THE OCCLUSION OF CHILDREN AS RELATED TO WATER FLUORIDE CONCENTRATION AND SOCIOECONOMIC STATUS

By

Walter Ray Davis, Jr.

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INTRODUCTION

Following the discovery that a controlled amount of fluoride ion in the drinking water would substantially reduce the prevalence of dental caries and subsequent tooth loss, the possibility that the fluoride ion might influence the occlusion was considered. This hypothesis was investigated on several occasions and the conclusions varied; however the data were usually limited to the prevalence of normal occlusion and malocclusion. Consequently in this study an attempt was made to more critically evaluate the occlusion of children and to determine if the deviations were related to fluorides in the communal water supply.

Since recent findings have emphasized the importance of considering social and economic factors in dental epidemiological studies, each child was interviewed and assigned a position in the socioeconomic strata. This information was important since an additional factor was controlled during the evaluation of the relationship between water fluoride and the developing occlusion. It was also considered desirable to investigate the relationship between socioeconomic status and the occlusion of children.

REVIEW OF THE LITERATURE

The Review of the Literature is divided into two parts. The first part contains information reviewed by this author concerning the relationship of fluoride in the communal water supply to the dental occlusion of children. In the second part the association of socioeconomic status to dental occlusion and caries is discussed.

The Relationship of Fluoride in the Communal Water Supply to the Dental Occlusion of Children

Plater[1] reported, in 1945, the results of a survey of 369 Wisconsin school children 12 to 17 years of age. The children resided in Union Grove where the fluoride content of the drinking water was approximately 1.0 part per million or in Madison where the fluoride content was approximately 0.05 part per million. The areas studied were reported as being comparable in all other conditions except the variation in the fluoride content of the drinking water.

Plater found that in 40 per cent of the Union Grove children the occlusion approached the ideal, all of the teeth being in correct mesiodistal relation. However, similar conditions were found in only 12 per cent of the Madison children. Therefore, malocclusions were recorded in 60 per cent of the Union Grove sample of children and in 88 per cent of the

Madison group. More specifically, conditions similar to Angle Class I malocclusions were found in 30 per cent of the Union Grove children and in 50 per cent of the Madison group. Distal occlusions were reported in 30 per cent of the Union Grove children and 36 per cent of the Madison children. Mesial occlusion was not recorded in the Union Grove sample but was present in 2 per cent of the Madison group.

Plater also observed that the prevalence of dental caries was approximately three times higher in the Madison children as compared to the Union Grove children. A conclusion in this study was that when a fluoride area and a fluoride-deficient area were compared, the prevalence of malocclusion was lower in the fluoride area due to a lower prevalence of dental caries.

Pelton and Elsasser,[2] in 1953, reported the results of their investigations on 850 school children 6 to 13 years of age who were continuous residents of Nampa or Coeur d'Alene, Idaho. The drinking water of Nampa contained fluoride in the amount of 1.5 parts per million, while the water was fluoride-free in Coeur d'Alene. Dentofacial relationships of the children were determined by the clinical orthometric examination method described by Elsasser.[3, 4] A value, referred to as the dentofacial index (DFI), was obtained for each child by this method which was compared to an established normal range and to the scores of other children.

Pelton and Elsasser found that the prevalence of malocclusion, as expressed by the average DFI values, did not vary significantly between the children in Nampa and Coeur d'Alene. However, it was reported that the prevalence of cross-bite in the fluoride area was slightly lower in the 6 to 9 year old children and considerably lower in the 10 and 11 year old children. The DMF rate was 1.79 in the fluoride area and 3.80 in the nonfluoride area. Therefore, Pelton and Elsasser concluded that dental caries was not a primary etiologic factor in malocclusion.

Salzman and Ast,[5] in 1955, reported the results of a cephalometric study of dentofacial growth and development as related to the fluoride content of the drinking water supply. Public school children 6 to 10 years of age were studied in Newburgh, New York, where the fluoride content of the drinking water was adjusted between 1.0 and 1.2 parts per million for the previous 9 years, and in the comparable city of Kingston, New York, where the drinking water was fluoride-deficient. Profile cephalometric roentgenograms for 386 Newburgh children and 373 Kingston children were studied by a series of 6 angular measurements. The results of this study by Salzman and Ast indicated that there were no clinically significant differences in the facial patterns of the Newburgh children when compared to the Kingston group.

Okyay[6] published a research report, in 1957, concerning the role of fluoride in the etiology of malocclusion. Previously a survey was conducted to determine the prevalence of malocclusion and dental caries in 1736 school children 6 to 18 years of age who resided in Isparta and Antalya, Turkey. Fluoride occurs naturally in the drinking water of Isparta and apparently the content varies between 1.41 and 4.30 parts per million. Dental fluorosis was common in the area. The fluoride content of the drinking water in Antalya was 0.26 parts per million. In this study the occlusion was recorded as either normal or abnormal.

Okyay found that the prevalence of abnormal occlusion in the 6 to 12 year old children was similar when the two areas were compared, for abnormal occlusion was recorded in 57.32 per cent of the Isparta children and in 55.13 per cent of the Antalya sample. However, a considerable difference was found in the prevalence of abnormal occlusion in the 12 to 18 year old group, for abnormal occlusion was found in 44.20 per cent of the high fluoride area students and in 65.32 per cent of the low fluoride area students.

The percentages of missing teeth and dental caries were considerably lower in the high fluoride sample of children as compared to the low fluoride group of children. Okyay concluded that it was possible that the low prevalence of abnormal occlusion in the children residing in the high fluoride area was related to the low percentage of dental caries and missing teeth.

Hill et al[7] reported, in 1959, on the prevalence of malocclusion among children residing in Evanston, Illinois (fluoridated) and Oak Park, Illinois (fluoride-free) utilizing the Angle classification of malocclusion. Over 8,000 examinations were made of white public school children 6 to 8 and 12 to 14 years of age. After fluoridation, the rate of dental caries in the Evanston children decreased 62.65 per cent in the 6 to 8 year old group and 46.22 per cent in the 12 to 14 year old students.

The findings of Hill and his co-workers indicated that the incidence of malocclusion decreased 20.48 per cent in the 6 to 8 year old Evanston children and 17.03

per cent in the 12 to 14 year old Evanston children when compared to the prefluoride data. However in the control city of Oak Park, the incidence of malocclusion increased 3.26 per cent in the 6 to 8 year old group and 3.54 per cent in the 12 to 14 year old students. It was interesting to note that the prevalence of malocclusion among the 6 to 8 year old children was 29.54 per cent in the fluoride area in 1955 and 30.98 per cent in the control area in 1956. Comparing the 12 to 14 year old children, the prevalence of malocclusion was 46.32 per cent in the fluoridated area in 1957 and 48.65 per cent in the control area in 1956. Therefore, it was noted that the prevalence of malocclusion in Evanston in 1955 and 1957 was similar to that found in Oak Park in 1956. However, while the data in Evanston demonstrated a decreased incidence of malocclusion after fluoridation, there was an increase in the incidence of malocclusion in Oak Park during the 9 year period between examinations. The conclusion reached by Hill and his associates regarding the effect of water fluoridation on the prevalence of malocclusion among children was that no definitive statement was possible.

Walther reported,[8] in 1960, the results of an orthodontic survey of 1000 English school children in three areas with varying concentrations of fluoride in the drinking water. Children 11 to 13 years of age were studied in (1) Colchester where the fluoride content of the water varied between 1.2 and 2.0 parts per million, (2) Chelmsford which had a fluoride content ranging between 0 and 1.0 part per million, and (3) Norwich where the fluoride content was approximately 0.17 part per million.

In this study reported by Walther, changes were found in the percentage distribution of the dental base skeletal patterns when the various fluoride groups were compared. The changes tended to favor the fluoride groups for there were improvements in the distributions of skeletal patterns with increasing amounts of fluoride in the drinking water. However, Walther concluded that it was not possible to make a definite statement as to whether the improvement in skeletal patterns was due to the fluoride content of the drinking water or to ethnic differences in the sample of children.

Walther found Angle Class I malocclusions in 57 per cent of the Colchester children with lifelong exposure to fluoride. The percentage of Class I malocclusions in the other groups of children decreased, relative to decreasing concentrations of fluoride in the water, to a low of 41 per cent of Class I cases in the Norwich children. The differences in the percentage distribution of Angle Class I cases were largely related to the percentage of Angle Class II, division 2 malocclusions, as the percentages of the other types of malocclusions remained relatively constant when the various groups of children were compared. Consequently, the percentage of Angle Class I cases was highest in the Colchester children who were continuous residents, while the percentage of Angle Class II, division 2 malocclusions was lowest in the same group. Likewise, the percentage of children with Angle Class I malocclusions was lowest in Norwich, while the percentage of Angle Class II, division 2 cases was highest in this group. Walther concluded that even though differences were found in the percentage distribution of Angle Class I and Class II, division 2 malocclusions, which were apparently related to the fluoride content of the drinking water, additional research was necessary before definite conclusions were made.

Ast et al[9] reported, in 1962, on the prevalence of malocclusion among 302 school children 13 to 14 years of age in Newburgh (fluoridated) and Kingston (fluoride-deficient), New York. Both the incidence of dental caries and the prevalence of missing first permanent molar teeth were significantly lower in the Newburgh children. Ast and his associates found normal occlusion in 35.2 per cent of the Newburgh children and in only 12.7 per cent of the Kingston group. Malocclusion, as determined by a modified version of Angle's classification, was present in the total Newburgh sample of children in the following frequencies: Class I, 42.7 per cent; Class II, 20.9 per cent; and Class III, 1.2 per cent. Likewise, considering the total group of children examined in Kingston, malocclusion was prevalent in the following order: Class I, 51.4 per cent; Class II, 32.4 per cent; and Class III, 3.5 per cent. The prevalence of physically handicapping malocclusions was 9.4 per cent in the Newburgh children and 22.5 per cent in the Kingston group. Ast and his co-workers concluded that the lower prevalence of malocclusion found in Newburgh as compared to Kingston was related to the lower prevalence of loss of permanent teeth, particularly first molars.

The Association of Socioeconomic Status
to Dental Occlusion and Caries

Calisti et al[10] reported, in 1960, on the relationships between socioeconomic level, malocclusion, and oral habits among 491 Massachusetts preschool children. Socioeconomic classification was determined by the census tract rating of the school which the children attended. Malocclusion was recorded with a modified version of the Angle classification of malocclusion, as the mesiodistal arch relationship was determined by the positions of the second deciduous molars and the maxillary deciduous cuspids. Somewhat paradoxical results were obtained by Calisti and his associates for no statistically significant correlation was found between the socioeconomic level of the children and the prevalence of malocclusion, but significant positive relationships were found between the socioeconomic levels and the prevalence of oral habits and between oral habits and the prevalence of malocclusion.

In the literature reviewed by this author, no other research was found regarding the association between the socioeconomic status and the prevalence of malocclusion among children. However, relationships between socioeconomic levels and dental caries have been studied which were considered pertinent to the discussion by this author.

Franzen[11] reported, in 1932, the influence of social and economic factors on the dental health of school children. Decayed, missing, or filled first permanent molars were studied, and these conditions were correlated with social and economic variables. Franzen found a high positive relationship between the proportion of filled teeth and the position in the social and economic strata. Likewise, there was a high negative correlation between missing first permanent molars and social and economic factors.

Mitchell[12] reported, in 1933, on the association of socioeconomic variables and dental caries in 10 year old Puerto Rican children. The study indicated a tendency for the better socioeconomic groups of children to have a higher prevalence of dental caries in the first permanent molars than the lower socio-economic groups.

Cohen[13] reported, in 1936, on the relationship between socioeconomic level and the prevalence of dental caries in Minnesota children 2 to 15 years of age. The results of this study by Cohen indicated that children from high socioeconomic families tended to have less dental caries in the deciduous teeth, but more caries in the permanent teeth, when compared to low socioeconomic families. Mansbridge[14] reported, in 1959, similar findings in Scottish school children 5 to 17 years of age.

Greenwald,[15] Klein and Palmer,[16] Hagan,[17] and McCauley and Frazier[18] all have reported little or no association between the socioeconomic status and dental caries experience among children. However, these authors generally found that the loss of teeth was more frequent in the low socioeconomic status children. Savara and Suher[19] reported, in 1955, that among the preschool children studied, there was no association between parent income and the prevalence of dental caries; however, a significant negative association was found between the educational level of the parents and the dental caries experience of the children.

Szwejda[20] reported, in 1960, on the association of socioeconomic conditions and the prevalence of dental caries among white school children living in Buffalo, New York. The socioeconomic classification was determined by the census tract in which the children resided. Szwejda found that the children in the high economic areas had the lowest prevalence of dental caries in both the deciduous and permanent teeth, while the children from the low economic areas had the highest caries experience. Likewise, the children from the average economic housing tracts had caries rates which tended to fluctuate between the high and low economic groups.

Castaldi et al[21] reported, in 1962, that among children 10 to 12 years of age, there were no association between socioeconomic levels and deciduous dentition caries attack rates. However, the low socioeconomic group had higher permanent dentition caries attack rates than the other socioeconomic groups. Castaldi and his co-workers found that there were significant differences in the treatment level of the children in favor of the high socioeconomic group.

Szwejda[22] reported, in 1962, the relationship of the socioeconomic level to the dental caries experience of white children 6 to 11 years of age living in Charlotte (fluoridated) or Mecklenburg County (fluoride-deficient). The socioeconomic levels of the children were determined by a questionaire completed by the parents. The results of this study by Szwejda indicated that both the high socioeconomic city and county children had a higher percentage of deciduous cuspids and molars present and caries free when compared to the respective city and county low socioeconomic groups. In the county children the high socioeconomic group had fewer average DMF permanent teeth than the low socioeconomic group. However, in the city children, the average DMF permanent teeth rates did not vary significantly between the socioeconomic levels. Szwejda noted that, regardless of socioeconomic level, the city children had less accumulated dental caries than the county children.

STATEMENT OF PROBLEM

The purpose of this study was to provide additional information regarding the relationship between the fluoride ion in the communal water supply and the occlusion of children. To obtain meaningful results age, sex, and socioeconomic status were controlled, and these results were subjected to a biometrical analysis.

An additional consideration in this study was to determine any possible association between socioeconomic status and the occlusion of children, for in previous epidemiological studies of the occlusion, this variable was usually neglected.

EXPERIMENTAL PROCEDURE

The description of the experimental procedure is divided into 4 parts: sample selection, water fluoride content, clinical examination, and socio-economic status scale.

Sample Selection

A sample of 955 school children was selected for study in 3 Indiana cities where the fluoride ion content of the communal water supply differed (Table I). The study group included 486 females and 469 males. In order to control for age differences, the sample was divided into 2 age groups. The age range of these groups was from 7 to 10 years and 11 to 13 years. Age was determined at the last birthday. Each age group consisted of approximately equal numbers of children for each respective age year (Table I). Due to the population size differences between the larger city, Indianapolis, and the 2 smaller cities, Bloomington and Frankfort, it was determined that the sample of children from Indianapolis (485) would be approximately twice that of Bloomington (235) and Frankfort (235).

The Frankfort sample of children attended public schools, while only Catholic school children were available for study in Indianapolis. The Bloomington sample of children attended both public and Catholic schools. The Frankfort and Indianapolis children were examined in the schools, while the Bloomington children were examined at the Indiana University Dental Study Clinic. The schools in Frankfort and Indianapolis were selected according to geographic location in an attempt to make the sample of children representative of the respective areas. The Bloomington sample was selected from a list of children who were enrolled in the public schools and the Catholic school in the city and who had previously participated in a dental caries study. The children examined in Frankfort had also participated in a dental caries study.

Only white children were studied and all were life long residents of the respective areas, not being away for longer than 1 month in any given year. Also, it should be noted that children who were undergoing active orthodontic treatment or who gave a past history of such treatment were excluded from the study.

Water Fluoride Content

During the period between 1948 and 1962, the communal water supplies of Bloomington, Frankfort, and Indianapolis were similar except for the fluoride ion content.[23,24] The Bloomington water was essentially fluoride-free since the fluoride ion content at the plant tap was less than 0.1 part per million. Fluoride has occurred naturally in the water in Frankfort and the content at the plant tap has ranged between 0.7 and 1.1 parts per million during the indicated period. The water in Indianapolis was fluoridated with sodium silicofluoride in August, 1951. However the fluoride ion content was not maintained at the optium level of 1 part per million, but has ranged between 0.5 and 0.8 part per million. Prior to fluoridation, the fluoride content of the Indianapolis water ranged between 0 and 0.3 part per million. During the selection of the sample, it was ascertained that the water in the homes of the children was always supplied by the respective city water company.

Clinical Examination

The clinical examinations of the occlusion were conducted by the author. Each examination required approximately 5 minutes. A portable dental chair and lamp were used in Frankfort and Indianapolis, while a conventional dental chair and light were available in Bloomington. Other equipment necessary for the examinations included dental mirrors, 4-1/2 inch Arrow Ringhead Bow dividers, Dixon Boley gauges with the edges ground to sharp points, millimeter rulers, and dental floss. A dental assistant recorded the results of each examination on a specially designed data sheet (Figure 1). All measurements were recorded to the nearest millimeter.

The mesiodistal relationship of the first permanent molars was determined on both sides of the mouth. Or more specifically, the mesiodistal relationship of the triangular ridge on the mesiobuccal cusp of the upper first permanent molar to the buccal groove of the lower first permanent molar was recorded when the teeth were in occlusion. The procedure involved placing a vertical pencil line which originated at the cusp tip on the buccal surface of the mesiobuccal cusp of the upper molar, and a vertical line in the buccal groove of the lower molar. The triangular ridge and buccal groove relationship was carefully examined, and when the ridge occluded in the groove, the relationship was recorded as 0. When the buccal groove was distal to the triangular ridge, then this horizontal distance was measured with a Boley gauge using the pencil lines as guides and recorded in millimeters as a minus value (-). Likewise, when the buccal groove was mesial to the triangular ridge, the measurement was recorded as a positive (+) value. The molar relationship was recorded as "measurement not possible" when the respective teeth were absent or not fully erupted or when the anatomical landmarks were indistinct due to extensive caries, restorations, enamel hypoplasia, etc.

The mesiodistal interdigitation of the upper and lower cuspids was determined on both sides of the mouth. A vertical pencil line which originated at the cusp tip was placed on the labial surface of each cuspid. The relationship of these vertical lines was examined with the teeth in occlusion. When the lines appeared to coincide, the cuspid interdigitation was recorded as 0. However, when there was a horizontal deviation between these lines, the distance was measured in millimeters and recorded as a positive value (+) when the lower cuspid was mesial to the upper or as a negative value (-) when the lower cuspid was distal. When the cusp tip was indefinite due to abrasion, the vertical pencil line was placed in the middle of the tooth. The cuspid interdigitation was recorded as "measurement not possible" when the teeth had not erupted sufficiently or when the anatomy of the teeth was indistinct due to caries, fracture, restorations, etc.

Overjet, or the horizontal overlap of the upper and lower central incisors, was measured in millimeters with a Boley gauge. The horizontal distance from the labial surface of the lower central incisor to the labial surface of the upper central incisor was determined. Readings were obtained for both the right and left central incisors, and the largest value was recorded. The overjet reading was designated as a positive value (+) if the upper incisor was labial to the lower incisor, or as a negative value (-) when the upper incisor was lingual to the lower incisor. The overjet was recorded as 0 if the labial surfaces of both the upper and lower central incisors were in the same vertical plane. It was not possible to determine the overjet if the central incisors were missing, incompletely erupted, or severely fractured.

Overbite, or the vertical overlap of the upper and lower central incisors, was also measured in millimeters with a Boley gauge. When the teeth were in occlusion, a pencil mark was placed on the labial surface of each lower central incisor at the level of the incisal edge of the corresponding upper central incisor. With the jaws open, the distance from the incisal edge of each lower incisor to the corresponding pencil line was measured, and the largest value was recorded as overbite. The overbite was designated as a positive value (+) if the upper central incisor was labial to the lower incisor or as a negative value (-) if the upper central incisor was lingual to the lower incisor. If both the upper and lower central incisors were in an end-to-end relationship, the overbite was recorded as 0. Overbite could not be determined if the central incisors were missing, incompletely erupted, or severely fractured.

For the purposes of this study, anterior open-bite was the presence of vertical space between the incisal edges of erupted upper and lower anterior teeth when the posterior teeth were occluded. This space was measured in millimeters with a Boley gauge at a right angle to the natural occlusal plane. The largest value obtained in the central and lateral incisor area was recorded for anterior open-bite.

Cross-bite of the deciduous and permanent teeth was determined with the teeth in occlusion. An anterior tooth was considered to be in cross-bite only when the labioincisal aspect of the upper tooth was lingual to the labioincisal aspect of the opposing lower incisor(s). Posterior cross-bite was the condition when the tip of the lingual cusp(s) on the upper tooth occluded buccally to the tip of the buccal cusp(s) of the opposing tooth or teeth. When the tip of the buccal cusp(s) of the upper tooth occluded lingually to the tip of the buccal cusp on the lower tooth or teeth, then this was also considered to be posterior cross-bite. Occasionally, it was difficult to decide whether the upper or lower tooth should be designated as being in cross-bite. In these instances the alignment of both teeth was examined from the incisal or occlusal aspect, and the tooth demonstrating the greatest labiolingual or buccolingual deviation was recorded as being in cross-bite.

Malaligned teeth were assumed to represent a lack of space in the dental arches. A tooth was regarded as being malaligned when the mesiodistal space between the adjacent teeth was inadequate and the alignment of the crown, as viewed from the incisal or occlusal aspect, deviated from the ideal or smooth contact line. The total number of malaligned teeth was recorded during each examination.

The premature loss of deciduous cuspids and/or molars as a result of dental infection was another aspect of this study. It was assumed that all prematurely missing deciduous cuspids and/or molars were lost due to dental infection except for (1) teeth which the child reported had been extracted for orthodontic purposes, and (2) deciduous cuspids which had exfoliated apparently following ectopic eruption of the permanent lateral incisors. Premature loss of deciduous teeth was determined after a consideration of the chronological age and the shedding/eruption development and/or when the child reported a history of dental extraction.

In this study it was desirable to classify each child's occlusion. Frequently, the methods which have been used to record the occlusion were concerned with a "normal" range which was sometimes poorly defined and highly subjective. Therefore, rather than attempt to precisely define "normal occlusion", it was decided that "ideal occlusion" was a more absolute condition and hence, easier to define. Cases which were not considered as representing "ideal occlusion" were classified with a modified version of the Angle classification of malocclusion.[25] The classification of occlusion used in this study is as follows:

Classification of Occlusion

I. Ideal Occlusion

A. Right and left first permanent molar mesiodistal relationship: the triangular ridge of the mesiobuccal cusp of the upper molar occludes in the buccal groove of the lower molar or the deviation of this relationship is no more than one-half the width of a cusp.

B. Right and left cuspid interdigitation: values for each side between (+) 2 and (+) 5

C. Horizontal overjet of the central incisors: value between (+) 1 and (+) 4

D. Vertical overbite of the central incisors: value between (+) 1 and (+) 4

E. Midline relationships: maxillary and mandibular midlines must coincide on the mid-sagittal facial plane

F. No previous extractions or missing teeth, no loss of arch length due to caries

G. No cross-bite present

H. No malaligned teeth present

I. No ectopic eruption present

J. No ankylosis present

K. No unusual spacing

L. No supernumary teeth present clinically

II. <u>Modified Version of the Angle Classification of Malocclusion</u>

A. <u>Class I Malocclusion</u>

1. Right and left first permanent molar mesio-distal relationships: the triangular ridge of the mesiobuccal cusp of the upper molar occludes in the buccal groove of the lower molar or the deviation of this relationship is no more than one-half the width of a cusp

2. Any discrepancy in ideal occlusion, other than molar relationship, would indicate Class I

Malocclusion

B. <u>Class II Malocclusion</u>

1. Right and left first permanent molar mesiodistal relationship: the buccal groove of the lower molar is distal to the triangular ridge of the mesiobuccal cusp of the upper molar by more than one-half the width of a cusp
2. Subdivision: distal relationship of the lower molar on one side only

C. <u>Class III Malocclusion</u>

1. Right and left first permanent molar mesiodistal relationship: the buccal groove of the lower molar is mesial to the triangular ridge of the mesiobuccal cusp of the upper molar by more than one-half the width of a cusp
2. Subdivision: mesial relationship of the lower molar on one side only

D. <u>Classification Not Possible</u>

1. Malocclusions with loss or absence of the permanent molars, whereby the Angle classification could not be applied
2. Malocclusions with extensive loss of deciduous teeth and the first permanent molar positions appeared to have changed, whereby the Angle classification would possibly be in-

accurate

Following the premature loss of deciduous teeth, the first permanent molar relationship may change due to the migration of either or both of the permanent molars. The subsequent appraisal with the Angle classification might not reflect true changes in the dental arch relationships or be representative of the arches prior to the untimely tooth loss. Therefore, the author attempted to classify these cases by the assumed molar relationship prior to any premature loss. This was determined by (1) a clinical and radiographic evaluation of the axial inclination of the first permanent molars and the cuspids, and (2) the size of the space where the loss had occurred compared to the mesiodistal width of the corresponding tooth on the opposite side of the arch. If these interpretations did not appear reasonably accurate, e.g., when there was extensive loss of teeth, then classification with the Angle system was not possible.

Socioeconomic Status Scale

Duncan's Occupational Socioeconomic Status Index[26] was used to stratify the sample by socioeconomic status (SES). Duncan's index is based on education and income.

The occupation of the head of the household of each child was obtained from the information reported by the child. This information (Questions 5 to 11) was recorded on a form (Table 2) at the time of the clinical examination. Then on the basis of Duncan's scale, a score was assigned to this occupation, placing each child somewhere along the continuum of the SES scale.

Later, the sample was divided into class categories by dividing the scale into three groups of scores:

0-29: Low socioeconomic level, i.e., laborers and unskilled workers

30-59: Middle socioeconomic level, i.e., skilled workers, foremen, white collar

60-96: High socioeconomic level, i.e., proprietors, businessmen, professionals.

RESULTS

A dental assistant recorded the results of each examination on a form. This information was coded and transferred to International Business Machine cards to facilitate the tabulation of the data. The data for each observation or measurement was summarized by city and then separated by socioeconomic status, age, and sex. Socioeconomic status was divided into three categories: high, middle, and low. Two age groups were used: 7 to 9 years and 11 to 13 years. Preliminary analysis of the data demonstrated that sex was not an important variable in this study; therefore this aspect was not considered in the results presented herein.

There was some variation in sample size for each observation or measurement since, occasionally, data could not be obtained due to missing teeth, extensive caries, fracture, etc.

A biometric analysis, utilizing the chi-square test for significance, was completed for the majority of the results. Only P scores of $< .05$ were accepted as being significant.

First permanent molar relationships on each side of the mouth were divided into three groups: normal, (-) deviations, and (+) deviations. When the frequency distribution of the right molar relationship was studied, no significant difference was found when Bloomington, Frankfort, and Indianapolis were compared (Table II). Analysis within each age and socioeconomic group also indicated that there was no significant difference in the distribution of the right molar relationships of the 3 cities (Table III).

When socioeconomic levels were compared, no consistent trends were noted for the distribution of the right molar relationship (Table IV).

The left first permanent molar relationship data conflicted somewhat with that of the right side. A significant difference ($P < .05$) was found in the frequency distribution of the left molar relationship when the 3 cities were compared (Table V). Analysis within subgroups indicated significant differences only in the low SES group ($P < .01$) and the 7 to 9 year group ($P < .02$) (Table VI). The outstanding differences in the low SES group were: (1) a high percentage of normal molar relationships in Frankfort, (2) a low percentage of (+) deviations in Frankfort, and (3) a high percentage of (-) deviations in Indianapolis (Table VII). The 7 to 9 year data demonstrated that the Frankfort children had a higher percentage of normal molar relationships and a lower percentage of (-) deviations compared to the children in Bloomington and Indianapolis (Table VII).

A comparison of socioeconomic levels indicated that there were no consistent trends associated with the frequency distribution of the left molar relationships (Table VII).

Measurements of the horizontal overjet of the central incisors were separated into two groups: normals (+1 to +4) and deviations (+5 and greater, 0 and - numbers). A significant difference ($P < .05$) was found in the distribution of the two overjet groups when the 3 cities were compared (Table VIII). However, a comparison of the 3 cities within each age and socioeconomic group indicated that there was no significant difference in overjet distribution (Table IX).

A significant difference ($P < .02$) was found when the data for the 3 cities was combined and only socioeconomic groups were compared (Table XI), and as socioeconomic level decreased, the percentage of children with normal overjet increased. Likewise, as socioeconomic level decreased, the percentage of children with overjet deviations decreased. The frequency of normal overjet in each socioeconomic level was; high SES, 55.1 per cent; middle SES, 58.8

per cent; and low SES, 67.4 per cent. Overjet deviations were found in the following order: high SES, 44.9 per cent; middle SES, 41.2 per cent; and low SES, 32.6 per cent.

Vertical overbite measurements of the central incisors were divided into 2 groups: normals (+1 to +4) and deviations (+5 and greater, 0 and - numbers). A significant difference ($P < .05$) was found in the distribution of the overbite groups of the 3 cities (Table XII). When the cities were compared within each age and socioeconomic group, a significant difference ($P < .05$) was found only in the 11 to 13 year group (Table XIII). Further study of this age group revealed that the percentage of children with normal overbite was similar in Bloomington and Indianapolis, while the percentage was lower in Frankfort (Table XIV). The percentage of 11 to 13 year old children with overbite deviations was highest in Frankfort, and the values were similar in Bloomington and Indianapolis.

No significant difference was found in the overbite distribution of the 3 socioeconomic levels. However, an interesting trend was observed when the data for the 3 cities was combined and socioeconomic groups were compared (Table XV). As socioeconomic level decreased, the percentage of children with normal overbite increased. Conversely, as socioeconomic level decreased, the percentage of children with overbite deviations decreased.

The prevalence of cross-bite of 1 or more teeth was similar in Bloomington, Frankfort, and Indianapolis, and there was no significant difference when the cities were compared (Table XVI). When the subgroups of children living in the 3 cities were analyzed, no significant differences were found (Table XVII).

No consistent trend for cross-bite was found when the various socioeconomic groups were compared (Table XVIII).

There was a significant difference ($P < .05$) in the prevalence of anterior open-bite when Bloomington, Frankfort, and Indianapolis were compared (Table XIX). The percentage of children with anterior open-bite was similar in Bloomington (3.4 per cent) and Indianapolis (3.0 per cent) but was lower in Frankfort (0.4 per cent). Due to the small number of cases with anterior open-bite, analysis was not completed for the subgroups.

When the data for anterior open-bite was separated by socioeconomic class only, no significant differences were found (Table XX).

The data for the premature loss of 1 or more deciduous cuspids and/or molars indicated that there was a significant difference ($P < .01$) when the 3 cities were compared (Table XXI). When age and SES were controlled, the comparison of the frequency of premature loss of deciduous teeth in the 3 cities indicated that there was a significant difference ($P < .01$) within each subgroup except the high socioeconomic level (Table XXII). The premature loss of 1 or more deciduous cuspids and/or molars was consistently highest in Frankfort, while Bloomington was slightly lower, and premature loss was lowest in Indianapolis (Table XXIII).

When the data for premature loss was separated by socioeconomic class only, a significant difference ($P < .02$) was found (Table XXIV). A negative relationship was present between socioeconomic level and premature loss, for as the socioeconomic level decreased the frequency of premature loss of 1 or more deciduous cuspids and/or molars increased. The percentage of children with premature loss in each socioeconomic group was: high SES, 14.8 per cent; middle SES, 20.7 per cent; and low SES, 25.4 per cent.

The data for the modified Angle classification of occlusion indicated that there was a significant difference ($P < .01$) when Bloomington, Frankfort, and Indianapolis were compared (Table XXV). When a comparison of the 3 cities was made within each age and socioeconomic group, significant differences ($P < .01$) were found only in the middle SES group and the 11 to 13 year old children (Table XXVI). Further examination of the data revealed that in both the middle SES group and the 11 to 13 year group the largest deviations were: (1) a high percentage of Class I malocclusion in Bloomington, (2) a low percentage of Class I malocclusion and a high percentage of Class II and Class III malocclusions in Frankfort, and (3) a high percentage of ideal occlusion in Indianapolis (Table XXVII).

No consistent trends or differences associated with the classification of occlusion were found when the socioeconomic levels were compared (Table XXVII).

FIGURES AND TABLES

Figure 1 Form used to record findings of clinical examinations

Malocclusion Survey

Name____Age______

School________________________City______________________

first permanent molar relationship: mm.

right left

_____ _____0
_____ _____+
_____ _____-
_____ _____measurement not possible

cuspid interdigitation: mm.

right left

_____ _____0
_____ _____+
_____ _____-
_____ _____measurement not possible

classification of occlusion

_____ideal
_____class I
_____class II
_____division I
_____division II
_____subdivision
_____class III
_____subdivision
_____classification not possible

overjet: mm.

_____0
_____+
_____-
_____measurement not possible

ectopic eruption

3 7 10 14
30 26 23 19

_____ectopic eruption not present

amount of space closure due to premature loss of post. dec. teeth or from destruction of the crown; mm.

_____E, D, C,
_____C, D, E,
_____E, D, C,
_____C, D, E,
_____premature loss of dec. teeth - no space loss
_____no premature loss of dec. teeth

_____malaligned teeth

_____no malaligned teeth

_____cross-bite

_____cross-bite not present

overbite: mm.

_____0
_____+
_____-
_____measurement not possible

Figure 2 Form used to record socioeconomic information

DIRECTIONS: This form is to be completed from information given by the child.

Interviewer ______________________ Date __________

School ______________________ Grade __________

1. Name ______________________ 2. Age __________

3. Sex ( )Female ( )Male

4. Race ( )White ( )Negro ( )Other

5. Where do you live? ______________________

   What is your address? ______________________

6. What does your father do? ______________________

   Where does he work? ______________________

7. Does he work for someone? Who? ______________________
   ( )Yes ( )No

8. Does your mother work away from home?
   ( )Yes What does she do? ______________________

   Where does she work? ______________________
   ( )No, she does not work away from home.

9. Are you the oldest child in your family? ( )Yes
   ( )No

   (If No), How many older brothers and sisters do you have? __________
   How many younger brothers and sisters do you have? __________

10. How many people live at your house? __________
    Count brothers and sisters, mother and father, yourself and anyone else.

11. How many bedrooms are there in your house? __________

    Do you have a kitchen? __________
    dining room? __________
    living room? __________
    den or family room? __________

    Total number of rooms __________

Table I. Sample distribution by city, age, sex and socioeconomic status

		Bloomington				Frankfort				Indianapolis			
Age	Sex	High SES	Middle SES	Low SES	Total	High SES	Middle SES	Low SES	Total	High SES	Middle SES	Low SES	Total
7	M	5	4	8	17	1	9	10	20	5	19	16	40
7	F	6	7	5	18	1	10	7	18	9	20	11	40
8	M	9	5	5	19	2	8	9	19	10	16	15	41
8	F	7	5	8	20	2	6	12	20	9	20	11	40
9	M	8	6	5	19	3	6	11	20	8	22	10	40
9	F	13	6	2	21	0	11	10	21	9	18	12	39
11	M	5	11	3	19	1	11	8	20	12	19	9	40
11	F	6	10	5	21	2	8	10	20	9	31	8	38
12	M	9	7	5	21	0	9	9	18	9	19	11	39
12	F	2	11	7	20	1	9	10	20	7	20	12	39
13	M	10	3	6	19	3	7	10	20	5	26	7	38
13	F	5	11	5	21	4	4	11	19	7	17	17	41
Total		85	86	64	235	20	98	117	235	99	247	139	485

Table II. Frequency distribution of right first permanent molar relationship by city

City	Normal f	Normal %	(-)Deviations f	(-)Deviations %	(+)Deviations f	(+)Deviations %	Total f
Bloomington	65	31.0	119	56.7	26	12.3	210
Frankfort	73	34.8	114	54.3	23	10.9	210
Indianapolis	127	27.7	272	59.3	60	13.0	459

$X^2 = 3.70$; P: N. S.

Table III. Chi squares of right first permanent molar relationship differences among subgroups of children living in 3 different fluoride areas

Fluoride Areas Subgroups	N	X^2	d.f.	P
High SES	197	2.43	4	N.S.
Middle SES	401	2.14	4	N.S.
Low SES	281	6.77	4	N.S.
7 to 9 years	443	4.68	4	N.S.
11 to 13 years	436	2.95	4	N.S.

Table IV. Frequency distribution of right first permanent molar relationship among subgroups

Normal Relationships	Total	7-9 Years	11-13 Years	High SES	Middle SES	Low SES
Bloomington						
frequency	65	24	41	19	29	17
% each group	31.0	22.4	39.8	23.8	36.3	34.0
Frankfort						
frequency	73	32	41	6	26	41
% each group	34.8	29.6	40.1	31.6	29.5	39.8
Indianapolis						
frequency	127	50	77	27	66	34
% each group	27.7	21.9	33.3	27.6	28.3	26.6
(-)Deviations						
Bloomington						
frequency	119	73	46	54	41	24
% each group	56.7	68.2	44.7	67.5	51.3	48.0
Frankfort						
frequency	114	69	45	11	50	53
% each group	54.3	63.9	44.2	57.9	56.8	51.5
Indianapolis						
frequency	272	166	106	57	139	76
% each group	59.3	72.8	45.9	58.2	59.7	59.4
(+)Deviations						
Bloomington						
frequency	26	10	16	7	10	9
% each group	12.3	9.4	15.5	8.7	12.4	18.0
Frankfort						
frequency	23	7	16	2	12	9
% each group	10.9	6.5	15.7	10.5	13.7	8.7
Indianapolis						
frequency	60	12	48	14	28	18
% each group	13.0	5.3	20.8	14.2	12.0	14.0

Table V. Frequency distribution of left first permanent molar relationship by city

City	Normal f	Normal %	(-)Deviations f	(-)Deviations %	(+)Deviations f	(+)Deviations %	Total f
Bloomington	59	28.0	96	45.5	56	26.5	211
Frankfort	86	39.3	88	40.2	45	20.5	219
Indianapolis	122	26.9	213	47.0	118	26.1	453

$X^2 = 11.60;\ P < .05$

Table VI. Chi squares of left first permanent molar relationship differences among subgroups of children living in 3 different fluoride areas

Fluoride Areas Subgroups	N	X^2	d.f.	P
High SES	196	6.45	4	N.S.
Middle SES	398	3.71	4	N.S.
Low SES	289	17.82	4	0.01
7 to 9 years	440	13.01	4	0.02
11 to 13 years	443	5.75	4	N.S.

Table VII. Frequency distribution of left first permanent molar relationship among subgroups

Normal Relationships	Total	7-9 Years	11-13 Years	High SES	Middle SES	Low SES
Bloomington						
frequency	59	28	31	13	26	14
% each group	28.0	25.9	30.1	23.8	33.3	26.4
Frankfort						
frequency	86	49	37	8	30	48
% each group	39.3	44.1	34.3	42.1	32.3	44.9
Indianapolis						
frequency	122	62	60	34	59	29
% each group	26.9	28.1	25.9	35.1	26.0	22.5
(-)Deviations						
Bloomington						
frequency	96	64	32	48	30	18
% each group	45.5	59.3	31.1	60.0	38.5	34.0
Frankfort						
frequency	88	47	41	7	43	38
% each group	40.2	42.3	38.0	36.8	46.2	35.5
Indianapolis						
frequency	213	134	79	42	111	60
% each group	47.0	60.6	34.1	43.3	48.9	46.5
(+)Deviations						
Bloomington						
frequency	56	16	40	13	22	21
% each group	26.5	14.8	38.8	16.2	28.2	39.6
Frankfort						
frequency	45	15	30	4	20	21
% each group	20.5	13.6	27.7	21.1	21.5	19.6
Indianapolis						
frequency	118	25	93	21	57	40
% each group	26.1	11.3	40.0	21.6	25.1	31.0

Table VIII. Frequency distribution of overjet by city

City	Normal f	Normal %	Deviations f	Deviations %	Total f
Bloomington	142	61.3	90	38.7	232
Frankfort	156	67.3	76	32.7	232
Indianapolis	275	57.7	202	42.3	477

$X^2 = 6.04; P < .05$

Table IX. Chi squares of overjet differences among subgroups of children living in 3 different fluoride areas

Fluoride Areas Subgroups	N	X^2	d.f.	P
High SES	203	1.17	2	N.S.
Middle SES	425	1.55	2	N.S.
Low SES	313	4.04	2	N.S.
Younger Group	459	4.42	2	N.S.
Older Group	482	2.86	2	N.S.

Table X. Frequency distribution of overjet among sub-groups of children living in 3 different fluoride areas

Normal Overjet	Total	7-9 Years	11-13 Years	High SES	Middle SES	Low SES
Bloomington						
frequency	142	63	79	49	50	43
% each group	61.3	57.3	64.8	58.3	59.5	67.2
Frankfort						
frequency	156	80	76	9	62	85
% each group	67.3	68.4	66.1	45.0	63.9	73.9
Indianapolis						
frequency	275	133	142	54	138	83
% each group	57.7	57.3	58.0	54.5	56.5	61.9
Overjet Deviations						
Bloomington						
frequency	90	47	43	35	34	21
% each group	38.7	42.7	35.2	41.7	40.5	32.8
Frankfort						
frequency	76	37	39	11	35	30
% each group	32.7	31.6	33.9	55.0	36.1	26.1
Indianapolis						
frequency	202	99	103	45	106	51
% each group	42.3	42.7	42.0	45.5	43.5	38.1

Table XI. Frequency distribution of overjet by socio-economic level

Socioeconomic Level	Normal f	Normal %	Deviations f	Deviations %	Total f
High SES	112	55.1	91	44.9	203
Middle SES	250	58.8	175	41.2	425
Low SES	211	67.4	102	32.6	313

$X^2 = 9.13; P < .02$

Table XII. Frequency distribution of overbite by city

City	Normal f	Normal %	Deviations f	Deviations %	Total f
Bloomington	143	63.5	82	36.5	225
Frankfort	129	55.8	102	44.2	231
Indianapolis	302	65.7	157	34.3	459

$X^2 = 6.04$; $P < .05$

Table XIII. Chi squares of overbite differences among subgroups of children living in 3 different fluoride areas

Fluoride Areas Subgroups	N	X^2	d.f.	P
High SES	198	0.44	2	N.S.
Middle SES	412	5.77	2	N.S.
Low SES	305	4.54	2	N.S.
Younger Group	436	2.54	2	N.S.
Older Group	479	7.74	2	0.05

Table XIV. Frequency distribution of overbite among subgroups of children living in 3 different fluoride areas

Normal Overbite	Total	7-9 Years	11-13 Years	High SES	Middle SES	Low SES
Bloomington						
frequency	143	69	74	47	50	46
% each group	63.5	66.3	61.2	56.6	64.1	71.8
Frankfort						
frequency	129	77	52	11	49	69
% each group	55.8	66.4	45.2	55.0	50.5	60.5
Indianapolis						
frequency	302	158	144	58	152	92
% each group	65.7	73.1	59.3	61.0	64.1	72.4
Overbite Deviations						
Bloomington						
frequency	82	35	47	36	28	18
% each group	36.5	33.7	38.8	43.4	35.9	18.2
Frankfort						
frequency	102	39	63	9	48	45
% each group	44.2	33.6	54.8	45.0	49.5	39.5
Indianapolis						
frequency	157	58	99	37	85	35
% each group	34.3	26.9	40.7	39.0	35.9	27.6

Table XV. Frequency distribution of overbite by socio-economic level

Socioeconomic Level	Normal f	%	Deviations f	%	Total f
High SES	116	58.5	82	41.6	198
Middle SES	251	60.9	161	39.1	412
Low SES	207	67.8	98	32.2	305

$X^2 = 5.50$; N.S.

Table XVI. Frequency distribution of cross-bite of 1 or more teeth by city

City	Normal f	%	Cross-bite f	%	Total f
Bloomington	185	78.7	50	21.3	235
Frankfort	179	76.1	56	23.9	235
Indianapolis	397	81.8	88	18.2	485

$X^2 = 3.36$; P: N.S.

Table XVII. Chi squares of cross-bite differences among subgroups of children living in 3 different fluoride areas

Fluoride Areas Subgroups	N	X^2	d.f.	P
High SES	204	2.22	2	N.S.
Middle SES	431	5.98	2	N.S.
Low SES	320	3.81	2	N.S.
Younger Group	472	0.94	2	N.S.
Older Group	483	5.85	2	N.S.

Table XVIII. Frequency distribution of cross-bite of 1 or more teeth among subgroups of children living in 3 different fluoride areas

Cross-bite of 1 or more teeth	Total	7-9 Years	11-13 Years	High SES	Middle SES	Low SES
Bloomington						
frequency	50	16	34	18	14	18
% each group	21.3	14.0	28.0	21.2	16.3	28.1
Frankfort						
frequency	56	22	34	4	30	22
% each group	23.9	18.6	29.0	20.0	30.6	18.8
Indianapolis						
frequency	88	41	47	13	52	23
% each group	18.2	17.0	19.1	13.1	21.1	16.5

Table XIX. Frequency distribution of anterior open-bite by city

City	Normal f	Normal %	Anterior Open-bite f	Anterior Open-bite %	Total f
Bloomington	227	96.6	8	3.4	235
Frankfort	234	99.6	1	0.4	235
Indianapolis	465	97.0	20	3.0	485

$$X^2 = 7.48; P < .05$$

Table XX. Frequency distribution of anterior open-bite by socioeconomic level

Socioeconomic Level	Normal f	Normal %	Anterior Open-bite f	Anterior Open-bite %	Total f
High SES	198	97.1	6	2.9	204
Middle SES	417	96.8	14	3.2	431
Low SES	311	97.2	9	2.8	320

$$X^2 = 0.12; \text{ N.S.}$$

Table XXI. Frequency distribution of premature loss of 1 or more deciduous cuspids and/or molars by city

City	Normal f	Normal %	Premature Loss f	Premature Loss %	Total f
Bloomington	174	73.6	61	26.4	235
Frankfort	158	67.2	77	32.8	235
Indianapolis	423	87.2	62	12.8	485

$X^2 = 42.97; \; P < .01$

Table XXII. Chi squares of premature loss difference among subgroups of children living in 3 different fluoride areas

Fluoride Areas Subgroups	N	X^2	d.f.	P
High SES	204	4.07	2	N.S.
Middle SES	431	18.94	2	0.01
Low SES	320	17.76	2	0.01
Younger Group	422	28.26	2	0.01
Older Group	483	17.79	2	0.01

Table XXIII. Frequency distribution of premature loss of 1 or more deciduous cuspids and/or molars among subgroups of children living in 3 different fluoride areas

Premature loss of 1 or more deciduous cuspids and/or molars	Total	7-9 Years	11-13 Years	High SES	Middle SES	Low SES
Bloomington						
frequency	61	40	21	15	25	21
% each group	26.4	35.0	17.3	17.7	29.1	32.8
Frankfort						
frequency	77	55	22	5	31	41
% each group	32.8	46.6	18.8	25.0	31.6	35.0
Indianapolis						
frequency	62	48	14	10	33	19
% each group	12.8	20.0	5.7	10.1	13.4	13.7

Table XXIV. Frequency distribution of premature loss of 1 or more deciduous cuspids and/or molars by socioeconomic level

	Normal		Premature Loss		Total
Socioeconomic Level	f	%	f	%	f
High SES	174	85.2	30	14.8	204
Middle SES	342	79.3	89	20.7	431
Low SES	239	74.6	81	25.4	320

$X^2 = 8.49;\ P < .02$

Table XXV. Frequency distribution of classification of occlusion by city

City	Ideal f	Ideal %	Class I f	Class I %	Class II f	Class II %	Class III f	Class III %	Total f
Bloomington	2	0.9	160	73.1	56	25.6	1	0.4	219
Frankfort	4	1.7	130	56.8	85	37.1	10	4.4	229
Indianapolis	21	4.4	313	64.8	144	29.8	5	1.0	483

$X^2 = 30.13$; $P < .01$

Table XXVI. Chi squares of classification of occlusion differences among subgroups of children living in 3 different fluoride areas

Fluoride Areas Subgroups	N	X^2	d.f.	P
High SES	199	4.35	6	N.S.
Middle SES	423	42.78	6	0.01
Low SES	309	7.84	6	N.S.
Younger Group	454	10.92	6	N.S.
Older Group	477	26.77	6	0.01

Table XXVII. Frequency distribution of classification of occlusion among subgroups of children living in 3 different fluoride areas

Ideal Occlusion	Total	7-9 Years	11-13 Years	High SES	Middle SES	Low SES
Bloomington						
frequency	2	0	2	1	1	0
% each group	0.9	0	1.7	1.2	1.3	0
Frankfort						
frequency	4	1	3	0	1	3
% each group	1.7	0.9	2.6	0	1.0	2.6
Indianapolis						
frequency	21	12	9	4	12	5
% each group	4.3	5.0	3.7	4.1	4.9	3.6
Class I Malocclusion						
Bloomington						
frequency	160	68	92	54	61	45
% each group	73.1	66.7	78.6	65.9	76.3	78.9
Frankfort						
frequency	130	69	61	12	47	71
% each group	56.8	61.1	52.6	63.2	49.0	62.3
Indianapolis						
frequency	313	143	170	68	162	83
% each group	64.8	60.1	69.4	69.4	65.6	60.1
Class II Malocclusion						
Bloomington						
frequency	56	33	23	27	18	11
% each group	25.6	32.4	19.7	32.9	22.5	19.3
Frankfort						
frequency	85	41	44	7	40	38
% each group	37.1	36.3	37.9	36.8	41.7	33.3
Indianapolis						
frequency	144	82	62	25	73	46
% each group	29.8	34.5	25.3	25.5	29.5	33.3
Class III Malocclusion						
Bloomington						
frequency	1	1	0	0	0	1
% each group	0.4	0.9	0	0	0	1.8
Frankfort						
frequency	10	2	8	0	8	2
% each group	4.4	1.7	6.9	0	8.3	1.8
Indianapolis						
frequency	5	1	4	1	0	4
% each group	1.1	0.4	1.6	1.0	0	2.9

DISCUSSION

The molar data indicated that the frequency distribution of right and left molar relationships was not related to the fluoride content of the communal water supply. When the right molar relationships were analyzed, with and without the SES and age groups as controls, no significant differences were found when Bloomington, Frankfort, and Indianapolis were compared. The data for the left molar relationship differed somewhat, for when the 3 cities were compared without the controls, a significant difference ($P < .05$) was found. This difference, apparently, was not related to the fluoride content of the water, since generally, the extreme percentages for the left molar relationships were found in Frankfort, while the percentages observed in Bloomington, usually ranged between those of Frankfort and Indianapolis. When SES was controlled, a significant difference ($P < .01$) in the distribution of the left molar relationships for the low SES level was found in the comparison of the 3 cities. This difference was apparently not associated with fluoride since the percentages of the specific molar relationships for Bloomington generally varied between those of Frankfort and Indianapolis. Analysis of the left molar data for the 7 to 9 year group indicated a significant difference ($P < .02$) when the cities were compared.

However, this difference apparently was not related to the fluoride content of the drinking water since the percentage for the specific relationships were similar in Bloomington and Indianapolis, while the outstanding differences were found in Frankfort. Molar relationship measurements were not recorded in previous studies of the association between water fluoride and the occlusion; therefore, comparisons between these studies and this data were not possible.

No consistent trend was found relating socioeconomic level to specific molar relationships for either the right or the left side. Therefore, it appeared that within each city, there was no direct association between the specific molar measurements and the socioeconomic level. To the author's knowledge, molar relationships have not been previously related to SES in the dental literature.

The results of this study indicated that the overjet distribution was not related to the fluoride content of the drinking water. Analysis of the overjet distribution revealed a significant difference ($P < .05$) in the 3 cities, but this variation was apparently not related to fluoride. The percentages of normals and deviations in Bloomington ranged between the overjet distribution percentages found in Frankfort and Indianapolis. Furthermore, when SES and age were controlled, no significant difference was found when the 3 cities were compared. To the author's knowledge, no information has been published in which the relationship between fluoride and overjet was studied.

The results of this investigation demonstrated that there was an association between overjet distribution and SES. A significant difference ($P < .02$) was found in the overjet distribution of the 3 socioeconomic levels. An interesting trend was found, for the percentage of children with normal overjet decreased as SES increased. Also, the percentage of children with overjet deviations increased as SES rose. A possible explanation for these findings was that oral habits were more prevalent as SES increased. Oral habits were not recorded in this study, but Calisti et al[10] found a significant positive relationship between the prevalence of oral habits and the socioeconomic levels of preschool children.

In the sample of children studied, the distribution of the vertical overbite of the central incisors was apparently not related to the fluoride content of the drinking water. Analysis of the overbite distribution, utilizing the SES and age groups as controls, indicated that a significant difference ($P < .05$) was found only in the 11 to 13 year group when Bloomington, Frankfort, and Indianapolis were compared. However, this difference apparently was not related to fluoride, for the distribution of the overbite groups was similar in Bloomington and Indianapolis but differed in Frankfort. No prior research was found relating overbite to the fluoride content of the drinking water.

No significant difference was found in the overbite distribution when only socioeconomic levels were compared. However, the trend of the overbite distribution was similar to that of the overjet distribution, for the percentage of children with normal overbite decreased as SES increased. Overbite deviations were most frequent in the high SES group and decreased as SES decreased. From the information obtained in this study, it appears that there may possibly be a subtle association between the positions of the anterior teeth of children and the socioeconomic level. Further study is needed to confirm this association.

The results of this study indicated that the prevalence of cross-bite of 1 or more teeth was apparently not related to the fluoride content of the drinking water or to socioeconomic level. No significant difference was found in the prevalence of cross-bite when the 3 cities were compared, with and without the control groups, or when socioeconomic levels only were compared. Pelton and Elsasser[2] found that the prevalence of cross-bite in 6 to 9 year old children was slightly lower in the fluoride area as compared to the fluoride-free area and that the prevalence of cross-bite was considerably lower in the 10 and 11 year old children from the fluoride area. However, this data was not subjected to a biometrical analysis. In the literature reviewed by the author, no other reports were found in which the prevalence of cross-bite was related to fluoride or to socioeconomic level.

The results of this study indicated that the prevalence of anterior open-bite apparently was not related to the fluoride content of the drinking water. A significant difference was found when the 3 cities were compared but the deviations were not correlated with the fluoride content of the water. The percentage of children with anterior open-bite was similar in Bloomington (3.4 per cent) and Indianapolis (3.0 per cent) but was lower in Frankfort (0.4 per cent). Okyay[6] found a slightly higher percentage of open-bite in a fluoride city as compared to a fluoride-deficient city, but the difference was very small.

The prevalence of anterior open-bite apparently was not related to socioeconomic level, for no significant difference was found when the 3 socioeconomic levels were compared. This finding may contradict the suggestion previously made that undesirable oral habits were possibly associated with the difference in the frequency of overjet deviations by socioeconomic level, since oral habits have been frequently related to anterior open-bite. Before a more conclusive statement could be made, oral habits and the other factors that have been previously associated with anterior open-bite and overjet deviations, i.e., dentofacial skeletal development, soft tissue morphology and function, etc., would have to be evaluated. To the author's knowledge, there was no previous research concerning the association of anterior open-bite and socioeconomic level.

The observations of this study indicated that premature loss of 1 or more deciduous cuspids and/or molars was not apparently directly related to the fluoride content of the communal water supply. When the age and SES groups were controlled, the percentage of children with premature loss of deciduous teeth was consistently highest in Frankfort. The percentages for the fluoride-deficient city, Bloomington, ranged between those of the two fluoride cities but were generally more similar to those found in Frankfort. These findings were undoubtedly influenced by the demand for dental service and the availability of dental treatment in the respective cities. Unfortunately the assessment of these factors was not undertaken in this study. Muhler[23] has reported some pertinent findings among children of the same 3 cities, indicating that the average age of the initial visit to the dentist was 8.16 years in Frankfort, 5.45 years in Bloomington, and 4.85 years in Indianapolis. Furthermore, Muhler reported that the percentages of children who had never been to the dentist were: Frankfort 59.5 per cent, Bloomington 44.2 per cent, and Indianapolis 37.1 per cent. The application of these findings to the author's study would imply that the demand for dental service and/or the availability of dental treatment were not similar in the 3 cities. The extent that these factors modify the prevalence of premature loss of deciduous cuspids and molars was not known. To obtain more conclusive results regarding the prevalence of premature loss of deciduous teeth in these 3 cities, the level of dental care available and the attitudes of the children and their parents should be evaluated in future studies.

Some interesting findings concerning the premature loss of 1 or more deciduous cuspids and/or molars were obtained when the sample was separated only by SES. A significant difference ($P < .02$) was found when socioeconomic levels were compared, and there was a negative association between premature loss of deciduous teeth and SES. These findings indicate that in the children studied, there was a definite association between socioeconomic level and the premature loss of deciduous teeth. Other authors[16, 17, 18, 19] have reported that loss of permanent teeth was most frequent in the low socioeconomic level. Relating the level of dental care to SES, Castaldi et al[21] reported that the dental treatment level was most favorable in the high socioeconomic group. The author's findings in the children of Bloomington, Frankfort, and Indianapolis indicate the importance of controlling for SES in studies concerned with the prevalence of missing teeth.

The data for the modified Angle classification of occlusion did not reveal outstanding differences which were clearly related to the presence of fluoride in the communal water supply. In several instances, significant differences were found when Bloomington, Frankfort, and Indianapolis were compared. Further analysis revealed that the differences were similar in each comparison of the 3 cities. These consistent deviations were: (1) Bloomington had the largest percentage of Class I malocclusions, (2) Frankfort had the lowest percentage of Class I malocclusions and the highest percentage of

Class II and III cases, and (3) Indianapolis had the largest percentage of ideal occlusions. When both fluoride cities were compared to the fluoride-deficient city, a lower prevalence of Class I malocclusion and a higher prevalence of Class II malocclusion was found in Frankfort and Indianapolis. The lower prevalence of Class I malocclusion in the fluoride cities agrees with the findings of Plater,[1] Hill et al,[7] and Ast et al[9]. However, Walther[8] reported a higher prevalence of Class I malocclusion in the fluoride areas than in the fluoride-deficient areas. The larger percentage of Class II malocclusion recorded in the fluoride cities during this study did not agree with the findings of Plater,[1] Hill et al,[7] Walther,[8] or Ast et al.[9] Considering that the differences found in this study were sometimes small and that there was considerable variation in the distribution of the classes of occlusion among the cities, it was not possible to make a conclusive statement regarding the relationship of fluoride in the communal water supply to the distribution of the classification of occlusion.

No consistent trend was found in Bloomington, Frankfort, and Indianapolis relating the distribution of the classification of occlusion to socioeconomic level. Therefore, within each city there was apparently no direct association between the distribution of the classification of occlusion and socioeconomic level. In the literature reviewed by the author, no research was found in which any classification of occlusion was related to socioeconomic level.

Factors regarding the classification of occlusion which may have influenced the findings of this study were that the classification probably did not adequately describe the occlusion and/or that the application of the classification was not consistent or accurate. Other authors[27, 28, 29, 30] have previously acknowledged the deficiencies in the various methods of recording the occlusion and have indicated the need for an improved method of assessment of the occlusion which would be applicable to epidemiological research. Also, the possibility of error in the application of the classification used in this study must be considered.

SUMMARY AND CONCLUSIONS

The purpose of this study was to provide additional information regarding the relationship of fluoride in the communal water supply to the occlusion of children. In the 3 Indiana cities investigated, the communal water supply was similar except for the fluoride ion content. Bloomington was essentially fluoride-free, as the fluoride content was less than 0.1 part per million. Frankfort had naturally occurring fluoride and the level ranged from 0.7 to 1.1 parts per million. Indianapolis was fluoridated with sodium silicofluoride in 1951, but the optimum level was not maintained and the fluoride content ranged from 0.5 to 0.8 parts per million.

The sample consisted of 955 white school children and was equally divided by sex. The age range was from 7 to 9 years and 11 to 13 years.

The clinical examination of the occlusion included millimeter measurements of the first permanent molar relationships, horizontal overjet, and vertical overbite. Other findings recorded were the classification of occlusion and the prevalence of cross-bite, anterior open-bite, and the premature loss of deciduous cuspids and molars.

Each child was interviewed and his socioeconomic status was determined with Duncan's occupational SES index.

The salient conclusion of this study was that the differences in the measurements or observations of the occlusion in the children of Bloomington, Frankfort, and Indianapolis were apparently not related to the fluoride content of the communal water supply. This conclusion was supported by the following results:

(1.) right and left first permanent molar relationships were not related to the fluoride content of the water supply,

(2.) horizontal overjet of the central incisors was not related to the fluoride content of the water supply,

(3.) vertical overbite of the central incisors was not related to the fluoride content of the water supply,

(4.) the prevalence of cross-bite of 1 or more teeth was not related to the fluoride content of the water supply,

(5.) the prevalence of anterior open-bite was not related to the fluoride content of the water supply,

(6.) no outstanding differences in the modified Angle classification of occlusion were clearly related to the fluoride content of the water supply.

Furthermore, the premature loss of 1 or more deciduous cuspids and/or molars, a possible contributing factor to malocclusion, was not directly related to the fluoride content of the drinking water.

The results of this study indicated that there was an association between the horizontal overjet of the central incisors and the socioeconomic level. A significant difference ($P < .02$) was found in the overjet distribution of the 3 socioeconomic levels. A positive association was found, whereby, the percentage of overjet deviations increased as the SES improved.

The premature loss of 1 or more deciduous cuspids and/or molars was directly related to SES. When the 3 socioeconomic levels were compared, a significant difference ($P < .02$) was found. A negative association was present, for the premature loss of 1 or more deciduous cuspids and/or molars increased as the SES decreased.

The other aspects of the occlusion studied were apparently not related to SES.

Future studies should include a more thorough assessment of the occlusion and of the contributing factors to malocclusion. The author felt that the method of recording the occlusion utilized in this study was an improvement over previous epidemiological methods.

Refinement of this method to include a more complete evaluation of the dental, skeletal, and soft tissue relationships would permit a more critical appraisal of the occlusion.

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VITA

Walter Ray Davis, Jr.

October 2, 1934	Born in Miami, Florida
1952	Miami Jackson High School Miami, Florida
1952 - 1954	Emory University Atlanta, Georgia
1954 - 1958	D.D.S., Emory University School of Dentistry Atlanta, Georgia
1958 - 1961	Captain, United States Air Force Yokota AFB, Japan
1961 - 1963	Graduate Dental School Indiana University Indianapolis, Indiana

Professional Organizations

The American Dental Association

The American Society of Dentistry for Children

The American Stomological Society of Japan

Psi Omega Fraternity

ABSTRACT

A study to determine the relationship between the occlusion of children and the fluoride content of the communal water supply was undertaken in 3 Indiana cities (Bloomington 0 - 0.1 ppm, Indianapolis 0.5 - 0.8 ppm, and Frankfort 0.7 - 1.1 ppm). The sample included 955 white school children, 7 to 9 and 11 to 13 years of age. Age, sex, and socioeconomic status (SES) were controlled in the study. Socioeconomic status was determined by Duncan's index. The clinical examination of the occlusion included measurements of the first permanent molar relationship, overjet, and overbite, and also observations regarding the Angle classification and the prevalence of cross-bite, anterior openbite, and the premature loss of deciduous cuspids and molars. The chi-square test for significance was used.

The results of this study indicated that the differences recorded in the various measurements and observations of the occlusion in the 3 cities were apparently not related to the fluoride content of the water.

Analysis of the data after controlling for SES only, indicated a significant difference ($P < .02$) in the overjet distribution of the 3 socioeconomic levels and a positive association between overjet deviations and SES. The premature loss of 1 or more deciduous cuspids and/or molars was significantly different ($P < .02$) when socioeconomic levels were compared, and a negative association was found between premature loss and SES. Other aspects of the occlusion were apparently not related to SES.

The method of assessment of the occlusion appeared valid, but refinements would permit a more critical appraisal of the occlusion.