDI, TPI, OI, HMAR. They concluded that the OI best correlated with clinical standard.

A further method to define treatment need was developed, the Matched-pair similarity technique. A new patient can be compared with a grouping (TPI- Grainger 1967) to find the closest match, then assigned that score (Freer, 1972). Introducing this second process of matching to a previously scored series, would seem to add no advantage, and may compromise accuracy.

The other major approach to establish treatment need, is to define traits, or degrees of severity of traits, that constitute a threat to the health, aesthetics, functioning, or longevity of the dentition, and place these traits into groups of varying need for treatment according to this rating. Indices based upon the classification of morphological traits rely on the subjective opinion of an experienced judge to define the dividing lines between each trait (Linder-Aronson, 1974; Lundstrom, 1977; Malmgren, 1980). Used as such, the percentage concordance ranges from 55.9 to 74.6 per cent (Malmgren, 1980)

The best known index of this type was the index developed by the Swedish Board of Health and Welfare (Linder-Aronson, 1974; Lundstrom, 1977) and Denmark (Socialstyrelsen 1990), NOTI (Norway 1990), IOTN ( Brook and Shaw 1989). Essentially this is based on the type and degree of morphological deviation from normal. The Swedish Medical Board (Linder-Aronsen 1974) which classifies patients into grades ranging from very urgent need for orthodontic treatment to little need. The two main problems with this index are that the guidelines for allocating malocclusions into each grade were frequently subjective, leaving too much scope for individual interpretation and the index also attempts to give some measure of aesthetic impairment, but in doing so again gives the examiner only subjective guidelines. There is also loss of reproducibility if used by non- orthodontic personnel.

The Dental Health component of the IOTN, Brook & Shaw (1989), is loosely based on the Swedish Board Index. Each occlusal trait thought to contribute to the longevity and satisfactory functioning of the dentition is defined and placed into 5 grades with clear cut-off points between the grades - Grade 5 (great need) to Grade I (no need for treatment). A premise of the index is that dental diseases are site specific and only the most severe trait is identified as the basis for grading the individuals need for treatment on dental health grounds. Summing scores for a series of individual traits is not performed. The DHC cannot be validated in the strictest sense of the word, but it has been validated against 74 dentists to represent current British Orthodontic opinion. Further, a small number of comparative trials have compared a number of indices in terms of the reliability and ease of use. So and Tang (1994), found that both the OI and the IOTN had shortcomings for the purposes to which the authors intended to use them, but found the IOTN quicker and easier to administer.

The orthodontic index of treatment need, IOTN (Brook and Shaw 1989) has examiner agreement levels that compare well with any of those previously developed. As its development was based upon a full analysis of the available literature (Brook, 1987) and the experience gained from a longitudinal survey (Shaw et al., 1986), it is not felt that its validity can be inferior to that of other indices. The inclusion of a separate index to record aesthetic impairment removes the most subjective element from indices of this kind with good levels of agreement for this component.

Subjective opinion does not necessarily have any validity taken alone and any assessment of treatment need should be based on accurate knowledge regarding the consequences of malocclusion (Carlos, 1970; Jarvinen and Väättäjä, 1987). However, the need for treatment has been regarded as more or less arbitrary because the knowledge about the consequences of malocclusion has been inadequate.

Different structures of indices could be accountable for differences in epidemiological estimates of treatment need. This has been investigated by Burden and Pine (1994), who found that epidemiological indices used in the UK commonly underestimate the

number of children with severe malocclusion. The differences in results are due to poor reliability and validity of many of the existing indices.

Table 2.4 shows a collection of surveys undertaken over the last 10 years in which professional need has been identified within various populations in Europe. The professionally determined need varies widely and depends on the age, gender, type of population studied and the cut off levels for severity of malocclusion. However, using different methods including subjective assessment and indices, estimates of treatment need range from 33% (Holmes 1992, Burden and Holmes 1994) to 74.8% (Myrberg and Thilander 1973). Some studies indicate greater need in males than females (Ingervall et al. 1972, Brook and Shaw 1989, Holmes 1992a), while other studies indicate equal need for treatment amongst the sexes (Espeland et al 1992).

Thus in summary the aims of treatment need indices are:-

- a). To carry out treatment only when there is a positive indication, thus reducing regional variations in the provision of care (Stephens & Bass 1973).
- b). Limiting the utilisation of limited funds to patients who will benefit from treatment (Schanschieff report 1986).
- c). The aims of indices is to record treatment need in a population and assign priority to cases and to plan resources (staff, equipment and facilities). In the presence of limited services/resources, and with an uneven spread of availability of treatment, individuals with the greatest treatment need can be assigned priority, similarly, patients with little treatment need can be safeguarded from the potential risks of treatment (Shaw 1988).

Table 2.4

	INDEX	EXAMINER CALIBRATE D	TYPE OF SAMPLE	AGE GROUP	% NEED	% DEMAND	DATE	AUTHOR
DENMARK	BJORK et al	N	REPRS 145 BOYS 148 GIRLS	13-17	45-61%		1975	HELM et al
	BJORK et al OWN	N	REPRS 531 REPRS 1000	9-10 11-12	70% 59.9%		1987 1974	ROLLING FOSTER & DAY
ENGLAND AND WALES	OWN	N	REPRS 127 BOYS 142 GIRLS	14	50%		1974	LUFFINGHIM
	IOTN IOTN	N N	333 REPRS REPRS 244 BOYS 225 GIRLS	11-12 14	SEVERE 32.7% SEVERE 25.3%	14%	1989 1989	BROOK & SHAW ROBERTS et al
FINLAND	OWN	Y	REPRS 793	9-15	SEVERE 8 yrs 46.7% 12 yrs 40.2% 15 YRS 22.4%		1992	HILL
	IOTN IOTN	Y N	REPRS 955 REPRS 10,291	12 9-15	SEVERE 36.3% 9 yrs 31% 5-15 years 15-33% 11-12 yrs 27.5%	12 yrs 16%	1992 1993	HOLMES OPCS
	IOT N IOTN	Y Y	REPRS 506	15-16 11-12	SEVERE 30.4%		1994 1994	BURDEN et al BURDEN & HOLMES
	IOTN	Y	REPRS 289	11-12	SEVERE 30%		1994	BURDEN & PINE
	BJORK et al	N	REPRS 100 BOYS 100 GIRLS	7-7	23.5 NEED 34.5 OBSERVE		1978	HEIKINHEIMO
			N	370 RECRUITS REPRS 256	6-11	50%		1992 1990
GERMANY		N						
ITALY		N						

NETHERLANDS	OWN	N	208 MALE RECRUITS	9 AND 10.5	50%	22%	1978	PRAHL ANDERSEN
	OWN	N	REPRES	15-74	15 yrs 35-39%	15-19 yrs 23.5%	1991	BURGERSDIJK et al
NORWAY	NOTI	Y	99 48 GIRLS 51 BOYS	10-11	MOD-SEVERE 64%		1992	ESPELAND et al
SWEDEN	BJORK et al	N	REPRES 3.093 BOYS 3.305 GIRLS	7-10-11	73%		1973	THILANDER AND MYRBERG
	BJORK et al	N	301 MALE RECRUITS	18 yrs 8 mths	60%	4%	1974	INGERVALL & INGERVALL & HEDEGARD
	BJORK et al BJORK et al	N Y	357 MEN 920	21-54 >20	76.7% 35% MALE 40% FEMALE	2% 8% MALE 11% FEMALE	1978 1992	INGERVALL et al SALONEN et al
	SNHBI	Y	324	9-12	40% MOD-SEVERE		1972	INGERVALL et al

## **E. Indices to record aesthetic impairment**

Though there is some evidence to support the contention that malocclusion may have an adverse effect on function and oral health (Miller and Hobson, 1961; Poulton and Aaronson, 1961) there is little evidence that all orthodontic treatment improves function and oral health over the long term. Recent research has placed doubt on the importance of malocclusion for dental health and the functioning of the dentition.

Recent research has also called into question many of the previously held views on the benefits of orthodontic treatment (Shaw et al., 1980). There may be small effects on the susceptibility to temporomandibular dysfunction (Roth, 1973; Mohlin and Thilander, 1984) and periodontal disease (Horup et al., 1987; Sandali, 1973; Davies et al., 1988; Addy et al., 1988). However, so many studies have been undertaken on these subjects, with differing conclusions, and often only weak statistical associations, that it is difficult to believe that the effect, with a small number of specific exceptions, can be anything but minor.

However, McNamara et al (1995), in reviewing the literature regarding the interaction of morphologic and functional occlusal factors relative to Temporomandibular Disorders indicates that there is a relatively low association of occlusal factors in characterising TMD. They state that skeletal anterior open bites, overjets greater than 6-7 mm, retruded cuspal position/intercuspal position slides greater than 4 mm, unilateral lingual crossbite, and five or more missing posterior teeth are the five occlusal features that have been associated with specific diagnostic groups of TMD conditions.

However, social science surveys have highlighted the importance of the aesthetic impairment on patients' psycho-sociological well-being. Social science research indicates that unacceptable dental appearance may stigmatise, impede career advancement and peer group acceptance, encourage negative stereotyping and have a negative effect on self-concept, (Cons, Jenny, Kohout 1986). As a result, any meaningful index of treatment need must include a component designed to measure aesthetics and by implication the likely level of psychological disadvantage. Such an

index should not only establish a priority of treatment for the individual according to the severity of the malocclusion and the functional disability, but also measure and evaluate the degree of aesthetic handicap associated with the malocclusion.

Several indices have been developed to record aesthetic impairment, the Photographic Index (Banack et al, 1972), Dental Aesthetic Index (Cons et al, 1986) and the Scan Index (Evans and Shaw, 1987), Index of Orthodontic Treatment Need Aesthetic Component (Shaw et al, 1991), Tedesco et al (1983) and more recently a Dutch index proposed by Peerling et al (1995).

Most indices used in assessing treatment need contain a weighting factor for aesthetic impairment. The Dental Aesthetic Index by necessity, uses two stages. Firstly, it records occlusal traits, then it derives a score using weighted multiples of these traits. Thus, it does not record directly the aesthetics of the patient, who may have many more interrelating variables going to make up their dental appearance, than those specifically recorded.

It is more convenient however, to consider aesthetics as a separate entity. This led to the SCAN Index (Standardised Continuum of Aesthetic Need) , developed by Evans and Shaw (1987) based on a series of photographs of labial views of teeth with varying degrees of irregularity. A measure of aesthetic impairment may be made by choosing a photograph with a similar degree of aesthetic impairment. Good agreement between patients/parents, and orthodontists on results has been demonstrated and is included as the aesthetic component (AC) of the Index of Treatment Need (IOTN), Brook and Shaw (1989). The SCAN index suffers from the opposite problem. As pointed out by Cons et al (1986), only a few configurations are represented on any pictorial scale. Yet the occlusal conditions of people vary so much. Thus it is difficult to rate the aesthetics of a great many individuals adequately, since malocclusions of the type the patient presents with, may not be illustrated on the scale.

Obvious shortcomings of the scale are its poor ability to represent dentofacial imbalance in the antero-posterior plane, which is often associated with malocclusion. Consideration might also be given to the use of photographs from an older sample, since some of the 12-year-old sample had dentitions that were still transitional. On the other hand, its very simplicity and apparent ease of conceptualisation by different judges may commend its use in everyday practice as well as in epidemiological studies.

Taken together with an appraisal of the dental health implications of a particular malocclusion, some estimate of relative need for treatment is possible. In circumstances of limited resources where treatment priority requires determination, or where a broader context is required in individual patient counselling and in guiding the subject through cost-benefit analysis of the desirability of treatment, such an index may have an application. Clearly eventual treatment decisions should be sensitive to the needs of the individual (for example, an allowance made for the lower self-rating of subjects with reduced self-esteem).

## **F. Indices to record treatment standards**

These indices compare pre-and post-treatment records to register the outcome of the orthodontic care. The success of orthodontic treatment can be monitored, allowing comparison of start and finish records (Elderton & Clark 1983, 1984). Finish records can be compared with those of the condition some time out of retention, so as to monitor relapse (Berg 1979).

Several indices have been developed specifically to assess the success of treatment (Eismann, 1974, 1980; Gottlieb, 1975 and Berg, 1979 ; the PAR index developed by Richmond et al, 1992 a and b). Apart from the PAR Index the reliability and validity of these other indices has never been established. Comparative studies have shown reliability and validity for PAR and the OI were high (intra class correlation  $> 0.9$  for both indices), but greater ease of use for the PAR index was observed (Buchanan et al 1993). A further comparison has been undertaken by Turbill et al (1994), which supports the high reliability of PAR index.

The Occlusal index of Summers (1971) has been used by several authors to assess the outcome of treatment (Pickering and Vig, 1974; Elderton and Clark, 1983, 1984). Pickering and Vig, (1974) in the first application of an index to assess the effectiveness of orthodontic treatment used Summer's Occlusal Index (Summers, 1971) as an outcome measure to evaluate the effectiveness of treatment provided . This study appears to give valid and reliable results in quantifying treatment change in occlusal terms and revealed that a proportion of patients did not benefit from treatment and that fixed appliances were the most effective treatment method.

Berg (1979), Berg and Fredlund (1981) using the TPI of Grainger (1967) used a criterion based approach to assess samples of consecutively treated cases. They concluded that 43% and 60% of cases had normal occlusions following treatment. The authors coined the term "partial success". In contrast to these results an analysis of completed cases at the Scottish Dental Estimates Board using Summer's Occlusal Index (Summers, 1971) revealed that treatment change was inadequate and the standard of treatment required improvement. (Elderton and Clark 1983,1984).

Jones, (1988) carried out an extensive study using a three-dimensional assessment of occlusal change. He concluded that the overall success of treatment was high. This was influenced by the method of treatment, two arch fixed appliances being more effective than removable appliances.

The Peer Assessment rating (PAR) Index has been specifically developed to measure treatment change provided within the British National Health Service, (Richmond et al 1990). The PAR Index (Richmond 1992) provides a single summary score for all the occlusal anomalies and may be used for all types of malocclusions, treatment modalities and extraction/non-extraction cases. The components of the PAR Index have been weighted to reflect current British dental opinion, (Richmond et al,1992). The score provides an estimate of how far a case deviates from normal and the difference in scores for pre-and post-treated cases reflects the perceived degree of improvement and therefore the success of treatment. By applying the pre- and post treatment scores to a nomogram, 3 categories of judgement can be obtained for all

severities and types of malocclusion, (great improvement/moderate improvement/ no change). The PAR Index offers uniformity and standardisation in assessing the outcome of orthodontic treatment. By applying the results, patients who exhibit high priority are treated by practitioners competent to carry out the treatment to a high standard and with lasting stability. Excellent reliability within and between examiners has been demonstrated using the PAR Index.

There are basically two methods of assessing improvement using the PAR Index, reduction in the weighted PAR score and percentage reduction in the weighted PAR score. The percentage reduction in weighted PAR score could be used to assess or set the standard of orthodontic treatment within a publicly funded health care system. For a practitioner to demonstrate consistently high standards, the proportion of the case load in the 'worse or no different' category should be negligible and the mean percentage reduction should be as high as possible, (Richmond et al, 1992).

Two large scale studies have been carried out by Richmond, (1991) and Turbill et al, (1996), assessing patient's records obtained from the Dental Practice Board of England and Wales for orthodontic treatment need and treatment standards with the Index of Orthodontic Treatment Need (Brook and Shaw, 1989) and the Peer Assessment Rating (Richmond et al., 1992) respectively. He concluded that the standard of treatment was poor and many patients did not receive an improvement in occlusion following a course of orthodontic treatment. Again, two arch fixed appliance therapy was the most effective treatment method.

The fine balance of risk and benefit and the important inter-relationship of treatment need and treatment standards is shown clearly in the General Dental Service in England and Wales, where orthodontic treatment standards appear to be poor. Several reports have suggested that British orthodontic results are not as good as those achieved in North America and Northern European countries (Cousins, 1973; Shaw, 1983, Haynes, 1979; British Orthodontic Standards Working Party, 1986). An unacceptable proportion of the patients had an occlusion which was unimproved or

made worse as a result of treatment. This may be related to a high case load, (Haynes 1981) or to the use of removable appliances.

This risk was especially high for cases of borderline need. In the example of the hospital-based service (O'Brien, 1991), the overall chance of a beneficial outcome was higher, with the majority of cases taken on having high need and generally receiving treatment which achieved a substantial improvement.

Arguably, patients with malocclusion in the lower two grades of the dental health component ie. Grades 2 and 3 are unlikely to obtain any dental health benefit from orthodontic treatment, and, similarly, children in the lower ranges of the aesthetic component will not evoke adverse social stereotyping. They are very firmly within the normal range. Such patients run a substantial risk of being worse off after treatment. In a study of borderline cases Richmond et al., (1992c), as many as 50 per cent of patients did not appear to benefit from treatment.

A report on child dental health in England and Wales (Todd and Dodd, 1985) found that 30 percent of 15-year-olds who had previously received orthodontic treatment were in need of further treatment. During the year 1986/87, 35 800 orthodontic cases treated within the General Dental Services were reported as discontinued, (14 per cent of all non-prior approval cases and 26 per cent of prior-approval cases). The evaluation of treatment results in various fields of medicine is frequently based on the consideration of the following aspects, success or failure rates, degree of improvement or aggravation, result as related to the time factor, and result as related to the cost factor. In orthodontic treatment, the study of these aspects is currently receiving great attention.

Perhaps the greatest risk in orthodontic treatment is that of partial or total failure in accomplishing a worthwhile, lasting change. This may be caused by poor co-operation by the patient (Haynes 1991) and/or incorrect diagnosis and mechanics on behalf of the operator, the constraints imposed by an underlying skeletal discrepancy, which cannot be changed by orthodontic treatment alone.

## **USES/ADVANTAGES OF AN INDEX OF MALOCCLUSION**

The application of indices offers several advantages as stated by Richmond (1992).

### **a). Uniformity -**

The use of an index of orthodontic treatment should influence dentist referral threshold by providing a set of guidelines that should lead to more uniformity of assessment of the need for orthodontic treatment.

### **b). Safeguards for Patients**

The benefits of all medical and dental intervention have to be balanced against treatment risks and costs in order to safeguard individuals from procedures which are of little benefit or even harmful.

### **c). Patient Counselling**

Patients who express a desire for treatment may accept a dentists advice more readily if this is based on broadly agreed convention rather than a personal view. A major disadvantage of indexing systems is the insensitivity to patients with minor irregularities who are concerned about their malocclusions.

### **d). Resource Allocation and Planning**

In the view of limited public resources for health care - better treatment of fewer patients seems to be a better proposition than a dilution of resources which will result in a mediocrity of standards and a risk/benefit imbalance. Manpower and resource planning is possible where cut-off points are agreed and the proportion of treatment uptake can be estimated realistically.

### **e). Monitoring and Promoting Standards**

Self assessment for the individual practitioner. To determine differences between various treatment modalities. Indices may be used with some confidence as an indicator of clinical performance for the interested practitioner or for quality control within State/Insurance programmes.

#### **f). Education**

Education is an important element in the maintenance of standards. As a self-teaching device, indices can improve the quality of future treatment. This can only be achieved using an objective assessment and it might be argued that occlusal indices should be a mandatory component of undergraduate and postgraduate education.

#### **g). Clinical Audit/Promotion of Profession**

Firstly, the profession is accountable to the public from which it obtains authority and economic support to practice. Secondly, there must be a continuous striving to promote and improve the standard of care provided. Thirdly, there is a need to demonstrate proficiency to potential patients, the public at large and third party payment agencies. The benefits of clinical audit are improved clinical care, improved effectiveness and efficiency and enhanced job satisfaction.

#### **h). Determine differences between health care systems**

The use of occlusal indices would allow one to determine differences between health care systems and can facilitate international comparisons when standards are agreed upon.

## SUMMARY

Assessments of treatment need or outcome can be made by subjective judgement or using a criterion based structure called an index. The utility of indices lies in the facility to accomodate comparable assessments by different operators. The use of indices should ensure uniform interpretation and application of criteria. Although numerous indices have been developed none as yet have been universally accepted. The use of precise criteria are essential, requiring a quantitative objective method of measuring malocclusion and efficacy of treatment.

Restricting and intrusive as it may seem, perhaps the time has come for the profession to consider the use of some form of treatment need and treatment success indexing in order to improve our clarity in thought in risk/benefit appraisal and assessment of the worth of orthodontic treatment to the population.

The goals will need to be assessed in concord with the norms and values of the population in question regarding oral health and well being. The use of indices introduces an element of "trans-scientific decisions", which has been described as "the component where science is asked to resolve a problem which cannot be answered by science because it involves value, moral and/or aesthetic judgements". The values of the individuals whom the health care system is serving should therefore be considered when indices for treatment need are established.

Many orthodontists and public health administrators who are responsible for providing orthodontic treatment in publicly funded programs have expressed a belief that undesirable occlusal traits can have a negative effect upon social functioning. Although objective methods exist for measuring occlusal conditions, to date no one has found a way to measure the relationship between occlusal morphology and social functioning as a factor in assessing treatment needs. Nor has anyone yet developed a method for predicting which occlusal morphologies might become a social handicap for an individual.

During recent decades, the health and social services budgets in industrialised countries have been continuously growing and account for an increasing proportion of the Gross National Product year by year. In many countries, this growth has lately shown a tendency towards stagnation, there is a limit to how much resources can be used for health care. This situation initiates a fiercer competition among medical fields for public money, and as a consequence, politicians require better quality of all kinds of data and/or arguments used by the various professions. In dentistry, this will comprise treatment need estimates, particularly those which may reflect population needs and may be used as a basis for public planning of services, personnel and education.

Current epidemiological data based on indices are necessary to detect trends or determine changes in the prevalence of malocclusion. However, in an age of increasing accountability, health care is attracting the attention of health economists working on behalf of socialised services and insurance schemes. There is certainly a need to improve diagnostic criteria and develop a common approach in assessing treatment need so that those patients who exhibit high priority are treated by practitioners competent to carry out the treatment to a high standard and with lasting stability.

## PART IV

### PATIENT AND PROFESSIONAL INTERACTIONS

#### A. COMPARISON BETWEEN LAY AND PROFESSIONAL PERCEPTIONS.

Traditionally, dentists and orthodontists are expected to give advice on the need for orthodontic treatment to improve appearance. To do this, the practitioner must possess some knowledge of the degree of irregularity which is generally acceptable to the community at large.

To determine the need for orthodontic treatment of a population and to distribute adequately the available manpower for the correction of malocclusions, it must be realised that the image the layman has of a normal and abnormal dentofacial region differs significantly from that of the professional who refers and treats malocclusions.

At present the information available on this topic is somewhat conflicting. Lindegard et al (1971), suggested that orthodontists and parents assessed the aesthetic indications for orthodontic treatment in a way which produced close agreement. However, the validity of this particular study might have been flawed as the interviewer defined normality for each parent by demonstrating first, models of a ideal occlusion. Similarly Jenny (1983), in comparing three malocclusion indices and orthodontist clinical judgement indicated that public and professional perceptions approximate each other to a significant degree as regards assessments of severity and need for treatment.

A recent study by Piättilä (1996), concluded that adolescents perceived satisfaction of their own dental appearance coincided well with objective treatment need.

Several studies have however, revealed a discrepancy between an individual's own views of the acceptability of his dental appearance and the views of dental assessors. Some subjects under-estimate the severity of their irregularity (Goldstein, 1969; Myberg and Thilander, 1973) while others express dissatisfaction with objectively good occlusion (Howitt et al., 1967; Lewit and Virolainen, 1968). Katz (1978), failed to find a meaningful association between subject's level of satisfaction with dental appearance and any of the currently used orthodontic indices. The British Child Dental Health Survey (Todd, 1975a) showed that almost half of the parents of children with upper incisor crowding appeared to be unaware of the condition.

Other studies indicated that subjective and objective assessments of malocclusion could be quite different (Myrberg and Thilander, 1973; Ingervall and Hedegard, 1974, Shaw, 1975). The discrepancy between lay and professional judgements has been alluded to by Secord and Backman (1959), Lewit and Virolainen (1968), and Howitt (1967) and co-authors among others, but it is most dramatically emphasised by Goldstein (1969). On the basis of clinical examinations and magnified photographs, he concluded that 97 percent of his subjects could have benefited from some treatment for esthetics and that 90 per cent needed this treatment. While most of the subjects agreed that it was possible for their dental appearance to be improved, only 28 per cent thought that their teeth detracted from their appearance. Since the subjects were all finalists in the Miss Atlanta Pageant, the social judgement concerning their appearance was clear.

To illustrate how large the discrepancy is between the judgement of the profession and the perceived need for treatment, two studies will be mentioned. In a Swedish study Ingervall and Hedegaard found in a group of 18-year old Swedish men, 60 percent were judged by the orthodontist to be in need of orthodontic treatment, but only 4 percent were aware of their malocclusion and desired orthodontic treatment. The other study to be mentioned has been conducted within the Nymegen Growth Study (1979). It was hypothesised that the severity of a malocclusion is judged by the orthodontist on functional, morphological, and aesthetic criteria, whereas parents' opinions of the severity of their children's dental condition probably are based on

different criteria. Fifty percent of the children were considered in need of orthodontic treatment. Twenty-two percent of the parents were aware of their children's malocclusion and wanted it treated.

In the evaluation of the need of treatment of an anomaly, much importance is often attached to defects believed to impair the patient's appearance and the belief that the patient therefore wants to have the anomaly corrected. But judging from the present investigations there is a considerable risk of overestimation of the subjective need of treatment. This low figure for awareness of anomalies and treatment desired is in line with the results published by Myrberg and Thilander (1973a), who found that one fifth of all patients who had received long and extensive orthodontic treatment had not even considered whether treatment had been successful or not.

These discrepancies may be explained by the study of Carlos (1970) who tested with orthodontic indices on 162 subjects with a mean age of 21 years. A patient's satisfaction with his own mouth and teeth was evaluated with the Eastman Esthetic Index (Howitt, Stricker, and Henderson 1967). All eight indices corresponded very poorly with one's self-image. Certainly these results indicate that the patients and their parents have a different norm concept, probably including other variables and other weightings than the norm handled by the profession, and that the patients subjective symptoms do not always match the objective signs registered by the orthodontist.

Studies comparing lay and professional differences for dental aesthetics, perceptions of dental-facial attractiveness, and their relationship to occlusal characteristics are quite conflicting. In a study by Tedesco et al.(1983) orthodontists consistently assessed the dental attractiveness of children as more attractive than the lay judges. However, the study by Holmes, 1991; Shaw, 1975) is in agreement with research by Prahl-Andersen, (1979), who found that the dental aesthetic ratings of orthodontists were less favourable than those of the children. Perhaps the cultural and social norms in the Netherlands and England, where their work was undertaken, do not place as

high a priority on occlusal features as in the United States. Occlusal features are very much a priority of orthodontists in any culture, however (Tedesco et al. 1983).

It is extremely difficult to assess the validity of indices used in the evaluation of the subjective need and demand for orthodontic treatment (Malmgren, 1980). The motivation to seek and accept orthodontic treatment does not seem to correlate with either the dental health or aesthetic needs of the patient. This again emphasises the problems in the perception of malocclusion and highlights the need to establish exactly what the patient dislikes most about their teeth when they attend for assessment. The patient's concept of their malocclusion may be at total variance with the professional assessment of their malocclusion.

The dentist's advice appears to be the major motivating factor for both the patients and parents in seeking orthodontic treatment (Shaw et al., 1979; Gosney, 1986). Since both general dental practitioners and orthodontists have been shown to be at variance with the dental aesthetic values of lay people (Shaw et al., 1975), advice on orthodontic treatment need, which may be of aesthetic value only, should be exercised with caution.

In summary, it is possible to assess aesthetic impairment associated with malocclusion. Lay judges seem to be more sensitive than orthodontic clinicians in assessments of dento-facial aesthetic impairment. Impartial judgements of dento-facial attractiveness made by lay judges, therefore, could provide a useful component in the evaluation of need for orthodontic treatment.

If the orthodontist has a scale of aesthetic values, with regard to the teeth, that differs from that of the community at large, he may tend to overprescribe treatment when his opinion is sought. If there are degrees of irregularity which are acceptable to the community this may have implications not only in the assessment of treatment need but also in the amount of orthodontic correction which should be aimed at. For individual treatment decisions the individual's self-perception is the most important variable (Stricker 1970, Albino & Tedesco 1991). No index of malocclusion used to

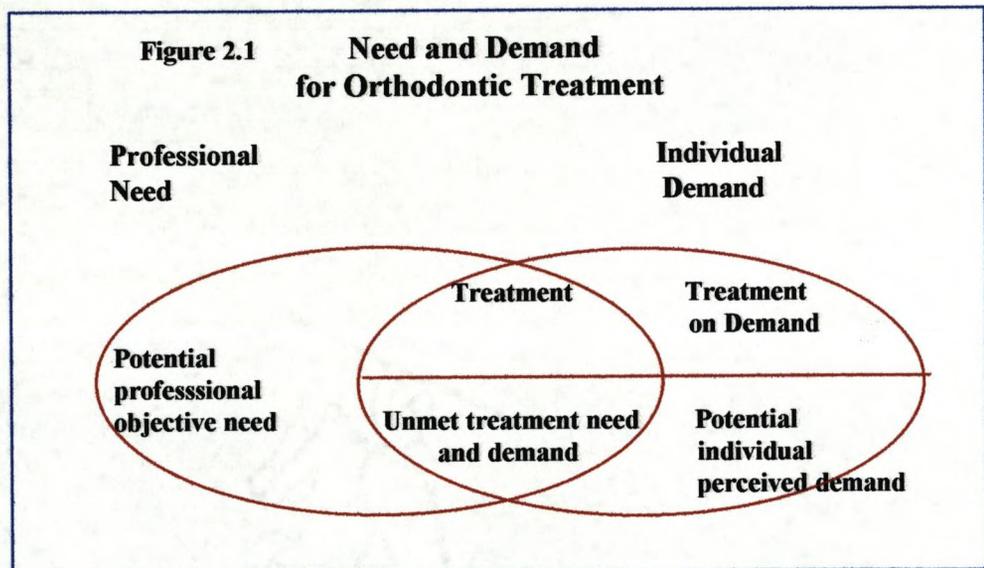
assess treatment need in the community can be meaningful until the range of occlusion generally acceptable is known and furthermore the literature indicates that the popularity, personality and general appearance of the individual child has considerable bearing on how much of a handicap any malocclusion actually is.

Although the cosmetic implications of malocclusion are generally regarded to be important, relatively little active research has been directed toward such topics as personal and parental perceptions of dental appearance and professional-versus-public judgements of orthodontic treatment need. As for dental features, previous investigations have been limited mainly to establishing a hierarchy of preference for different dental arrangements or to judgements of treatment need. These studies suggest that a widely held "form concept" prevails, such that professional concepts of ideal occlusion are also shared by the public, although the range of occlusion considered to be acceptable if not ideal is not yet clearly defined.

## B. NEED AND DEMAND

Need for orthodontic treatment is generally professionally determined in that specific occlusal traits and anomalies either in isolation or in combination impose a threat to longevity of the dentition or renders the individual disadvantaged socio-psychologically or threatens the individuals long term ambitions and potential achievement as discussed previously. Demand for orthodontic treatment results from the individuals desire to seek treatment as a result of a perceived problem with the dentition and, or surrounding structures.

Figure 2.1 illustrates the interaction of professional need and the individuals demand for orthodontic treatment.



If the professional indicates a need for treatment and the individual desires treatment then the treatment can progress in an environment with appropriate resources (e.g., appropriately trained staff, facilities and materials). However, if the resources are not sufficient an unmet treatment need and demand will result.

If the professional determines an objective need in the individual but the individual does not wish to have treatment there will be a potential professional objective need. These individuals may or may not wish to proceed with treatment at a later date.

In a situation where the individual perceives a problem although there is no objective need assessment the practitioner may enter treatment to satisfy the demand. However, if the practitioner refuses treatment this will be a potential individually perceived demand for orthodontic care (Richmond 1996). These issues are further graphically illustrated in Figure 2.1.

Using different methods including subjective assessment and indices, estimates of treatment need range from 33% (Holmes 1992, Burden and Holmes 1994) to 74.8% (Myrberg and Thilander 1973). However, very few studies have identified the lay persons desire/demand for treatment and this ranges from 2 percent to 23.5 percent. No gender differences between children's responses have been noted in studies by Graber and Lucker (1980), Helm et al. (1983) and Espeland et al (1992). Other studies have reported females as being more dissatisfied with their dental appearance and expressing a desire for treatment more often than males (Lewit & Virolainen 1968, Shaw 1981a, Gosney 1986, Gravely 1990, Holmes 1992b). The two studies by Espeland et al (1992) and Holmes (1992b) are quite uniform in their results between professionally assessed need, the frequency of children reporting dental dissatisfaction and desire for treatment, (Table 2.5). Among both the children and the parent's a desire for treatment was expressed more frequently than dissatisfaction with dental arrangement. The discrepancy between dissatisfaction and desire for treatment is probably due to a bias in respondents distorting their answers to make a favourable impression. This distortion increases significantly if the observer is known to the respondents.

The high frequency of individuals expressing a desire for treatment may also be an indication of a high professional trust or a basic general faith in the dental social services. This has been concluded from studies in Great Britain and the USA which demonstrated that parents expressed willingness to meet high costs of treatment for their children (Shaw et al, 1979; Tulloch et al, 1984). Other British studies based on mailed questionnaires found that a high frequency of parents stated that they were keen to obtain treatment for their children if they needed it, although this was not reflected in the actual frequency of children receiving treatment (Todd 1975,

Luffingham and Campbell 1976). These authors suggested that the discrepancy could be due to a parental unawareness of malocclusion.

Some studies have examined the relationship between satisfaction/perceived need and occlusal condition in children and adolescents (Howitt et al. 1967, Lewit and Virolainen 1968, Graber & Lucker 1980, Slakter et al. 1980, Shaw 1981a, Helm et al. 1985, Helm et al. 1986, Gosney 1986, Brown et al 1987, Holmes 1992b).

However, few of them have related measurements of dental satisfaction and desire for treatment to indices of treatment need. These studies may be examined closely in order to answer the question are indices of professionally assessed treatment need meaningful to laypersons. The findings have generally revealed weak or moderate relationships between the indices examined and the psychosocial measurements. Katz (1968) examined eight orthodontic indices and found all eight weak in their ability to distinguish individuals (16 - 25 years) who were satisfied with their dental appearance from those who were dissatisfied.

Espeland's 1992 study reveals that about 60% of the individuals with a great or obvious need according to the index, were unconcerned about their occlusal condition. Interpretation of the findings has to take into account that the individuals were not informed about any aspect of their occlusal status or treatment factors. The importance of the professional advice for decisions to undergo treatment has been demonstrated (Shaw et al. 1979, Tulloch et al. 1984, Gosney 1986, Holmes 1992b).

TABLE 2.5 - Relative frequency of children with treatment need (the three upper grades of the applied indices), and reported dissatisfaction with dental appearance and desire for orthodontic treatment.

	n	Age, yr	Need % (F/M)	Dissatisfaction % (F/M)	Desire % (F/M)
Holmes 1992b	955	12	65 (62/69)	27 (32/22)	48 (52/44)
Espeland et al 1992	99	10 - 11	65 (67/63)	29 (33/25)	46 (50/43)

TABLE 2.6 - Studies on the relationship between dental satisfaction/desire for treatment and occlusal condition assessed by treatment need indices in children and adolescents.

	n	Age, yr	Satisfaction/Desire variables	Index of treatment need
Howitt et al. 1967	120	13 - 18	"How satisfied are you with the general appearance of your teeth?"	Eastman Esthetic Index (EEI)
Slakter et al. 1980	154 + parents	8th & 9th grade	Concern for own (child's) occlusion: 6 (4) items  Wish for own (child's) treatment: 7 (5) items	Treatment Priority Index (TPI) Grainger 1967)
Brown et al. 1987	117	13	Acceptability of own occlusal condition: 12 items.	Treatment Priority Index (TPI) (Grainger 1967)
Holmes 1992b	955	12	a. "Do you like the look of your teeth?"  b. "Do you think that your teeth need straightening?"	Index of Orthodontic Treatment Need: Dental Health component and Aesthetic Component (Brook & Shaw 1989)
Espeland et al 1992	99 children 93 parents	10-11	Questionnaire to child and parents. a. Are you satisfied with the arrangement of your/child's teeth. b. Do you want to have your/child's teeth straightened.	Need for Orthodontic Treatment Need (NOTI)-Norway 1990

The need and demand for orthodontic care fluctuates throughout the different life cycle events and is influenced by the dental and facial growth, social and cultural conditions as well as dentist interventions as a result of dental decay and loss of teeth. One of the most comprehensive studies in the area has been England and Wales where 10,291 children aged between 9 and 15 were studied. The Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN) was employed. Those individuals falling into grades 4 and 5 of DHC ranged from 31 percent of 9 year olds to 15 percent of 15 year olds, (Table 2.7). Obviously the reduction is a result of orthodontic care being undertaken in early teens.

TABLE 2.7 *Index of orthodontic treatment need by age (United Kingdom, 1993)*

	AGE						
	9 %	10 %	11 %	12 %	12 %	14 %	15 %
None	10	8	10	10	14	15	18
Little	37	37	39	43	42	49	49
Moderate	23	23	21	21	21	17	19
Great	14	16	15	16	14	13	11
Very Great	17	17	15	11	8	6	4
Base (100%)	1609	1645	1633	1502	1489	1284	1129

In addition, the dental aesthetics had improved using the aesthetic component of IOTN from 51 percent of 9 year olds with good aesthetics to 79 percent of 15 year olds. 8 percent of 12 year olds had extractions for orthodontic reasons (1983) compared with 4 percent in (1993); and 24 percent of 15 year olds (1983) had extractions compared to 8 percent in 1993.

The proportion of children who had orthodontic treatment in the past or were receiving treatment at the time of the survey was significantly different between 1983 and 1993. At 15 years of age in 1983, 34 percent of children had received or were undergoing orthodontic treatment compared with 26 percent in 1993.

TABLE 2.8 *Current and past orthodontic treatment by age (United Kingdom 1982, 1983)*

AGE	Treatment Received					
	Appliance In Past		Extractions In Past		Under treatment	at time of survey
	1983 %	1993 %	1983 %	1993 %	1983 %	1994 %
9	1	2	1	*	1	2
10	4	4	2	1	1	1
11	4	4	5	4	3	4
12	5	4	8	4	9	9
13	10	5	13	5	8	13
14	14	6	19	7	6	14
15	17	8	24	8	5	11

The authors suggested that in 1993 orthodontic treatment was being deferred until the age of 15 or later for many children in need of treatment. Although, another possible explanation could be that the demand for treatment has fallen or that there is an unmet treatment need and demand due to limited access to orthodontic care in England and Wales.

Table 2.9 presents findings from some previous studies on individuals' response to own occlusion in samples with variable proportions of individuals with orthodontic experience. As the samples include both previously treated and untreated individuals, comparisons should be performed with caution. Also, the range of age varies in the different studies. Furthermore, different measurements (indices) have been applied to assess treatment need.

However, a comparison can be made between a Dutch study (Burgerdijk et al. 1991), who has reported a frequency (22%) of reported dissatisfaction among orthodontically untreated individuals, in a population with a treatment frequency of 22 - 27%, with , Espeland (1992 ) who reports a similar frequency of dissatisfaction (20%) between untreated individuals in different areas with population treatment frequencies of 34% and 18%.

These results indicate that there exists an unmet demand for treatment among young adults in the respective populations. Further, individuals from the low treatment frequency area exhibited more occlusal deviations in the anterior region. This difference in occlusal status between the two samples was not accompanied by a similar difference in reported concern, which in part might be explained by the lower level of awareness among the subjects in the area with a low treatment uptake. The observation that these individuals seemed to accept dental irregularities to a greater extent might also indicate that different norms for acceptable dental appearance exists in different societies. Other mechanisms could also operate, as factors such as attitudes among referring dentists and availability of services may indirectly influence an individual's desire for orthodontic treatment (Shaw et al. 1991a). It appears from Table 2.9 that an increased treatment frequency in the childhood population does not necessarily eliminate perceived need or expressed dissatisfaction among the individuals at a later stage in life.

A recent survey by Salonen et al. (1992) assessed treatment need and treatment demand in a randomly selected adult Swedish population. In the age group 20 - 29 years, 28% of the individuals had received orthodontic treatment, whereas in the age group 30 - 39 years only 8% had received treatment (Table 2.9). Despite this difference in treatment frequency, the proportion of individuals expressing a desire for treatment was the same in the two groups (11 - 12%). As the frequency of professionally assessed need also was similar, the figures were explained by the less successful outcome of orthodontic treatments provided in the 1970's.

It has been suggested that the availability of orthodontic services may increase the orthodontic awareness of the population, and hence, stimulate demand for treatment (O'Brien 1991). Furthermore, it has been postulated that the overall treatment frequency in a population may influence individuals' requirements to an aesthetically acceptable occlusion (Helm 1990). Comparisons between populations with different availability and utilisation of services have, however, failed to demonstrate differences in individuals' evaluation of dental aesthetics, valuation of well-aligned teeth, and

TABLE 2.9 - Studies on frequencies of professionally assessed treatment need, subjects' desire for treatment, and expressed dissatisfaction with dental appearance assessed in adult and adolescent populations.

	n	Age, yr	Previous treatment %	Need %	Desire %	Dissatisfaction %
1. Ingervall & Hedegard 1974	278 males	18	16	30	4	-
2. Ingervall et al 1978	389 males	21 - 54	9	25	3	-
3. Mohlin 1982	205 females	20 - 45	25	34	9	-
4. Helm et al 1983	841	28 - 34	10	-	7	-
5. Burgersdijk et al 1991	1778 (530)	15 - 34 (15-19)	22 (27)	39	-	23 (24)
				44	-	28
				38	-	22
6. Salonen et al. 1992	156 179	20 - 29 30 - 39	28 8	20 25	11 12	- -
7. Gravely 1990	492 1506	15 15	32 26	- -	15 10	- -
8. Espeland et al 1992	50 94	17.8 17.6	untreated untreated	26 39	14 16	20 22

1. Frequencies based on subjects' reports
2. In studies 1, 2, 3 and 6 treatment need was assessed according to the Swedish National Board of Health and Welfare index (moderate, urgent, and very urgent need groups). In study 5 treatment need was assessed by the Dutch Ziekenfonds index. In study 8 treatment need assessed by Need for Orthodontic treatment Index -Norway 1990.
3. Two groups from different regions were studied
4. Population treatment frequency - 34%
5. Population treatment frequency - 18%

attitudes towards orthodontic treatment (Tulloch et al. 1984). On the other hand, it has been suggested that as treatment levels increase, the wearing of conspicuous appliances becomes more acceptable, thereby increasing demand for treatment (Gravely 1990).

## CHAPTER 3

CONQUEROR

## **AIMS AND OBJECTIVES**

1. To assess and record the differences in opinions of professional orthodontists and lay persons on dentofacial aesthetics, dental health, deviation from normal occlusion, orthodontic treatment need and orthodontic treatment outcome.
2. To investigate whether professional standards for orthodontic treatment need, treatment outcome and dento-facial aesthetics are meaningful to the public.

## **HYPOTHESES**

Differences exist between orthodontists and lay persons on dento-facial aesthetics, dental health, deviation from normal occlusion, treatment need and treatment outcome.

## CHAPTER 4

CONQUEROR

## MATERIALS AND METHODS.

The study was carried out at the Orthodontic Department, University of Wales, College of Medicine, School of Dentistry. The opinion of the lay public was collected by recording judgements of a panel of lay public using various patient records as stimuli. Each person was asked to examine the entire sample of 68 cases. For each set of records examined, each member of the lay public panel indicated their opinion using five (5) point ordinal rating scales ranging from one (1) to five (5). Judgements were made by assessments of 68 study casts in respect of:-

- \* the need for orthodontic treatment on dental health grounds.
- \* the need for orthodontic treatment on dental aesthetic grounds.
- \* deviation from normal occlusion.
- \* the decision whether to treat.

In addition, judgements were made on a sample of 50 pairs of outline facial profiles before and after treatment in respect of:

- \* deviation from normal facial aesthetics
- \* comparison of aesthetics pre-treatment and post-treatment.

Furthermore, assessments on 50 pairs of pre-treatment and post-treatment study casts in respect of:

- \* degree of improvement as a result of treatment.
- \* acceptability of result.

The detailed guidance and answer formats are given in Appendix 1.

### **Sample of lay public**

Fifty-six (56) people were invited to participate in the study. This panel was further sub-divided into a dental technicians group (12) and a dental nurses group (6). The possession of a dental technicians and dental nurses qualification being the only inclusion criterion. The balance of (38) constituted lay people who were not involved in the clinical process. The figure below reflects sample of lay persons examining models.



### **Professional Sample**

Ninety-Seven (97) orthodontists formed the basis of the professional sample. A similar study currently conducted by Charles Daniels of UWCM canvassed professional opinion on treatment need and treatment outcome from 8 European Countries as well as the USA.

Each member of both the professional and lay panel completed a simple questionnaire relating to personal details (Appendix 2).

## **Patient records**

Clinical records for treatment need, outcome and profile assessments were drawn from the archives of the University of Wales College of Medicine Dental School and Community Clinics in the surrounding districts. All records were anonymous, being marked only with a number. The issues concerning the construction of a valid and representative sample are dealt with briefly below.

## **Construction of the Test Sample**

A number of determining factors influenced the make up of the study sample hereafter referred to as the validation sample.

- \* The sample size was chosen for convenience.
- \* The sample was designed to address the issue of reliability assessment.
- \* The validation sample was chosen to be as representative of a normal population as possible.
- \* Sample was designed to maximise efficiency to give the largest useful data yield for the number of cases included.
- \* A sub-set of the parent sample used to canvass professional opinion was chosen.

These issues are covered in greater detail below.

## **Intra-Examiner Reliability**

The problem of assessing intra-examiner reliability of perceptions has a direct effect on the structure of the validation sample.

Reliability is usually determined by comparing duplicated assessments on two or more separate occasions spaced in time. The practical limitations of asking the panel to avail themselves on a second occasion precluded this option. A compromise solution was reached by incorporating duplicate study casts within the sample. The number of duplicated cases for treatment need was 18, and 15 for each of the sections for treatment outcome and profile assessments. Duplicate casts were allocated one to

each half of the sample to separate their examination by some time period usually between one to three hours.

Despite this it is recognised that memory effects may permit an over optimistic estimate of reliability. Statistical analysis is discussed later.

The number of unique cases in each section was therefore 50 for treatment need, and 35 for both treatment outcome and facial profiles.

The following description of the sample will assume the exclusion of half of the duplicates for each section. This is because half of the duplicates were excluded in the aggregate analysis to conserve independence of observations.

## **REPRESENTATIVE SAMPLE**

### **Treatment need**

Occlusal traits should be present in the validation sample in approximately similar prevalence as occurs in a 'normal population'. In the context of this study, the population in this instance is the population of England and Wales. This requires some knowledge of what the normal prevalence is. In order to obtain reliable estimates of orthodontic treatment need, objective reliable methods are required which indicate both the quantitative and qualitative prevalence of malocclusion in the normal population. The supply of reliable, valid information in small.

For the sake of completeness a non-random sampling method was used to include all possible occlusal traits which fall within the range of orthodontic correction. In other words the sample used as a stimulus for this study is a highly selected sample to mimic the 12 year old population.

By classifying the sample according to its morphological and aesthetic characteristics it is possible to assess the nature of the malocclusions used for the validation sample - Shaw et al (1995).

The frequencies for the aesthetic component scores of the sample are given in Figure 4.1, and is reasonably representative of an 11 - 15 year old population in Britain.

The frequency distribution of occlusal traits using the IOTN Dental Health component to classify the validation sample is shown in Figure 4.2. Classification is based on the single most significant occlusal trait in the DHC of the IOTN. Grade I is the least severe and Grade 5 is the most severe trait.

Some traits are dichotomous such as impacted teeth. Examination of the Figure 4.2 reveals that the predominant occlusal trait is displacement of interproximal contact points which is analogous to crowding.

### **Sample validity**

The validity of non-random sampling methods depends on whether the selected sample is representative of the normal population. This method has been used previously by Cons et al (1986) for the creation of a validation sample for the Dental Aesthetic Index.

To assess whether the sample has obtained a good range of malocclusion which is broadly in line with a normal sample of this size, the cross classified data in Figure 4.2 has been compared with epidemiological data from a U.K. survey conducted by Holmes in 1992 using IOTN as the recording method. By cross classifying the data using the Dental Health score and the qualifier (most significant occlusal trait), a comparison is possible of the relative prevalence of different occlusal traits between the 2 samples.

Using the raw frequencies from the classification for the two sets of data ( Population and test sample ) a Spearman correlation co-efficient of 0.67 is obtained  $p < 0.001$  which shows a high degree of association between the frequencies of traits making up these data sets.

The IOTN was chosen to classify the validation sample since training in the use of this index was readily available and a calibrated standard could be obtained to assess reliability. (Richmond, et al 1995). Excellent reliability estimates have been reported for the application of this index during the survey. (Kappa = 0.88 for the aesthetic

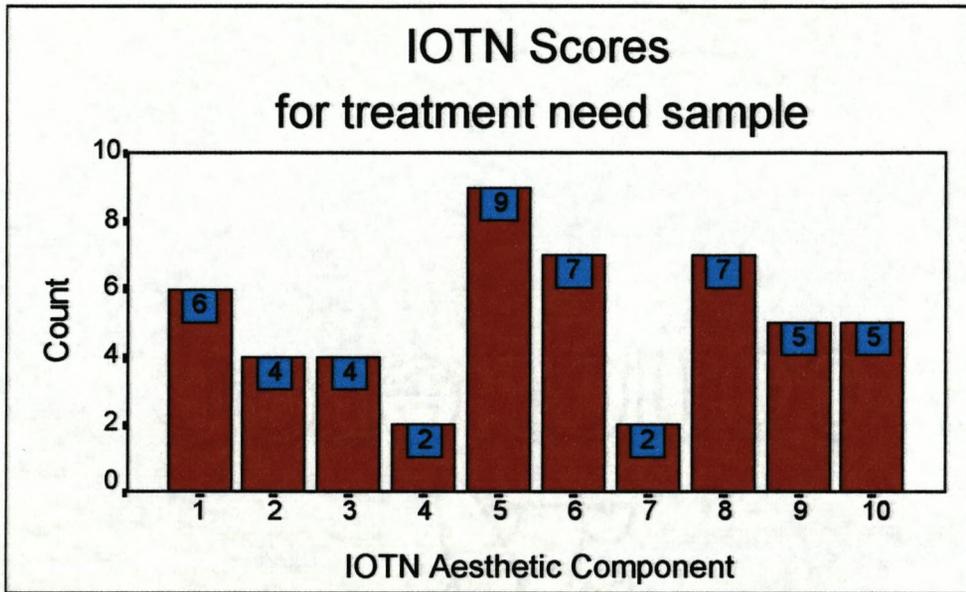


Figure 1

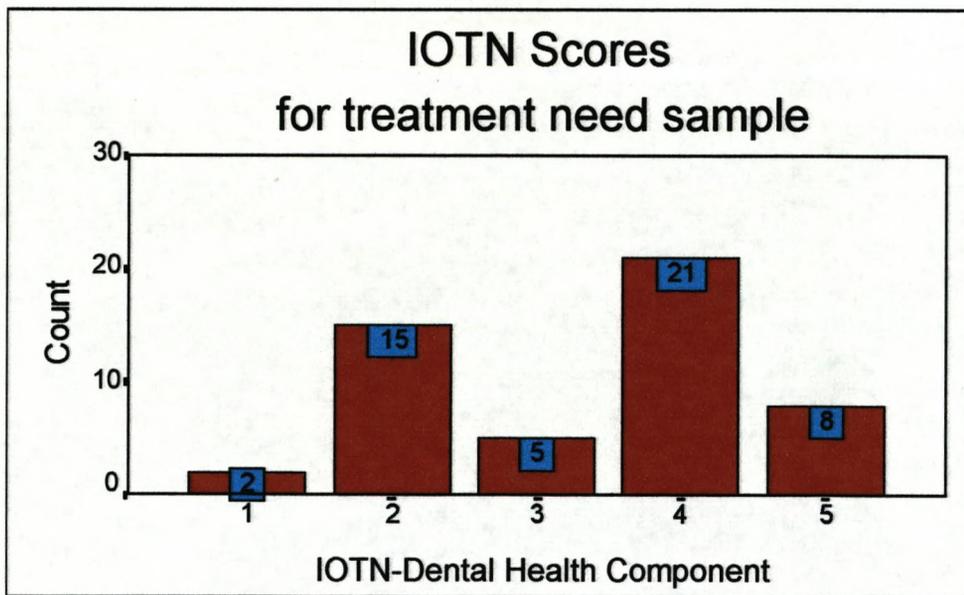


Figure 2

component, 95% Lower confidence limit 0.68. Kappa = 0.84 for the Dental Health Component, 95% Lower confidence limit 0.64.)

### **Treatment outcome**

This study has been designed to assess lay perceptions of acceptability of treatment outcomes and ultimately to compare these perceptions with professional orthodontists perceptions of treatment outcomes. Many of the issues of reliability and validity of a sample of treated cases are similar to those outlined above for treatment need. The judgement of whether a case is acceptable is a subjective measure which probably contains consideration of factors including degree of improvement, treatment difficulty, patient co-operation and limitations of skeletal form.

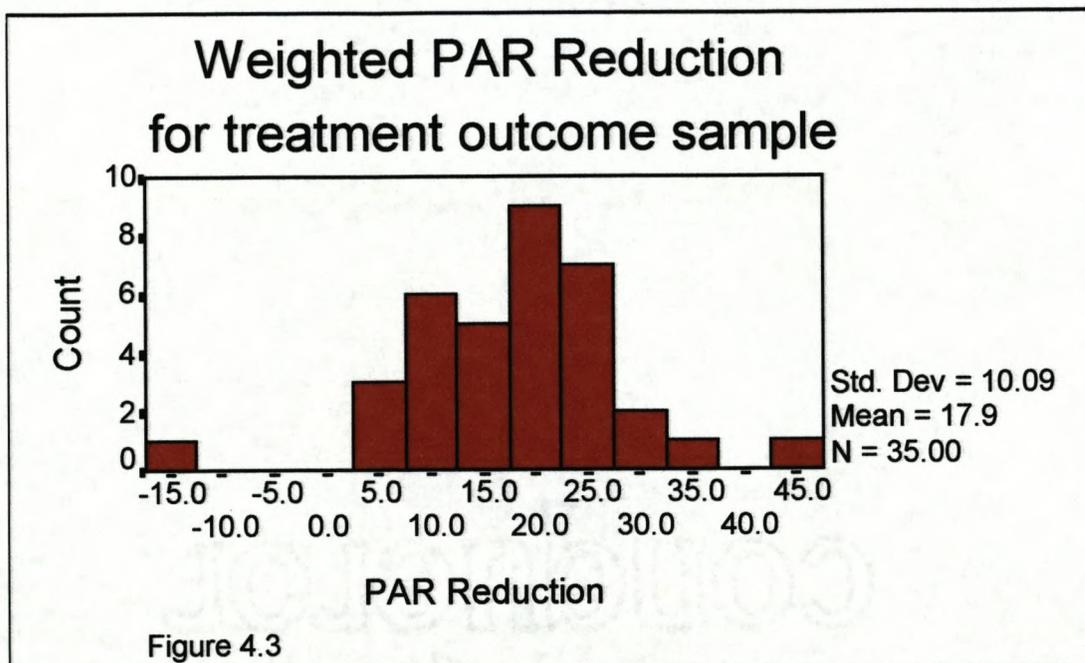
It is highly unlikely that lay persons would consider the latter factors when passing judgement on acceptability of result. For this specific reason, the questionnaire excluded lay persons having to pass judgement on issues of treatment complexity.

If an ideal occlusal form can be constructed, then deviancy from this form can be scored and improvements measured relative to the start condition.

The PAR index has been developed on this concept. Thirty-five cases were selected to represent a wide range of outcomes and this has been evaluated using weighted PAR reduction as an objective measure of outcome. Figure 4.3 shows the sample PAR score reduction for treatment outcome and demonstrates a wide range of finishes which is not unduly skewed.

### **FACIAL PROFILE**

The use of profile outlines to canvass opinion on facial profiles and the impact of treatment on the profile is subject to the same problems of sample validity and reliability as treatment need and outcome samples. Many methods have been proposed for the evaluation of facial profile, (Prahl-Anderson 1979) but there is no information available to indicate the prevalence of varying degrees of normality for facial morphology. Case material for this section was dependent on the inclusion of the corresponding study models into treatment outcome.



## CHOICE OF MATERIALS

The use of study casts as the sole stimulus on which to base assessments of aesthetic indications of treatment need by lay persons has been utilised before by Lindegard (1971) and may be criticised as being a medium unfamiliar to lay persons, while dental technicians and dental nurses are familiar with the medium of study casts. However, it is highly unlikely that the provision of full clinical records i.e. photographs, cephalogram and orthopantomogram would have any validity at all in the decision by lay persons on treatment need and outcome.

Work done by Han and Vig (1991) has shown that the dichotomous treatment decision (treat/not treat) by orthodontists based on study models alone is 92% consistent with decisions based on full clinical records. At a higher level of treatment planning i.e. with the addition of photographs and radiographs, intra-examiner reliability was quite poor compared to the simpler dichotomous decision. Further support for the study model only approach is gained from Naccache et al (1989), who described the validity of model alone judgements as equivalent to patient alone, but found the sensitivity and specificity of judgement to be higher for models alone. Further, the test sample was measured for individual occlusal traits which were included in the multiple regression techniques in an attempt to predict the decision

making process on issues of treatment need and treatment outcome. These issues are discussed further in modelling the data in greater detail. Table 4.1 reflects the individual occlusal trait measurements carried out on the test sample.

TABLE 4.1 *Test sample occlusal trait measurements included into the regression equations:*

- 
1. Upper labial segment alignment
  2. Lower labial segment alignment
  3. Anterior Overbite
  4. Anterior Open Bite
  5. Centreline
  6. Presence (1) Or Absence (0) Of Impacted Teeth
  7. Upper Buccal Segment Alignment (Left And Right Added Together)
  8. Lower Buccal Segment Alignment (Left And Right Added Together)
  9. Buccal Segment Sagittal Relationship (Left And Right Added Together)
  10. Buccal Segment Vertical Relationship (Left And Right Added Together)
  11. Anterior Or Posterior Crossbite With Mandibular Displacement (Any Extent)
  12. Presence Of Any Number Of Missing Teeth Excluding 3rd Molar (For Any Reason)
  13. Aesthetic Assessment Based On IOTN Aesthetic Component
  14. Overjet In Mm (centred at 3mm)
  15. Reverse Overjet In Mm
  16. Upper Incisor Inclination Relative To The Occlusal Plane (centred at 95 degrees)
  17. Lower Incisor Inclination Relative To The Occlusal Plane (centred at 90 degrees)
  18. Overall Upper Arch Crowding/Spacing
  19. Overall Lower Arch Crowding/Spacing
  20. Lip Competency.
  21. Lower Inter canine Width
  22. Lower Intermolar Width
  23. An interaction of overjet (centred at 3 mm) multiplied by upper incisor inclination (centred at 95 degrees)
-

The definition and measurement protocols for 1 to 12 are already published in the Introduction to Occlusal Indices (Richmond et al 1992). The upper and lower arch crowding variables are 5 point ordinal scales which take the following values:

- \* Upper arch crowding/spacing. This is measured initially in millimeters using a method described by Kahl-Nieke et al 1995 (anterior to last standing molar). The score is then given an ordinal value according to the following protocol:

Crowding up to 2mm	=0	or Spacing up to 2mm
Crowding 2mm to 5mm	=1	or Spacing up to 2mm to 5mm
Crowding 6 to 9mm	=2	or Spacing up to 6mm to 9mm
Crowding 10 to 13mm	=3	or Spacing > 9mm
Crowding 14 to 17mm	=4	
Crowding > 17mm	=5	or impacted teeth

- \* Reverse overjet (defined as all four upper incisors in lingual occlusion) takes the value of 0 for all positive overjet greater than edge to edge than negative values as measured in mm.
- \* Positive overjet takes value of 0 for all reverse overjet up to and including edge to edge. All positive overjets are measured in mm and centred at the ideal by subtracting 3mm. The positive difference was then used as the variable in the regression calculations and gives a measure of the degree of deviance from the ideal of 3mm.
- \* Tooth inclination relative to the occlusal plane was measured in degrees using a customised protractor. The readings were 'centred' by subtracting 95 degrees from the upper incisor inclination and 90 degrees from the lower incisor inclination. The positive difference was taken as the deviancy from the 'ideal values of 95 and 90 degrees respectively and used as the variable in the regression.

Positive and negative overjets were given separate variables to allow their coefficients to obtain different weights.

The interaction term for centred overjet multiplied by central incisor alignment was included to account for situations when dental compensation gives differing levels of significance to similar overjets.

## STATISTICAL ANALYSIS

### Intra-examiner agreement

As previously stated 18 cases were duplicated in treatment need and 15 cases were duplicated in treatment outcome and profile assessment. Thus these identical cases were examined twice. Reliability for the 5 point scales was examined using the weighted Kappa statistic. This statistic is an appropriate measure of agreement for ordinal scales such as the 5 point scale and assesses the level of agreement which is greater than random association. Linear weights were used for this study. A full exposition of weighting the Kappa statistic is found elsewhere (Kingman 1986).

Reliability for the dichotomous decisions of treatment recommendation and outcome acceptability were examined using the unweighted (Cohen's ) Kappa statistic (Cohen 1960). The interpretation of the kappa scores has been suggested by Landis and Koch (1977) as follows (Table 4.2):

TABLE 4.2. *Interpretation of Kappa Scores*

---

Kappa =0	agreement no better than chance
$0 < \text{Kappa} < 0.2$	slight agreement
$0.2 < \text{Kappa} < 0.4$	fair agreement
$0.4 < \text{Kappa} < 0.6$	moderate agreement
$0.6 < \text{Kappa} < 0.8$	substantial agreement
$0.8 < \text{Kappa} < 1$	almost perfect agreement
Kappa = 1	perfect agreement

---

## **Inter-examiner agreement**

Inter-examiner agreement on the 5 point scales and 2 point scales was examined using the multi-rater kappa statistic  $S(av)$  as described by O'Connell and Dobson (1984). This statistic was used on the sample of unique cases plus the first half of the duplicate cases for reasons of independence of observations. The statistic has currently been applied to 5 point and 2 point scale judgements for all examiners together on a group by group basis.

The statistic derived is not strictly comparable outside the experiment in which it was determined because it is dependent on both the number of examiners and the number of cases examined, as well as the level of agreement. Using the fortran programme of O'Connell and Dobson (1984) gives an estimate ( $S_i$ ) for each case examined which is an indication of the level of agreement on that particular case. The mean value of  $S_i$  is the multi-rater kappa statistic  $S(av)$  and gives an indication of the level of agreement for the group of examiners and subjects studied using a particular rating scale. Because the differing judgements use similar 5 point scales their relative reliability can be compared with each other. This exercise will allow further scrutiny of the reliability of the elements of the treatment decision.

Examiners will not interpret the use of the point scales uniformly so that even if two examiners agree on a particular severity they may each accord a different score. A simple comparison of the raw scores would appear to signify a disagreement. The condition of marginal homogeneity is met when both examiners use the various scale scores with the same frequency. The converse of this situation is when the examiners have distinct score frequency profiles and is known as the condition of marginal independence. An examination of the marginal score distributions for varying orthodontists reveals that marginal independence is the correct assumption, which has been applied to the calculation of the statistics.

A further consideration is the weighting of any to apply to partial agreements. On a five point ordinal scale it is clear that a pair of judgements (1,3) are in less disagreement than (1,5). On a categorical scale, all disagreements are of equal

weight. These issues can be reflected by weighting the various forms of disagreement pairs. Linear disagreement weights have been used for the calculations of the multi-rater kappa statistic for 5 point scales and no weighting has been accorded to disagreements on the dichotomous scales.

### **Aggregate measures and summaries**

A small number of interesting summary statistics were obtained which permit comparison of the aggregate assessments across the whole sample, for each different section. The assumptions of normality were examined using Shapiro-Wilks and Kolmogorov-Smirnov statistics and when satisfied parametric methods have been employed to explore the data.

### **Modelling the data**

Multiple logistic regression techniques were employed to model the data variance of the subjective judgement for treatment need for each case. Stepwise regression was used to develop a predictive model for the decision process and to give insight into the nature of the treatment decision. Logistic regression was used to model the logit probability function of dichotomous outcomes e.g. treatment versus no treatment.

condemner

## CHAPTER 5

## RESULTS

The presentation of some data will employ box and whisker plots, please see Appendix 3 for description.

### Summary data for panel

The questionnaire used to solicit personal background information from the participants is reproduced in Appendix 2. Table 5.1 shows the lay samples exposure to previous orthodontic treatment cross-tabulated by gender.

TABLE 5.1 *Shows the Lay samples exposure to previous orthodontic treatment cross tabulated by gender*

		Male	Female	Total
Treatment	Yes	1	22	25 (44.5%)
	No	2	19	31 (55.4%)

The descriptive frequencies have been broken down by gender and occupation. The lay sample numbered 56 in total of which 6 were trained dental nurses, 12 were trained dental technicians and the balance of 38 were lay people employed in an administrative capacity, 41 were female and 15 male. Overall mean age was 29 years and 3 months with a range of 18 to 62 years. The female group was on average approximately 7.3 years younger than the male group using a simple independent t-test ( $p=0.023$ ). The vast majority of the lay sample resided in an urban environment.

When cross-tabulating experience of previous orthodontic treatment by gender, it is interesting to note that females exposure to orthodontic treatment was approximately four times as much as males.

The orthodontist sample numbered 97 in total, of which the overwhelming majority were practitioners in private practice and resided in an urban environment, 63 were males and 34 female. The overall mean age was 43 years and 5 months with a range of 27 years to 61 years. The female group was statistically significantly 5 years younger than the male group using a simple independent t-test ( $p=0.001$ ).

## **A.INTRA-EXAMINER RELIABILITY**

### **Treatment need**

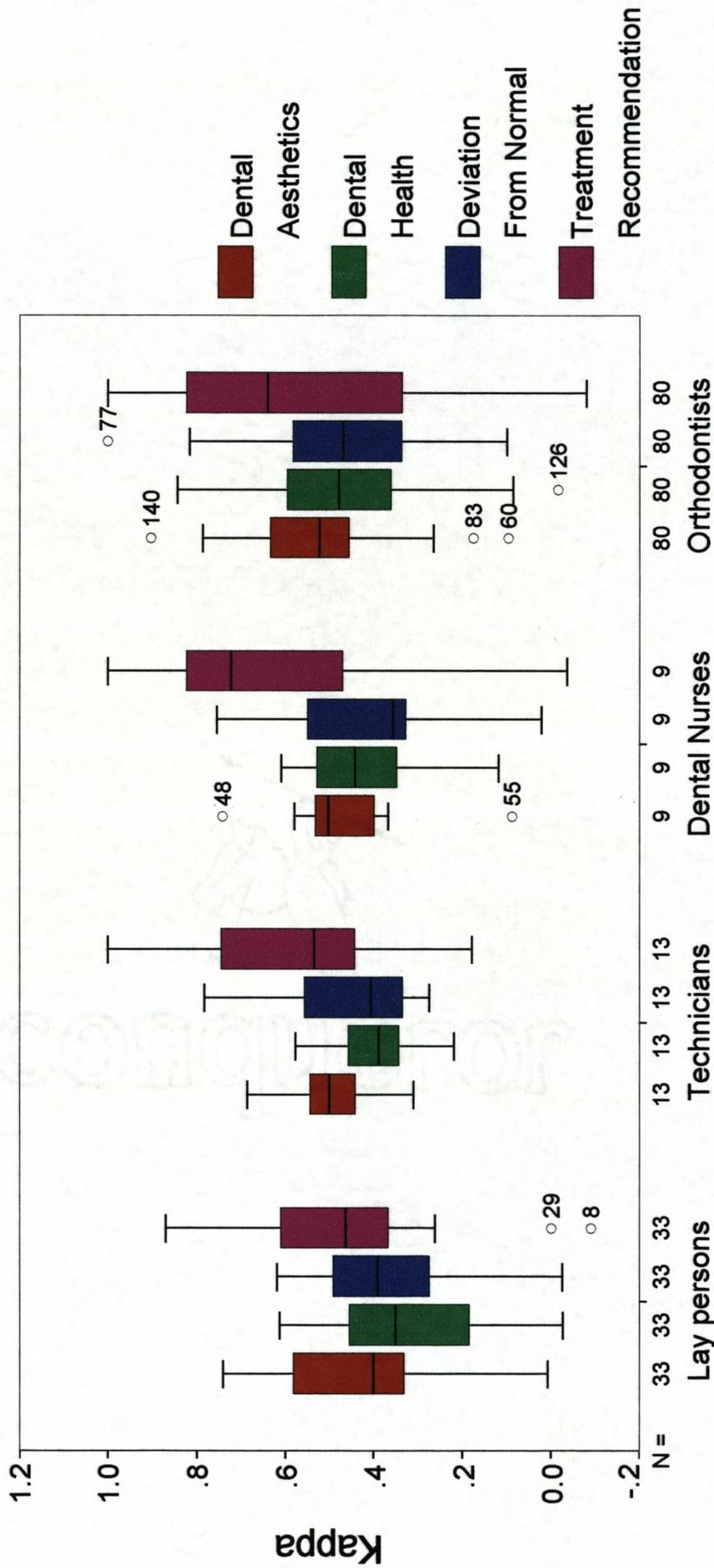
Using the 18 duplicates the reliability of assessments for treatment need on the grounds of dental health, dental aesthetics, deviation from normal and the decision to treat for both lay and professional groups are shown in Figure 5.1. These figures show the distribution of the Kappa scores obtained by participants for each aspect of treatment need compared on a group basis.

From this we conclude that for each assessment there is a range of reliabilities achieved by both orthodontists and lay groups. Visual inspection of Figure 5.1 reveals that in general there is a range of reliabilities achieved for all aspects in the treatment need sample which reflects fair to moderate agreement. Further, the professional group appears to be more reliable than the lay group.

The differences in reliabilities between lay and professional groups have been examined using multivariate and one way ANOVA. The multivariate analysis reveals that there is a significant difference in reliability between the lay and professional groups. (Hotelling  $T^2$  significance  $p<0.001$ ).

This confirms that when the 4 measures of mean Kappa reliability scores are taken together there may be a difference between two or more groups, which would indicate that one group is more reliable than another.

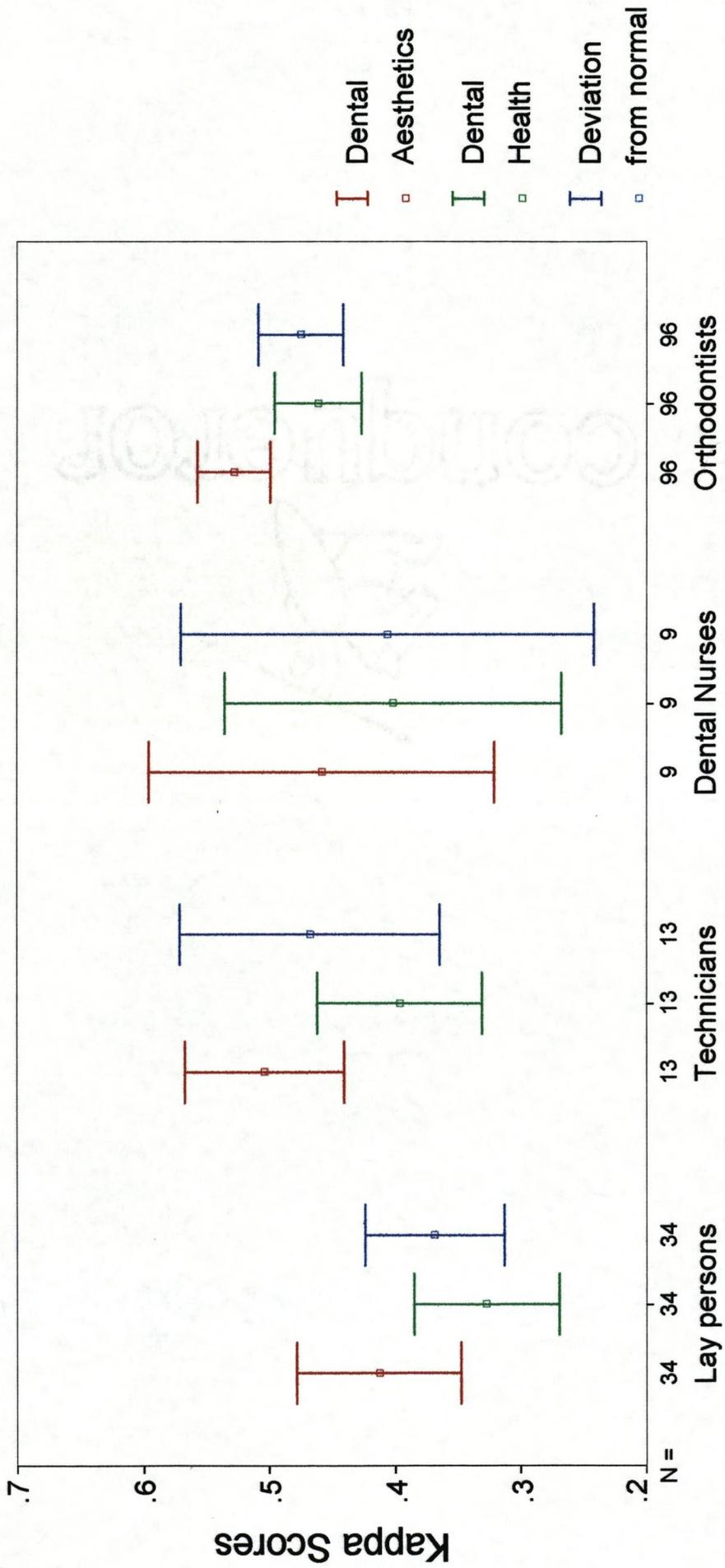
# Intra-Examiner Reliability Scores



Job Description

Figure 5.1

# 95% Confidence Interval Error Bar Plot



Job Description

Further examination of the variables with one way ANOVA reveals significant F ratios for dental aesthetics (F=4.899 p=0.0028 df 3.148); deviation from normal (F=3.6228 p=0.0146 df 3.148) and dental health (F=5.7098 p=0.010 df 3.148).

From this one may infer that the orthodontist group is statistically significantly more reliable than the lay group in their assessments of dental aesthetics, dental health and deviation from normal. It may be argued that the technician and dental nurses group are more familiar with the medium of study casts which could perhaps account for the similarity in reliability assessments between the technician/dental nurse groups and the orthodontist group.

TABLE 5.2 *Significant differences in intra-examiner reliabilities between groups for Dental Aesthetics (p<0.05)*

Group	Dental Aesthetics Mean kappa	Lay persons
Lay persons	0.4128	
Technicians	0.4587	
Dental nurses	0.5041	
Orthodontists	0.5282	*

TABLE 5.3 *Significant differences in intra-examiner reliabilities between groups for Deviation from Normal (p<0.05)*

Group	Deviation from Normal Mean kappa	Lay persons
Lay persons	0.3686	
Technicians	0.4679	
Dental nurses	0.4064	
Orthodontists	0.4753	*

TABLE 5.4 *Significant differences in intra-examiner reliabilities between groups for Dental Health*

Group	Dental Health Mean kappa	Lay persons
Lay persons	0.3274	
Technicians	0.3963	
Dental nurses	0.4017	
Orthodontists	0.4616	*

Once a correction has been made for multiple tests (Bonferroni) significant differences are still found for dental aesthetics, dental health and deviation from normal. These are graphically illustrated by the 95% Confidence Interval Error bar plot (Figure 5.2) and depicted in Tables 5.2, 5.3 and 5.4.

The mean values for the Kappa statistics are given for each group and then any statistically significant differences between groups are marked with a star\* to the right.

There are no statistically significant differences between groups in reliability for assessments of the treatment decision.

The data would seem to suggest that the orthodontist group is consistently more reliable than the lay group in reliability assessments of dental aesthetics, dental health and deviation from normal, but, not for the treatment recommendation. This difference is, however not seen between the orthodontist and technician/dental nurse groups which would seem to suggest that the exposure to an orthodontic environment has contributed to the reliability scores for the technician/dental nurse groups.

## Treatment outcome

There are two measures of intra-examiner reliability for treatment outcome i.e. Kappa scores for the judgement of degree of improvement (using 5 point scales) and the acceptability of the result (dichotomy). The reliability estimates are based on 15 (fifteen) duplicate examinations.

The distribution of the reliabilities for the degree of improvement and for the decision to accept are shown in Figure 5.3.

These are further graphically illustrated by the 95% Confidence Interval Error bar plot (Figure 5.4). The difference in reliabilities between orthodontist and lay groups have been examined using multivariate and one way ANOVA.

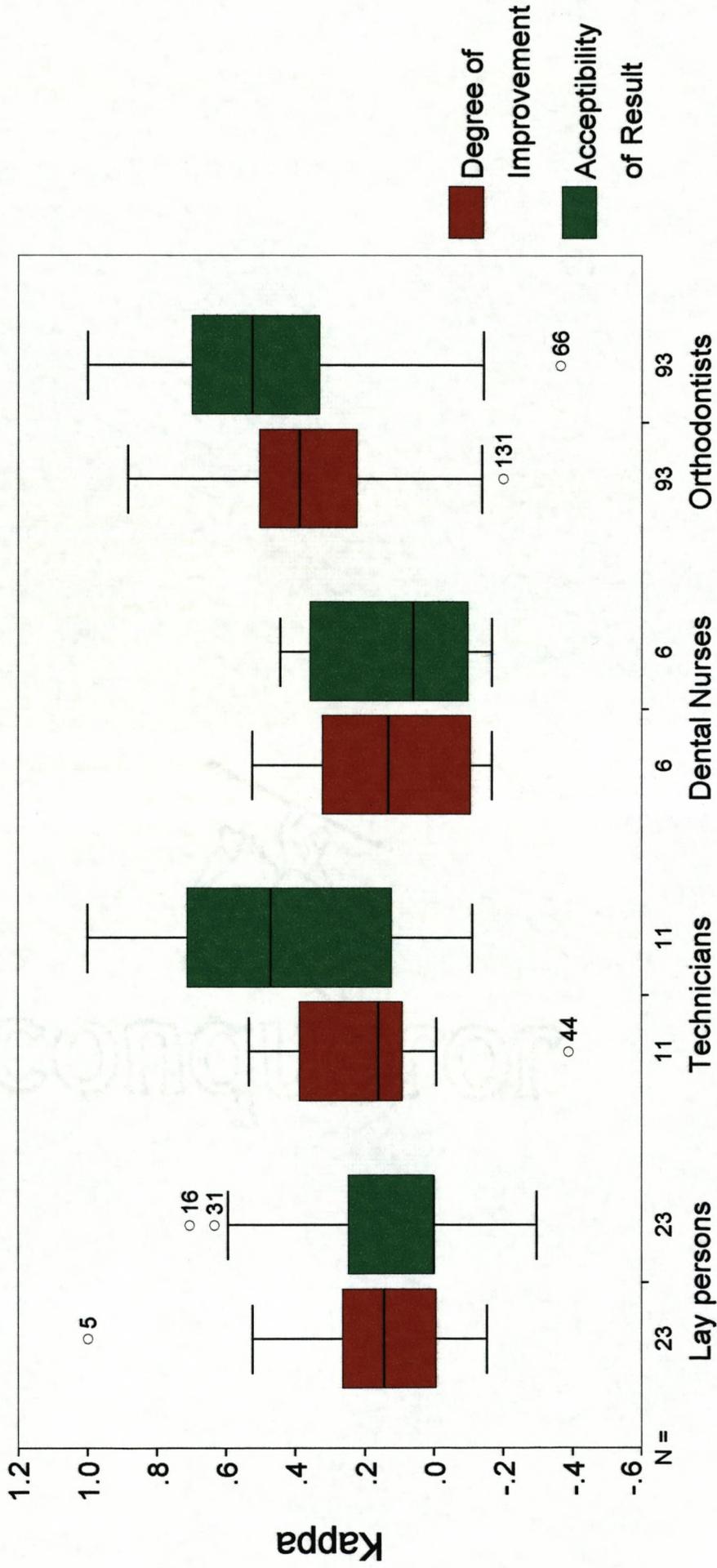
Further examination of the variables with one way ANOVA reveals significant F ratios for both degree of improvement achieved ( $F=11.1546$   $p=0.00$   $df$  3.146) and acceptability of result ( $F=12.1941$   $p=0.00$   $df$  3.129).

Once a correction has been made for multiple tests (Bonferroni) significant differences are still found for both degree of improvement and acceptability of result. These are depicted in Tables 5.5 and 5.6. The mean values for the Kappa statistics are given for each group and then any statistically significant differences between groups are marked with a star \* to the right.

TABLE 5.5 *Significant differences in intra-examiner reliabilities between groups for degree of improvement*

Group	Mean kappa	Degree of Improvement			
		Lay persons	Technicians	Dental nurses	Orthodontists
Lay persons	0.1434				
Technicians	0.1859				
Dental nurses	0.1636				
Orthodontists	0.3746	*	*	*	

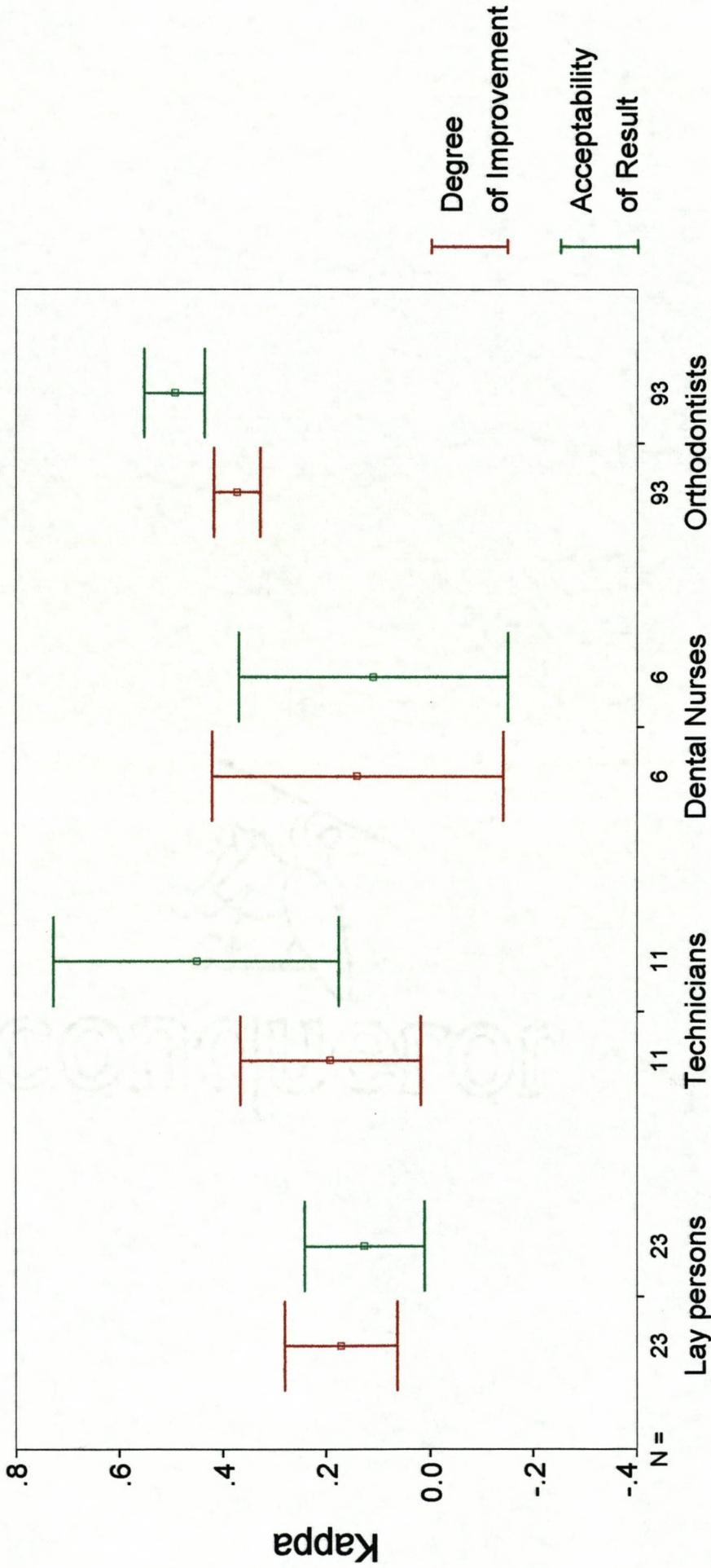
# Intra-Examiner Reliability Scores



Job Description

Figure 5.3

# 95% Confidence Interval Error Bar Plot



Job Description

Figure 5.4

TABLE 5.6 *Significant differences in intra-examiner reliabilities between groups for acceptability of results*

Group	Acceptability of Result				
	Mean kappa	Lay persons	Technicians	Dental nurses	Orthodontists
Lay persons	0.1260				
Technicians	0.4505	*			
Dental nurses	0.1093				
Orthodontists	0.4943	*		*	

From the above it can be seen that the orthodontist group is significantly more reliable than lay persons\technicians\dental nurses group in assessing degree of improvement achieved. From Table 5.6 it can be inferred that the orthodontist group is significantly more reliable than the lay persons\dental nurses group, while the technician group is significantly more reliable than the lay group in assessments of acceptability of result.

One may again argue that the orthodontists and technicians exposure to the medium of study casts tends to make them more reliable in their assessments.

The reliabilities are generally lower than those in the treatment need section and reflect a wider spread. This may be attributed to fatigue effects as this section of the study was conducted during the latter half of the study.

It would appear that the judgements for the dichotomous scales (acceptability of result) appear to be more reliable than the judgements for degree of improvement (5 point scales). The mean values for these two measures of reliability have been compared using a simple paired t-test and acceptability of result judgements are significantly more reliable than judgements of degree of improvement ( $p=0.002$ ) when measured using the Kappa statistic.

## B. INTER-EXAMINER AGREEMENT

### Treatment need

The results for inter-examiner agreement for lay and professional judges as a group are presented in Table 5.7.

TABLE 5.7 *Inter-examiner agreement on 50 treatment need cases for Lay & Professional groups overall using Multi-rater kappa*

	Dental Health	Dental Aesthetics	Deviation from Normal	Treatment Recommendation
Orthodontists	0.650	0.491	0.516	0.383
Lay persons	0.551	0.434	0.460	0.367

It will be obvious that the pattern of agreement is similar to the intra-examiner reliability in that the levels of agreement are higher within the orthodontist group with the exception of the recommendation to treat, where both orthodontist and lay groups are fairly similar. It would appear that for both orthodontist and lay groups that the agreements for dental health, deviation from normal and dental aesthetics enjoys agreement in descending order of importance.

The results give an indication of the relative elements which would determine the entry threshold for orthodontic treatment. Certainly, dental health is the most widely agreed upon. Next, it would appear that deviation from normal enjoys reasonable agreement followed by dental aesthetics which is not surprising since dental aesthetics is a very subjective element.

It would appear that the treatment decision enjoys the least agreement, and probably represents the relative inherent weakness of dichotomous scales.

## **Aggregate assessments of treatment need**

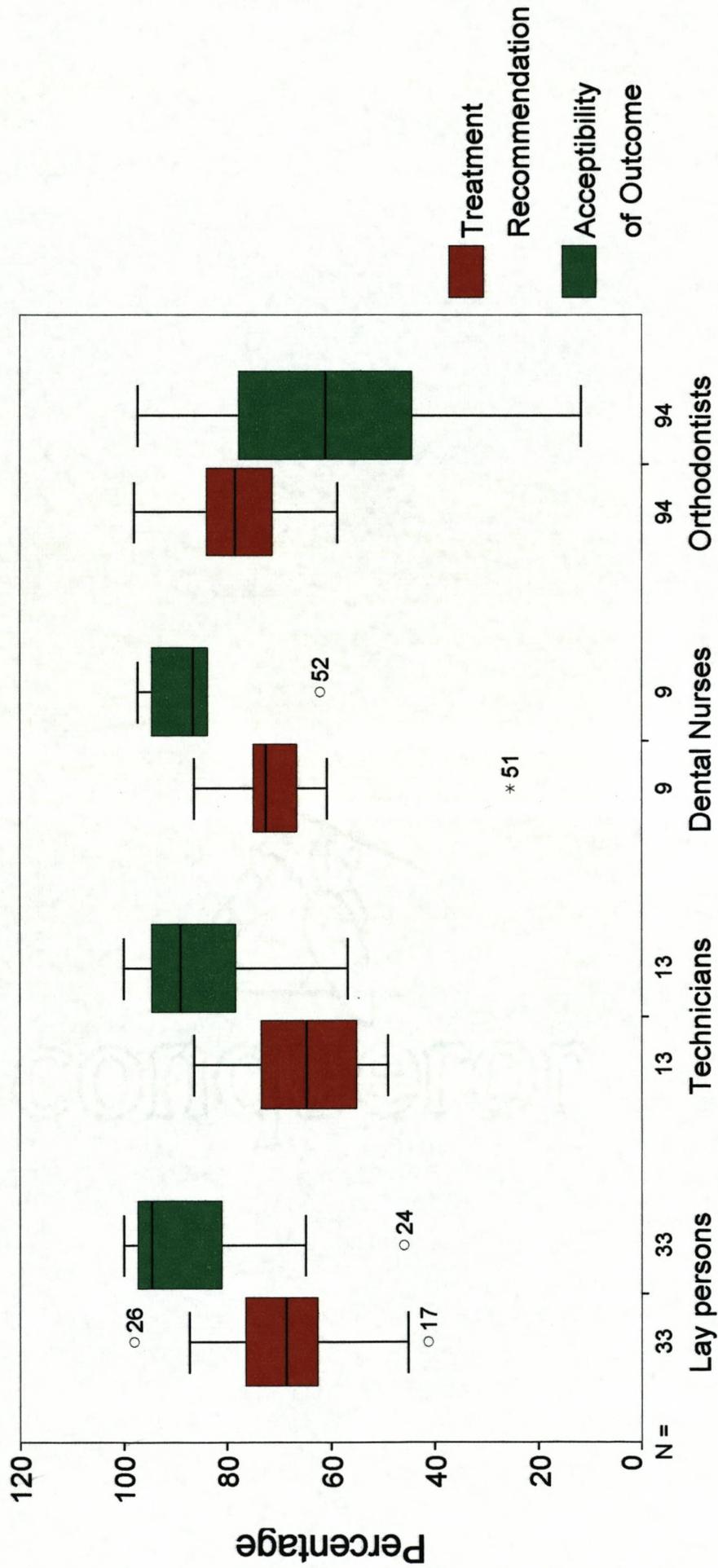
Figure 5.5 shows the group distributions for the percentage of 50 cases which were recommended for treatment. Percentages have been used here because comparison of raw data is misleading due to missing data present for some candidates. Provided the sample size is large enough, proportions can be treated as continuous variables for analytical purposes - Altman 1994.

Essentially, this gives us an overall idea of the prescribing behaviour of the different groups when presented with this sample of occlusions which is a fairly representative sample of occlusal traits found in the parent population .

Visual appraisal of Figure 5.5 tells us that there is a fairly narrow band which describes the treatment recommendation rate of the lay groups, which appears to be distinct from the prescribing behaviour of the orthodontist group. This is further graphically illustrated in Figure 5.6 which represents the 95% Confidence Interval Error bar plot.

It should be remembered that the dental nurses/technician groups consists of a fairly small sample size, and therefore Kolmogorov-Smirnov normality tests were performed which did not reveal any distribution to be significantly different from normal which may in part be due to the small sample size. Levene's test for homogeneity of variances was performed to examine this assumption for the ANOVA test and was not significant ( $p=0,114$ ) ANOVA revealed significant differences at the 5% level ( $F=12.5175$   $p= 0.000$   $df 3.148$ ) between the proportion of the sample recommended for treatment between the groups marked with a star \* in Table 5.8. Once again a Bonferroni correction has been applied for multiple tests. Also detailed are the means, standard deviations and standard errors for each group's proportion.

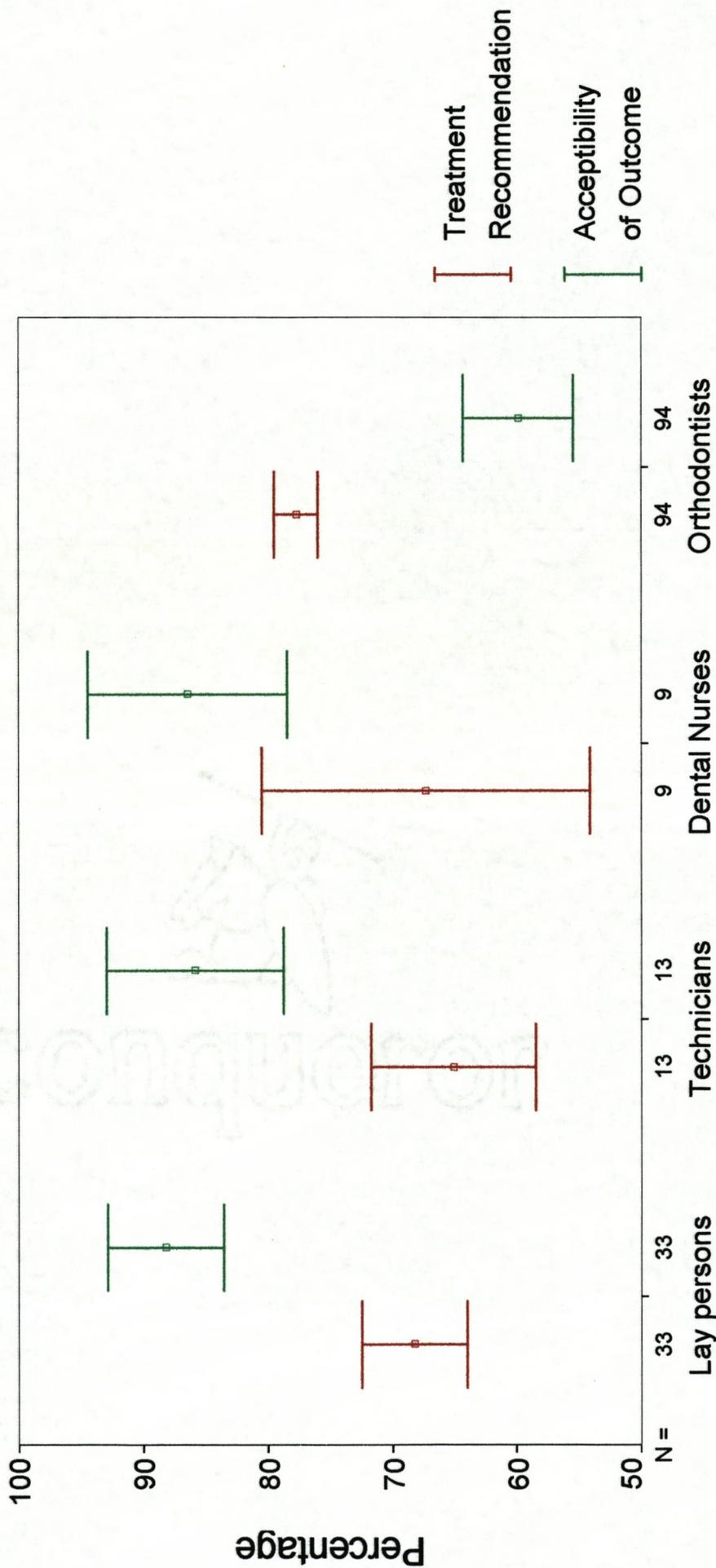
# Aggregate Percentage



Job Description

Figure 5.5

# 95% Confidence Interval Error Bar Plot



Job Description

Figure 5.6

TABLE 5.8 *Aggregate percentage of 50 cases recommended for treatment and significant differences marked as \* ( $p < 0.05$ )*

	Mean	STD deviation	STD error	Lay persons	Technicians	Dental nurses	Orthodontists
Lay persons	68.1147	11.8926	2.0396				
Technicians	65.1077	10.9903	3.0482				
Dental nurses	67.3222	17.1420	5.7140				
Orthodontists	77.6531	8.4850	0.8660	*	*	*	
Total	73.8349	11.2736	0.9144				

This would seem to imply that there is good agreement between the lay groups treatment recommendation rate which is within a very narrow band. In contrast, the professional group has a statistically significant and distinctly higher rate of treatment recommendation. This might be due to their professional training and critical objective appraisal of the occlusions presented for judgements when compared to the lay groups. In order to bring these two groups towards a common treatment need recommendation rate, this rate should approximate 73%.

### **Treatment outcome**

The multi-rater Kappa statistics are presented for judgements of degree of improvement and acceptability of result in Table 5.9.

TABLE 5.9 *Inter-rater agreement for measures of outcomes using multi-rater kappa for 35 cases for Lay & Professional Groups*

	Degree of Improvement	Acceptability of Result
Orthodontists	0.249	0.314
Lay persons	0.185	0.193

It will be obvious that the pattern of agreement is similar to the intra-examiner reliability in that the levels of agreement are higher within the orthodontist group than the lay group overall. Once again, it appears that the dichotomous scale of

acceptability of result appears to enjoy marginally greater agreement than the agreement demonstrated for degree of improvement. However, it must be said that these agreement statistics appear to be very poor compared to judgements of treatment need.

## **AGGREGATE ASSESSMENTS OF TREATMENT OUTCOME**

Figure 5.5 shows the group distributions of the percentage of the outcome sample of 35 cases which were deemed acceptable. This is further graphically illustrated by the 95% Confidence Interval Error bar plot in Figure 5.6. Again, proportions have been treated as continuous variables for analytical purposes - Altman 1994.

Essentially, this gives us an idea of the acceptability of treatment results deemed acceptable by the groups when presented with a range of treatment outcomes as classified by the PAR Index which are fairly representative of treatment outcomes achieved by U.K. orthodontists.

Visual appraisal of Figure 5.5 implies that there is a fairly narrow band that describes the treatment outcome results that were deemed acceptable by the lay groups, which appears to be distinctly higher than the orthodontist group. Again, Kolmogorov-Smirnov normality tests were performed which did not reveal any distribution to be significantly different from normal.

The difference between lay and orthodontist groups were examined using ANOVA and with a Bonferroni correction for multiple tests. ANOVA revealed significant differences at the 5% level ( $F= 24.6017$   $p = 0.000$   $df 3,146$ ) between the proportions of the sample with regard to treatment outcome between the groups marked with a star\* in Table 5.10. Also detailed are the means, standard deviations and standard errors for each groups proportion.

TABLE 5.10 *Aggregate percentage of 35 cases deemed acceptable by each group & significant differences marked as a \* (p < 0.05)*

	Mean	STD deviation	STD error	Lay persons	Technicians	Dental nurses	Orthodontists
Lay persons	88.1909	13.1205	2.2840				
Technicians	85.8538	11.7185	3.2501				
Dental nurses	86.4556	10.3704	3.4568				
Orthodontists	60.0126	21.5402	2.2100	*	*	*	
Total	70.0380	22.8405	1.8649				

A Kruskal-Wallis 1-way ANOVA test was performed and confirms the pattern of treatment outcome deemed acceptable, the results of which are presented in Table 5.11.

TABLE 5-11 *Kruskal-Wallis 1 way ANOVA test*

Mean Rank	Cases	Job Description
113.68	33	Lay persons
105.92	13	Technicians
107.72	9	Dental nurses
55.02	95	Orthodontists
	150	

Chi-square	DF	Corrected for Ties Significance
58.0521	3	0.00

There is generally excellent agreement between the lay groups on treatment outcome results deemed acceptable.

In contrast, the orthodontist group are much more critical in their appraisal of treatment outcome deemed acceptable and reject approximately 25% of cases deemed

acceptable by the lay groups. Again, this would be attributed to their professional training. The results would imply that lay persons are more willing to accept minor discrepancies in occlusion.

## **FACIAL PROFILE ASSESSMENT**

The intra-examiner reliabilities for the facial profile assessment are based on duplicate examinations of 15 outline profiles which were obtained by tracings of pre-treatment and post-treatment cephalometric radiographs.

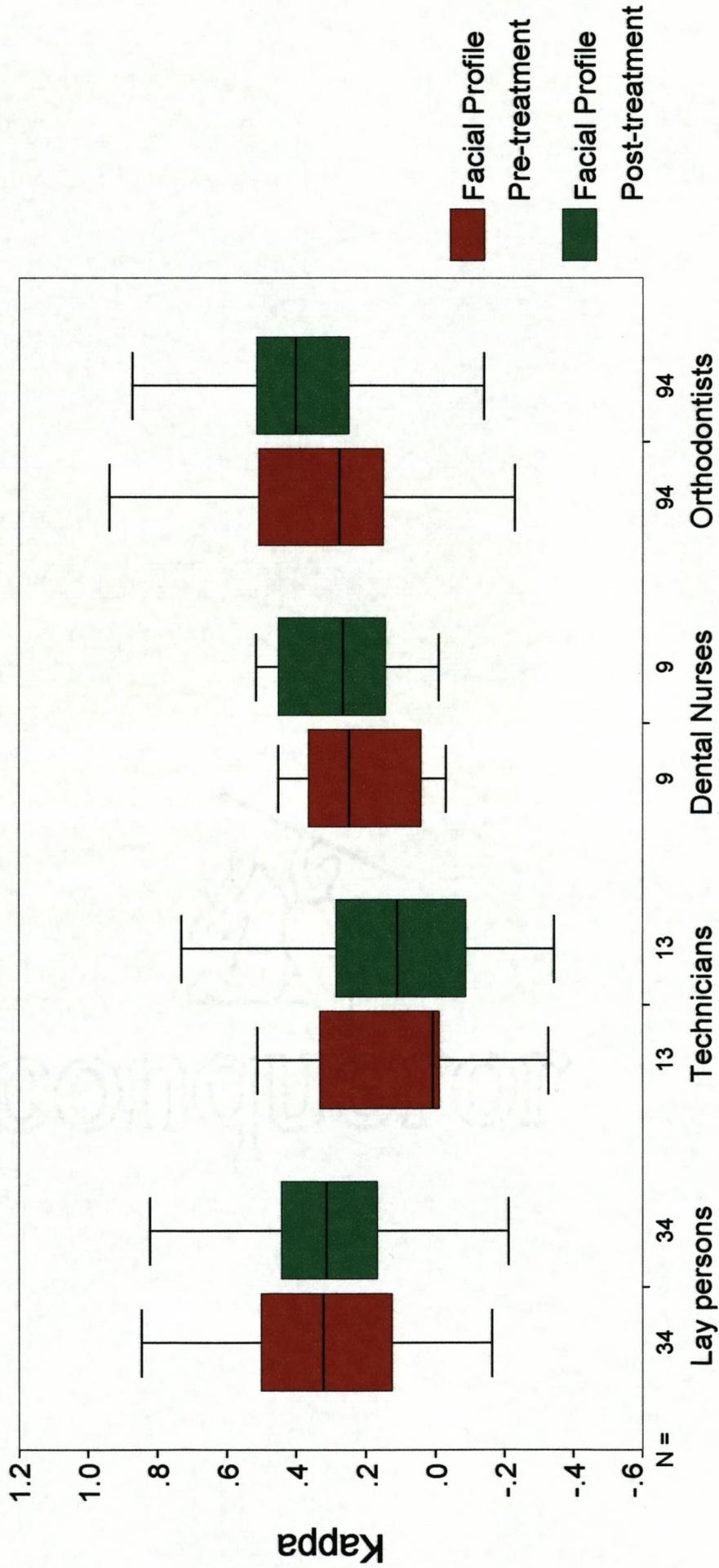
Examination of the variables with one way ANOVA reveals significant F ratios for two of the three profile estimates i.e. for profile estimates pre-treatment (pre Kappa) ( $F = 3.1905$   $p=0.0255$   $df 3.146$ ) and profile estimates post-treatment ( $F = 5.4948$   $p = 0.0013$   $df 3.146$ ).

There are no statistically significant differences for reliability assessments of the effect of treatment on the facial profile. Once a correction has been made for multiple tests (Bonferroni) significant differences are still found for profile estimates pre and post-treatment, which are shown in Figure 5.7. These are further graphically illustrated by the 95% Confidence Interval Error bar plots in Figure 5.8 and depicted in Tables 5.12 and 5.13.

The mean values for the Kappa statistics are given for each group and then any statistically significant differences between groups are marked with a star \* to the right.

It would appear that the orthodontist and lay groups are significantly more reliable than the technician group in profile assessments pre-treatment while the orthodontist group is significantly more reliable than the technician group in profile assessments post-treatment. These differences are somewhat difficult to explain and indeed many members of all 3 non clinical groups commented that they could not differentiate between the profiles before and after treatment.

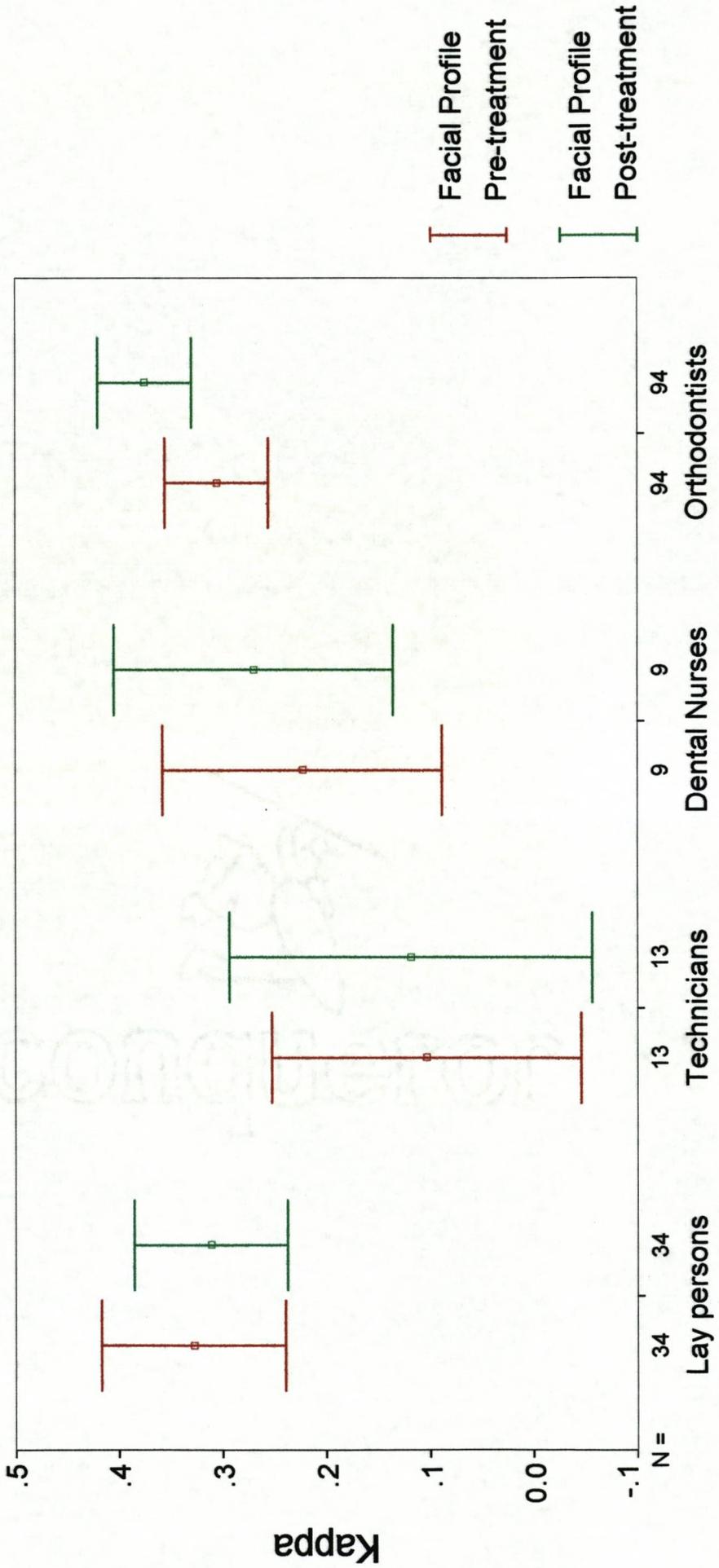
# Intra-Examiner Reliability Scores



Job Description

Figure 5.7

# 95% Confidence Interval Error Bar Plot



Job Description

TABLE 5.12 *Significant differences in intra-examiner reliabilities between groups for profile assessment pre-treatment (PREKAP)*

Group	Profile assessment Pre-treatment Mean kappa	Lay persons	Technicians	Dental nurses	Orthodontists
Lay persons	0.3282		*		
Technicians	0.1034				
Dental nurses	0.2230				
Orthodontists	0.3052		*		

TABLE 5.13 *Significant differences in intra-examiner reliabilities between groups for profile assessment post-treatment (POSTKAP)*

Group	Profile Assessment Post-treatment Mean kappa	Lay persons	Technicians	Dental nurses	Orthodontists
Lay persons	0.3114				
Technicians	0.1185				
Dental nurses	0.2700				
Orthodontists	0.3749		*		

In Table 5.14 and 5.15 below the means, standard deviations, maximum and minimum values for all of intra-examiner reliability estimates are presented for both lay and orthodontist groups on a group basis.

It will be seen that the reliability estimates for the pre-treatment and post-treatment facial profiles, as well as the reliability of lay persons degree of occlusal improvement, are the poorest of all the estimates.

The reliability for the effect of treatment on the profile by the professionals is similar to that for the degree of occlusal improvement. This means that they are assessed with similar levels of reliability. The two measures are however not interchangeable because they are measuring different qualities.

TABLE 5.14 Overall measures of intra-examiner reliabilities for all judgements

## LAY PERSONS GROUP

Intra-examiner reliability	Mean kappa	STD deviation	Max	Min
Aesthetics	0.44	0.17	0.742	0.007
Dental health	0.36	0.16	0.613	-0.027
Deviation from normal	0.40	0.17	0.783	-0.026
Treatment Y/N ?	0.53	0.25	1.0	-0.091
Improvement	0.16	0.23	1.0	-0.387
Acceptability Y/N ?	0.21	0.34	1.0	-0.296
Profile Pre-treat	0.26	0.26	0.845	-0.328
Profile Post-treat	0.26	0.24	0.822	-0.345
Profile treat-effect	0.34	0.25	0.924	-0.310

TABLE 5.15 Overall measures of Intra-examiner reliabilities for all judgements

## ORTHODONTIST GROUP

Intra-examiner reliability	Mean kappa	STD deviation	Max	Min
Aesthetics	0.53	0.14	0.903	0.097
Dental Health	0.46	0.17	0.843	-0.016
Deviation from normal	0.48	0.17	1.0	0.10
Treatment Y/N ?	0.55	0.35	1.0	-0.08
Improvement	0.37	0.22	0.885	-0.20
Acceptability Y/N ?	0.49	0.28	1.0	-0.36
Profile Pre-treat	0.31	0.24	0.938	-0.23
Profile Post-treat	0.37	0.22	0.872	-0.140
Profile treat-effect	0.39	0.27	1.0	-0.383

## MODELLING THE DATA

### Treatment need

From the results seen so far, it is obvious that the raw data is highly variant in its reliability within and between examiners. There were wide variations between the lay and orthodontist perceptions of the proportion of the sample which required treatment.

The most reliable estimates for both lay and orthodontist groups were the dichotomous treatment decision followed by dental aesthetics, deviation from normal and then dental health. In order to predict the treatment decision it is convenient to think of the decision process as being dependant on the possible benefits to dental aesthetics, health and function, and if these 'independents' are known, the decision can be derived 'mechanically'.

The main effects influencing treatment decisions were analysed using multiple logistic regression. This has the advantage that a dichotomous outcome is the product of an equation. Ordinal and categorical data can be included in a logistic regression which is particularly well suited to the explanation of the data. This technique separates the unique contribution of independent variables and co-variates in exploring the data and gives a scale bound co-efficient which indicates both the size and sign of the effect that an independent variable has on the dependant. However, interpretation is somewhat more difficult than linear regression because the function which is actually modelled is the logit function of the probability of success or failure,

$$\text{Logit } P = \text{Ln} ( P ) / ( 1-p )$$

In the treatment need question using stepwise logistic regression technique, the following variables have been entered into the model, dental health, dental aesthetics, deviation from normal and a host of occlusal traits details of which are found in Table 4.1. This procedure is used to model a probability (between 0 and 1) for dichotomous outcomes such as the decision to recommend treatment. A cut off value is then determined to maximise specificity and sensitivity.

In general, diagnostic tests are evaluated by calculating their sensitivity and specificity. Sensitivity may be defined as the proportion of subjects with the condition who have a positive test and this indicates how good a test is at identifying the diseased.

It equals,  $\text{True Positive (TP)} / [\text{True Positive (TP)} + \text{False Negative (FN)}]$ .

Specificity may be defined as the proportion of subjects without the condition who have a negative test and this indicates how good a test is at identifying the non diseased.

It equals,  $\text{True Negative (TN)} / [\text{True Negative (TN)} + \text{False Positive (FP)}]$ .

Using the occlusal trait scores as explanatory variables in a stepwise logistic regression, we have analysed how those traits contribute to the decision for treatment, and the output is shown in Table 5.16. Using the raw data part of the output for lay and orthodontist groups respectively is as follows:-

TABLE 5.16 Stepwise logistic regression output LAY GROUPS

Step	Improv			Model			Correct			Coefficients
	Chi-Sq	df	sig	Chi-Sq	df	sig	Class %	Variables		
1	1316.037	1	.000	1316.037	1	.000	86.66	IN: IOTNAC	0.5753	
2	10.252	1	.000	1326.289	2	.000	86.66	IN: CHEWDIFF		
3	17.411	1	.000	1343.700	3	.000	86.66	IN: LARBS XB	0.1512	
4	11.732	1	.000	1355.432	4	.000	86.66	IN: LARBS AP	-0.3769	
5	10.251	1	.000	1365.684	5	.000	86.66	IN: UIINCLMX	0.0389	
6	7.754	1	.000	1373.437	6	.000	86.66	IN: PAR2	0.0884	
7	6.550	1	.000	1379.987	7	.000	86.66	IN: PAR1	0.1114	
8	7.108	1	.000	1387.096	8	.000	86.66	IN: MISSING	0.8515	
9	11.304	1	.000	1398.400	9	.000	86.66	IN: POSOJ	0.2058	
10	-0.004	1	.000	1398.395	8	.000	86.66	IN: CHEWDIFF		

IOTNAC	Aesthetic assessment based on IOTN aesthetic component
CHEWDIFF	Chewing difficulty
LARBS XB	Buccal segment transverse relationship (Left and right added together)
LARBS AP	Buccal segment sagittal relationship (Left and right added together)
UIINCLMX	Upper incisor inclination maximum
PAR 2	Lower labial segment alignment
PAR 1	Upper labial segment alignment
MISSING	Presence of any number of missing teeth excluding 3rd molars
POSOJ	Overjet in mm
CHEWDIFF	Chewing difficulty

The regression co-efficient can be used to assess how various factors influence the treatment decision. A positive co-efficient is interpreted as an increase in the likelihood of treatment as a variable increases (becomes more positive). A co-efficient of 0 would signify average probability of treatment. A high CHI-square value for a given variable suggests it is important in explaining the observed variation.

Dental aesthetics plays a foremost role in the assessment of treatment need. This reflects the fact that many occlusal traits which are thought to compromise the health or function of the teeth such as large overjet, reverse overjet and anterior cross-bite also manifest a significant aesthetic impairment. The aesthetic component of the Index of Orthodontic Treatment Need, was used to assess aesthetics for each case and was the single most important predictive factor by a substantial margin.

Further substantial contributions were made by the left and right buccal segment sagittal relationships, left and right buccal segment cross-bite, upper incisor inclination to the maxillary plane, lower anterior segment contact point displacement, upper anterior segment contact point displacement, missing teeth and positive overjet. While the latter factors are statistically significant, their practical significance is low once the previous traits have been measured.

Factors which were not significant included upper and lower labial segment alignment, anterior open bite and centre line. The variance of these features is correlated with and largely explained by the more significant features, which renders them redundant in a stepwise model such as this. Using all the variables from Table 5.17, obtains a model which predicts 86.62% of decisions correctly, with a specificity of 71.2% and a sensitivity of 93.25%.

The output for the orthodontist group is shown in Table 5.17.

Further, it can be seen that dental aesthetics also plays a significant role for the orthodontist group and was the single most important predictive factor by a substantial margin. Other substantial contributions were made by upper anterior

segment contact point displacement, positive overjet, lower incisor inclination and cross-bite.

The significance of the models is that it means that the decision process is predictable, and it can be seen that dental aesthetics is the single most important factor for both lay and orthodontist groups in predicting the treatment recommendation decision.

TABLE 5.17 *Stepwise logistic regression output ORTHODONTIST GROUP*

Step	Improv			Model			Correct			Coefficients
	Chi-Sq	df	sig	Chi-Sq	df	sig	Class%	Variables		
1	2427.485	1	.000	2427.485	1	.000	91.56	IN: IOTNAC	0.4397	
2	111.286	1	.000	2538.771	2	.000	91.56	IN: PAR1	0.2267	
3	96.996	1	.000	2635.767	3	.000	90.88	IN: POSOJ	0.7883	
4	50.124	1	.000	2685.891	4	.000	91.06	IN: LIINCLMX	-0.0781	
5	47.276	1	.000	2733.167	5	.000	91.06	IN: CROSSBIT	1.2049	
6	24.542	1	.000	2757.709	6	.000	91.06	IN: LARBS AP	0.3091	
7	13.710	1	.000	2771.418	7	.000	91.81	IN: PAR2	0.1168	
8	11.961	1	.000	2783.379	8	.000	92.32	IN: PAR6	0.3372	
9	5.341	1	.000	2788.721	9	.000	92.32	IN: ANT XB	0.5675	

IOTNAC	Aesthetic assessment based on IOTN aesthetic component
PAR 1	Upper labial segment alignment
POSOJ	Overjet in mm
LIINCLMX	Lower incisor inclination maximum
CROSSBIT	Posterior crossbite with mandibular displacement
LARBS AP	Buccal segment sagittal relationship (Left and right added together)
PAR 2	Lower labial segment alignment
PAR 6	Centreline
ANT XB	Anterior cross bite

## Treatment outcome

Again, regression coefficients generated during the multiple logistic regression was used to assess how various factors influence the treatment outcome acceptability decision. A positive coefficient is interpreted as an increase in the likelihood of acceptance as a random variable increases (becomes more positive). A coefficient of 0 would signify average probability of acceptance. The co-efficient signifies the effect that a particular variable has while keeping all other variables constant.

A high chi square value for a given variable suggests it is important in explaining the observed variation.

In this particular section only the occlusal traits found in the post-treatment study casts were used as explanatory variables in a stepwise logistic regression, the outputs of which for both lay and professional groups are shown in Tables 5.18 and 5.19 respectively.

Table 5.18 *Stepwise logistic regression output LAY GROUPS*

Step	Improv			Model			Correct			
	Chi-Sq	df	sig	Chi-Sq	df	sig	Class %	Variables	Coefficients	
1	139.824	1	.000	139.824	1	.000	89.46	IN: REVERSOJ	1.1272	
2	58.620	1	.000	198.445	2	.000	89.46	IN: LARBS VT	0.8822	
3	21.839	1	.000	220.284	3	.000	89.46	IN: UCROWDIN	0.7949	
4	16.265	1	.000	236.548	4	.000	89.46	IN: PAR5	0.8939	
5	16.998	1	.000	253.546	5	.000	89.46	IN: L3WIDTH	0.2597	
6	4.295	1	.000	257.841	6	.000	89.46	IN: LCROWDIN	0.5313	
7	4.746	1	.000	262.588	7	.000	89.46	IN: LARBS AP	0.1681	

REVERSOJ	Reverse overjet in mm
LARBS VT	Buccal segment vertical relationship (Left and rigght added together)
UCROWDIN	Upper arch crowding
PAR 5	Anterior overbite and/or openbite
L3 WIDTH	Lower intercanine width
LCROWDIN	Lower arch crowding
LARBS AP	Buccal segment sagittal relationship (Left and right added together)

TABLE 5.19 *Stepwise logistic regression output ORTHODONTIST GROUP*

Step	Improv			Model		Correct		Variables	Coefficients
	Chi-Sq	df	sig	Chi-Sq	df	sig	Class %		
1	552.993	1	.000	552.993	1	.000	72.28	IN: IOTNAC	0.5124
2	95.212	1	.000	648.205	2	.000	69.13	IN: LARBS AP	0.6208
3	89.793	1	.000	737.998	3	.000	70.55	IN: LARBS VT	0.7924
4	54.253	1	.000	792.251	4	.000	71.66	IN: ANT XB	1.2183
5	72.827	1	.000	865.078	5	.000	74.19	IN: PAR1	-0.4382
6	37.905	1	.000	902.983	6	.000	74.19	IN: UIINCLMX	-0.0595
7	33.258	1	.000	936.241	7	.000	74.19	IN: L3WIDTH	0.2685
8	11.643	1	.000	947.883	8	.000	74.59	IN: PAR2	0.3204
9	10.067	1	.000	957.950	9	.000	74.59	IN: LIINCLMX	-0.0227
10	4.677	1	.000	962.627	10	.000	74.38	IN: UCROWDIN	-0.223

IOTN AC	Aesthetic assessment based on IOTN aesthetic component
LARBS AP	Buccal segment sagittal relationship (Left and right added together)
LARBS VT	Buccal segment vertical relationship (Left and right added together)
ANT XB	Anterior cross bite
PAR 1	Upper labial segment alignment
UIINCLMX	Upper incisor inclination maximum
L3 WIDTH	Lower intercanine width
PAR 2	Lower labial segment alignment
LIINCLMX	Lower incisor inclination maximum
UCROWDIN	Upper arch crowding

The results for the lay group tend to mirror those of the logistic regression for the treatment need decision in that occlusal traits, in this particular instance reverse overjet plays the foremost role in the assessment of acceptability of outcome. This further reflects the fact that occlusal traits which are thought to compromise the function of the dentition also present a significant aesthetic impairment.

This particular co-efficient is negative because we are modelling the decision to accept, so we would expect the presence of deviant occlusal traits in the finished cases to reduce acceptance of outcome.

Further, substantial contributions were made by left and right buccal segments (vertical); upper arch crowding, centreline and lower intercanine width change. There were also significant (but not substantial) contributions from lower arch crowding and left and right buccal segments (antero-posterior). Factors which were not significant included anterior open bite and centre line.

Using all the variables from Table 5.18 obtains a model which predicts 89.46% of decisions correctly, with a 99.35% sensitivity for correct decisions and 18.72% specificity for unacceptable decisions.

The results seen from Table 5.19 for the orthodontist group are again quite similar to the logistic regression for the treatment need section. Here, once again, dental aesthetics was the most significant factor in the assessments of outcome acceptability. The results also tend to mirror those of the lay assessments of outcome. Substantial contributions were made by left and right buccal segment (anteroposterior), left and right buccal segment (vertical), anterior cross bite, upper anterior segment contact point displacement, upper incisor inclination and lower intercanine width change. Significant but not substantial contributions were made by lower anterior segment contact point displacement and lower incisor inclination. Factors which were not significant included anterior open bite and centre line.

The following assessments had no significant effect on assessment of outcome, lower arch crowding\spacing, lower intermolar width change, reverse overjet, overbite and anterior open bite. Using all of the significant traits in Table 5.19, obtains a model which predicts 74.38% of the decisions correctly with sensitivity of 86.54% and a specificity of 54.47%.

CONQUEROR

**CHAPTER 6**

## DISCUSSION

### **Orthodontist and lay sample**

The orthodontist sample is likely to be biased by geographical, motivational, educational and financial factors.

The study is most likely to attract lay participants who are local to the venue i.e. Cardiff, giving a geographic bias. Perceptions of the public may differ on a community and regional basis depending on the demand and availability of services. Self-selection bias is unavoidable in voluntary participation. Further, no financial compensation was offered. Which ever method of selection is used, some form of bias is unavoidable .

One also needs to note that examination order bias may have occurred. Order bias occurs when the mean score for a particular variable changes over time, when the magnitude or character of the stimulus is actually unchanged i.e. there is a shift in the use of the rating scales because there will inevitably be acclimatisation to the general standard of the sample, as well as possible fatigue effects. The effect of bias on the overall 'mean' scores for an individual subject is minimised by the allocation of different examination orders to each of the examiners, assuming that order bias affects each candidate equally, the overall effect is cancelled out.

The sum total effect of these sources of bias is impossible to assess completely, but is probably small.

### **Sample validity**

The limits on the validity of the sample are likely to arise from the following sources:

- \* The variation (in estimated treatment need) may be attributable to epidemiological methodology, it is now common to publish reliability estimates for the recording methods, allowing for a more meaningful interpretation of recent survey findings.

- \* A random sampling technique may not select traits of low prevalence e.g. cleft palate, when the sample size is minimised.

For the sake of completeness a non-random sampling method was used to include all possible occlusal traits which fall within the range of orthodontic correction. In other words the sample used as a stimulus for this study is a highly selected sample, but mimics the 12 year old population.

Although a subset of the parent sample used to canvass professional opinion was drawn, the constitution of the sample was determined by selecting cases which showed a full range of malocclusion according to objective criteria specified by the IOTN.

The validation sample size was chosen to power the statistical analysis, to address the issues of reliability assessment, and to yield the largest useful data for the number of cases included. However, the validation sample needs to be closely representative of an untreated 11 - 13 year old population of malocclusions. For reasons of completeness, a small number of cases exhibiting occlusal traits of missing teeth due to elective exodontia and cleft lip and palate were included in the validation sample. The proportion of adult orthodontic patients has been estimated to be around 3.5% in England and Wales (Nattrass 1995), while as many as 25% of adult patients may be re-treatment cases (Khan, Horrocks 1991).

There is little reliable qualitative information on the prevalence of malocclusion traits. This means that it is impossible to say how truly representative the sample is. By comparing the relative prevalence of occlusal traits in the sample with those found in the United Kingdom using IOTN by Holmes (1992), suggests that the sample is a fairly representative one.

Additionally, all panel members were observing the same cases under similar environmental conditions and comparisons of their judgements are valid at least within the range of the malocclusions present in the sample.

Limiting factors were imposed by time i.e. the sample size had to be reduced so as to permit examination by the lay public within a few hours since no financial incentives were offered. Nevertheless, the project was viable and has produced information of use.

## **RELIABILITY**

Some degree of recording error (recording the correct score against the wrong case number) will inevitably be reflected in lower Kappa reliability scores. It is not possible to ascertain how much of the reliability estimates had been affected by recording error. Examination fatigue may also similarly affect reliability estimates.

### **A. Treatment need**

In general, there is a range of reliabilities achieved for all aspects in the treatment need sample which reflects fair to moderate agreement for both lay and orthodontist groups, utilising interpretation of the Kappa scores as suggested by Landis and Koch (1977).

However, statistical analysis reveals that the orthodontist group is statistically significantly more reliable than the lay group in their assessments of dental aesthetics, dental health and deviation from normal. This difference could be accounted for by the professionals orthodontic training. The reliabilities of the dental nurse\technician groups are fairly similar to the orthodontist group, and it may be argued that the dental nurse\technicians exposure to an orthodontic environment and specifically to the medium of study casts has resulted in the similarity in reliabilities.

However, this difference in reliabilities between lay and orthodontist groups does not extend to the decision to recommend treatment, or in other words lay people are as reliable as orthodontists in the decision to recommend treatment.

### **B. Treatment outcome**

The reliabilities for treatment outcome are generally lower than those seen in the treatment need section with the degree of improvement generally reflecting lower Kappa scores than acceptability of result.

Statistical analysis reveals that the orthodontist group is significantly more reliable than the lay\dental nurse\technician groups in reliabilities assessing degree of improvement.

However, the orthodontist group is significantly more reliable than the lay\dental nurse groups, while the technician group is also more reliable than the lay group in reliabilities assessing acceptability of result.

One may again surmise that the orthodontists\technicians exposure to an orthodontic environment would serve to make them more reliable than lay persons in assessments of both degree of improvement and acceptability of results.

In summary, the reliabilities are generally lower than those in the treatment need section and reflect a wider spread. This may be attributed to fatigue effects as this section of the study was conducted during the latter half of the study. Further, it appears that judgements for the dichotomous scales (acceptability of result) appears to be more reliable than judgements for the 5 point scales (degree of improvement).

## **INTER-EXAMINER AGREEMENT**

### **A. Treatment Need**

The pattern of agreement seen in this section is similar to the intra-examiner reliability in that the scores for agreement as revealed by the multi-rater Kappa scores are higher amongst the orthodontists for dental health, dental aesthetics and deviation from normal. Further, it appears that the agreements for dental health, deviation from normal and dental aesthetics enjoys agreement in descending order of importance. This difference does not however, extend to the decision to recommend treatment, in that the levels of agreement between lay and orthodontists are fairly similar.

The results give an indication of the relative elements which would determine the entry threshold for orthodontic treatment.

Certainly, dental health is the most widely agreed upon. Next, it would appear that deviation from normal enjoys reasonable agreement, followed by dental aesthetics which is not surprising since dental aesthetics is a very subjective element.

It would appear that the treatment decision enjoys the least agreement and probably represents the relative inherent weakness of the dichotomous scales.

### **Aggregate assessments of treatment need**

Statistical analysis given us an idea of the overall perceptions of the different groups when presented with this sample of occlusions which is a fairly representative sample of occlusal traits found in the parent population.

There is a fairly narrow band (between 65.1% to 68.1%) which describes the treatment recommendation rate of the lay\dental nurse\technician groups, which

appears to be distinct from the prescribing behaviour of the orthodontist group. This would seem to imply that there is good agreement between the lay groups treatment recommendation rate. In contrast, the orthodontist group have a distinctly higher rate (77.6%) of treatment prescription.

This may imply that the malocclusion sample is skewed or possibly that orthodontists over-estimate the need for treatment perhaps due to their critical objective appraisals or greater awareness of the long term threats to the occlusion.

In order to bring these two groups towards a common treatment need recommendation rate, this should approximate 73%. However, it is questionable whether the aggregate treatment rate of 73% would be borne out in terms of the level of treatment provided or demanded in practise. Also, it is likely that the perceptions of the patients would be significantly different from those of the profession both in terms of the need for treatment and the result of treatment. (Salonen 1992, Thilander 1973, Ingervall 1973).

## **B. Treatment outcome**

It will be quite obvious that the multi-rater Kappa agreement scores are much lower than those seen in the treatment need section. Further, the pattern of agreement is similar to the intra-examiner reliability in that the levels of agreement are slightly higher within the orthodontist group than the lay group overall. Also, it appears that the dichotomous scale of acceptability of result appears to enjoy marginally greater agreement than the agreement demonstrated for degree of improvement.

### **Aggregate assessments of treatment outcome**

Essentially, the statistical analysis gives us an idea of the acceptability of treatment result deemed acceptable by the groups when presented with a range of treatment outcomes as classified by the PAR index, which are fairly representative of treatment outcomes achieved by U.K. orthodontists.

There is a fairly narrow band between 85.8% to 88.1% and hence excellent agreement that describes the treatment outcome results which are deemed acceptable by the lay groups. This is distinctly higher than the 60% deemed acceptable by the professional group, who are much more critical in their appraisal of treatment results deemed

acceptable and reject approximately 25% of cases deemed acceptable by the lay groups. This could perhaps be attributed to their professional training and striving for textbook ideal occlusions. These results tend to support the earlier work of Holmes (1991), Shaw (1975) and Prah-Anderson (1979) that orthodontists in general apply a more critical scale in their occlusal assessments. The results would thus imply that lay persons are willing to accept less than ideal occlusion.

### **Facial profile assessment**

It will be quite obvious that the Kappa scores for reliability assessments of the profile are all towards the lower end of the scale signifying poor reliability. However, it would appear from interpretation of the statistical analysis that the orthodontist and lay groups are significantly more reliable than the technician group in profile assessments pre-treatment while the orthodontist group is significantly more reliable than the technician group in profile assessments post-treatment.

There are no statistically significant differences for reliability assessments of the effect of treatment on the facial profile. These differences are somewhat difficult to explain and indeed many members of all groups commented that they could not differentiate between the profiles before and after treatment.

## **MODELLING THE DATA**

### **A. Treatment Need**

The study models have been scored using a protocol described in Appendix 4. Using the occlusal trait scores as explanatory variables in a stepwise logistic regression, we have analysed how those traits contribute to the decision for treatment.

Dental aesthetics plays a foremost role in the assessment of treatment need. This reflects the fact that many occlusal traits which are thought to compromise the health or function of the teeth such as large overjet, reverse overjet and anterior cross-bite also manifest a significant aesthetic impairment. The aesthetic component of the Index of Orthodontic Treatment Need, was used to assess aesthetics for each case and was the single most important predictive factor by a substantial margin.

Further substantial contributions were made by the left and right buccal segment sagittal relationships, left and right buccal segment cross-bite, upper incisor inclination

to the maxillary plane, lower anterior segment contact point displacement, upper anterior segment contact point displacement, missing teeth and positive overjet.

While the latter factors are statistically significant, the practical significance is low once the previous traits have been measured.

Factors which were not significant included upper and lower labial segment alignment, anterior open bite and centre line. The variance of these features is correlated with and largely explained by the more significant features, which renders them redundant in a stepwise model such as this.

Further, it can be seen that dental aesthetics also plays a significant role for the orthodontist group and was the single most important predictive factor by a substantial margin. Other substantial contributions were made by upper anterior segment contact point displacement, positive overjet, lower incisor inclination and cross-bite.

The significance of the models is that it means that the decision process is predictable, and it can be seen that dental aesthetics is the single most important factor for both lay and orthodontist groups in predicting the treatment recommendation decision.

#### **b. Treatment outcome**

Again, regression coefficients generated during the multiple logistic regression was used to assess how various factors influence the treatment outcome acceptability decision. A high chi square value for a given variable suggests it is important in explaining the observed variation.

In this particular section only the occlusal traits found in the post-treatment study casts were used as explanatory variables in a stepwise logistic regression.

The results for the lay group tend to mirror those of the logistic regression for the treatment need decision in that occlusal traits, in this particular instance reverse overjet plays the foremost role in the assessment of acceptability of outcome. This further reflects the fact that occlusal traits which are thought to compromise the function of the dentition also present a significant aesthetic impairment. This particular co-efficient is negative because we are modelling the decision to accept, so we would expect the presence of deviant occlusal traits in the finished cases to reduce acceptance of outcome.

Further, substantial contributions were made by left and right buccal segments (vertical); upper arch crowding, centreline and lower intercanine width change. There were also significant (but not substantial) contributions from lower arch crowding and left and right buccal segments (antero-posterior). Factors which were not significant included anterior open bite and centre line.

Using all the variables in a stepwise logistic regression obtains a model which predicts 89.46% of decisions correctly, with a 99.35% sensitivity for correct decisions and 18.72% specificity for unacceptable decisions.

The results for the orthodontist group are again quite similar to the logistic regression for the treatment need section. Here, once again, dental aesthetics was the most significant factor in the assessments of outcome acceptability. The results also tend to mirror those of the lay assessments of outcome.

Substantial contributions were made by left and right buccal segment (anteroposterior), left and right buccal segment (vertical), anterior cross bite, upper anterior segment contact point displacement, upper incisor inclination and lower intercanine width change. Significant but not substantial contributions were made by lower anterior segment contact point displacement, lower incisor inclination and upper arch crowding. Factors which were not significant included anterior open bite and centre line.

The following assessments had no significant effect on assessment of outcome, lower arch crowding\spacing, lower intermolar width change, reverse overjet, overbite and anterior open bite. Using all of the significant traits obtains a model which predicts 74.38% of the decisions correctly with a sensitivity of 86.54% and a specificity of 54.47%.

CONQUEROR

**CHAPTER 7**

## CONCLUSIONS

Both lay and orthodontist perceptions have been surveyed under standardised and somewhat artificial conditions. It is possible that practitioners perceptions may be modified by the demands of the patients for whom they work and by conditions of supply and demand. It is also possible that lay perceptions may be biased on a geographical basis being influenced by societal peer norms.

Judgements made in this study by the orthodontists are in isolation from the patients. It is therefore likely that the treatment recommendation rate of 73% would not be borne out in terms of the level of treatment provided or demanded in practice. Indeed, it is likely that the perceptions of the patients would be significantly different from those of the profession both in terms of the need for treatment and the outcome of treatment. In actual practice this method may not reflect what happens in the clinical environment because patients may demand (and receive) treatment when there is only limited objective need and conversely may refuse treatment when considered to be in need.

1. A comparison between orthodontist and lay groups determination of treatment need and treatment outcome has been analysed by recording judgements under standardised conditions.
2. Orthodontists subjective judgements are more reliable than lay persons in their assessments of dental aesthetics, dental health and deviation from normal.
3. Orthodontists tend to recommend 10 - 12 % more treatment than lay persons.
4. The levels of orthodontist agreement for dental health, deviation from normal and dental aesthetics were higher than for the lay groups.
5. The level of agreement for the decision to recommend treatment is similar between orthodontists and lay groups ie. lay persons are as reliable as orthodontists in the decision to recommend treatment.
6. The treatment decisions made by the lay and orthodontist groups on this sample of study models can be predicted using 5 occlusal traits with an overall

accuracy of 86.62% and 92.32% respectively. These traits for the lay group are dental aesthetics, left and right buccal segment sagittal relationships, left and right buccal segment cross-bite, upper incisor inclination to the maxillary plane and lower anterior segment contact point displacement. The traits for the orthodontist group are dental aesthetics, upper anterior segment contact point displacement, positive overjet, lower incisor inclination and cross-bite.

7. Both lay and orthodontist groups have poor reliabilities in facial profile assessments.
8. The orthodontist group were more reliable than the lay group in assessing degree of improvement and assessment of outcome.
9. Orthodontists reject approximately 25% of cases deemed acceptable by the lay group.
10. Dental aesthetics appeared to be the most important feature in the assessment of treatment outcome by both orthodontists and lay groups.
11. The outcome judgements by both lay and orthodontist groups on this sample of cases can be predicted using 5 occlusal traits with an accuracy of 89.46% and 74.38% respectively. These traits for the lay group are reverse overjet, left and right buccal segment vertical relationship, upper arch crowding, centreline and lower intercanine width change.
12. The occlusal traits for the orthodontist group are dental aesthetics, left and right buccal segment sagittal relationship, left and right buccal segment vertical relationship, anterior cross bite and upper anterior segment contact point displacement.

Computer

## CHAPTER 8

## **SUGGESTIONS FOR FUTURE RESEARCH**

- The information gained from this study can be used to develop an index of treatment need and outcome by incorporating a weighting for lay perceptions. Different linear weightings could apply to different countries as lay perceptions are inevitably culture specific.
- It may be possible to define specific malocclusion traits that evoked disagreement between lay persons and orthodontists on issues pertaining to treatment need and outcome. However, this would require complex statistical methods involving multivariate analysis of variance.

CONQUEROR



**CHAPTER 9**

## BIBLIOGRAPHY

**Addy M, Griffiths GS, Dummer PMH, Kingdom A, Hicks R and Hunter ML. (1988)**

The association between tooth irregularities and plaque accumulation, gingivitis, and caries in 11-12 year old children.

*European Journal of Orthodontics; 10: 76-83*

**Albino JE, Cunat JJ, Fox RN, Lewis EA, Slakter MJ, Tedesco LA. (1981)**

Variables discriminating individuals who seek orthodontic treatment.

*Journal of Dental Research; 60: 1661-7.*

**Albino JE, Tedesco LA. (1991)**

Aesthetic need for orthodontic treatment.

*In: Melsen B, ed. Current controversies in orthodontics. Chicago: Quintessence; 11 24.*

**Albino JE, Lewis EA, Slakter MJ. (1978)**

Examiner Reliability for Two Methods of Assessing Malocclusion.

*Angle Orthodontist; Vol 48 No 4: 297-302.*

**Altman DG. (1991)**

Practical statistics for medical research.

*Blackwell Publishers*

**Angle EH. (1899)**

Classification of malocclusion.

*Dental Cosmos; 41: 248-264.*

**Baldwin DC and Barnes ML. (1966)**

Patterns of motivation in families seeking orthodontic treatment (preprinted abstr.)

*I.A.D.R.*; 45: 412.

**Baldwin DC, Barnes ML, Baldwin MA and Papajohn JT. (1967)**

Social and cultural variables in the decision for orthodontic treatment (preprinted abstr.), *I.A.D.R.*; 46: 309.

**Banack AR., Cleall JF and Yip ASG. (1972)**

Epidemiology of malocclusion in 12 year old Winnipeg school children.

*Journal of the Canadian Dental Association*; 12: 437-455.

**Baume LJ, Horowitz HS, Summers CJ, Bacher Dinks O, Brown WAB, Carlos JP, Freer TJ, Harvold EP, Moorees CFA, Saltzman JA, Schmuth G, Solow B, Taatz H. (1973)**

A method of examining occlusal traits developed by the F.D.I. Commission on Classification and Statistics for Oral Conditions. (COCSTOC)

*International Dental Journal*; 23: 530-537.

**Berg R. (1979)**

Post-retention analysis of treatment problems and failures in 264 consecutively treated cases.

*European Journal of Orthodontics*; 1: 55-68

**Berg R and Fredlund A. (1981)**

Evaluation of orthodontic treatment results

*European Journal of Orthodontics*; 3: 181-185.

**Birkeland K, et al. (1996)**

Orthodontic concern among 11-year-old children and their parents compared with orthodontic treatment need assessed by Index of Orthodontic Treatment Need.

*American Journal of Orthodontics*; 110: 197-205.

**Birte Prah-Anderson, Herman Boersma, Frans P.G.M. van der Linden, Alton W. Moore. (1979)**

Perceptions of dentofacial morphology by laypersons, general dentists and orthodontists.

*Journal of the American Dental Association; Vol 98: 209-212.*

**Bezroukov V, Freer TJ, Helm S, Kalamkarov H, Sardo Infirri J and Solow B. (1979)**

*Bulletin of the World Health Organisation; 57: 6: 955-961.*

**Bjork A, Krebs AA and Solow B. (1963)**

A method for epidemiological registration.

*Acta Odontologica Scandanavica; 22: 27-41.*

**Bowden DEJ and Davies AP. (1975)**

Inter- and intra- examiner variability in assessment of orthodontic treatment need.

*Community Dentistry and Oral Epidemiology; 3: 198-200.*

**British Dental Association (1954)**

Memorandum on Orthodontic Services.

*British Dental Association; 1-12.*

**British Orthodontic Standards Working Party 2nd Report March (1985)**

**British Orthodontic Standards Working Party (1986)**

British Orthodontic Standards Working Party 2nd Report.

*British Journal of Orthodontics; 13: 165-173.*

**British Standards Institute (1983)**

Glossary of Dental Terms.

*BSI: London: (BS4492)*

**Brook PH.. (1987)**

The development of an index for orthodontic treatment priority.

*European Journal of Orthodontics; 11: 309-332.*

**Brook P. and Shaw WC. (1989)**

The development of an index of orthodontic treatment priority.

*European Journal of Orthodontics; 11: 309-320*

**Brown DF, Spencer AJ, Tolliday PD. (1987)**

Social and psychological factors associated with adolescents' self-acceptance of occlusal condition.

*Community Dentistry and Oral Epidemiology;15: 70-3.*

**Buchanan et al (1993)**

A comparison of the reliability and validity of the PAR Index and Summer's Occlusal Index .

*European Journal of Orthodontics;15:27-31.*

**Burden D. and Holmes. (1994)**

The need for orthodontic treatment in the child population of the United Kingdom.

*European Journal of Orthodontics; 16: 395-399.*

**Burden D. and Pine C. (1994)**

A comparison of orthodontic screening methods used in school dental inspections.

*Community Dental Health; 11: 224-226.*

**Burgersdijk RCW, Truin GJ, Frankenmolen FWA, Kalsbeek H, Hof Ma Van't,**

**Mulder J. (1991)**

Malocclusion and orthodontic treatment need of 15 - 74 year-old Dutch adults.

*Community Dentistry and Oral Epidemiology; 19: 64-67.*

**Carlos JP and Ast DS. (1966)**

An evaluation of the HLD Index as a decision making tool.

*Public Health Report; 81(7): 621-6.*

**Carlos JP. (1970)**

Evaluation of indices of malocclusion.

*International Dental Journal; 20: 4:606-617*

**Case CS. (1963)**

Techniques and principles of dental orthopedia (reprint of 1921 edition).

*New York: Leo Bruder; 16-8*

**Cohen J. (1960)**

A coefficient of agreement for nominal scales.

*Educational Psychological Measurement; 20: 37-46.*

**Cohen LK and Horowitz HS. (1968)**

A study of occlusal relations in Caucasian and Negro children born and reared in an optimally fluoridated community. Social-psychological findings.

*Read before the American Public Health Association, Dental Health Section Nov. 13.*

**Cohen LK, Horowitz HS. (1970)**

Occlusal relations in children born and reared in an optimally fluoridated community.

Social-psychological findings.

*Angle Orthodontist; 40: 159-69.*

**Cons NC , Jenny J, Kohout FJ, Freer TJ, Eismann D. (1983)**

Perceptions of occlusal conditions in Australia, the German Democratic Republic and the United States of America.

*International Dental Journal; 33: 200-6.*

**Cons NC, Jenny J, Kohout FJ, (1986)**

DAI: The Dental Aesthetic Index.

*Iowa City: University of Iowa, 1986.*

**Cousins AJP. (1973)**

National Health Service Orthodontics in general practice.

*Transactions of the European Orthodontic Society; 497-504.*

**Crabb JJ and Rock WP. (1986)**

Orthodontic screening of nine year-old children.

*British Journal of Orthodontics; 13: 43-47.*

**Davies TM. (1987)**

The relationship of anterior Overjet to plaque and gingivitis in children.

*British Journal of Orthodontics; 14:60 (Research Report)*

**Davies TI. (1992)**

A study into various perceptions of malocclusions by subjects of various ages.

*British Journal of Orthodontics; 100: 212-219.*

**Dorsey J, Korabik K. (1977)**

Social and psychological motivations for orthodontic treatment.

*American Journal of Orthodontics; 72: 460.*

**Draker HL. (1960)**

Handicapping Labio-lingual Deviations: a proposed index for public health purposes.

*American Journal of Orthodontics; 46: 295-315.*

**Eismann D. (1974)**

A method of evaluating efficiency of orthodontic treatment.

*Transactions of the European Orthodontic Society; 223-232.*

**Eismann D. (1980)**

Reliable assessment of morphological changes results from orthodontic treatment.

*European Journal of Orthodontics*; 2: 19-25.

**Elderton RJ, Clark JD. (1983)**

Orthodontic treatment in the General Dental Service assessed by the Occlusal Index.

*British Journal of Orthodontics*; 10: 178-186.

**Elderton RJ, Clark JD. (1984)**

An investigation of treatment in the general Dental Service for patients with Class II Division 1 malocclusions.

*British Journal of Orthodontics*; 11: 2-8.

**Espeland LV, Ivarsson K, Stenvik A. (1992a)**

A new Norwegian index of orthodontic treatment need related to orthodontic concern among 11-year olds and their parents.

*Community Dentistry and Oral Epidemiology*; 20: 274-279.

**Espeland LV, Gronlund G, Stenvik A, Alstad TA. (1992b)**

Perception of malocclusion in 11-year old children and comparison between personal and parental awareness.

*European Journal of Orthodontics*; 14: 350-358.

**Evans R. and Shaw WC. (1987)**

Preliminary evaluation of an illustrated scale for rating dental attractiveness.

*European Journal of Orthodontics*; 9: 314-318.

**Fisk RO. (1963)**

Physiological and socio-psychological significance of malocclusion.

*Journal of the Canadian Dental Association*; 29: 635-43.

**Foster TD. (1980)**

Orthodontic surveys: A critical appraisal.  
*British Journal of Orthodontics*; 7: 59-63.

**Foster TD and Walpole Day AJ. (1973)**

A survey of malocclusion and the need for orthodontic treatment in a Shropshire school population.  
*British Journal of Orthodontics*; 3: 73-78.

**Freer TJ. (1972)**

Assessment of occlusal statures; the matched pair similarity technique.  
*International Dental Journal*; 22: 412-422.

**Gardiner JH. (1956)**

A survey of malocclusion and some aetiological factors in 1000 Sheffield schoolchildren.  
*An interim report. The Dental Practitioner*; VI: 6: 187-201.

**Ghafari J, Locke SA, Bentley JM. (1989)**

Longitudinal evaluation of the Treatment Priority Index (TPI).  
*American Journal Orthodontics*; 96: 382-9.

**Goochman DS. (1975)**

The measurement and development of dentally relevant motives.  
*Journal Public Health Dent*; 35: 160-4.

**Goldstein RE. (1969)**

Study of need for aesthetics in Dentistry.  
*Journal of Prosthetic Dentistry*; 21: 589-598.

**Gosney MBE. (1986)**

An investigation into some of the factors influencing the desire for orthodontic treatment.

*British Journal of Orthodontics*; 13: 87-94

**Gottlieb EL. (1975)**

Grading your orthodontic treatment results.

*Journal of Clinical Orthodontics*; IX: 3: 156-161.

**Graber LW, Lucker GW. (1980)**

Dental aesthetic self-evaluation and satisfaction.

*American Journal of Orthodontics*; 77: 163-73.

**Grainger RM. (1967)**

Orthodontic treatment priority index.

*Public Health Service Public. No 1000 Ser 2, No 25, Washington, DC:*

*U.S. Government Printing Office.*

**Gravely JF. (1990)**

A study of need and demand for orthodontic treatment in two contrasting National Health Service regions.

*British Journal of Orthodontics*; 17: 287-92.

**Gravely JF and Johnson DB. (1974)**

Angle's classification of malocclusion: an assessment of reliability.

*British Journal of Orthodontics*; 1: 3: 79-86.

**Gray AS, Demurjian A. (1977)**

Indexing occlusion for dental public health programmes.

*American Journal of Orthodontics*; 72(2): 191-7.

**Han UK, Vig K, Weintraub J, Vig P, Kowalski C. (1991)**

Consistency of orthodontic treatment decisions relative to diagnostic records.

*American Journal of Orthodontics; 100: 212-219.*

**Haynes S. (1973)**

Orthodontic treatment needs in English children aged 11-12 years.

*British Journal of Orthodontics; 1: 9-12.*

**Haynes S. (1979)**

A quantitative study of general dental practitioner orthodontic care in Scottish Health Board areas (1966-1975).

*British Journal of Orthodontics; 6: 171-176.*

**Haynes S. (1982)**

Discontinuation of treatment in the general dental service in England and Wales.

*British Dental Journal; 152: 127-129*

**Helm S, Kreiborg S, Barlebo J, Caspersen J, Eriksen JH, Hansen W, Hanusardottir B, Munck C, Perregaard J, Prydso U, Reumert C, Spedtsberg H. (1975)**

Estimates of orthodontic treatment need in Danish schoolchildren.

*Community Dentistry and Oral Epidemiology; 3: 136-142.*

**Helm S. (1977a)**

Intra-examiner reliability of epidemiological registrations of malocclusion.

*Acta Odontologica Scandinavica; 35: 161-165.*

**Helm S. (1977b)**

Epidemiology and public health aspects of malocclusion.

*Journal of Dental Research Special Issue C; 56: c27-c31.*

**Helm S. (1979)**

Aetiology and treatment need of malocclusion .

*Journal of Canadian Dental Association; 45: 673-676.*

**Helm S. (1982)**

Orthodontic treatment priorities in the Danish Child Dental Health Services.

*Community Dentistry and Oral Epidemiology; 10: 260-3.*

**Helm S, Kreiborg S, Solow B. (1983)**

A 15-year follow-up study in 30-year-old Danes with regard to orthodontic treatment experience and perceived need for treatment in a region without organised orthodontic care.

*Community Dentistry and Oral Epidemiology, 11: 199-204.*

**Helm S, Kreiborg S, Solow B. (1985)**

Psychological implications of malocclusion: A 15-year follow-up study in 30-year-old Danes.

*American Journal of Orthodontics; 87: 110-118.*

**Helm S, Petersen PE, Kreiborg S, Solow B. (1986)**

Effects of separate malocclusion traits on concern for dental appearance.

*Community Dentistry and Oral Epidemiology; 14: 217-220.*

**Helm S. (1990)**

Reappraisal of the criteria for orthodontic treatment.

*Thesis, University of Oslo.*

**Hermanson PC, Grewe JM. (1970)**

Examiner variability of several malocclusion indices.

*Angle Orthodontist; 40: 219-35.*

**Hilzenrath SS and Baldwin DC. (1966)**

Achievement motivation - A factor in seeking orthodontic treatment (preprinted abstr.)

*I.A.D.R. 45: 412.*

**Holmes A. (1992a)**

The prevalence of orthodontic treatment need.

*British Journal of Orthodontics; 19: 177-182.*

**Holmes A. (1992b)**

The subjective need and demand for orthodontic treatment.

*British Journal of Orthodontics; 19: 287-97.*

**Holst D and Rise J. (eds) (1986)**

Epidemiologi tandvarden

Goteborg: The Nordic School of Public Health.

*Tandlakarfolaget.....*

**Horup N, Melson B, Terp S. (1987)**

Relationship between malocclusion and maintenance of teeth.

*Community Dentistry and Oral Epidemiology; 15: 74-78.*

**Howitt JW, Stricker G, Henderson R. (1967)**

Eastman Aesthetic Index.

*New York State Dental Journal 33: 215-20.*

**Ingervall B, Hedegard B. (1974)**

Awareness of malocclusion and desire of orthodontic treatment in 18 year old Swedish men.

*Acta Odontologica Scandinavica; 32: 93-101.*

**Ingervall B and Ronnerman A. (1975)**

Index of need of orthodontic treatment.

*Odontol. Review; 26: 59-82.*

**Ingervall B, Seeman L, Thilander B. (1972)**

Frequency of malocclusion and need of orthodontic treatment in 10-year old children in Gothenburg.

*Swedish Dental Journal; 65: 7-21.*

**Isaacson RJ, Christianson RL, Evance CA, Reidel RA. (1975)**

Research on variation in dental occlusion: A state of the art workshop conducted by the Craniofacial Anomalies Program the National Institute of Dental Research.

*American Journal of Orthodontics; 68: 241-255.*

**Jago JD. (1974)**

The epidemiology of dental occlusion; a critical appraisal.

*Journal of Public Health Dentistry; 34: 80-93.*

**Jarvinen S and Väättäjä P. (1987)**

Variability in assessment of need for orthodontic treatment when using certain treatment need indices.

*Community Dentistry and Oral Epidemiology; 15: 245-148.*

**Jenny J. (1975)**

A social perspective on need and demand for orthodontic treatment.

*International Dental Journal; 25: 248-56.*

**Jenny J, Cons NC, Kohout FJ, Frazier PJ. (1980)**

Test of a method to determine socially acceptable occlusal conditions.

*Community Dentistry and Oral Epidemiology; 8: 424-33.*

**Jenny J, Cons NC, Kohout FJ. (1983)**

Comparison of SASOC, a measure of dental aesthetics, with three orthodontic indices and orthodontist judgement.

*Community Dentistry and Oral Epidemiology; 11: 236-41.*

**Jenny J, Proshek JM. (1986)**

Visibility and prestige of occupations and the importance of dental appearance.

*Journal of Canadian Dental Association; 52: 987-9.*

**Jenny J, Cons NC, Kohout FJ. (1983)**

Comparison of SASOC, a measure of dental aesthetics, with three orthodontic indices and orthodontic judgement.

*Community Dentistry and Oral Epidemiology; 11: 236-241.*

**Jones ML. (1989)**

The Barry Project:- A three dimensional assessment of occlusal treatment change in a consecutively referred sample:- The incisors.

*British Journal of Orthodontics; 17: 1: 1-19.*

**Kahl-Nieke B, Fischback H, Schwarze CW. (1995)**

Post-retention crowding and incisor irregularity: A long term follow-up evaluation of stability and relapse.

*British Journal of Orthodontics; 22: 249-257.*

**Katz RV. (1978)**

Relationships between eight orthodontic indices and an oral self-image satisfaction scale.

*American Journal of Orthodontics; 73: 328-34.*

**Kingman, A 1986**

A procedure for evaluating the reliability of a gingivitis index

*Journal of Clinical Periodontology 13: 385-391*

**Klufas, M (1995)**

A non invasive method for measuring incisor inclination

*MScD theses University of Manchester*

**Knox E.D (ed). (1979)**

Epidemiology in health care planning.

*Oxford, New York, Toronto: Oxford Uni Press.*

**Landis JR., Koch GG. (1977)**

The measurement of observer agreement for categorical data.

*Biometrics; 33: 159-74.*

**Lau D, Griffiths G, Shaw WC. (1984)**

Reproducibility of an index for recording alignment of individual teeth.

*British Journal of Orthodontics; 11: 80-84.*

**Lewit DW, Virolainen K. (1968)**

Conformity and independence in adolescents' motivation for orthodontic treatment.

*Child Development; 39: 1189-1200.*

**Lindegard B, Lindegard L, Carlson M, Larsson. (1971)**

Need and Demand for Orthodontic Treatment.

*Tandlaegeblatt; 75: 1198-1210.*

**Linder-Aronson S. (1974)**

Orthodontics in the Swedish Public Dental Health Service.

*Transactions of the European Orthodontic Society; 233-40.*

**Lindsay SJE, Hodgkins JFW. (1983)**

Children's perceptions of their own malocclusions.

*British Journal of Orthodontics; 10: 13-20.*

**Linn EL. (1966)**

Social meanings of dental appearance.

*Journal of Health and Human Behaviour*; 7: 289-95.

**Little RM. (1975)**

The Irregularity index: A quantitative score of mandibular anterior alignment.

*American Journal of Orthodontics*; 68: 554-563.

**Luffingham JK, Campbell M. (1976)**

Attitudes to malocclusion amongst the parents of 10-12 year old children in Glasgow.

*British Journal of Orthodontics*; 3: 101-4.

**Lundstrom A. (1977)**

Need for treatment in Cases of Malocclusion.

*Transactions of the European Orthodontic Society*; 53: 111-123.

**Macgregor FC. (1951)**

Some psycho-social problems associated with facial deformities.

*American Sociological . Review*; 16: 629-638, 1951.

**Malmgren O. (1980)**

Studies on the need and demand for orthodontic treatment.

*Swedish Dental Journal*; Suppl 6.

**McLain JB, Proffitt WR. (1985)**

Oral health status in the United States: Prevalence of malocclusion.

*Journal of Dental Education*; 49: 386-96.

**McNamara JA. (1995)**

Occlusion, Orthodontic Treatment, and Temporomandibular Disorders: A Review.

*Journal of Orofacial Pain*; 9: 73-90.

**Miller J and Hobson P. (1987)**

The relationship between malocclusion, oral cleanliness, gingival conditions and dental caries in school children.

*British Dental Journal; 111: 42-53*

**Mohlin B and Thilander B. (1984)**

The importance of the relationship between malocclusion and mandibular dysfunction and some clinical application in adults.

*European Journal of Orthodontics; 6: 192-204*

**Murray J. (1969)**

Prevalence of malocclusion in fifteen-year-old children from fluoride and non-fluoride communities.

*British Dental Journal; 127: 128-131.*

**Myrberg N, Thilander B. (1973a)**

Orthodontic need of treatment of Swedish school children from objective and subjective aspects.

*Scandinavian Journal Dental Research; 81: 81-4.*

**Myrberg N, Thilander B. (1973b)**

An evaluation of the duration and the results of orthodontic treatment.

*Scandinavian Journal of Dental Research; 81: 85-91.*

**Myrberg N, Thilander B. (1973)**

An evaluation of the duration and the results of orthodontic treatment.

*Scandinavian Journal of Dental Research 81: 85-91.*

**Naccache H, Bernard C, Brodeur JM, Fournier A. (1989)**

Epidemiological evaluation of a computerized diagnosis in orthodontics.

*Journal Dental Research; 68: Abstract 776.*

**O'Brien KD. (1991)**

Orthodontic interactions: the relationships between the orthodontic services in England and Wales.

*British Journal of Orthodontics*; 18: 91-8.

**O'Connell DL and Dobson AJ. (1984)**

General Observer agreement measures on individual subjects and group of subjects.

*Biometrics*; 40: 973-983.

**Pickering EA and Vig P. (1975)**

The occlusal index used to assess orthodontic treatment.

*British Journal of Orthodontics*; 2: 47-51.

**Peerling et al. (1995)**

A photographic scale to measure facial aesthetics.

*European Journal of Orthodontics*; 17: 101-109

**Piers EV. (1969)**

Manual for the Children's Self Concept Scale.

*Nashville Tennessee Counsellor Recording and Tests.*

**Piätälä and Piätälä (1996)**

Dental appearance of orthodontic services assessed by 15 - 16 year old adolescents in Eastern Finland.

*Community Dental Health*; 13: 139-144.

**Prahl-Andersen B. (1978)**

The need for orthodontic treatment.

*Angle Orthodontist*; 48:1-9.

**Prahl-Andersen B, Kowalski CJ, Heijndael P. (1979)**

A mixed - longitudinal interdisciplinary study of growth and development.

*New York: Academic Press.*

**Prahl-Andersen B, Boersma H, van der Linden FPGM, Moore AW. (1979)**

Perceptions of dentofacial morphology by laypersons, general dentists, and orthodontists.

*Journal of the American Dental Association; 98: 209-12.*

**Poulton DR. and Aaronson. (1961)**

The relationship between occlusion and periodontal status.

*American Journal of Orthodontics; 47:691-699.*

**Richmond S. (1984)**

The feasibility of categorising Orthodontic treatment difficulty - the use of three-dimensional plotting.

*MScD. Thesis University of Wales.*

**Richmond S. (1990)**

A critical evaluation of orthodontic treatment in the general dental services of England and Wales.

*PhD Thesis, University of Manchester, United Kingdom.*

**Richmond S, Shaw WC, O'Brien KD, Buchanan IB, Jones R, Stephens CD, Roberts CT, Andrews M. (1992a)**

The development of the PAR Index (Peer Assessment Rating): Reliability and validity.

*European Journal of Orthodontics 14: 124-140.*

**Richmond S. et al. (1992b)**

The PAR Index (Peer Assessment Rating): Methods to determine outcome of orthodontic treatment in terms of improvement and standards.

*European Journal of Orthodontics; 14: 180-187.*

**Richmond S, Shaw WC and Stephens CD. (1992)**

Orthodontics in the General Dental Services of England and Wales: the provision of treatment.

*British Dental Journal*; 172: 150-152.

**Richmond S, O'Brien KD, Buchanan I, Burden D. (1994)**

An Introduction to occlusal indices.

ISBN 1-898922-00-4.

**Richmond S, Buchanan IB, Burden D, O'Brien KD, Andrews M, Roberts CT, Turbill E. (1995)**

Calibration of Dentists in the use of occlusal indices.

*Community Dentistry and Oral Epidemiology*; 23: 173-176.

**Robertson NRE, Jones ML, Richmond S and May E. (1987)**

The screening and categorisation of patients: A case for natural selection.

*British Journal of Orthodontics*; 14: 181-186.

**Roth RH. (1973)**

Temporomandibular pain-dysfunction and occlusal relationships.

*Angle Orthodontist*; 43: 136-154.

**Salonen L, Mohlin B, Gotzlinger B, Hellden L. (1992)**

Need and demand for orthodontic treatment in an adult Swedish population.

*European Journal of Orthodontics*; 14: 359-68.

**Saltzman JA. (1968)**

Handicapping malocclusion assessment to establish treatment priority.

*American Journal of Orthodontics*; 54: 749-65

**Samuels and Proshek. (1973)**

The importance of dental appearance in a prestige hierarchy of occupations.  
Journal of Dental Research, Program of abstract of papers.  
*I.A.D.R. 273, 52, special issue 118.*

**Sandali T. (1973)**

Irregularities of the teeth and their relation to the periodontal condition with particular reference to the lower labial segment.  
*European Orthodontic Society Transactions; 319-333.*

**Schanschieff Report (1986)**

Report of the Committee of Enquiry into Unnecessary Dental Treatment.  
*London: HMSO.*

**Sergl HG and Stodt W. (1970)**

Experimental investigation of the aesthetic effect of various tooth positions after loss of an incisor tooth.  
*Transactions of the European Orthodontic Society; 46: 497.*

**Shaw WC, Rees G, Dawe M, et al. (1975)**

The influence of dentofacial attractiveness of young adults.  
*American Journal of Orthodontics; 87: 1, 21-26.*

**Shaw WC, Lewis HG, Robertson NRE. (1975)**

Perception of malocclusion.  
*British Dental Journal; 138: 211-6.*

**Shaw WC, Gabe MJ, Jones BM. (1979)**

The expectations of orthodontic patients in South Wales and St. Louis, Missouri.  
*British Journal of Orthodontics; 6: 203-5.*

**Shaw WC, Addy M, Ray C. (1980)**

Dental and Social effects of malocclusion and effectiveness of orthodontic treatment - a review.

*Community Dentistry and Oral Epidemiology*; 8:36-45.

**Shaw WC, Meek SC and Jones DS. (1980b)**

Nicknames, teasing and the salience of dental features among school children.

*British Journal of Orthodontics*; 7: 75-80

**Shaw WC. (1981)**

Factors influencing desire for orthodontic treatment.

*European Journal of Orthodontics*; 3: 151-162.

**Shaw WC. (1981a)**

Folklore surrounding facial deformity and the origin of facial prejudice.

*British Journal of Plastic Surgery*; 34: 237-246.

**Shaw WC. (1981a)**

Factors influencing the desire for orthodontic treatment.

*European Journal of Orthodontics*; 3:151-62.

**Shaw WC. (1981b)**

The influence of children's dentofacial appearance on their social attractiveness as judged by peers and lay adults.

*American Journal of Orthodontics*; 79: 399-415.

**Shaw WC, Humphreys S. (1982)**

Influence of children's dentofacial appearance on teacher expectations.

*Community Dentistry and Oral Epidemiology*; 10: 313-319.

**Shaw WC. (1983)**

A comparison of orthodontic services in England and Wales, the Netherlands and Scandinavia.

*European Journal of Orthodontics*; 5: 295-305.

**Shaw SC, Rees G, Dawe M, Charles CR. (1985)**

The influence of dentofacial appearance on the social attractiveness of young adults.

*American Journal of Orthodontics*; 87: 21-6.

**Shaw WC, Addy M, Dummer PMH, Ray C and Frude N. (1986)**

Dental and social effects of malocclusion and effectiveness of orthodontic treatment: a strategy for investigation.

*Community Dentistry and Oral Epidemiology*; 14: 60-64.

**Shaw WC. (1988)**

Risk benefit appraisal in orthodontics.

*In: Moorrees CFA, van der Linden FPGM, eds. Orthodontics: Evaluation and future.*

*The Netherlands: Department of Orthodontics, University of Nijmegen*; 63-81.

**Shaw WC, O'Brien KD, Richmond S. (1991a)**

Quality Control in orthodontics: factors influencing the receipt of orthodontic treatment.

*British Dental Journal*; 170: 66-8.

**Shaw WC, Richmond S, O'Brien KD, Brook P, Stephens CD. (1991b)**

Quality control in orthodontics: indices of treatment need and treatment standards.

*British Dental Journal*; 170: 107-12.

**Shaw WC, Richmond S, O'Brien KD. (1995)**

The use of occlusal indices: a European perspective.

*American Journal of Orthodontics*; 107 (1): 1-10.

**Simon PA. (1924)**

On gnathostatic diagnosis in orthodontics.

*International Journal of Orthodontics; 10: 755-762.*

**Slakter MJ, Albino JE, Green LJ, Lewis EA. (1980)**

Validity of an orthodontic treatment priority index to measure need for treatment.

*American Journal of Orthodontics; 78: 421-5.*

**So L, and Tang E. (1994)**

A comparative study using the Occlusal index and the Index of Orthodontic Treatment Need.

*The Angle Orthodontist; 63: No 1: 57-64.*

**Standing Dental Advisory Committee (1973)**

The scope and limitations of orthodontic treatment.

*DHSS, London, Welsh Office, Cardiff.*

**Stephens CD and Bass TP. (1973)**

Regional variations in the provision of orthodontic treatment in England and Wales.

*British Journal of Orthodontics; 1, 13-17.*

**Stephens CD. (1985)**

Orthodontic experience and clinical confidence of the recent dental graduate.

*British Dental Journal; 159: 301-303.*

**Stephens CD and Harradine NWT. (1988)**

Changes in the complexity of orthodontic treatment for patients referred to a teaching hospital.

*British Journal of Orthodontics; 15: 27-32*

**Stricker G. (1970)**

Psychological issues pertaining to malocclusion.  
*American Journal of Orthodontics*; 58: 276-83.

**Stricker G, Clifford E, Cohen LK, Giddon DB, Meskin LH, Evans CA. (1979)**

Psychosocial aspects of craniofacial disfigurement.  
*American Journal of Orthodontics*; 76: 410-22.

**Summers CJ. (1971)**

The occlusal index: a system for identifying and scoring occlusal disorders.  
*American Journal of Orthodontics*; 59: 552-67.

**Secord PF and Backman CW. (1959)**

Malocclusion and psychological factors.  
*Journal of the American Dental Association*; 59: 931-938.

**Tang L. K. and Wei H.Y. (1993)**

Recording and measuring Malocclusion - A review of the literature  
*American Journal of Orthodontics*; 103: 344-351

**Tedesco LA, Albino JE, Cunat JJ, Green LJ, Lewis EA, Slakter MJ. (1983)**

Dental-facial attractiveness scale. Part I. Reliability and validity.  
*American Journal of Orthodontics*; 83: 38-43.

**Todd JE. (1975)**

Children's dental health in England and Wales 1973.  
*Her Majesty's Stationery Office, London.*

**Todd JE and Dodd D. (1985)**

Childrens dental health in the United Kingdom  
*HMSO London.*

**Tulloch JFC, Shaw WC, Underhill C, Smith A, Jones G, Jones M. (1984)**

A comparison of attitudes toward orthodontic treatment in British and American communities.

*American Journal of Orthodontics; 85: 253-9.*

**Turbill E. et al. (1994)**

A preliminary comparison of the DPB's grading of completed orthodontic cases with the PAR index.

*British Journal of Orthodontics; 21: 279-285.*

**Turbill EA, Richmond S and Wright JL. (1996)**

Assessment of General Dental Services Orthodontic Standards: the Dental Practice Board's Gradings compared to PAR and IOTN.

*British Journal of Orthodontics; 23: 2110-220*

**World Health Organisation (1962)**

Standardisation of reporting of dental diseases and conditions.

6. The assessment of handicapping dentofacial anomalies.

*Technical Report Series; No 242.*

*Geneva, World Health Organisation*

**APPENDIX 1**



CONQUEROR

# **EURO-QUAL Project**

Validation Study  
For The Assessment Of Treatment Need And Outcome Between Lay  
Persons And Professional Orthodontists.

**CARDIFF**

**6 TH DECEMBER 1995.**

## Instructions To Participants

During this study you are asked to give your opinion on various aspects of malocclusion. The study is aimed at determining areas of agreement and disagreement in international orthodontic opinion and therefore there are no 'right' or 'wrong' answers. Please do not discuss judgements of the clinical material with other participants during the study.

There are three types of records you will be asked to judge:

### *Type 1*

68 sets of untreated patient records comprising study models. Please grade these cases for treatment need, dental aesthetics and deviation from ideal occlusion.

### *Type 2*

50 pairs of pre-treatment and post-treatment facial profiles are provided please indicate how you think the treatment has affected the facial aesthetics.

### *Type 3*

50 pairs of pre-treatment and post-treatment dental study casts are supplied for the assessment of treatment standards and degree of improvement resulting from orthodontic treatment.

**Each record is marked with an identification number which you should copy into the space on the answer sheet.** Pre-treatment records all carry a white label and post-treatment records carry a yellow label.

Use the scales as follows :

## Answer section 1

**Treatment need** by assessment of 68 study casts

### TREATMENT NEED ON GROUNDS OF DENTAL HEALTH

DENTAL HEALTH	no need	1	2	3	4	5	great need
---------------	---------	---	---	---	---	---	------------

### TREATMENT NEED ON GROUNDS OF DENTAL AESTHETICS

DENTAL AESTHETICS	no need	1	2	3	4	5	great need
-------------------	---------	---	---	---	---	---	------------

### DEVIATION FROM NORMAL OCCLUSION

DEVIATION FROM NORMAL	normal	1	2	3	4	5	abnormal
-----------------------	--------	---	---	---	---	---	----------

### DECISION TO TREAT

SHOULD THIS BE TREATED?	no	1				2	yes
-------------------------	----	---	--	--	--	---	-----

## Answer section 2

**Facial aesthetics** by assessment of 50 pairs of facial profiles before and after treatment

### FACIAL AESTHETICS

Before treatment	poor facial profile	1	2	3	4	5	ideal facial profile
After treatment	poor facial profile	1	2	3	4	5	ideal facial profile
Profile change	worse	1	2	3	4	5	improvement

If you think the profile is unchanged answer 3

## Answer section 3

**Treatment standards** by assessment of 50 pairs of pre-treatment and post-treatment study casts

### TREATMENT STANDARD

Improvement	worse	1	2	3	4	5	greatly improved
Is the result acceptable ?	Yes	1				2	No

If you think that the occlusal problem is neither worse nor better following treatment answer 3.

## EURO-QUAL Project

Candidate Name \_\_\_\_\_

Start at record \_\_\_\_\_

### ANSWER SECTION 1

**TREATMENT NEED** by assessment of 68 study casts

Treatment need on grounds of dental health

**Dental Health**                      no need              1 2 3 4 5                      great need

Treatment need on grounds of dental aesthetics

**Dental Aesthetics**                      no need              1 2 3 4 5                      great need

Deviation from normal occlusion

**Deviation From Normal**              normal              1 2 3 4 5                      very abnormal

Decision to treat

**Should This Be Treated?**      no                      1                      2                      yes

If this book is found please return to:  
Ismail Vally  
Department of Child Dental Health  
Dental School  
University of Wales College of Medicine  
Cardiff  
CF4 4XY  
UK

# EURO-QUAL Project

Candidate Name \_\_\_\_\_

Start at record \_\_\_\_\_

## ANSWER SECTION 2

**FACIAL AESTHETICS** by assessment of 50 pairs of facial profiles before and after treatment

### Facial Aesthetics

Before treatment	poor facial profile	1	2	3	4	5	ideal facial profile
After treatment	poor facial profile	1	2	3	4	5	ideal facial profile
Profile Change	worse	1	2	3	4	5	improvement

If you think the profile is unchanged answer 3

If this book is found please return to:  
Ismail Vally  
Department of Child Dental Health  
Dental School  
University of Wales College of Medicine  
Cardiff  
CF4 4XY  
UK

## EURO-QUAL Project

Candidate Name \_\_\_\_\_

Start at record \_\_\_\_\_

### ANSWER SECTION 3

**Treatment standards** by assessment of 50 pairs of pre-treatment and post-treatment study casts

#### TREATMENT STANDARD

Improvement	worse	1	2	3	4	5	greatly improved
Is the result acceptable ?	Yes	1			2		No

If this book is found please return to:  
Ismail Vally  
Department of Child Dental Health  
Dental School  
University of Wales College of Medicine  
Cardiff  
CF4 4XY  
UK

**APPENDIX 2**

CONQUEROR

# EURO-QUAL Project

Questionnaire

CARDIFF

Candidate Number.....

Please answer the question by circling the appropriate answer number at the end of the question in the space provided.

QUESTIONS		ANSWERS
A]	What is your year of birth ?	A].....
B]	Sex 1. male 2. female	B] 1 2
C]	Have you received orthodontic treatment previously ?	YES NO
D]	What is your post-code?	-----
E]	How frequently do you visit a dentist for routine check ups?	-----

CONQUEROR

**APPENDIX 3**

CONQUEROR

## **BOX AND WHISKER PLOTS**

The box width encompasses the inter-quartile range (25th to 75th percentile) and the whiskers denote the highest or lowest non-outlying value. An outlying value is denoted by a circle O and is defined as a value which lies between 1.5 and 3 box widths from the box ends. An extreme value lies beyond this region and is denoted by a star \*. The median value is denoted by the heavy bar in the box and gives some idea of the degree of skew.