RELATIONSHIPS BETWEEN DIET AND DENTAL CARIES IN ADOLESCENT FEMALES

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TABLE OF CONTENTS

Chapter Page

I. INTRODUCTION 1

Purpose and Objectives 2
Hypotheses 3
Assumptions 4
Limitations 5
Definitions 5

II. REVIEW OF LITERATURE 7

The Components of the Oral Environment 8
The Tooth 8
Development 8
Structure 9
Saliva 10
Plaque 11
Bacteria 11
Acids 12
Substrate 13
Cariogenic Dietary Factors 14
Carbohydrates 14
Epidemiological Surveys 14
Human Studies 15
Mechanism of Cariogenicity 18
Minerals and Vitamins 19
Cariostatic Dietary Factors 20
Trace Minerals 20
Fluoride 20
Other Trace Minerals 21
Macro Minerals 22
Phosphorus 22
Animal Studies 24
Human Studies 26
Ca:P Ratio 29
Proteins 29
Fats 30
Cariostatic Properties of Foods 30
Chemical Properties of Milk and Cheese 30
Physical Properties of Edible Plants . 31

Chapter | Page

Dental Disease and Nutrition in Adolescence. . . 31
Periodontal Disease 32
Braces 34
National Health Surveys 35
The National Health Examination Survey (1966-70) 35
Ten-State Nutrition Survey (1968-70). . . 36
First National Health and Nutritional Examination Survey (1971-74). 37
Summation 38

III. METHODS AND PROCEDURES 40

Sample 40
Dietary Assessment 41
The Dental Examination 44
Dental Scores 45
Periodontal Index (PI). 45
Fluoride and Fluoride Treatment 45
Braces Information 46
Statistical Analysis 46

IV. RESULTS AND DISCUSSION 48

Description of Dental Indices and Other Demographic Variables 48
Relationship of Demographic Variables to DMFT and DMFS 56
Age Categories 56
Age in months, Race, and Per Capita Income 56
Relationship of Dietary Variables to DMFT and DMFS 61
Dietary Variables 62
Relationship of Meal Variables to DMFT and DMFS 70
Relationship of Other Selected Variables to DMFT and DMFS 75
Fluoride 75
Topical Fluoride Treatments 77
Braces 78
Periodontal Index (PI). 79
Longitudinal Changes in DMFT and DMFS Scores from 1981 to 1983 81
Relationship of Dietary, Demographic, and Meal Variables to Longitudinal Changes in DMFT and DMFS 83

V. SUMMARY 88

Chapter | Page

SELECTED BIBLIOGRAPHY 91

APPENDICES 100

APPENDIX A - DENTAL EXAMINATION FORMS A4 AND A5 . . 101

APPENDIX B - S-150 REGIONAL PROJECT INSTRUCTIONS (Periodontal Scores only). 107

APPENDIX C - DIETARY RECALL FORM (First Page) 109

APPENDIX D - MAXIMUM R^2 STEPWISE ANALYSIS MODELS. . 111

APPENDIX E - PEARSON CORRELATION COEFFICIENTS . . . 113

APPENDIX F - INDIVIDUAL DATA 115

LIST OF TABLES

Table | Page

I. Description of the Sample for 1981 and 1983 42

II. Description of Sample for 1981 and 1983 by Examiner and by Race 44

III. Means ± SD by Year for Dental Scores in Adolescent Females Surveyed 49

IV. Means ± SD and Ranges for DMFT and DMFS for Adolescent Females by Race for Each Year of Study and for Subjects Re-examined in Second Year of Study 50

V. Description of 1981 and 1983 DMFT and DMFS (Mean ± SD) in Adolescent Females by Race and Age Category 54

VI. Description of Per Capita Income (Mean) by Race and Age Category 55

VII. Chi-square Test for Age Categories and DMFT and DMFS for Each Year of Study 57

VIII. Analysis of Covariance of DMFT and DMFS for 1981 and 1983 in Adolescent Females by Race, Examiner, Age in Months and Per Capita Income 58

IX. Mean ± SD of Dietary Components Analyzed for Study by Age Category. 63

X. Analysis of Covariance of DMFT Scores for 1981 and and 1983 by Several Dietary Variables, Adjusted for Age and Per Capita Income. 64

XI. Analysis of Covariance of DMFS Scores for 1981 and and 1983 by Several Dietary Variables, Adjusted for Age and Per Capita Income 65

XII. Means ± SD and Ranges of Meal Variables for Selected Nutrients and Spearman Rank Correlation Probabilities for DMFT and DMFS in 1981 and 1983 73

XIII. Chi-square Test for Fluoride Concentration (ppm) and DMFT and DMFS for Each Year of Study 76

Table		Page

XIV. Means ± SD and Ranges for Periodontal Index by Race for Both Years of Study 81

XV. Means ± SD for DMFT and DMFS Longitudinal Changes by Race and Age Category for Subjects Present Both Years of Study 82

XVI. Longitudinal Differences in Mean DMFT and DMFS Scores from 1981 to 1983 by Race and Age Category 83

XVII. Analysis of Covariance for Longitudinal Changes in DMFT and DMFS Scores by Selected Dietary Variables, Adjusted for Age and Per Capita Income 85

XVIII. Means ± SD and Ranges of Meal Variables for Selected Nutrients and Spearman Rank Correlation Probabilities for Longitudinal Changes in DMFT and DMFS 86

LIST OF FIGURES

Figure Page

1. Average Numbers of Decayed (D), Missing (M), and Filled (F) Teeth (T) and DMFT Scores (above Bar) by Race for 1981 and 1983 for All Females Examined in Both Years (1) or for Only Those Examined that Year (2). 52

2. Average Numbers of Decayed (D), Missing (M), and Filled (F) Surfaces (S) and DMFS Scores (above Bar) by Race for 1981 and 1983 for All Females Examined in Both Years (1) or for Only Those Examined that Year (2). . . 53

CHAPTER I

INTRODUCTION

Dental caries is the most widespread health problem in the United States today (Nizel, 1977). It is a chronic condition that affects all ages beginning in infancy and continuing throughout life. Dental caries is the most common dental problem found in children (Miller and Rosenstein, 1982). Its incidence continues to rise with age to a peak in the adolescent years and then levels off in early adulthood (Fomon and Wei, 1976). Certain nutrients in the diet play specific and significant roles in regulating the dental caries process; furthermore, their influence has an immediate and local effect on dental plaque. Therefore, the study of the incidence of decay in relation to diet is necessary to develop effective preventative programs.

The word "caries" comes from the Latin word "carius" which means "rottenness." For 98% of United States residents, "rotten" teeth create a troublesome, expensive problem which is responsible for much pain, infection, facial disfigurement, chewing and speech impairment, and ultimately malnutrition (Nizel, 1977). The active caries period of adolescence, characterized by many biological, emotional, and psychological changes that can have direct impact on oral health, occurs while the adolescent is developing food habits and dental hygiene practices that become imbedded for life. The adolescent's lack of knowledge concerning dental disease and nutrition, combined with an immature crystalline structure in the teeth and an increased snacking on foods high in refined sugar, makes the teeth extremely vulnerable to decay (Casamassimo and Castaldi, 1982). Unfortunately, the introduction into public water supplies of fluoride, the only nutrient known to increase resistance to dental caries (Hartles and Leach, 1975), continues to meet community resistance in many areas, despite the abundant research attesting to its safety (Alfano, 1981). In addition, Miller and Rosenstein (1982) have noted that almost 114 million people reside in areas without fluoridated water; hence, there is a need for research into nutrients other than fluoride that may have cariostatic properties.

Several studies, such as those reported in the 1976 Symposium on Nutrition, suggest that the differences in individual cases of caries could be related more to the mineral composition of individual diets than to the challenge of sugar (Kreitzman, 1976); others clearly demonstrate that certain minerals other than fluoride, such as phosphorus, play protective roles in the fight against cariogenic substances in the diet (Nizel and Harris, 1964). Even dietary protein and fat may have a role in reducing the incidence of dental caries (Nizel, 1981). This study was undertaken to identify and clarify the relationship between selected nutrients in the diet of the adolescent female and dental health.

Purpose and Objectives

One purpose of this study is to determine whether ingestion of certain nutrients by adolescent females from North Central Oklahoma is related to dental caries, as measured by the decayed-missing-filled teeth (DMFT) and decayed-missing-filled surfaces (DMFS) indices. It also investigates demographic factors and other variables related to dental health. The more specific objectives of this study are:

1. To assess in a mixed cross-sectional and longitudinal study the caries experience of adolescent females as measured by the scores for DMFT and DMFS,
2. To assess the ingestion of selected nutrients by female adolescents from North Central Oklahoma,
3. To correlate scores for DMFT and DMFS with nutrient intakes and the number of meals/snacks eaten containing sugar, fat, or phosphorus,
4. To correlate DMFT and DMFS scores with the ratio of calcium to phosphorus in the diet,
5. To relate DMFT and DMFS scores to the adolescent's race, age, and family per capita income,
6. To determine whether fluoride levels in drinking water, topical fluoride treatments, braces, or periodontal disease as measured by the periodontal index (PI) affect the DMFT and DMFS scores.

Hypotheses

For purposes of this study, the following null hypotheses will be considered:

H.1 No significant relationship exists between age, race, or income and the scores for DMFT and DMFS.

H.2 No significant relationship exists between the dietary nutrient intakes and scores for DMFT and DMFS.

H.3 No significant relationship exists between the dietary Ca:P ratio and the scores for DMFT and DMFS.

H.4 No significant relationship exists between the number of meals/snacks containing total sugars, fat, or phosphorus and the scores for DMFT and DMFS.

H.5 No significant relationship exists between the fluoride concentrations in the drinking water, recent application of topical fluoride treatments, presence of braces, or periodontal index status and the scores for DMFT and DMFS.

Assumptions

The researcher assumes the following:

1. The dietary information obtained from the two 24-hour dietary recalls of an adolescent female provided an accurate account of her usual dietary intake.
2. The dentist or dental assistant who performed the examination used standard dental instruments and followed the specified methods approved for the regional project.
3. Information collected about fluoride levels in the drinking water accurately indicated the fluoride intake from beverages and water used in the preparation of meals.
4. The subject furnished truthful and accurate information about her use of braces and topical fluoride teatments.

Limitations

The researcher acknowledges the following limitations:

1. The research sample provides no information about the dietary habits of adolescent males as only adolescent females participated in the study.
2. The research sample includes only adolescent girls who volunteered for a regional nutritional study.
3. Lack of dental radiographs results in probable under-estimation of the true number of decayed teeth.
4. Information concerning early childhood diet and exposure to fluoride, either systemically or topically applied, was unavailable.
5. The use of the DMFT and DMFS indices, cumulative measures of the lifetime dental caries experience, may not accurately reflect recent changes in dental hygiene or diet.
6. This survey demonstrates statistical relationship; it does not propose causality.

Definitions

Terms pertinent to this study are defined as follows:

Adolescent female--a human female between 11.5 and 16.5 years of age on March 1, 1981.

Dental caries--"a localized destruction of tooth enamel and dentin initiated by acid demineralization . . . resulting from the fermentation of sugar by enzymes of dental plaque bacteria" (Nizel, 1977).

Decayed teeth--total number of permanent teeth with unfilled cavities (See Form A4, Appendix A).

Filled teeth--total number of permanent teeth with fillings (See Form A4, Appendix A).

Missing teeth--total number of carious extractions among the permanent teeth (See Form A4, Appendix A).

DMFT Index--sum of decayed (D), missing (M), and filled (F) permanent teeth (Burt et al., 1982).

Decayed surfaces--total number of surfaces with unfilled cavities in the permanent teeth (See Form A4, Appendix A).

Filled surfaces--total number of surfaces with fillings in the permanent teeth (See Form 4A, Appendix A).

DMFS Index--sum of decayed and filled surfaces on the permanent teeth plus the number of carious extractions among permanent teeth (See Form A4, Appendix A).

Periodontal disease--inflammatory disease of the supporting tissue surrounding the tooth which includes the periodontal membrane, the gingiva, and alveolar bone (Dorland, 1951).

Mean Periodontal Index (PI)--sum of periodontal index scores for individual teeth divided by the total number of permanent teeth present (See Regional Dental Instructions, Appendix B).

CHAPTER II

A REVIEW OF THE LITERATURE

Dental caries, a disease process of localized destruction of tissues by products of bacterial metabolism (Newbrun, 1982), has become the most common disease of Western civilization; in fact, in the United States alone, it affects 98% of the population, peaking in adolescent years (Nizel, 1977). Caries is a multi-factored disease involving a susceptible tooth, the presence of bacteria, an adequate amount of substrate, and the recurrence of substrate in the mouth. If any of these factors is altered or modified, the incidence of dental caries may also change (Newbrun, 1979). Furthermore, diet selection may play a very important role in the dental caries process (Hartles and Leach, 1975). Hence, many health professionals, scientists, and governmental authorities have recently turned their attentions to the role that diet can play in the development of preventive dental health programs (Reynolds, 1982). Thus, the currently recommended strategy in the battle against dental caries entails a three-fold attack:

1. The systemic and topical application of fluoride, which makes the tooth less susceptible to decay;
2. The mechanical acts of brushing and flossing, which remove the dental plaque.

3. The modification of diet through elimination of substrates, which are necessary for acid production. (Amer. Dent. Assoc., 1982)

A thorough discussion of dental caries must examine the currently available literature on 1) the components of the oral environment, 2) cariogenic dietary factors, 3) cariostatic dietary factors, 4) dental disease and adolescents, and 5) the major surveys conducted on the disease.

The Components of the Oral Environment

The Tooth

Development

The tooth develops in three stages.

1. During the developmental stage, the enamel-forming cells (ameloblasts) and the dentin-forming cells (odontoblasts) lay down organic matrix and minerals precipitate to harden the enamel and dentin. This process begins at birth and continues until about the eighth year.
2. During the pre-eruptive stage, the mineralization of deciduous teeth occurs from before birth through the second year. The mineralization of the permanent teeth begins about age two and continues until about age thirteen, except for the third molars, which continue to mineralize until age eighteen. Thus, the important mineralization process in which tri-calcium-phosphate is transformed into hydroxyapatite continues into early adolescence when systemic fluoride,

capable of converting hydroxyapatite into fluorapatite, exerts its major influence.

3. During the post-eruptive stage, the chemical composition of the enamel interacts with the oral environment for about two to three years as the teeth mature. (Alford and Bogle, 1982)

Structure

The tooth is composed of four different materials: enamel, which covers the crown; dentin, which forms the body of the tooth; cementum, which covers the roots; and pulp, which provides nourishment to the tooth (Alford and Bogle, 1982).

Enamel consists of 96% mineral, 1% organic material, and 3% water. The primary mineral found in enamel is calcium phosphate in its crystalline form, hydroxyapatite. Enamel crystals differ from bone in that they are larger and more closely packed; therefore, teeth are harder, more dense, and less sensitive to change than is bone. Other minerals found in enamel are magnesium, carbonates, sodium, zinc, potassium, lead, strontium, iron, and fluoride, while its organic composition consists of proteins, collagen, lipids, and citrate (Weatherell, 1975).

Dentin contains about 70% mineral, 20% organic matter, and 10% water. The mineral content consists of calcium, phosphorus, magnesium, carbonates, and fluoride. The crystals of dentin are much smaller than those of enamel thereby allowing a ready exchange of ions. Its organic matter consists of collagen, citric acid, lipids, mucopolysaccharides, and proteins (Nizel, 1981).

The cementum, whose crystals are even smaller that those of the dentin, is 60% mineral, including calcium, phosphorus, magnesium, fluoride, and other trace minerals, a composition similar to that of bone. It also contains 25% organic matter (collagen and sialic acid) and 15% water (Nizel, 1981).

The pulp is the soft vascular part of the tooth composed of nerves, blood vessels, and connective tissues (Dorland, 1951). It lies in the center of the tooth within the dentin in the pulp chamber.

The tooth is retained in the socket of the alveolar bone by the periodontal tissue. This tissue consists of the periodontal membrane, which connects the root to the jawbone and the gingiva (Shaw and Sweeney, 1980).

Saliva

Saliva, the slightly acidic mucoserous secretion formed by the oral mucous glands (Zwemer, 1982), is the essential fluid in which the teeth are constantly bathed. Although it is mostly water, some organic components (such as proteins, uric acid, urea, lipids, and ammonia) and inorganic components (such as sodium, potassium, phosphate, fluoride, and bicarbonates) are suspended in it (Fosdick, 1962). In addition, the chemical composition and rate of flow of the saliva, which may change with the diet (Krasse and Gustafsson, 1958), has a decisive influence upon the susceptibility of the tooth to decay. Thus, saliva is potentially important in the prevention of dental caries as it facilitates the removal of acid from the plaque by diluting the acids produced by sugar fermentation and neutralizing over 90% of them with buffers such as bicarbonates and calcium phosphates

(Fosdick, 1962). Saliva further qualifies as the primary guardian against dental caries by functioning as a rinsing, antibacterial, immunological, and remineralizing agent (Alford and Bogle, 1982).

Plaque

Plaque, the soft, sticky, bacterial mass that forms around the teeth, can be effectively removed by proper brushing and flossing (Critchley, 1970). It is 80% water and 20% dry weight consisting of micro-organisms, antibodies, salivary products, and polysaccharides synthesized by bacterial metabolism of dietary sugars. Plaque acts as a permeable membrane to simple sugars, which quickly diffuse through it. However, it is less permeable to acids, so they diffuse out of the plaque less rapidly, accumulating beneath the plaque and promoting decay (Fosdick, 1962). Plaque occurs not only in the areas of least self-cleaning, as in the pit and fissures and between the teeth, but also on the smooth surfaces due specifically to the production of glucans from the *Streptococcus mutans* bacteria (Keyes, 1968). Littleton et al. (1967) found that plaque formed even when sucrose was not given orally but that acid production was minimal, suggesting the importance of consumption of carbohydrates by mouth in the dental caries process.

Bacteria

The principal agents in the etiology of dental caries, the cariogenic bacteria present in plaque, are able to convert fementable carbohydrates into organic acids capable of demineralizing the surface of the tooth (Russell, 1974). Two important bacterial agents are involved in the dental caries process:

1. *Streptococcus mutans*, a bacterium essential for producing dental caries (Fitzgerald and Keyes, 1960), is able to metabolize sucrose to glucose and fructose, from which are formed the polymers glucan and levan, respectively, This bacterium not only encourages the rapid fermemtation of sucrose to lactic acid but also produces the sticky matrix (glucan) of plaque "gluing" bacteria to the teeth. *Streptococcus mutans* is a most powerful cariogenic agent on the smooth surfaces of the teeth (Gibbons and Van Houte, 1975).
2. *Lactobacillus acidophilus*, discovered by Jay in 1938, primarily produces levans from sucrose, with only trace amounts of glucans, which do not have adhesive powers comparable to those of *Streptococcus mutans*. Its cariogenic action comes from its ability to colonize by packing into the crevices of the teeth, thereby becoming the principal agent responsible for pit and fissure caries (Shovlin and Gillis, 1969).

Acids

Organic acids, a product of the fermentation of carbohydrates by enzymes present in dental plaque bacteria, interact with the hydroxyapatite of the tooth, creating micropores in the closley packed crystals of the enamel that eventually cause them to collapse into carious lesions. The demineralization of the enamel surface allows the bacteria into the tooth, which results in a soft, mushy cavity (Fosdick, 1962).

The major organic acids found in plaque, lactic, pyruvic, acetic, and propionic (Kleinberg, 1970), lie beneath the surface plaque, where they are protected from the buffering action of the saliva. Moreover, Stephan (1940) found that these acids are capable of lowering the pH rather quickly from 6.5 to 5.5 or less, a level at which significant demineralization may begin. In fact, according to Stephan's curve, if the acid is allowed to remain in contact with the tooth for 20 to 30 minutes, substantial demineralization will occur. Not until about 40 minutes later does the pH gradually begin to return to its original value; however, complete recovery may take as long as three hours.

Substrate

Carbohydrates, the principal fermentable substrates involved in the dental caries process, provide a source of energy for the growth of bacteria in plaque. Bacteria in the plaque (specifically *Streptococcus mutans*) are able to synthesize from simple sugars such as sucrose, which are readily soluble and easily diffused throughout the plaque, adhesive polymers (glucans) necessary for smooth surface caries (Brown, 1975). Also, starches, although less cariogenic than sugars because of their slower rate of diffusion and inability to produce significant amounts of sticky glucans, contribute to the development of decay (Hartles and Leach, 1975). Therefore, one method of preventing or controlling dental caries is to remove or reduce the amount of concentrated sugar in the diet as well as the number of exposures to carbohydrate substrates each day.

Cariogenic Dietary Factors

Carbohydrates

Over 2000 years ago, Aristotle suggested a relationship between the use of sugar-rich foods and the incidence of dental caries when he noted a correlation between the eating of soft, sweet figs and damage to the teeth. Since then, many studies have confirmed the consistent and intimate cause-effect relationship between sugar intake and the incidence of dental caries (Newbrun, 1982). The following studies, selected from the extensive mass of data relating dental caries and sugar intake, best recapitulate the conclusions drawn from the research to date.

Epidemiological Surveys

A survey of the primitive Eskimo in the early part of this century established a link between the use of sucrose and the prevalance of caries. Before they were corrupted by Western foods high in carbohydrates, these people had a very low incidence of caries, but as more and more new carbohydrates entered their diets, the incidence of caries increased (Rosebury and Waugh, 1939).

Sreebny (1982 a) investigated the relationship between caries and sugar supplies in six- and twelve-year-old children from several nations. He found that when sugar intake was at or below 50 grams per day, the caries score on the decayed-missing-filled teeth index was low (DMFT $\leq$ 3.0); conversely, when the ingestion of sugar was higher than

50 grams per day the caries incidence increased markedly.

However, prevalence of caries unrelated to sugar consumption was reported in primitive groups in Papua, New Guinea. The people located the farthest from the trading posts (and hence farthest from refined sugars) had a higher decay incidence than those closer to the trading posts, suggesting that availability of refined sugars was not the sole determinant of tooth decay (Schamschula et al., 1978).

Human Studies

Weiss and Trithart (1960) examined 783 Tennessee children between five and six years of age to find that the incidence of caries rose with the number of between-meal snacks of high sugar content and sticky consistency. The children eating no snacks had low dental scores of 3.3 or less, while those eating four or more snacks had scores of 9.8 or more. Children of Seventh Day Adventists, who restricted their intake of sugar and sticky carbohydrates and did not eat between meals, had less decay than did other children (Glass and Hayden, 1966). Roberts and Roberts (1979) found that children under 6 who took sugar-based syrup medicine each day for six months or longer had significantly more caries than other children of the same age. Examinations of subjects with hereditary fructose intolerance (HFI) revealed that they had very little caries experience compared with individuals who did not have this disease (Newbrun et al., 1980), perhaps because of the severe restrictions on sugar in the diet of HFI subjects (who could not metabolize fructose or sucrose, the disaccharide that contains fructose).

Futher evidence of the positive relationship between dietary sugar and dental caries prevalence came from a home for children in Australia. Harris (1963) studied the diets of 82 children from 10 to 15 years of age at the Hopewood House in Australia for five years. The children living in the orphanage were fed diets that did not include sugar or other refined carbohydrates. Their caries incidence during this time was consistently less than that of similar aged children in other state schools not adhering to the same diet. When these children were relocated and no longer on this original diet, a steep increase in dental caries occurred. The study supported the positive relationship between the presence of dietary sugar and the prevalence of dental caries.

The classic study demonstrating the importance of increased sugar consumption to increased dental caries was the Vipholm Study in Sweden (Gustafsson et al., 1954). This five-year study of adult mental patients was one of the first to report that the consistency of foods containing sucrose and repeated exposure to sugar were more important to the production of decay than was the amount of sugar consumed. Patients who increased their sugar consumption from 30 to 330 grams per day had little increase in caries per year provided that the additional sugar was ingested in solution during meals. Further, those who ate bread containing 50 grams of sugar with their meals showed the same slight increase in decay. However, when sticky forms of sweets such as toffee or caramel were ingested between meals, the incidence of caries rose significantly.

Steinberg et al. (1972) conducted a three-year study to investigate the effect of the physical form of the sugar-containing food upon caries production. Interestingly, they found that twelve ounces of carbonated beverage added to the normal diet of 281 mentally subnormal, institutionalized subjects produced no significant increase in DMFT scores when compared to the scores of the control group consisting of 286 subnormal subjects from the same institution who did not consume the additional beverage.

Contrary to the results of other studies, Samuelson et al. (1971) found no relationship between the number of times sugars were eaten and decay in children ages 4, 8, and 13 of a northern Swedish country. As an explanation of these unusual results, the study cited the difficulties of comparing short-term dietary variables with caries scores that reflect the effects of a lifetime.

Although the epidemiological data suggest a causal relation between sugar consumption and caries incidence, the literature does not show a clear correlation between the number of times sugar is consumed and the prevalence of decay. Therefore, the research and literature to date support only three definite statements about sugar:

1. Low DMFT scores are almost always associated with the absence of simple sugars in the diet.
2. High DMFT scores are usually associated with increased length of time that the tooth was exposed to sugary foods.
3. Increases in the total amount of sugar foods consumed by a population over an extended period of time is usually

associated with increased incidence of caries. (Sreebny, 1982 b)

Mechanism of Cariogenicity

All carbohydrates have cariogenic potential, but the simple sugars (mono- and disaccharides) are the most cariogenic. The size of the molecules may partially account for the difference in cariogenic potential: the sugar molecule is very small in comparison to the large starch molecule. Moreover, it is also very soluble and can easily diffuse rapidly throughout the dental plaque. Fosdick (1962) noted that the concentration of the simple sugar was important; the more concentrated the sugar, the faster it penetrated the plaque. Conversely, the larger starch molecule is relatively insoluble and does not diffuse through the plaque as quickly; thus, it does not ferment as quickly as sugar, giving the saliva time to buffer any acid formed from it (Hartles and Leach, 1975).

Not all sugars have the same cariogenicity (C), hence the following decrease in cariogenicity based on a review of human and animal studies: C(sucrose) > C(glucose) > C(maltose) = C(lactose) = C(fructose) (Makinen and Philosophy, 1972). Sucrose is considered the most cariogenic because Streptococcus mutans can metabolize it to significant amounts of insoluble glucans and highly soluble levans that readily ferment into lactic acid. Insoluble glucans enable plaque to stick to the smooth surfaces of the tooth. While levans are not as sticky, they are responsible for the packing effect in the crevices of the teeth. Although other simple sugars and starches can contribute to caries activity, only sucrose can be transformed into the adhesive glucan polymers in significant amounts (Keyes, 1969). However, all simple sugars as well as complex carbohydrates serve as fermentable energy sources for bacterial growth which ultimately leads to the production of acid on the tooth surface. Therefore, all carbohydrates play a role in the etiology of caries (Brown, 1975).

Minerals and Vitamins

The cariogenic role of trace elements has received little attention. Although Navia (1972) suggested a classification of elements according to their cariogenic properties based on the results of experiments with animals, there is very little research on human beings to substantiate his list. Furthermore, few epidemiological studies have been conducted. One survey, conducted by Hadjimarkos et al. (1952), has investigated the caries incidence in children living in regions with high selenium concentrations in the soil. They found that children living in Western Oregon (where selenium concentrations were high) had a higher incidence of caries than did comparable children in Eastern Oregon (where selenium was not present).

The role of vitamins in the caries process has not been clearly determined. At present, there is no evidence to suggest that a diet rich in water-soluble vitamins exhibits any local cariogenic function (Hartles and Leach, 1975). Adequate amounts of vitamins C, A, and D are needed for the chemical and structural development of the teeth during their formation and calcification, but no correlation between these vitamins and dental caries in man has been found (Nizel, 1981).

Cariostatic Dietary Factors

Just as dietary factors can promote tooth decay, so can many components of the diet help to minimize the cariogenic effects of fermentable carbohydrates (Alfano, 1981). Most cariostatic foods possess the following characteristics: a high buffering capacity, large particle size, high fat and protein content, liquid form, and protective mineral composition.

Trace Minerals

Fluoride

Several major studies demonstrate the carioreductive benefits of fluoride in community water supplies during tooth development (Ast et al., 1956; Hayes et al., 1957; Blayney and Hill, 1967; Lemke et al., 1970). More recent research suggests how fluoride may function as a cariostatic agent: it converts the hydroxyapatite in the enamel to fluorapatite, thereby producing a stronger and more resistant tooth; it contributes to the remineralization of the enamel surface, and its antibacterial action decreases acid production (Nizel, 1981).

The local protective action of fluoride, in which the amount of fluoride in the enamel surface is increased, has been demonstrated with topical fluoride applications. Recently, Beiswanger et al. (1980) directed a three-year study to determine the effects of applying a 9% fluoride prophylactic paste and a 10% topical solution together and separately along with an untreated group receiving placebo prepartions in both paste and solution. A total of 526 children between ages 8 and 16 received semi-annual prophylaxes using a) both the fluoride paste and topical applications of fluoride, b) the paste only, c) the topical application only, and d) a placebo preparation. The results indicated that the combination of both treatments was not signigicantly more effective than the single treatment with topical solution of fluoride, which produced a 40%-60% caries reduction rate compared to the untreated group. The fluoride paste alone was not significantly effective in reducing decay when compared to the untreated group.

At present, health officials can most realistically distribute fluoride to the public through fluoridation of communal water supplies. The nationally recommended amount of fluoride in water is 1 mg per liter of water (1 ppm) (National Academy of Sciences, 1980). However, in the Northern states, where water consumption is typically low, 1.0-1.2 ppm is desirable; whereas, in Southern states, only 0.6-0.7 ppm is necessary to achieve the daily intake recommended. When systemic fluoride occurs at recommended levels from birth through the adolescent years, fluoride remains a permanent part of the tooth, providing lifetime benefits against decay (Shaw and Sweeney, 1980).

<u>Other Trace Minerals</u>

The influence of other trace minerals is still somewhat confusing. When available in high levels in the water supply, boron, lithium, molybdenum, strontium, and vanadium have been associated with a low caries incidence (Losee and Ludwig, 1970). Although it has been postulated that the function of these elements is to make the tooth less soluble, thereby increasing its resistance to decay, further research is still needed in this area (Nizel, 1981).

Macro Minerals

Calcium and phosphorus are essential elements in the body, needed for the formation of apatite structure in mineralization of bone and teeth. The crystalline structure of hydroxapatite, composed of calcium phosphate and calcium carbonate, accounts for the strength and rigidity of the bones and teeth (Czajka-Narins, 1979).

For adolescent girls between ages 11 and 18, the National Academy of Sciences recommends a daily intake of 1200 mg of each mineral, in a Ca:P ratio of 1:1 (1980). Dietary sources of calcium include milk and milk products, sardines, clams, oysters, kale, turnip greens, and broccoli. Dietary sources of phosphorus include cheese, egg yolk, milk, meat, fish, poultry, whole grain cereals, legumes, nuts, and other foods and beverages with phosphate additives (Czajka-Narins, 1979).

Phosphorus

The only element other than fluoride generally accepted as having cariostatic properties is phosphorus (Nizel and Harris, 1964). The amount of phosphorus in the normal diet of an average adult female consuming 2000 kcal per day is estimated at about 900 to 1200 mg per day (Greger and Krystofiak, 1982). The latest reports from the 1976-80 HANES II Study indicated that females in the 12-14 and the 15-17 year old age groups had mean phosphorus intakes of 1,130 mg and 1,061 mg, respectively (U.S. Deparment of Health and Human Services (HHS), 1983). Although the American diet is high in phosphate-containing foods, such as processed and convenience foods, soft drinks, meat, milk, and whole grain products, no decrease in caries incidence (in comparison to that of countries with lower phosphorus intake) has been demonstrated (Massey and Strang, 1982).

In 1937, Osborn and Noriskin reported one of the earliest accounts of the cariostatic effects of dietary phosphate. These researchers found that the African Bantus who ate unprocessed bread made from crude flour experienced a lower caries incidence than those in the tribe who ate white bread. They postulated that the organic phosphate in the native bread was the protective agent (1937).

Lambrou (1974) conducted a study to compare the cariogenicity of white bread and whole wheat bread. Plaque was collected on the mouth guards that four subjects wore for several days. These guards were not brushed nor were they worn during meals. The guards were removed and exposed to each food for the same amount of time. Whole wheat bread caused significantly less decalcification than the white bread. Since the contact time was the same, the sticky quality of the breads was ruled out as a possible cause. He therefore attributed this difference to some protective agent, possibly phosphate, in the whole wheat bread.

Sutfin et al. (1970) investigated the local effects of calcified plaque and dental caries in 164 children in two Guatemalan villages. The diet of these people contained lime-treated tortillas which were high in calcium and phosphorus. The dental examination revealed that the village with the highest consumption of tortillas had the lowest caries prevalence and the highest incidence of calculus. They postulated that calcium phosphate precipitated onto the tooth surface when the person ate the tortillas.

The source of organic phosphate in whole grain cereals has been identified as phytic acid (Van Soest, 1978). Phytates, the salts formed from phytic acid, are natural constituents of unrefined carbohydrates and cereal products. Anti-cariogenic properties of phytates may arise from their physical stimulation of saliva flow as well as of remineralization (Madsen, 1981). In addition, the release of free phosphate from phytates during the leavening process increases the concentration of phosphate in the plaque (Czajka-Narins, 1979). The fact that phytate is largely removed during the refining process may account for the more cariostatic properties of whole wheat products were those made with refined flour or meal (Jenkins, et al., 1959).

Animal Studies. Animal studies in the last 30 years have demonstrated that increased levels of phosphates (non-metallic salts of phosphorus) in the diet reduced the severity of dental caries. McClure and Muller (1959) found that inorganic dietary phosphate supplements of disodium phosphate and diammonium phosphate in the diets of rats displayed cariostatic properties. Later McClure (1960) studied the effects of phosphated bread in rats and found similar results. The organic phosphate, sodium phytate, in the bread reduced caries 77%. Then in 1963, he compared the cariostatic action of different organic phosphates in rats (McClure,1963). He found organic phosphates to be uniformly cariostatic. Later, McClure (1964) reported an anti-caries property of fructose-(1,6)-diphosphate, which he hypothesized to be due to the buffering properties of the phosphate in this compound.

Another animal study was undertaken by Stookey and Muhler (1966) on the anticariogenic effects of phosphate added to plain and sugar-coated cereals fed to rats. Inorganic sodium dihydrogen phosphate was added to the cereals, resulting in a significantly reduced caries incidence compared to the control group regardless of the sugar content of the cereal.

A study conducted by Harris et al. (1967) compared the cariostatic effects of five types of sodium phosphate compounds: simple orthophosphate with a single phosphorus atom; three chained phosphates (pyro-, tripoly-, and hexameta-) with two or more phosphorus atoms bonded linearly; and trimetaphosphate (TMP) with three or more phosphorus atoms bonded in a phosphate ring. Orthophosphate proved least cariostatic in rats while TMP showed the greatest effectiveness in reducing decay.

Despite the cariostatic potential of TMP, many in the scientific community expressed a nutritional concern over increasing the sodium in the human diet with the use of sodium TMP supplements. So, Shaw (1980) conducted a study to determine the cariostatic potential of various other TMPs. He found that calcium TMP reduced caries in rats as much as did sodium TMP. This phosphate was suggested as a more suitable supplement in a variety of sugar and baked products.

Stookey and McDonald (1980) conducted two studies with rats in which low and high concentrations of oat hulls and sodium TMP, as well as combination of both at their lowest concentration were used. The results indicated a greater caries protection from a combination of both than by either used alone. For humans, this result indicated that the combination of two phosphate agents at lower concentrations might increase cariostatic activity better than one agent at higher levels, without increasing sodium significantly.

Englander and Keyes (1970) discovered that phosphate content alone was not the sole factor. Hamsters eating a phosphate-supplemented diet had a lower caries incidence only when the supplements were consumed continuously, indicating the importance of repeated exposure to the cariostatic phosphates.

Human Studies. Efforts to duplicate animal studies in humans were first conducted by Stralfors (1964). He investigated the use of calcium phosphate supplements that were added to soft and hard breads, and into flour and sugar used in cooking served once daily during school to third graders. The two-year study found a 40% reduction in mean caries increment in the 6 schools where the mineral supplemented foods were served compared with the 7 schools consuming unsupplemented foods.

Averill and Bibby (1964) completed a two-year study on the caries-preventive effects of phosphate in the flour and sugar used to make breads, pastries, and desserts fed to institutionalized children in New York. No significant changes occurred with the phosphate-supplemented group compared to the control group; thus, they concluded that phosphate additives failed to reduce caries incidence.

Another clinical study by Ship and Mickelsen (1964) investigated the effects of calcium acid phosphate added to the flour used to make breads and cake products in eight boarding schools in North and South

Dakota. The children were given four dental examinations with radiographs during the three-year tests. Again there was no difference in the DMFT or DMFS scores in the control or experimental group from 1959-1962, indicating the lack of an anticaries effect in humans.

An Indiana group of dental researchers tested the effect of sodium dihydrogen phosphate added to breakfast cereals of adults subjects. After one year the control group had a mean caries increment of 0.26 compared to an increment of 0.15 for the phosphate group indicative of a reduction of 42.3% (Carroll et al., 1968). Brewer et al. (1970) also indicated a significant reduction in new decay in institutionalized children and adults eating sodium dihydrogen phosphate-enriched presweetened cereal for two years. They observed a 48.5% reduction in mean increment for DMFT scores in the phosphate group compared to the control group and a 55.3% reduction in the mean increment for the DMFS score.

Finn and Jamison (1967) found dicalcium phosphate in chewing gum effective in reducing decay in deaf and blind children between six and seventeen years of age. The sugar-phosphate gum produced a reduction in increase in decay of 55.3% for the mean DMFS score compared with the group who chewed gum containing sugar only. A later study by Finn et al. (1978) on school-age children using TMP in sucrose containing gum demonstrated 23.3% fewer new caries than their control groups.

Wycoff et al. (1980) investigated the use of mouth rinse containing calcium glycerophosphate on the amount of plaque formed on the tooth. The study used 60 children between 13 and 16 years of age. They found that there was a significant increase in the phosphorous content of plaque with the mouth rinse in the experimental group compared to the control group, which may have augmented the buffering capacity of the plaque.

Efforts to duplicate animal studies in humans have proved disappointing. Perhaps the rats' relatively large number of exposures to the phosphate supplements in their diets may account for the differing effects between the two species. Therefore, the additon of phosphate supplements to a wider variety of foods, thereby increasing the exposure of the tooth surface to phosphorus, may diminish the differences. However, since adding phosphorus to the diet may alter the dietary Ca:P ratio, Nizel (1981) suggested that we limit the use of phosphate supplements to calcium hydrogen trimetaphosphate only.

Thus, the cariostatic action of phosphorus appears to be primarily a local and topical one (Sobel, 1964; Nizel, 1977). The suggested mechanisms responsible for this action are as follows:

1. The common ion effect. Phosphates in the mouth may prevent the loss of phosphorus from the tooth enamel.
2. The remineralization action. Phosphorus as well as calcium and fluoride ions may be restored to the enamel surface making it harder and smoother.
3. The detergent action. Phosphates probably interfere with the adherence of plaque bacteria to the tooth surface.
4. The buffering effect. Phosphates in saliva neutralize the acids, thereby preventing the drop in plaque pH and thus the growth of bacteria.

Ca:P Ratio

Due to the presence of calcium and phosphorus ions in the plaque and their influence on the caries process (Nizel and Harris, 1964), analysis of the Ca:P ratio from the diet has been investigated.

A high dental caries score has been found in rats that were fed a Ca:P ratio very different from the recommended 1:1. When such diets were supplemented to achieve a 1:1 ratio, decay was retarded (Haldi, et al., 1959). Human data by Stanton (1969) suggested that caries occurred least frequently when the dietary Ca:P ratio was about 0.55. Sobel et al. (1960) observed that the low phosphorus diet fed to rats produced a caries increase four times greater than a low calcium diet. They suggested that the apparent cariostatic action of a low phosphorus diet was due to the high carbonate content of the tooth that made it relatively soluble and susceptible to decay.

At this time, the future role of phosphate supplements in the prevention of decay is still undetermined. What effect, if any, that the Ca:P ratio has on the incidence of decay is still unanswered. Therefore, future research in the use of calcium phosphate supplements in a number of foods appears to be the most productive means of using the full potential of the cariostatic mineral phosphorus.

Proteins

The cariostatic action of some protein-containing foods has often been suggested. The single amino acid lysine in skim milk powder demonstrated cariostatic action in the diets of rats studied by McClure and Folk, 1955). Bowen's (1978) paper to the Geneva conference reported that plaque formed in the presence of protein (casein only) lacked the ability to produce acid from sugar. Since casein is a phosphoprotein, the phosphate in the protein may be the primary factor exerting the anti-cariogenic effect.

Fats

Fats have also been considered dietary components that may reduce caries. The incidence of caries was lower in rats fed a diet of 9% fat and oil when compared to one of 3% fat and oil (Alam et al., 1973). Although traces of fatty acids stimulated the growth of bacteria in plaque, high concentrations inhibited growth (Critchley, 1970). Other factors associated with the cariostatic action of fats may be the coating of the tooth surfaces (McBeath and Verlin, 1942), which reduces the adhesion of plaque to the tooth, thus lowering bacterial growth and decreasing the penetration of bacterial enzymes and acid production in the plaque.

Cariostatic Properties of Foods

Chemical Properties of Milk and Cheese

Milk and cheese both have been shown to possess potential anti-caries properties. An early experiment by Jenkins and Ferguson (1966) strongly suggested that milk protected against caries-promoting foods, presumably due to the calcium and phosphate in milk. These minerals reduced the amount of enamel dissolving, by redepositing calcium phosphate on the decalcified tooth as well as by acting as buffers, reducing the drop in pH. Moreover, the fat in milk may form a protective layer on the tooth, insulating it from bacterial invasion. Rugg-Gunn et al. (1975) found that cheese raised the pH of dental plaque, while sweetened coffee had a pH-depressing action. They further discovered that cheese probably increased saliva flow, as well as the amount of plaque calcium. The protective effect of cheese suggests that ending the meal with cheese may protect the tooth from the sucrose in food during a meal.

Physical Properties of Edible Plants

The physical properties of some foods have been believed to exert protective effects against the action of sucrose. Hard and coarse foods, such as apples and raw vegetables, were thought to have a detergent action during chewing, but few experiments have results that support this hypothesis (Hartles and Leach, 1975). These foods do not appear to remove plaque, but they do clear the mouth of food, which decreases the time the tooth is exposed to sugar. Mastication of fibrous foods also increase the flow of saliva (Sreebny, 1972). Trimble et al. (1938) found that dental students with high salivary secretion rates developed fewer new cavities to those with lower secretion rates.

Dental Disease and Nutrition in Adolescence

Adolescence is a time of rapid physical and psychological changes that have direct impact on the oral cavity. The mixture of deciduous and permanent teeth becomes complete permanent dentition during the adolescent years. By the age of twelve or thirteen, all primary teeth have been replaced with permanent teeth. The calcification of permanent teeth begins at birth and is completed around the thirteenth year with the exception of the third molar, which is extended into the sixteenth or seventeenth year (Casamassimo and Castaldi, 1982).

Rapid tooth replacement during early adolescence can cause orthodontal problems such as crowding, resulting in the need for bands or braces. Crowding, poor dental hygiene practice on newly erupted teeth, plus the presence of braces which interfere with brushing all contribute to the problem of decay in the adolescent. In addition, poor dietary habits and frequent snacking further complicate the problem. As a result, the adolescent years have been described as the peak caries period (U.S. Department of Health, Education, and Welfare (HEW), 1972).

A study by Linn (1976) showed that adolescents knew about tooth decay and the importance of daily brushing, but they lacked knowledge about what was needed for optimal dental health. Few even knew about periodontal disease or what plaque was, and only one out of ten flossed daily. Girls seemed more worried about dental appearance and discolored teeth than did boys; therefore, they were more likely to brush their teeth. Girls also reported going to the dentist for regular checkups more often than did boys. Lack of knowledge appeared to be an important factor contributing to the increase in decay during the vulnerable years of adolescence.

Periodontal Disease

Periodontal disease is a chronic inflammation of the periodontal tissues. It is progressive disease and the number one cause of tooth loss in adults over 35 (Sinkford, 1981). It results in the destruction of the gingiva (gum tissue), the periodontal membrane (connective tissue), and the alveolar bone (jawbone). The primary factor in periodontal disease is dental plaque due to poor oral hygiene (Amer. Dent. Assoc., 1982).

Periodontal disease is often first seen during adolescence. Although the disease is usually not advanced at this age, mild gingivitis is not uncommon. Physiological and hormonal changes during puberty may be partly responsible for the level of inflammation of the gingival tissues (Casamassimo and Castaldi, 1982).

Due to the presence of plaque in the development of both periodontal disease and dental caries, a relationship between the incidence of decay and periodontal status was investigated by Burt et al. (1982). They failed to demonstrate a clear relationship between the two variables. The role of nutrition and its effect on periodontal disease indicates that malnutrition may predispose the person to the disease, which then allows local irritants such as plaque buildup to further aggravate the problem (Alford and Bogel, 1982).

Nutrition may have its greatest impact on periodontal disease in the healing capacity. It increases resistance to infection in gum tissue. Therefore, the role that diet plays in the management of periodontal disease is primarily one of prevention and maintenance. Other benefits of the diet may be the local cleansing properties of fibrous foods which appear to have no local effect on the removal of gingival plaque, but do stimulate salivary flow, speeding the removal of food debris responsible for plaque formation (Sreebny, 1972). The beneficial effects from the muscular activity of chewing have been demonstrated; it promoted strong periodontal tissue making the gingiva less permeable to bacterial penetration and increasing the density of the jawbone (Coolidge, 1937).

Braces

Malocclusion generally becomes apparent when primary teeth are being replaced by permanent teeth. Although there is no age limit, the adolescent years are the usual time for treatment of malocclusion due to the rapid changes in tooth position as well as facial growth during these years (Amer. Dent. Assoc., 1982). If left untreated, malocclusion can make the teeth more susceptible to decay, because saliva is not able to get to areas that are crowded (Fosdick, 1962). The presence of bands or braces themselves can hinder proper brushing, increasing the chances for decay. Therefore, with or without treatment, malocclusion further complicates the decay problems for the adolescent in an already active caries period.

An assessment of occlusion of U.S. youths at ages twelve to seventeen revealed a high degree of malocclusion among this group (Kelly and Harvey, 1977). It was suggested that due to better dental care, youths were retaining more of their permanent teeth by having them filled instead of losing some of them because they let the cavity get too large. Many adolescents can not accomodate all of their permanent teeth without crowding problems so retaining all of their permanent teeth has increased the prevalence of malocclusion in this age group. When groups were classified according to treatment needs, 11% of the youths studied had normal occlusion, 35% had minor problems, about 25% had definite malocclusion but treatment was elective, 13% had malocclusion in which treatment was highly desirable, and 16% had malocclusion severe enough to require treatment. An estimated 10.7% had had their teeth straightened through orthodontic treatment. This percentage increased with age, from 7% for 12 year olds to 13% for 17-year-old adolescents. Use of braces was closely associated with family income, with only 2% in the low income group receiving treatment and 29% of the higher family income group receiving treatment.

National Health Surveys

The National Health Examination Survey (1966-1970)

During 1966-1970, the United States conducted a national caries survey of 7,514 youths between the ages of twelve and seventeen (Kelly and Harvey, 1974). DMFT scores by age, sex, race, and income were reported for adolescents. This study indicated that males had lower caries incidence than females with a mean DMFT of 5.8 for males and 6.5 for females. This difference was thought to be due to the earlier eruption of permanent teeth in females, which exposed their teeth to substrates in the diet for a longer period of time.

Differences between races were also apparent, with a 6.3 DMFT score for whites and a 5.6 DMFT for blacks. Whites had four times as many fillings as blacks, while blacks had twice as many decayed and missing teeth as whites. DMFT scores for the group increased with age, with a DMFT of 4.0 for 12 year olds to a high of 8.7 for 17 year olds. Dental neglect was common between 12 and 17 as reflected in the total mean score of 6.2 DMFT for all youths (Kelly and Harvey, 1974). Furthermore, DMFT scores did not rise consistently with income; however, the combined components DM decreased from 3.9 to 1.0 with rising income while component F increased steadily from 1.6 to 5.4 with increases in income, a change which suggests that those who could afford fillings received treatment.

Ten-State Nutrition Survey (1968-1970)

In the Ten-State Nutrition Survey, dental as well as nutritional assessments were made to determine the dental health of selected segments of the country (U.S. Dept. of HEW, 1972). Data collected on children between the ages of 6 and 17 included three ethnic groups, each with low and high incomes. DMFT increased with age at the same rate for all races. No sex or race differences in DMFT scores were reported for children in high-income states, but black males from low-income states had lower caries scores than did black females. Except for Spanish Americans, the other races reported no difference in DMFT scores for children between the ages of 6 and 17 from either high or low income families. Low-income Spanish American females had the largest mean DMFT score of any race surveyed. High-income white children had the most filled teeth; low-income black children had the smallest number of filled decayed teeth; and low-income Spanish American children had the highest number of missing teeth. This study also showed a positive relationship between refined carbohydrates eaten between meals and DMFT scores for all 3 races in the high-income groups but no association in low-income whites or Spanish Americans. High-income blacks were the only group who showed a relationship between comsumption of refined carbohydrates during the meal and their dental scores. Thus, in this survey, caries increased with age and amount of sugar snacks eaten, but race, sex, and income interacted with other variables so that consistent effects were not observed.

Rowe et al. (1976) reviewed the Ten-State survey to analyze the tooth-by-tooth in order to show which teeth were carious instead of using the DMFT index. They found that carious teeth increased with age, with caries beginning after eruption and increasing to a plateau around 18 years of age. Racial differences were more evident than indicated in the original reports, with blacks experiencing less decay than whites. Small sex differences were found, with girls exhibiting higher caries rates than did boys. They also found that income-related effects became apparent in the re-examination, with lower-income groups showing less caries incidence that higher-income groups.

Garn et al. (1980), who also re-analyzed the Ten-State Survey data, investigated the differences between high and low intakes of sugar-containing foods and dental caries. Adolescents with high DMFT scores ate more sugary foods consumed during and between meals than those with low scores; in fact, caries incidence increased with age and doubled in adolescents consuming large amounts of sugar, regardless of sex or race.

First National Health and Nutritional Examination Survey (1971-1974)

This survey was conducted in order to evaluate data on the nutritional as well as dental health of the United States population.

Dental and nutritional data were collected from approximately 20,000 people between the ages of one and 74 between 1971 and 1974. The mean DMFT score for the 12- to 17-year-old group was 6.2, with whites registering a higher DMFT score than did blacks (U.S. Dept. of HEW, 1979). The relationship between diet and dental health was further analyzed by Burt et al. (1982). Dietary factors related to the DMFT score included the percent of energy ingested from sugar-rich foods between meals, number of times sugar-rich foods were eaten between meals, and the number of times less-sugary foods, defined as food that do not include sugar or primarily sugar products, desserts, sweets, cereal and grain products, were eaten between meals. No relationship could be found between the Ca:P ratio or the intake of individual nutrients. Fluoride content in enamel was related inversely to decay.

Summation

Dental caries is a widespread disease process that can lead to pain, expense, and loss of teeth. It continues for as long as we live. For decay to occur, there must be a susceptible tooth, cariogenic bacteria, and fermentable substrates in the diet. A review of the literature indicates that carbohydrates, primarily simple sugars, are important dietary factors contributing to decay. Research also indicates that certain nutrients present in the diet help to prevent decay; fats and proteins, for example, may play a significant, protective role in the prevention of tooth decay. Further, the benefits of fluoridated water in the control of decay have been substantiated, while another mineral, phosphorus, was also cariostatic.

National surveys indicate that during the adolescent years, the incidence of decay may be at its zenith. This period is characterized by rapid growth that may lead to crowding of the teeth, poor dietary practices, frequent and substantial between-meal snacks, and a lack of adequate oral hygiene practice. Therefore, for a preventive dental health program to be effective, it must include proper brushing, adequate intakes of fluoride, and a diet that reduces the number of times cariogenic foods are consumed while increasing the number of times cariostatic foods are eaten.

Research therefore indicates that diet (as well as such other factors as age, race, sex, and income) has a significant effect on the prevalence of decay. Despite the possibility of genetic influences, an important role of nutrition has been implicated in the promotion of dental health, or as Pickerill humorously noted, "The main hereditary factor in dental caries is the inheritance of the family cookbook" (cited in Bibby, 1970).

CHAPTER III

METHODS AND PROCEDURES

This study was part of a USDA Southern Regional Research Study of adolescent girls over a three-year period. One part of this study evaluated the nutrient intake of teenage girls in order to relate diet to dental health. The study relied on two 24-hour dietary recalls and a dental examination on each of 2 years to derive its assessments.

Sample

The subjects for this study consisted of 150 adolescent females with no organic disorders from North Central Oklahoma. They agreed to participate in the regional study entitled "Nutritional Health of Adolescent Females." Random sampling was not attempted due to the likelihood of a low response rate. Instead, voluntary sampling from selected schools in cities of differing sizes provided the subjects from North Central Oklahoma.

Between February and May of 1981, researchers collected data on these girls, aged 11.5 to 16.5 years, through extensive physical and dental examinations and 24-hour dietary recalls. In the spring of 1983, 99 of the girls were re-examined. On one of eight days in 1981 and one of five days in 1983 (mostly Saturdays) designated as data collection days, each girl came to a central location where she underwent a dental examination and provided dietary and other information. In addition, researchers conducted interviews with the subject's mother in her home to obtain information about income and race and conducted a second 24-hour dietary recall. For research purposes, the girls were divided into three categories according to age: the "12 years" group consisted of girls 11.5 through 13.4 years of age; the "14 years" group consisted of girls 13.5 through 15.4 years of age; the "16 years" group consisted of girls 15.5 through 16.5 years of age. Similar age groupings were employed in 1983 when all the girls were two years older.

Dietary data for 149 girls and family per capita income data for 147 girls collected in 1981 were used in this study. Since dietary data for 1983 was unavailable for use at the time of this writing, the income data for 1983 were also not used. Dental data for 125 girls were collected in 1981; some of the girls were not present for a dental examination, and no dentist was present to examine the girls on one day of data collection. Dental data for all of the 99 girls returning in 1983 were available for this study. A description of the sample for 1981 and for 1983 appears in Table I.

Dietary Assessment

Trained nutritionists interviewed each subject twice each year to obtain dietary information. One interview was on a designated day at a dental examination site, the Oklahoma State University campus, a high school, or a Tulsa medical clinic; and one was at least two weeks before or after the examination date, in the subject's home.

TABLE I

DESCRIPTION OF THE SAMPLE FOR 1981 AND 1983

Data collected	Year	Race	Age category 12*	14**	16***	Total
Dietary information	1981	All	52#	64	33#	149
		White	43#	44	27	114
		Black	9	20	6#	35
Dental information	1981	All	40	52	33	125
		White	36	38	27	101
		Black	4	14	6	24
Dental information	1983	All	33	48	18	99
		White	28	34	15	77
		Black	5	14	3	22

* Age 12 = 11.5 - 13.4 yr.
** Age 14 = 13.5 - 15.4 yr.
*** Age 16 = 15.5 - 16.5 yr.

one subject in group did not provide income data

During the 24-hour dietary recall (see Appendix C), the interviewer asked the participant to list and describe what she ate and drank from the previous morning until bedtime the previous night. The subject was asked to report eating as she described her activities to aid her recall of foods and beverages consumed by associating food with various activities. The interviewer was careful not to suggest what she "should" or "should not" have eaten. Three-dimensional food models were used to help the girl describe the serving sizes and amounts of food and beverages consumed. In addition, the interviewer obtained the brand names of products and the recipes for the foods eaten. During the interview, the nutritionist asked the girl the amount of each food eaten and the time of day it was consumed. Dietary information was used to calculate the amount of each nutrient present in each of the seven possible eating periods per day (3 meals, 4 snacks).

After collecting the dietary information, foods and beverages were coded and nutrient intakes were calculated by the Nutritional Analysis System at Louisiana State University, Baton Rouge, Louisiana. Their nutrient data came from the Agriculture Handbook No. 8 (Watt and Merrill, 1963), food manufacturers' analyses, scientific literature, and calculated recipes. Each girl's diet was analyzed for nutrient content from the average of both recalls. The meal variables were determined from the average intakes of nutrients from the seven possible meals/snacks of both recalls as follows: the total number of meals/snacks per day in which any amount of total sugars (mono- and disaccharides) were consumed, the total number of snacks per day in which any amount of total sugars were eaten, and the total number of meals/snacks per day in which minimal amounts of total sugars and fat, total sugars and phosphorus, and total sugars, fat, and phosphorus were eaten together.

The Dental Examination

The dental examinations were performed by dentists or dental assistant (see Table II) using standard instruments and uniform work sheets approved for the regional project, and the findings recorded on Forms A4 and A5. Two questions about the presence of braces were added to the A5 form for 1983 (see Appendix A). The use of dental radiographs was not possible.

TABLE II

DESCRIPTION OF SAMPLE FOR 1981 AND 1983
BY EXAMINER AND BY RACE

Examiner	No. Subjects in 1981			No. Subjects in 1983		
	Total	White	Black	Total	White	Black
1	24	24	0	0	0	0
2	50	46	4	56	33	3
3	13	13	0	0	0	0
4	38	18	20	0	0	0
*5	0	0	0	43	24	19
Total	125	101	24	99	77	22

* Dental Assistant

Dental Scores

Each surface of each tooth present was examined for caries and fillings. The decayed-missing-filled teeth (DMFT) scores for each subject were calculated from the total of carious extractions in permanent teeth, and permanent teeth with cavities or fillings. The decayed-missing-filled surfaces (DMFS) scores for each subject were calculated from the total of the number of permanent teeth extracted due to cavities and the number of surfaces in the permanent teeth with either a cavity or a filling or both.

The status of each tooth was recorded with regard to its presence or absence. Deciduous teeth were identified by circling the letter that corresponded to each tooth. Permanent teeth were characterized as either present, carious extraction, unerupted, or accident loss or orthodontic extraction.

Periodontal Index (PI)

Periodontal scores were determined for subjects during the dental examination. Each tooth present in the mouth was scored as follows:

- 0 = negative
- 1 = mild gingivitis
- 2 = gingivitis
- 6 = gingivitis with pocket formation
- 8 = advanced destruction with loss of masticatory function

A complete explanation of scores can be found in Appendix B. PI for each subject was the average of the scores for all permanent teeth.

Fluoride and Fluoride Treatment Information

During the dental examination, subjects were asked about the fluoride level in their drinking water and the application of topical fluoride in the past six weeks (see Appendix A). When the subjects did not know the content of the fluoride in their water, the researcher obtained this information from the local water supply office. If the girl had a rural address, the researcher called the parent or guardian to obtain this information.

Braces Information

Two additional questions were added to the A5 form in 1983 that were not asked in 1981 (see Appendix A). The subjects were asked whether they had worn braces during the study, and, if so, for how long. Because only 99 subjects returned from 1981, the researcher called the girls who did not return in order to obtain this information from as many as possible of the other 51 subjects.

Statistical Analysis

Meal variables as defined in dietary assessment section were examined by the Spearman rank correlation method (SAS User's Guide, 1979). The researcher evaluated frequencies for low and high DMFT and DMFS scores across five variables independently: 1) age category, 2) low and adequate fluoride concentration, 3) fluoride treatments or lack thereof, 4) presence or lack of braces, and 5) three subgroups for PI scores were evaluated using the chi-square test (SAS User's Guide, 1979).

F tests were used to examine the main effects of selected classificaton and continuous variables on DMFT and DMFS in an analysis of variance. Classification variables included race (black/white) and examiner (dentist/dental assistant [DDS]). Continuous variables included age in months, per capita income, and nutrient intakes. Maximum R^2 Improvement Stepwise Regression analysis was used to help select most of the nutrient variables examined in the four analysis of covariance (SAS User's Guide, 1979). Simple Pearson's Correlation Coefficents were also calculated for selected dietary and demographic variables on dental scores. Finally, t-tests were used to evaluate the longitudinal differences between mean scores for DMFT and DMFS from 1981 to 1983.

CHAPTER IV

RESULTS AND DISCUSSION

The target population for this study consisted of adolescent females, 11.5 - 16.5 years of age, in North Central Oklahoma. They were 114 whites and 35 blacks, for a total of 149 girls assessed in 1981. The 1983 sample consisted of 99 girls, of whom 77 were white and 22 were black. Eighty-three girls were examined in both studies, of whom 67 were white and 16 were black. Dietary data (for 149 subjects) and income data (for 147 subjects) for 1981 were analyzed in this study. Dental data for 125 girls examined in 1981, for 99 girls in 1983, and for 83 girls in both years were related to various independent variables in this study. Since caries require 18 $\pm$ 6 months to develop (Parfitt, 1956), the effects, if any, of past as well as present dietary habits and purchasing power upon the cumulative lifetime measurement of caries incidence for 1981 and 1983 dental indices were analyzed in relation to 1981 dietary and income data.

Description of Dental Indices and Other Demographic Variables

The dental indices examined in this study were decayed-missing-filled teeth (DMFT) and decayed-missing-filled surfaces (DMFS) for 1981 and 1983. The mean scores for all subjects studied in each year of the study are presented in Table III.

TABLE III

MEANS ± SD BY YEAR FOR DENTAL SCORES
IN ADOLESCENT FEMALES SURVEYED

Year	Number	DMFT mean ± SD	DMFS mean ± SD
1981	125	3.8 ± 3.0	5.2 ± 4.8
1983	99	4.9 ± 3.0	6.9 ± 5.0

Both DMFT scores in this study for adolescent females in 1981 and 1983 were lower than the mean DMFT of 7.0 for females between 10 and 17 years of age in the 1968-70 Ten-State survey (U.S. Dept. of HEW, 1972). They were also lower than those for the females from 12 to 17 years of age in the 1971-74 First Health and Nutrition Examination Survey (HANES I), which reported DMFT scores of 6.6 (U.S. Dept. of HEW, 1979), and than the DMFT scores of 6.5 from the 1966-70 National Health Examination (Kelly and Harvey, 1974). However, our values were higher than the 3.1 DMFT and 4.7 DMFS for adolescent females, 11 to 17, in the most recent 1979-80 National Dental Caries Prevalence Survey (U.S. Dept. of Health and Human Services (HHS), 1981).

Means and ranges of dental indices by the two racial categories examined in this study, white (W) and black (B), and for subjects who were re-examined in the second year of the study are presented in Table IV. Graphic representations of the mean DMFT and DMFS scores by race for subjects in each year of study and those re-examined in 1983 are

TABLE IV

MEANS ± SD AND RANGES FOR DMFT AND DMFS FOR ADOLESCENT FEMALES BY RACE FOR EACH YEAR OF STUDY AND FOR SUBJECTS RE-EXAMINED IN SECOND YEAR OF STUDY

			DMFT		DMFS	
Year	Race	N	Mean + SD	Range	Mean + SD	Range
1981	W	101	3.7 ± 2.9	0 - 15	5.1 ± 4.8	0 - 27
	B	24	4.2 ± 3.7	0 - 15	5.9 ± 5.2	0 - 23
1983	W	77	5.1 ± 3.0	0 - 13	7.1 ± 5.0	0 - 23
	B	22	4.1 ± 2.9	0 - 9	6.0 ± 4.9	0 - 20
1981*	W	67	3.4 ± 2.6	0 - 9	4.4 ± 3.9	0 - 15
	B	16	3.4 ± 2.3	0 - 7	4.7 ± 3.3	0 - 10
1983*	W	67	5.3 ± 2.9	0 - 12	7.3 ± 4.8	0 - 23
	B	16	4.8 ± 2.7	0 - 9	6.9 ± 5.0	0 - 20

* = Girls examined in both years of study

presented in Figures 1 and 2. The dental scores in the bar graphs with the footnote 1 reflect longitudinal changes, and the bar graphs with the footnote 2 represent a description of caries incidence for each individual year.

This study demonstrated lower DMFT scores for all white girls examined in 1981 than for all white girls examined in 1983. More important, however, were the DMFT scores for the 83 white girls examined in both years, for these showed a longitudinal increase from 3.4 to 5.3. Data for the 24 black females examined in 1981 and the 22 blacks examined in 1983 displayed a decrease in DMFT scores. One explanation of this was that only 16 girls were present for both studies; therefore, the samples for both years differed by almost 30%. When the longitudinal changes were compared, the DMFT scores for the 16 blacks increased from 3.4 in 1981 to 4.8 in 1983. DMFS scores also demonstrated longitudinal changes among whites as well as blacks. Therefore this study indicates that as individual subjects of both races increased in age, so did their DMFT and DMFS scores. Table V displays the means and ranges of DMFT and DMFS in 1981 and 1983 by race and the initial age categories of 12, 14, and 16 years showing among whites and blacks in 1983 increasing mean scores for each higher age category.

Per capita income (PC INC) was examined in this study as a continuous variable. The means and ranges for 1981 income by race and age category in Table VI demonstrate higher mean incomes for whites than blacks in all age groups.

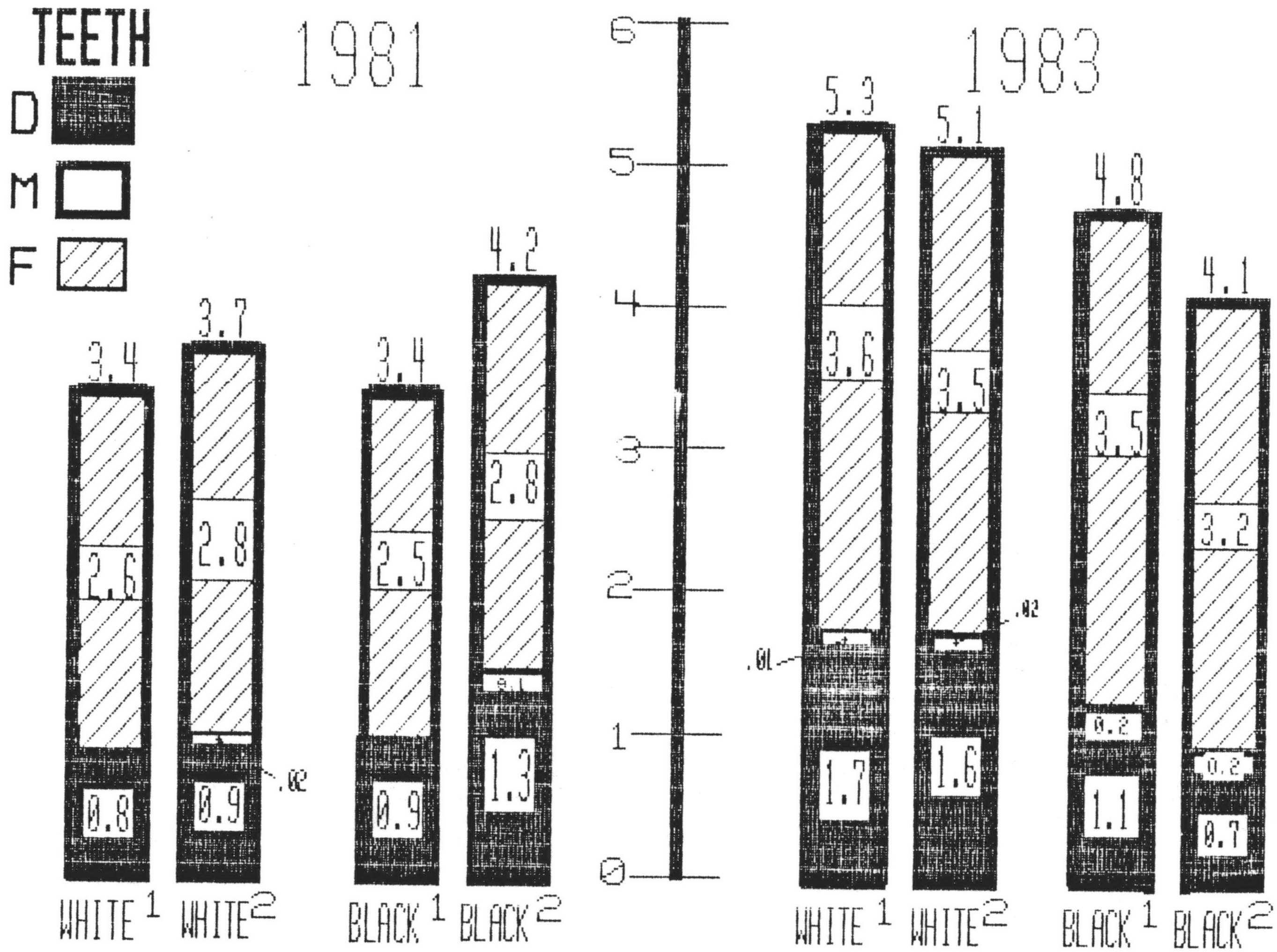

FIGURE 1

Average numbers of Decayed (D), Missing (M), and Filled (F) Teeth (T) and DMFT scores (above bar) by race for 1981 and 1983, for all females examined in both years (1) or for only those examined that year (2)

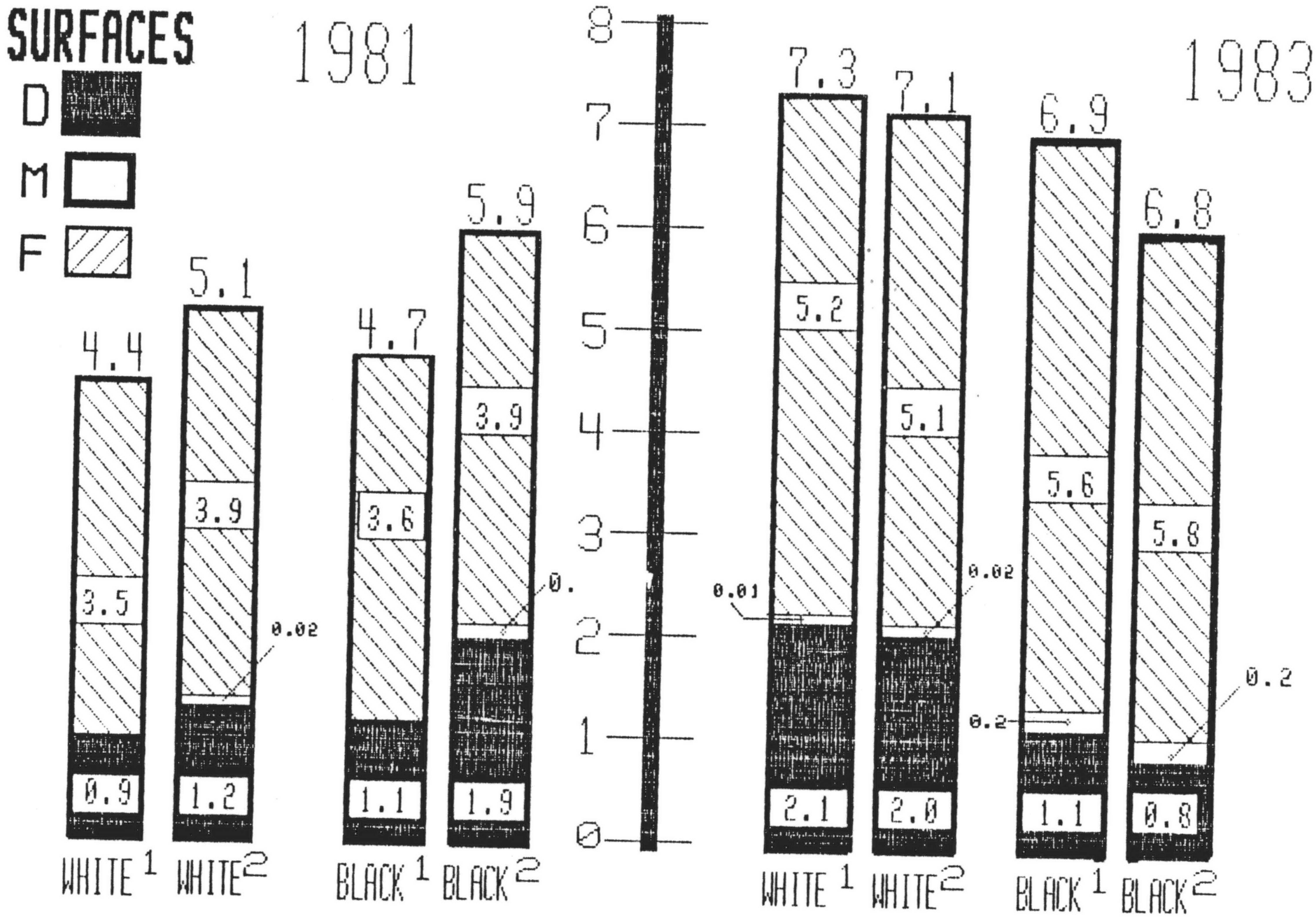

FIGURE 2

Average numbers of Decayed (D), Missing (M), and Filled (F) Surfaces (S) and DMFS scores (above bar) by race for 1981 and 1983, for all females examined in both years (1) or for only those examined that year (2)

TABLE V

DESCRIPTION OF 1981 AND 1983 DMFT AND DMFS (MEAN ± SD) IN FEMALE ADOLESCENTS BY RACE AND AGE CATEGORY

Year	Race	Initial Age Category*	N	DMFT Mean ± SD	DMFT Range	DMFS Mean ± SD	DMFS Range
1981	W	12	36	2.6 ± 2.5	0 - 7	4.1 ± 4.4	0 - 13
		14	38	3.9 ± 2.6	0 - 9	5.2 ± 4.2	0 - 16
		16	27	4.8 ± 3.4	0 - 15	6.3 ± 5.7	0 - 27
	B	12	4	5.0 ± 4.2	1 - 11	6.5 ± 5.4	1 - 14
		14	14	3.1 ± 2.3	0 - 6	4.4 ± 3.5	0 - 10
		16	6	6.5 ± 5.1	0 - 15	8.8 ± 7.6	0 - 23
1983	W	12	28	3.7 ± 2.9	0 - 11	5.1 ± 4.9	0 - 22
		14	34	6.0 ± 2.9	0 - 13	8.7 ± 5.1	0 - 23
		16	15	5.9 ± 2.8	1 - 11	7.3 ± 3.7	2 - 15
	B	12	5	2.8 ± 2.8	0 - 6	3.6 ± 3.9	0 - 9
		14	14	4.3 ± 3.0	0 - 9	5.8 ± 4.2	0 - 12
		16	3	5.7 ± 2.3	3 - 7	11.0 ± 7.8	6 - 20

* see methods section

TABLE VI

DESCRIPTION OF PER CAPITA INCOME (MEAN) BY RACE AND AGE CATEGORY

Initial Age Category*	Race					
	White			Black		
	N	Mean dollars/yr	Range	N	Mean dollars/yr	Range
12	42	6274	1776-17,500	9	4357	1047- 7,167
14	44	6461	846-20,000	20	4864	1349-13,000
16	27	6369	2500-12,500	5	2670	800- 5,000

* see methods section

Relationship of Demographic Variables to DMFT and DMFS Scores

Age Categories

Age categories as defined in Chapter III were examined first to describe effects that might not be a linear progression with age. A chi-square test was used to compare the distribution of low and high values for DMFT and DMFS by age category. "Low" DMFT values included scores from 0 through 3 with "low" DMFS values ranging from 0 to 6 (World Health Organization (WHO), 1979). "High" DMFT values ranged from 4 to a high of 15 while "high" DMFS scores varied from 7 through 27. The chi-square values were not significant for DMFT or for DMFS in 1981, but the distribution of the subjects with low and high DMFT and DMFS in 1983 was dependent upon age (see Table VII). A higher percentage of subjects demonstrated lower caries incidence in the 12-year-old category (actual age 14 in 1981), while a higher percentage of 14- and 16 year-old groups (age 16 and 18) had high caries scores.

Age in Months, Race, and Per Capita Income

In order to ascertain the effects of each of these demographic variables independently of each other, the researcher used an analysis of covariance model (see Table VIII). The classification variable, examiner (dentist/dental assistant [DDS]), was included in this model to account for any difference among dental professionals in determining dental index values. Results of analysis indicated no significant effect of examiner on DMFT or DMFS. The other classification variable included in the model was race (White or Black). Continuous variables

TABLE VII

CHI-SQUARE TEST FOR AGE CATEGORIES AND DMFT AND DMFS FOR EACH YEAR OF STUDY

Year	Dental Index	Dental Category	Statistical Category	Initial Age Category 12	Initial Age Category 14	Initial Age Category 16	Chi-Square	DF	P
1981	DMFT	0 - 3	n	22	25	11	3.51	2	0.1726
			column %	55.00	48.08	33.33			
		4 - 15	n	18	27	22			
			column %	45.00	51.92	66.67			
	DMFS	0 - 6	n	28	34	19	1.24	2	0.5387
			column %	70.00	65.38	57.58			
		7 - 27	n	12	18	14			
			column %	30.00	34.62	42.42			
1983	DMFT	0 - 3	n	17	10	4	9.41	2	0.0091
			column %	51.52	20.83	22.22			
		4 - 15	n	16	38	14			
			column %	48.48	79.11	77.78			
	DMFS	0 - 6	n	23	19	8	7.42	2	0.0245
			column %	69.70	39.58	44.44			
		7 - 27	n	10	29	10			
			column %	30.30	60.42	55.56			

TABLE VIII

ANALYSIS OF COVARIANCE OF DMFT AND DMFS FOR 1981 AND 1983 IN ADOLESCENT FEMALES BY RACE, EXAMINER, AGE IN MONTHS, AND PER CAPITA INCOME

Year	Dependent Variable	Independent Variable	DF	Sum of Squares	F-Values	P > F	Sign of B#
1981	DMFT	Race	1	0.0037	0.00	0.9828	
		Examiner*	3	34.6305	1.48	0.2229	
		Age**	1	87.4817	11.20	0.0011	+
		PC INC, $	1	14.7564	1.89	0.1719	
	DMFS	Race	1	0.3022	0.01	0.9047	
		Examiner*	3	56.2975	0.89	0.4483	
		Age**	1	100.0001	4.77	0.0310	+
		PC INC, $	1	20.0159	0.95	0.3307	
1983	DMFT	Race	1	0.0079	0.00	0.9745	
		Examiner*	1	20.2934	2.65	0.1070	
		Age**	1	77.3636	10.10	0.0020	+
		PC INC, $	1	50.4943	6.59	0.0118	+
	DMFS	Race	1	2.3258	0.11	0.7424	
		Examiner*	1	39.4357	1.84	0.1779	
		Age**	1	160.1732	7.48	0.0074	+
		PC INC, $	1	160.0538	7.48	0.0075	+

slope of regression coefficient

* Dentists and Dental Assistant
** in months

analyzed were age in months and PC INC.

After the effects of race, examiner, and PC INC were discounted (Table VIII) and in simple correlation (Appendix E), DMFT and DMFS significantly increased with age in months for each year of the study This finding agreed with that of other previous statistical health studies. The 1966-70 National Health Survey for 12- to 17- year-olds found that DMFT scores increased with age from 4.0 at 12 years of age to 8.7 at 17 years of age (Kelly and Harvey, 1974). The 1979-80 National Dental Caries Prevalence Survey reported that scores increased from 2.2 to 6.7 for DMFT and from 3.0 to 11.0 for DMFS between ages 11 and 17 year-old adolescent females (U.S. Dept of HHS, 1981). In the 1968-70 Ten-State Survey, the greatest rate of increase in DMFT scores with age occurred around the 18th year (U.S. Dept. of HEW, 1972).

When the effects of examiner, age in months, and PC INC were controlled, no significant difference between the races in DMFT and DMFS for either 1981 or 1983 was found (Table VIII), nor were Pearson correlations significant (Appendix E). Mean DMFT scores were 3.7 for whites and 4.3 for blacks in 1981 and 5.1 for whites and 4.1 for black girls in this study examined in 1983. The low ratio of blacks to whites in this study (24:101) in 1981 and (22:77) in 1983 may account for this lack of significance. Results of other studies such as the 1966-70 National Health Survey reported that white adolescent females had higher DMFT scores (6.6) than did blacks (6.0), with more fillings for whites and twice as many decayed teeth for blacks (Kelly and Harvey, 1974). The 1968-70 Ten-State Survey reported an estimated mean DMFT for white, black, and Spanish American adolescent females of 7.6, 7.1, and 6.3, respectively (U.S. Dept. of HEW, 1972). The 1971-74 HANES I study also demonstrated a higher DMFT score for white adolescent females than for blacks (6.7 and 6.0), respectively (U.S. Dept of HEW, 1979), whites having more fillings and blacks having more decayed and missing teeth. The 1979-80 National Dental Survey reported that white adolescent females had DMFT scores of 4.7 and blacks had scores of 3.9 (U.S. Dept of HHS, 1981). The slow decline in DMFT in the past 17 years from the 1966-70 survey to this survey completed in 1983 may be partially due to the increased number of communities who have had fluoridated public water supplies in the past decade.

When data from 1981 adjusted for age, race, and examiner were tested, DMFT and DMFS significantly increased with income for 1983, but not for 1981 (Table VIII). This same relationship was also demonstrated in simple correlation analysis (Appendix E). Therefore, this study found that past income better described caries incidence than did present purchasing power. One possible explanation for the positive relationship between 1981 income and 1983 dental scores could be that the children who can afford to have fillings get them, making the caries area highly visible during examination while those who cannot afford fillings may not have some caries areas recorded if they are between the teeth and not visible to the examiner without dental radiographs. Since the caries process takes 18 $\pm$ 6 months (Parfitt, 1956), it is not surprising that 1981 income used to purchase food might better describe 1983 decay than 1983 income because decay appearing in 1983 may have begun in 1981. Although past incomes have not been investigated, some other surveys, but not all, have found relationships between dental scores and present income brackets. The 1966-

70 National Survey by Kelly and Harvey (1974) demonstrated no association between DMFT scores and present income; however, income did vary directly with fillings and inversely with decayed and missing teeth. The review by Rowe et al. (1976) of the 1968-70 Ten-State Survey revealed a negative correlation between DMFT and income, suggesting that the lifestyle of the poor may protect against decay.

Null Hypothesis 1, that no significant relationship existed between age, race, or per capita income and the scores for DMFT and DMFS, was accepted for race for both years and for income in 1981 based on a model that included all these variables and based on simple correlation coefficients. On these bases, it was rejected for age for both years and for income for 1983.

Relationship of Dietary Variables to DMFT and DMFS Scores

The effect of diet on DMFT and DMFS was investigated in several multiple regression models. Variables selected in addition to age and income were total protein, fat, carbohydrate (CHO), and total sugars (mono- and disaccharides), sucrose, calcium (Ca), phosphorus (P), Ca:P ratio, and percent of energy from protein, fat, carbohydrate, total sugars, and sucrose. A Maximum R^2 Improvement Stepwise Analysis (SAS User's Guide, 1982) was used to help select most of the dietary variables mentioned above. All the dietary variables from the four best Stepwise models capable of describing DMFT and DMFS for each year of the study were used with the exception of the two meal variables, total sugars (meals/snacks) and total sugars (snacks only) (see Appendix C).

Two other variables, sucrose and protein, were added to the list because both have demonstrated significant relationships to decay in the scientific literature: sucrose, for its cariogenic properties, and protein, for its cariostatic factors (Nizel, 1981). Table IX presents the mean intakes and ranges for these nutrients by age category.

Four analysis of covariance models were used to test for independent effects of all dietary variables on DMFT and DMFS for each year of the study. The dietary variables were expressed either by percent of energy of by weight (g or mg) with the exception of the Ca:P ratio. They were grouped in four analysis models primarily by either one or the other nutrient intake measurement. The first three models combined dietary variables expressed in percent of energy in order to eliminate combinations of variables that were closely related. Model 1 also included the dietary variable phosphorus (g) and Models 2 and 3 included the dietary variable Ca:P ratio, because of the extensive, yet still controversial, evidence of cariostatic role of these two variables in the diet. The fourth model combined all dietary variables measured by intake in weight (g or mg). In addition, each regression model included the continuous variables "age in months" and PC INC.

Dietary Variables

Analysis of covariance for each of the four models indicated a significant relationship between several dietary variables and both dental indices (Tables X and XI). When all other variables were discounted in the first model, the percent of energy from protein and total sugars were individually related to DMFT and DMFS scores for 1981. An inverse relationship between percent of energy from protein

TABLE IX

MEANS ± SD OF DIETARY COMPONENTS ANALYZED FOR STUDY BY AGE CATEGORY

Nutrient	Initial Age Category 12 Mean ± SD	14 Mean ± SD	16 Mean ± SD
Energy (kcal)	2007 ± 723	1790 ± 570	1689 ± 525
Total Protein (g)	71 ± 29	61 ± 20	57 ± 19
Total Carbohydrate (g)	235 ± 80	209 ± 70	198 ± 78
Total Fat (g)	89 ± 41	80 ± 30	76 ± 24
Total Sugars (g)	120 ± 51	100 ± 42	92 ± 44
Sucrose (g)	76 ± 38	67 ± 31	63 ± 34
Calcium (mg)	945 ± 455	785 ± 328	702 ± 323
Phosphorus (mg)	1271 ± 471	1068 ± 367	1020 ± 371
Ca:P Ratio	0.73 ± 0.18	0.73 ± 0.16	0.68 ± 0.16
% Protein	14 ± 3	14 ± 3	14 ± 3
% Fat	39 ± 6	40 ± 6	41 ± 7
% Carbohydrate	47 ± 7	47 ± 6	46 ± 8
% Sugars	24 ± 7	22 ± 6	22 ± 8
% Sucrose	16 ± 8	15 ± 5	15 ± 6

% percent of energy from nutrient

TABLE X

ANALYSIS OF COVARIANCE OF DMFT SCORES FOR 1981 AND 1983 BY SEVERAL DIETARY VARIABLES, ADJUSTED FOR AGE AND PER CAPITA INCOME

Dependent Variable	Independent Variable	1981 F-Values**	1981 R	1981 Sign of B#	1983 F-Values**	1983 R	1983 Sign of B#
Model 1 DMFT	Age, months	5.02*	0.1625	+	12.21*	0.1819	+
	PC INC, $	--			9.92*		+
	##Sugars, % kcal	5.23*		-	--		
	Protein, % kcal	10.99*		-	--		
	Phosphorus, mg	--			--		
Model 2 DMFT	Age, months	7.05*	0.1637	+	12.95*	0.1746	+
	PC INC, $	--			8.67*		+
	Fat, % kcal	7.33*		+	--		
	•CHO, % kcal	5.97*		+	--		
	Ca:P	2.99		-	--		
Model 3 DMFT	Age, months	6.86*	0.1679	+	12.98*	0.1866	+
	PC INC, $	--			10.04*		+
	Sucrose, % kcal	--			--		
	Fat, % kcal	7.89*		+	--		
	•CHO, % kcal	5.92*		+	--		
	Ca:P	3.41		-	--		
Model 4 DMFT	Age, months	5.15*	0.1689	+	11.87*	0.1939	+
	PC INC, $	--			9.36*		+
	##Sugars, g	--			--		
	Protein, g	4.57*		-	--		
	Fat, g	5.32*		+	--		
	•CHO, g	--			--		
	Phosphorus, mg	--			--		
	Calcium, mg	--			--		
	Sucrose, g	--			--		

** Including all variables with P < 0.10

Slope of regression coefficient

* P < 0.05

Total mono- and disaccharides

• Carbohydrate

TABLE XI

ANALYSIS OF COVARIANCE OF DMFS SCORES FOR 1981 AND 1983 BY SEVERAL DIETARY VARIABLES, ADJUSTED FOR AGE AND PER CAPITA INCOME

Dependent Variable	Independent Variable	1981 F-Values**	1981 R	1981 Sign of B#	1983 F-Values**	1983 R	1983 Sign of B#
Model 1 DMFS	Age, months	--	0.1426		8.06*	0.1655	+
	PC INC, $	--			9.45*		+
	##Sugars, % kcal	6.73*		-	--		
	Protein, % kcal	13.29*		-	--		
	Phosphorus, mg	--			--		
Model 2 DMFS	Age, months	--	0.1359		9.98*	0.1596	+
	PC INC, $	--			8.30*		+
	Fat, % kcal	10.52*		+	--		
	.CHO, % kcal	7.95*		+	--		
	Ca:P	--			--		
Model 3 DMFS	Age, months	--	0.1367		9.88*	0.1613	+
	PC INC, $	--			8.12*		+
	Sucrose, % kcal	--			--		
	Fat, % kcal	10.27*		+	--		
	.CHO, % kcal	6.16*		+	--		
	Ca:P	--			--		
Model 4 DMFS	Age, months	--	0.1411		7.77*	0.1809	+
	PC INC, $	--			7.25*		+
	##Sugars, g	--			--		
	Protein, g	6.68*		-	--		
	Fat, g	6.45*		+	--		
	.CHO, g	--			--		
	Phosphorus, mg	--			--		
	Calcium, mg	--			--		
	Sucrose, g	--			--		

** Including all variables with $P < 0.10$

* $P < 0.05$

. Carbohydrate

Slope of regression coefficient

Total mono- and disaccharides

or total sugars and mean scores for DMFT and DMFS indicated that as the percent of energy from either nutrient increased in the diet, the DMFT and DMFS scores decreased, as seen in Model 1 and in simple correlation coefficients (Appendix E) for percent of energy from protein (with correlations for percent of energy from total sugars showing a slight tendency). Burt et al. (1982) found no significant relationship between caries and percent of energy from protein in their analysis of the 1971-74 HANES I data. Although cariostatic properties have been associated with high protein foods (Bowen, 1978), other factors such as the decrease in percent of energy from carbohydrates and/or fats may be of equal importance. A negative regression of dental indices on percent of energy from total sugars differed in this study from the results reported by Burt et al. (1982) of no significant relationship between sugar-rich foods and decay. While other literature (Gustafsson et al., 1954; Harris, 1963; and Sreebny, 1982b) has demonstrated a positive relationship between sugar and decay, expressing sugar as a percent of energy from the diet in survey data has seldom been done. Our data suggest that when expressed as percent of calories, total sugars may not reflect cariogenic properties.

Analysis of Models 2 and 3 demonstrated that the percent of energy from fat and carbohydrates contributed significantly to the variance in DMFT and DMFS for 1981 when the effects of other variables in both models were eliminated (Tables X and XI). Considered separately, percent of energy from fat but not carbohydrate was positively correlated with dental scores (Appendix E). Caries scores increased as the percent of fat increased in the diet. This finding opposed a report by Schweigert et al. (1946), that diets high in fat (20 parts lard and 22 parts sucrose) were associated with lower decay in animals compared to the sucrose control diets (0 parts lard and 67 parts sucrose). Burt et al. (1982) found no relationship between percent of fat and dental scores. Little information is available on percent of energy from fat and survey data, but this study indicates that percent of fat was not cariostatic; therefore, the form of fat, not examined here, rather than the amount of fat, may be important in preventing decay.

This study revealed a positive regression of dental indices on percent energy from carbohydrates in Models 2 and 3 (Tables X and XI), adjusted for effects of age, income, and other nutrients. There was no significant correlation for percent of energy from carbohydrate from either index without the adjustment for the other variables (Appendix E). Burt et al. (1982) found no significant relationship between percent of carbohydrate and decay. Although the sucrose in dietary carbohydrates contribute most to sticky plaque and the promotion of decay, Brown (1975) noted that other carbohydrates also have the ability to produce a less sticky plaque as well as serve as a fermentable energy source for plaque bacteria.

The relationship between the Ca:P ratio and incidence of dental caries in 1981 or 1983 was not statistically significant in Models 2 and 3 (Tables X and XI) after effects for age, income, and other nutrients were discounted. Burt et al. (1982), when investigating the Ca:P ratio in the diets of subjects in the 1971-74 HANES I study, also found no significant relationship between the Ca:P ratio in diet and caries incidence. However, a possible negative regression of DMFT on

Ca:P in 1981 was demonstrated in Models 2 and 3: as the Ca:P ratio increased from 0.32 to 1.16, there was a slight tendency for caries incidence to decrease (Table X). Similarly, the simple correlations of Ca:P with DMFT and DMFS for 1981 were significant and negative (Appendix E). Haldi et al. (1959) also found that the inclusion of additional calcium in experimental diets, which raised the Ca:P ratio from 1:2 to 1:1 or 1:0.3, significantly reduced decay. At the present time, the role of calcium and phosphorus and the importance of the Ca:P ratio to decay in human beings is not clearly understood. Therefore, additional research is needed in order to determine the significance of these minerals in human diets with respect to decay.

Absolute amounts of nutrients measured by weight (g or mg) were examined in Model 4 (Tables X and XI). Protein and fat were both individually related to 1981 DMFT and DMFS after correcting for effects of all other variables in Model 4. The negative regression on protein and the positive regression on fat were similar to the relationships displayed in Models 1 and 2 when these nutrients were expressed as percentages of energy. Therefore, protein consistently appeared to reduce decay, and fat, to increase it regardless of how the nutrients were expressed in regression analysis. However, these nutrients showed no significant correlation with dental scores based on Pearson R values (Appendix E). Results of the HANES I Survey indicated no relationship between protein (g) or fat (g) and decay (Burt et al., 1982). There was a negative correlation of 1981 calcium intake with DMFT scores and possibly with DMFS scores; however, the effect disappeared in combination with age, income, and other variables in regression Model 4.

The same four regression models used with 1981 DMFT and DMFS scores were also applied to 1983 dental scores in relation to 1981 dietary information (see Tables X and XI). No significant effects were found for any of the past dietary variables by either simple correlation (Appendix E) or the four regression models in Tables X and XI with respect to 1983 caries incidence. Therefore, 1981 dietary information was better in describing decay at the same time than it was in describing 1983 decay.

A possible explanation for the lack of correlation with many of the dietary variables in this study may be the inherent difficulties of trying to relate nutrient intakes from 24-hour dietary recalls based on only two days' intake to the subject's cumulative dental scores. Whether these dietary recalls accurately reflect dietary habits of the past 18 $\pm$ 6 months, when new caries formation began to form (Parfitt, 1956), is open to debate.

When age was examined in the regression models with dietary variables, it was significantly related to 1981 DMFT scores in all the models but not to DMFS scores in 1981, but it was related to both indices in 1983. No association between income analyzed with dietary variables and DMFT or DMFS was demonstrated for 1981 although both caries indices increased with income in 1983.

Null Hypothesis 2, that no significant relationship existed between the dietary nutrient intakes and the scores for DMFT and DMFS, was rejected for percent of energy from total sugars, protein, fat and carbohydrates as well as for total intake of protein, fat, and calcium as related to DMFT and DMFS scores for 1981; but it was accepted for the remaining dietary variables for 1981 as well as for all dietary variables in 1983. Both simple correlation and the four regression models showed significant effects for percent of energy from protein and fat. However, the results of these analyses differed with respect to percent of energy from total sugars, to percent of energy from carbohydrate, and to calcium (mg): percent of energy from total sugars showed a slight negative tendency by simple correlation which became significantly negative in Model 1 regression analysis; percent of energy from carbohydrate showed no significant correlation, but demonstrated a significant positive relationship in regression Models 2 and 3; and calcium (mg) displayed an inverse correlation, but showed no significant relationship in regression Model 4.

Null Hypothesis 3, that no significant relationship existed between the dietary Ca:P ratio and the scores for DMFT and DMFS, was accepted for data from 1981 and 1983, based on regression analysis models but was rejected in simple correlation. The Pearson correlation yielded a significant negative relationship between Ca:P ratio and scores for both DMFT and DMFS, but the regression models showed merely a slight negative tendency for DMFT only; DMFS was not significantly related to the Ca:P ratio in any regression model.

Relationship of Meal Variables to DMFT and DMFS

The number of times each subject ate food containing a specified amount of total sugars (mono- and disaccharides), fat, and phosphorus in a possible total of seven meals (four of which were snacks) was analyzed for possible relationships to the incidence of decay. These nutrients were selected due to the generally accepted cariogenic effect of total sugars and the suspected cariostatic properties of fat and phosphorus. The seven meal variables included 1) total number of meals/snacks per day in which any total sugars were eaten, 2) total number of snacks per day in which any total sugars were eaten, 3) total number of meals/snacks per day in which 10 g or more of total sugars was eaten, 4) total number of meals/snacks per day in which 12 g or more of fat was eaten, 5) total number of meals/snacks per day in which at least 10 g of total sugars and 12 g of fat were eaten together, 6) total number of meals/snacks per day in which at least 10 g of total sugars and 250 mg of phosphorus were eaten together, and 7) total number of meals/snacks per day in which at least 10 g total sugars, 12 g fat, and 250 mg phosphorus were eaten.

Evidence is lacking as to the minimal amounts of these three nutrients that may influence the incidence of decay. Sreebny (1982 b) suggested that ingestion of more than 50 g of sugar per day increased caries incidence significantly; therefore a minimum of 10 g per meal may correspond approximately to at least 50 grams of sugar per day, and would exceed the amount possibly present in vegetables or entrees. Animal studies indicated that fat providing at least 25% of energy reduced decay (Gustafson et al., 1955). This percentage was used to estimate a minimal amount of fat in a meal (12 g per eating occasion) which should be protective for a majority of the subjects in this study. The amount of phosphorus that may prevent decay has not been determined; therefore, the recommended dietary allowance of 1200 mg for the female between the ages of 11 and 18 was used (National Academy of Sciences, 1980). Since subjects ate about five times daily, a minimal amount of 250 mg was selected to provide amounts of phosphorus in each meal to meet the recommendation for the majority of subjects.

The means and ranges of the nutrients which met criteria for each of the seven meal variables are given in Table XII. No significant relationship was found between any of the seven meal variables and DMFT and DMFS scores for 1981 using the Spearman rank correlation method (Table XII). Another study by Samuelson et al. (1971) also failed to a demonstrate a positive relationship between the number of times sugars were eaten and dental scores. However, the Vipholm study found a positive correlation between the number of times sugar was eaten each day and caries incidence (Gustafsson et al., 1954). Weiss and Trithart (1960) also found a positive relation between decay and the number of between-meal snacks which increased the number of exposures of sugar in the diet. Burt et al. (1982) discovered a significant relationship between the number of sugary snacks and caries experience but not with the number of meals containing sugar. The 1968-70 Ten-State Survey analyzed the between meal consumption of refined carbohydrates measured in grams rather than in number of snacks and found that caries scores increased with between-meal snacks (U.S. Dept. of HEW, 1972). Interestingly, Madsen's (1982) research suggests that less than four exposures to cariogenic foods allowed the tooth time to remineralize; therefore, an increase in decay may peak at the 4th exposure with only slight increases with additional meals containing sugary foods thereafter. From the Spearman rank correlation method, the total number of

TABLE XII

MEAN ± SD AND RANGES OF MEAL VARIABLES FOR SELECTED NUTRIENTS AND SPEARMAN RANK CORRELATION PROBABILITIES FOR DMFT AND DMFS IN 1981 AND 1983

Meal Variable Per Day*	Mean ± SD	Range	Probability 1981 DMFT (N = 125)	Probability 1981 DMFS (N = 125)	Probability 1983 DMFT (N = 99)	Probability 1983 DMFS # (N = 99)
**Sugars, > 0 g	4.5 ± 0.9	2 - 7	0.9839	0.8879	0.1364	0.0473 -
Sugars, snacks > 0 g	1.7 ± 0.8	0 - 4	0.7032	0.9409	0.1843	0.1577
Sugars, ≥ 10 g	3.4 ± 1.2	0 - 5	0.9180	0.7701	0.2483	0.1805
Fat, ≥ 12 g	2.5 ± 0.9	1 - 5	0.1726	0.1766	0.2200	0.1135
Sugars, ≥ 10 g & Fat, ≥ 12 g	2.2 ± 1.0	0 - 4	0.2825	0.2658	0.5462	0.3158
Sugars, ≥ 10 g & ***P, ≥ 250 mg	1.8 ± 1.0	0 - 4	0.9760	0.9428	0.4369	0.6201
Sugars, ≥ 10 g & Fat, ≥ 12 g & ***P, ≥ 250 mg	1.6 ± 1.0	0 - 5	0.7500	0.7269	0.4108	0.5855

* meal variable as defined in text

** all "sugars" refer to total mono- and disaccharides

*** phosphorus

sign indicates slope of regression coefficient

meals/snacks per day in which any total sugars were eaten was negatively correlated with DMFS (but not with DMFT) in 1983 (see Table XII). This negative relationship and inconsistency with other research findings (Gustafsson et al., 1954; Weiss and Trithart, 1960; and Burt et al., 1982) may be due to the use of past dietary data with recent dental status.

A possible explanation for the lack of relationship of the meal variables to dental scores may have been the problem of correlating data for short-term dietary habits to the cumulative dental scores of a lifetime. Also, there is little evidence for estimating minimal amounts of these nutrients that are effective in preventing decay. Finally, the data used did not permit distinguishing between sticky sweets consumed at the end of an eating period and, for example, sweet beverages consumed during the meal, which may have very different effects on teeth.

Null Hypothesis 4, that no significant relationship existed between the number of meals/snacks containing total sugars, fat, or phosphorus and the scores for DMFT and DMFS, was accepted for all meal variables in both years with one exception. The hypothesis for the total number of meals/snacks per day in which any total sugars were eaten was rejected for 1983 DMFS scores.

Relationship of Other Selected Variables to DMFT and DMFS

Fluoride

The mean fluoride concentration in drinking water was 0.76 ± 0.21 ppm with a range of 0.16 to 1.00 ppm. The distribution of low and high scores for DMFT and DMFS (previously defined in age category analysis section) between areas with low and adequate fluoride concentrations were examined. "Low" fluoride levels were defined as less than 0.6 ppm and "adequate" levels were 0.6 ppm or more (Shaw and Sweeney, 1980). Because most of the blacks came from the urban areas of Tulsa, which had fluoride concentrations of at least 0.6 ppm, 33 of 35 blacks had adequate fluoride, while only 85 of 114 whites drank water containing at least 0.6 ppm. A chi-square test of frequency distributions for low and high DMFT and DMFS scores and low and adequate fluoride in the water demonstrated differences for 1983 DMFT scores but not for any 1981 scores (see Table XIII). Ninety percent of the girls from the low fluoride area had high DMFT scores in 1983, while 63% of the girls from high fluoride area had high DMFT scores. Other studies have also shown significant relationships between dental indices and fluoride concentrations in the water (Ast et al., 1956; Hayes et al., 1957; Blayney and Hill, 1967; and Lemke et al., 1970). A recent analysis of the 1971-74 HANES I data found that the fluoride content of enamel declined as decay increased, with younger subjects having higher fluoride content in the enamel than the older population groups (Burt et al., 1982). The 1979-80 National Dental Caries Survey (U.S. Dept. of HHS, 1981)

TABLE XIII

CHI-SQUARE TEST FOR FLUORIDE CONCENTRATION (ppm) AND DMFT AND DMFS FOR EACH YEAR OF STUDY

Year	Dental Index	Dental Category	Statistical Category	Fluoride Concentration* < 0.6	Fluoride Concentration* ≥ 0.6	Chi-Square	DF	P
1981	DMFT	0 - 3	n	13	45	0.330	1	0.5654
			column %	41.94	47.87			
		4 - 15	n	18	49			
			column %	58.06	52.13			
	DMFS	0 - 6	n	18	63	0.820	1	0.3652
			column %	58.06	67.02			
		7 - 27	n	13	31			
			column %	41.94	32.98			
1983	DMFT	0 - 3	n	2	29	5.293	1	0.0214
			column %	10.00	36.71			
		4 - 15	n	18	50			
			column %	90.00	63.29			
	DMFS	0 - 6	n	7	43	2.410	1	0.1205
			column %	35.00	54.43			
		7 - 27	n	13	36			
			column %	65.00	45.57			

* = in parts per million

reported lower caries incidence in females between 11 and 17 years living in urban areas (DMFT = 4.47, DMFS = 7.30) than non-urban areas (DMFT = 4.61, DMFS = 7.87). They suggested that this lower score was due to the cariostatic properties of fluoride; the presence of higher concentrations of fluoride in the urban areas, where fluoridation of the community water supply was more common, seems to yield more cariostatic effects than the lower concentrations of fluoride in non-urban areas, where usually only natural sources of fluoride were available.

No relationships for DMFS scores in 1981 and 1983 and fluoride in the drinking water were detected, possibly due to the lack of adequate information about childhood exposure to fluoride.

Topical Fluoride Treatments

Only 10% of the 1981 sample had received topical fluoride treatments during the past six weeks, and 18% in 1983. One of 23 blacks studied in 1981 and none of the blacks in 1983 had had topical fluoride treatments, while 11 of 99 whites in 1981 and 18 of 77 whites in 1983 received topical fluoride treatments. Information about other treatments in the past was not available.

A chi-square test was used to see whether frequencies of low and high scores for low and high DMFT and DMFS (as defined in age category analysis section) differed in girls who received fluoride treatments and those who did not. No relationship between groups in low and high dental scores and fluoride treaments was noted. Cariostatic properties of fluoride treatments have been demonstrated by others (Beiswanger et al., 1980). Failure to observe such an effect here may have occurred because of the small number of girls who had received fluoride treatments recently, and the failure of this analysis to account for past topical fluoride treatments throughout childhood at the same time.

Braces

Information about braces was collected for 106 subjects in 1981 and for 93 in 1983; of these numbers, 34 of those examined in 1981 and 27 of those examined in 1983 had worn or were wearing braces. Data collected for each year was analyzed with respect to caries incidence. A chi-square test examined the distribution of subjects according to low and high scores for DMFT and DMFS (identical to groups used in age category analysis section) and use of braces for each year to investigate whether differences in caries present depended on the presence or absence of braces. No significant relationship between DMFT and DMFS scores and braces was found. Only DMFS for 1983, with an observed chi-square of 3.45 for one degree of freedom and a probability of 0.06 suggested a possible difference in distributions. Sixty-seven percent of the females who had worn or were wearing braces were in the low caries group compared to 45% who had never worn braces; thirty-three percent of the subjects who had worn or were wearing braces were in the high caries group compared to 55% without braces.

The possible relationship between the presence of braces and caries incidence has not been an area of extensive investigation. However, the dental profession has acknowledged that malocclusion as well as the physical presence of braces can hinder adequate oral hygiene, thus increasing plaque and the promotion of decay (Amer. Dent. Assoc., 1982). If braces reduced the effectiveness of cleaning procedures, that effect was apparently countered by better dental care for those subjects wearing braces in this study.

The Periodontal Index (PI)

Periodontal scores, recorded during the dental examination, were related to caries prevalence. Of the five DDS who examined the girls, one failed to record PI scores during any of his examinations, and three did not record any scores on one or more of their designated days, indicating a low sensitivity of this measurement. Scores for only 83 of the 125 subjects with dental exams in 1981 and 43 of the 99 subjects examined in 1983 were collected. The mean PI score for all females in this study was 0.17 in 1981 and 0.12 in 1983. This was lower than the PI score of 0.26 for female adolescents in the 1971-74 HANES I Survey (U.S. Dept. of HEW, 1979). The 1968-70 Ten-State Survey also reported higher scores with children ages 10 through 17 years having approximatley the same PI scores of 1.0 or less (U.S. Dept. of HEW, 1972); mild gingivitis was the most common form of periodontal disease, with only very few demonstrating the beginnings of destructive periodontal disease at this age. Casamassimo and Castaldi (1982) suggested that hormonal changes during adolescence may be partially responsible for periodic occurrences of gingivitis, along with their poor dietary habits and inadequate oral hygiene practices.

The means and ranges for PI scores by race are outlined in Table

XIV. The PI scores are the same for both blacks and whites in 1981 but the whites were lower than the blacks in 1983. Scores from this study were lower than those reported in the 1971-74 HANES Survey in which white females had a score of 0.22 and black females had a score of 0.47 (U.S. Dept. of HEW, 1979).

Mean PI scores were divided into three subgroups similar to the groupings used in the 1968-70 Ten-State Nutrition Survey (U.S. Dept. of HEW, 1972). They defined PI scores of 0.0 to 0.2 as clinically healthy, 0.3 to 0.9 as mild gingivitis, and 0.7 to 1.9 as severe gingivitis. Lower ranges for PI scores were defined for this regional study due to the large number of subjects with very low scores. The new categories became a) 0.00 to 0.09, clinically healthy; b) 0.10 to 0.19, slight gingivitis; c) 0.20 to 0.80, mild gingivitis. A chi-square test of the frequency distributions of low and high DMFT and DMFS scores (as previously defined) and mean PI score categories showed no significant differences. This may have been due to the small number of girls with recorded PI scores as well as to the low incidence of periodontal problems from this adolescent group for which data were collected.

Null Hypothesis 5, that no significant relationship existed between the fluoride concentration in the drinking water, recent application of topical fluoride treatments, presence of braces, or periodontal index status and the scores for DMFT and DMFS, was accepted for all variables for 1981 and 1983 dental scores with the exception of fluoride in the drinking water, which was rejected for 1983 DMFT scores only.

TABLE XIV

MEAN ± SD AND RANGES FOR PERIODONTAL INDEX BY RACE FOR BOTH YEARS OF STUDY

Race	Item	1981	1983
WHITE	Number	73	24
	Mean ± SD	0.17 ± 0.15	0.08 ± 0.15
	Range	0 - 0.58	0 - 0.57
BLACK	Number	10	19
	Mean ± SD	0.16 ± 0.13	0.18 ± 0.24
	Range	0 - 0.39	0 - 0.79

Longitudinal Changes in DMFT and DMFS Scores from 1981 to 1983

Of the 83 females who were present for both dental exams, 16 were black and 67 were white. The mean DMFT score for all the 83 females examined both years was 3.4 ± 2.5 in 1981, with an increase to 5.2 ± 2.9 for the same girls in 1983. The mean DMFS score was 4.5 ± 3.8 for the 83 girls in 1981 and 7.2 ± 4.8 in 1983. Means and ranges for longitudinal changes in DMFT and DMFS by race and age category are presented in Table XV.

TABLE XV

MEAN ± SD FOR DMFT AND DMFS LONGITUDINAL CHANGES BY RACE AND AGE CATEGORY FOR SUBJECTS PRESENT BOTH YEARS OF THE STUDY

Dental Index	Race	Initial Age Category 12 N	12 Mean ± SD	14 N	14 Mean ± SD	16 N	16 Mean ± SD
DMFT	W	23	1.7 ± 2.2	29	2.1 ± 2.1	15	2.1 ± 1.9
	B	3	1.7 ± 3.1	10	0.9 ± 1.3	3	2.3 ± 4.0
DMFS	W	23	2.2 ± 3.2	29	3.6 ± 2.7	15	2.8 ± 3.0
	B	3	2.0 ± 3.6	10	0.9 ± 2.8	3	6.7 ± 11.5

The t-tests of means were used to measure any longitudinal differences compared to 0 (no differences) that may have occurred between 1981 and 1983 DMFT and DMFS scores (1983 dental indices minus 1981 dental indices). The t-tests for all the girls who were present for both dental exams indicated that there was a significant difference in DMFT and DMFS scores from 1981 to 1983 with a probability value of .0001 for both indices (t = +7.91 for DMFT, +7.20 for DMFS). These results indicate that caries incidence increased steadily with age for the adolescent females who were examined both years of the study. When similar t-tests were used to examine differences in dental scores by race and age group, white subjects in every age group demonstrated significant positive changes in DMFT and DMFS scores (see Table XVI). Blacks differed significantly only at the 14-year-old age group and for DMFT scores. This effect may have been the result of too few blacks in the 12- and 16- year-old age groups to be meaningful instead of a lack of change. Results of these tests suggest that caries incidence increased with age at a constant rate for all groups of more than 3 adolescent females.

TABLE XVI

LONGITUDINAL DIFFERENCES IN MEAN DMFT AND DMFS SCORES FROM 1981 TO 1983 BY RACE AND AGE CATEGORY

Dental Index	Initial Age Catagory	White Adolescents			Black Adolescents		
		N	t	PR > [t]	N	t	PR > [t]
DMFT	12	23	3.66	.0014	3	0.94	.4444
	14	29	5.34	.0001	10	2.21	.0543
	16	15	4.20	.0009	3	1.00	.4226
DMFS	12	23	3.35	.0029	3	0.96	.4380
	14	29	7.10	.0001	10	1.03	.3305
	16	15	3.67	.0025	3	1.00	.4226

Relationship of Dietary, Demographic, and Meal Variables to Longitudinal Changes in DMFT and DMFS

Analysis of longitudinal changes in DMFT and DMFS scores (1983 scores minus 1981) scores was conducted with the variables age, PC INC, and dietary variables in the same four linear regression models used with the cross-sectional data (see Table XVII). Analysis demonstrated that changes in neither DMFT nor DMFS scores were significantly related to age in months by regression adjusted for all other variables in each model or by simple correlation coefficients. Increases in DMFT and DMFS were positively related to 1981 PC INC when all other variables were discounted while only DMFS significantly increased with income in Pearson's Correlation analysis (Appendix E). Longitudinal changes in DMFT were positively related to percentage of energy from protein and the Ca:P and were negatively related to the percentages of energy from fat and carbohydrate, and to the absolute intake of fat when effects for all other variables in each model were accounted for. Only one variable, percent of energy from protein, was related to DMFS longitudinal changes when all other variables in each model were discounted. The direction of the significant relationships of caries incidence to absolute intake of fat, percentages of energy from fat and protein and the Ca:P ratio based on simple correlation was the same as it was in the regression analysis. However, percent of energy from carbohydrates, found to be significant in regression models, showed only a negative tendency by simple correlation.

The seven meal variables used to analyze dental scores for each year of the study were also used to examine longitudinal changes in dental scores in a Spearman Rank Correlation test (Table XVIII). The total number of meals/snacks per day in which at least 10 g of total

TABLE XVII

ANALYSIS OF COVARIANCE FOR LONGITUDINAL CHANGES IN DMFT AND DMFS SCORES BY SEVERAL DIETARY VARIABLES, ADJUSTED FOR AGE AND PER CAPITA INCOME

Dependent Variable	Independent Variable	DMFT F-Values**	DMFT R	DMFT Sign of B#	DMFS F-Values**	DMFS R	DMFS Sign of B#
Model 1 DMFT	Age, months	--	0.1759		--	0.1666	
	PC INC, $	3.11		+	6.86*		+
	##Sugars, % kcal	--			--		
	Protein, % kcal	12.96*		+	7.24*		+
	Phosphorus, mg	--			--		
Model 2 DMFT	Age, months	--	0.2076		3.71	0.1750	+
	PC INC, $	4.19*		+	7.86*		+
	Fat, % kcal	5.98*		-	3.18		-
	.CHO, % kcal	4.44*		-	2.91		-
	Ca:P	7.46*		+	3.64		+
Model 3 DMFT	Age, months	--	0.2367		3.38	0.1903	+
	PC INC, $	6.45*		+	9.32*		+
	Sucrose, % kcal	2.89		-	--		
	Fat, % kcal	3.19		-	--		
	.CHO, % kcal	--			--		
	Ca:P	6.52*		+	3.12		+
Model 4 DMFT	Age, months	--	0.2452		2.78	0.2144	+
	PC INC, $	3.09		+	6.56*		+
	##Sugars, g	--			--		
	Protein, g	--			--		
	Fat, g	4.86*		-	--		
	.CHO, g	--			--		
	Phosphorus, mg	--			--		
	Calcium, mg	--			3.06		+
	Sucrose, g	--			--		

** Including all variables with $P < 0.10$

* $P < 0.05$

. Carbohydrate

Slope of regression coefficient

Total mono- and disaccharides

TABLE XVIII

MEAN ± SD AND RANGES OF MEAL VARIABLES FOR SELECTED NUTRIENTS AND SPEARMAN RANK CORRELATION PROBABILITIES FOR LONGITUDINAL CHANGES IN DMFT AND DMFS

Meal Variable Per Day*	Mean ± SD	Range	Probability DMFT #	Probability DMFS #
			N = 83	
**Sugars, > 0 g	4.5 ± 0.9	2 - 7	0.9052	0.3039
Sugars, (snacks) > 0 g	1.7 ± 0.8	0 - 4	0.5624	0.2729
Sugars, ≥ 10 g	3.4 ± 1.2	0 - 5	0.8518	0.5064
Fat, ≥ 12 g	2.5 ± 0.9	1 - 5	0.0656 -	0.0119 -
Sugars, ≥ 10 g & Fat, ≥ 12 g	2.2 ± 1.0	0 - 4	0.5449	0.2993
Sugars, ≥ 10 g & ***P, ≥ 250 mg	1.8 ± 1.0	0 - 4	0.0490 +	0.1775
Sugars, ≥ 10 g & Fat, ≥ 12 g & ***P, ≥ 250 mg	1.6 ± 1.0	0 - 5	0.1643	0.4090

sign indicates regression coefficient

* meal variable defined in text

** all "sugars" referred to total mono- and disaccharides

*** phosphorus

sugars and at least 250 mg of phosphorus were eaten together was positively related with longitudinal changes in DMFT scores. The results suggested that the cariostatic properties of phosphorus reported by other researchers (McClure and Muller, 1959; Stralfors, 1964; and Brewer et al., 1970) were not able to protect the teeth when sugar was present in the same meal. No other meal variables were significantly related to longitudinal changes in DMFT scores from 1981 to 1983.

The only meal variable significantly related changes in DMFS scores was fat $\geq$ 12 g. As the number of meals/snacks in which fat was eaten increased, longitudinal changes in DMFS scores decreased, which suggested that fat may play a protective role.

Results of tests on longitudinal changes demonstrated that a few dietary variables, meal variables, as well as income were significantly related to dental scores. Although longitudinal data correlating demographic and dietary variables with dental scores have not been reported in other National Health Surveys, this study demonstrates that relationships do exist and maybe easier to demonstrate than in cross-sectional samples. Therefore, the researcher recommends future analysis of longitudinal as well as cross-sectional survey data in order to better understand the role of diet in the prevention of decay.

CHAPTER V

SUMMARY

The dental health of 125 females from 150 participants from North Central Oklahoma between the ages of 12 and 16 was studied in 1981, in order to relate their diet and other selected variables to their dental scores. In 1983, 99 of the 150 subjects were examined again; longitudinal dental data were obtained for 83 of the subjects in both 1981 and 1983. Intakes of protein, fat, carbohydrate, total sugars, sucrose, calcium, and phosphorus, the CA:P ratio, and the percentages of energy from protein, fat, carbohydrate, total sugars, and sucrose were calculated from two 24-hour dietary recalls in 1981. The number of times each subject ate foods containing specific nutrients, out of a possible total of 7 meal/snack periods per day, was calculated from both dietary recalls. DMFT and DMFS scores were examined across dietary and meal variables as well as in relationship to age categories, race, per capita income, fluoride concentrations in water, topical fluoride treatment, use of braces, and periodontal index for possible relationships in each year of the study. In addition, longitudinal changes in dental scores for 83 subjects present both years of the study were also examined to determine the relationship, if any, between changes in dental scores and the variables mentioned above.

The mean DMFT score for 125 girls in 1981 was 3.8 $\pm$ 3.0, and the DMFS score was 5.2 $\pm$ 4.8. The DMFT scores for the 83 girls examined

during both years of study were 3.4 ± 2.5 in 1981 and 5.2 ± 2.9 in 1983: the DMFS scores for these same 83 girls were 4.5 ± 3.8 in 1981 and 7.2 ± 4.8 in 1983. Longitudinal increases in the mean dental scores for the 83 girls examined in both years were significant by t-test, indicating that caries incidence increased with age.

Cross-sectional analysis of dental scores for each year of the study with various selected variables was conducted. Both dental scores increased with age for 1981 and 1983. DMFT and DMFS scores in 1983 also increased significantly with increases in 1981 per capita income. Both dental scores in 1981 were positively related to absolute intakes of fat, and percent of energy from fat and carbohydrate, and negatively related to intakes of protein after all other dietary and demographic variables in regression models were discounted and in simple Pearson correlations. The fluoride content in drinking water was related to 1983 DMFT only, and the number of meals/snacks per day containing any amount of total sugars (mono- and disaccharides) was inversely related to 1983 DMFS scores only. No significant relationship was found between race, periodontal disease, braces, or recent topical fluoride treatments and dental scores in either year of study.

Longitudinal changes in dental indices (1983 dental scores minus 1981 dental scores) for the 83 girls present in both studies with age, PC INC, dietary and meal variables were examined. Increases in DMFT and DMFS scores were positively related to PC INC. Changes in DMFT were positively related to the percent of energy from protein and Ca:P ratio, and were negatively related to the percent of energy from fat and carbohydrate and the absolute intake of fat, when adjusted for age, income, and other dietary variables in regression models. The number of meals/snacks containing at least 12 grams of fat was positively related to changes in DMFS scores, and the number of meals/snacks containing both more than 10 g of total sugars and 250 mg of phosphorus was negatively related to DMFT scores. Although the extent of decay increased with age, neither age nor any other dietary or meal variables were related to the changes in dental scores over two years, regardless of the type of statistical analysis used.

This study indicated that decay increased with age, that certain nutrients from the diet and income significantly affected the dental index scores, and that the frequency of consuming certain nutrients and the fluoride content of the water influenced the dental health of female adolescents in North Central Oklahoma.

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APPENDIX A

DENTAL EXAMINATION FORMS A4 AND A5

FORM A4

STATE ___

SUBJECT NO. _______________

STATION ___

DATE _______________

YEAR 1 OR 3 ___

DENTAL EXAMINATION
WORK SHEET

ON THE REVERSE SIDE OF THIS WORK SHEET, CHECK EACH TOOTH TO INDICATE IF IT IS DECIDOUS OR PERMANENT. ALSO INDICATE ITS STATUS AND THE NUMBER OF CAVITIES AND FILLINGS IN EACH TOOTH AS WELL AS THE NUMBER OF SURFACES INVOLVED. A PERIODONTAL INDEX WILL BE ASSIGNED TO EACH TOOTH PRESENT.

DECID - DECIDIOUS PERM - PERMANENT STAT - STATUS NO. - NUMBER SURF - SURFACES
PI - PERIODONTAL INDEX

STATUS: P - PRESENT U - UNERUPTED CE - CARIOUS EXTRACTION L - ACCIDENTAL LOSS OR ORTHODONTIC EXTRACTION

INDICATE BELOW THE DEBRIS INDEX AND CALCULUS INDEX FOR THE SUBJECT.

DEBRIS INDEX (DI)

	MOLAR RIGHT	CENTRAL LABIAL	MOLAR LEFT
UPPER	BUC	RIGHT	BUC
LOWER	LING	LEFT	LING

CALCULUS INDEX (CI)

	MOLAR RIGHT	CENTRAL LABIAL	MOLAR LEFT
UPPER	BUC	RIGHT	BUC
LOWER	LING	LEFT	LING

DECID	PERM	STAT	CAVITIES NO.	CAVITIES SURF	FILLINGS NO.	FILLINGS SURF	PI
	1						
	2						
	3						
A	4						
B	5						
C	6						
D	7						
E	8						
F	9						
G	10						
H	11						
I	12						
J	13						
	14						
	15						
	16						

DECID	PERM	STAT	CAVITIES NO.	CAVITIES SURF	FILLINGS NO.	FILLINGS SURF	PI
	17						
	18						
	19						
K	20						
L	21						
M	22						
N	23						
O	24						
P	25						
Q	26						
R	27						
S	28						
T	29						
	30						
	31						
	32						

TOTAL # OF DECIDIOUS TEETH PRESENT _____

TOTAL # OF PERMANENT TEETH PRESENT _____

TOTAL # OF PERMANENT TEETH UNERUPTED _____

TOTAL # OF CARIOUS EXTRACTIONS IN PERMANANT TEETH _____

TOTAL # OF PERM TEETH LOST DUE TO ACCIDENT OR ORTHODONTIC EXTRACTION _____

SUM OF PERIODONTAL INDEX _____

TOTAL # OF PERM TEETH WITH CAVITIES _____

TOTAL # OF CAVITIES IN PERMANENT TEETH _____

TOTAL # OF SURFACES WITH CAVITIES IN PERM TEETH _____

TOTAL # OF PERM TEETH WITH FILLINGS _____

TOTAL # OF FILLING IN PERM TEETH _____

TOTAL # OF SURFACES WITH FILLINGS IN PERM TEETH _____

SUBJECT

S-150 REGIONAL PROJECT

FORM A5

SUBJECT NO. ______-______

DATE ______________

SUBJECT ___ ___ ___ (1, 2, 3)

STATE ___ (4)

STATION ___ (5)

YEAR 1 OR 3 ___ (6)

DENTAL EXAMINATION

1. EXAMINATION PERFORMED BY
   1 = DENTIST 2 = DENTAL HYGIENIST? ___ (7)

2. TREATMENT NEEDS (ANSWER EACH ITEM)
   - A. REMOVAL OF DEBRIS AND CALCULUS — 1 = YES 2 = NO ___ (8)
   - B. GINGIVITIS TREATMENT — 1 = YES 2 = NO ___ (9)
   - C. PERIODONTAL DISEASE TREATMENT — 1 = YES 2 = NO ___ (10)
   - D. SEVERE MALOCCLUSION TREATMENT — 1 = YES 2 = NO ___ (11)
   - E. DECAYED PERMANENT TEETH — 1 = YES 2 = NO ___ (12)
   - F. OTHERS, SPECIFY ________________ — 1 = YES 2 = NO ___ (13)

3. OTHER CONDITIONS - INDICATORS OF VITAMIN C DEFICIENCY. (ANSWER EACH ITEM)
   - A. BLEEDING GUMS — 1 = YES 2 = NO ___ (14)
   - B. DIFFUSE MARGINAL INFLAMMATION — 1 = YES 2 = NO ___ (15)
   - C. SWOLLEN RED PAPILLAE — 1 = YES 2 = NO ___ (16)
   - D. RECESSION — 1 = YES 2 = NO ___ (17)

4. A.) WHAT IS THE FLUORIDATION LEVEL OF THE SUBJECT'S HOME DRINKING WATER? (RECORD IN PPM.) ___ ___ (18, 19)

   B.) HAS THE SUBJECT TAKEN A FLUORIDATION SUPPLEMENT AND/OR HAD A FLUORIDATED TREATMENT WITHIN THE PAST 6 WEEKS.
   1 = YES 2 = NO ___ (20)

5. A.) IS SUBJECT WEARING BRACES? — 1 = YES 2 = NO ___ (21)

   B.) HOW LONG HAS SHE BEEN WEARING BRACES? (RECORD IN MONTHS.) ___ ___ (22, 23)

S-150 REGIONAL PROJECT PAGE 2

FORM A5, CONT.

SUBJECT ________________

6. HAVE ANY OF THE FOLLOWING TEETH ERUPTED? (CONT.)

			Col.
D. TOOTH #14	1 = YES	2 = NO	__ 25
E. TOOTH #15	1 = YES	2 = NO	__ 26
F. TOOTH #16	1 = YES	2 = NO	__ 27
G. TOOTH #17	1 = YES	2 = NO	__ 28
H. TOOTH #18	1 = YES	2 = NO	__ 29
I. TOOTH #19	1 = YES	2 = NO	__ 30
J. TOOTH #30	1 = YES	2 = NO	__ 31
K. TOOTH #31	1 = YES	2 = NO	__ 32
L. TOOTH #32	1 = YES	2 = NO	__ 33

7. TOTAL NUMBER OF DECIDUOUS TEETH PRESENT.		__ 34	__ 35
8. TOTAL NUMBER OF PERMANENT TEETH PRESENT.		__ 36	__ 37
9. TOTAL NUMBER OF PERMANENT TEETH UNERUPTED.		__ 38	__ 39
10. TOTAL NUMBER OF CARIOUS EXTRACTIONS IN PERMANENT TEETH.		__ 40	__ 41
11. TOTAL NUMBER OF PERMANENT TEETH LOST DUE TO ACCIDENT OR ORTHODONTIC EXTRACTION.		__ 42	__ 43
12. TOTAL NUMBER OF PERMANENT TEETH WITH CAVITIES.		__ 44	__ 45
13. TOTAL NUMBER OF CAVITIES IN PERMANENT TEETH.		__ 46	__ 47
14. TOTAL NUMBER OF SURFACES WITH CAVITIES IN PERMANENT TEETH.		__ 48	__ 49
15. TOTAL NUMBER OF PERMANENT TEETH WITH FILLINGS.		__ 50	__ 51
16. TOTAL NUMBER OF FILLINGS IN PERMANENT TEETH.		__ 52	__ 53
17. TOTAL NUMBER OF SURFACES WITH FILLINGS IN PERMANENT TEETH.		__ 54	__ 55
18. SUM OF PERIODONTAL INDEX.	__ 56	__ 57	__ 58

A	4		1
77	78	79	80

S-150 REGIONAL PROJECT

FORM A5, CONT.

SUBJECT ______________

SUBJECT ___ ___ ___ [1 2 3]

STATE ___ [4]

STATION ___ [5]

YEAR 1 OR 3 ___ [6]

19. DI - UPPER MOLAR RIGHT	___.___ [7 8]
20. DI - UPPER CENTRAL LABIAL	___.___ [9 10]
21. DI - UPPER MOLAR LEFT	___.___ [11 12]
22. DI - LOWER MOLAR RIGHT	___.___ [13 14]
23. DI - LOWER CENTRAL LABIAL	___.___ [15 16]
24. DI - LOWER MOLAR LEFT	___.___ [17 18]
25. CI - UPPER MOLAR RIGHT	___.___ [19 20]
26. CI - UPPER CENTRAL LABIAL	___.___ [21 22]
27. CI - UPPER MOLAR LEFT	___.___ [23 24]
28. CI - LOWER MOLAR RIGHT	___.___ [25 26]
29. CI - LOWER CENTRAL LABIAL	___.___ [27 28]
30. CI - LOWER MOLAR LEFT	___.___ [29 30]

A [77] 4 [78] ___ [79] 2 [80]

APPENDIX B

S-150 REGIONAL PROJECT INSTRUCTIONS

(PERIODONTAL SCORES ONLY)

S-150 Regional Project Instructions

Periodontal Index

Since the health of the gums is related to nutritional health, the periodontal index will be determined as follows.

Scores are assigned according to these criteria:

0 - Negative. There is neither overt inflammation in the investing tissues nor loss of function due to destruction of supporting tissues.

1 - Mild gingivitis. There is an overt area of inflammation in the free gingiva, but the area does not circumscribe the tooth.

2 - Gingivitis. Inflammation completely circumscribes the tooth, but there is no apparent break in the epithelial attachment.

6 - Gingivitis with pocket formation. The epithelial attachment has been broken and there is a pocket (not merely a deepened gingival crevice due to swelling in the free gingiva). There is no interference with normal masticatory function: the tooth is firm in its socket and has not drifted.

8 - Advanced destruction with loss of masticatory function. The tooth may be loose: may have drifted: may sound dull on percussion with a metallic instrument.

RULE: When in doubt, assign the lesser score.

Each tooth present in the mouth, unless it is a root is scored. The arithmetic average will be calculated to obtain the subject's PI.

APPENDIX C

DIETARY RECALL FORM

(FIRST PAGE)

S-150 REGIONAL PROJECT

FORM D1

FOOD RECALL #1

SUBJECT NO. ___________

DATE ___________

SUBJECT ___ ___ ___ (1 2 3)

STATE ___ (4)

STATION ___ (5)

YEAR 1 OR 3 ___ (6)

1. HOW MANY DAYS EACH WEEK DO YOU USUALLY EAT SOMETHING BEFORE BREAKFAST? (CIRCLE ONE). 0 1 2 3 4 5 6 7 ___ (7)

2. WHERE DO YOU USUALLY OBTAIN THE FOOD IF YOU EAT SOMETHING PRIOR TO BREAKFAST? ___ (8)

   1. HOME
   2. SCHOOL CAFETERIA
   3. FAST FOOD RESTAURANT OR GROCERY
   4. OTHER RESTAURANT (NOT FAST FOOD TYPE)
   5. VENDING MACHINE OR SCHOOL SNACK BAR OTHER THAN CAFETERIA
   6. A FRIEND'S OR RELATIVE'S HOME
   7. OTHER: PLEASE SPECIFY ______________________

3. WHERE DID YOU OBTAIN THE FOOD IF YOU ATE SOMETHING PRIOR TO BREAKFAST YESTERDAY? ___

   1. HOME
   2. SCHOOL CAFETERIA
   3. FAST FOOD RESTAURANT OR GROCERY
   4. OTHER RESTAURANT (NOT FAST FOOD TYPE)
   5. VENDING MACHINE OR SCHOOL SNACK BAR OTHER THAN CAFETERIA
   6. A FRIEND'S OR RELATIVE'S HOME
   7. OTHER: PLEASE SPECIFY ______________________

4. WHAT DID YOU EAT AND/OR DRINK PRIOR TO BREAKFAST YESTERDAY?

A. FOOD/DRINKS	B. AMOUNT IN HOUSEHOLD UNITS	C. FREQ OF UNITS	D. NAS ID	E. WT IN GRAMS

APPENDIX D

MAXIMUM R^2 STEPWISE ANALYSIS MODELS

MAXIMUM R^2 STEPWISE ANALYSIS MODELS

Best Models for Dental Indices in 1981 and 1983

Year	Dental Index	Independent Variables	Over Score for Model R	Error MS	Prob > F
1981	DMFT	Age, months	0.19009	7.15639	0.0268
		Calcium, mg			0.2787
		Ca:P Ratio			0.0481
		*Sugars, % kcal			0.1380
		Protein, % kcal			0.0016
		*Sugars (Meals/Snacks)			0.3248
1981	DMFS	Age, months	0.22039	17.73591	0.2400
		#CHO, g			0.0213
		*Sugars, g			0.0666
		Phosphorus, mg			0.0361
		Ca:P Ratio			0.1325
		Fat, % kcal			0.0001
		#CHO, % kcal			0.0002
		*Sugars, % kcal			0.0037
		Sucrose, % kcal			0.0796
1983	DMFT	Age, months	0.23486	7.65292	0.0002
		PC INC, $			0.0018
		Fat, g			0.0916
		*Sugars, g			0.1405
		Fat, % kcal			0.0979
		#CHO, % kcal			0.0514
		Protein, % kcal			0.0682
		*Sugars (Snacks)			0.0912
1983	DMFS	Age, months	0.25350	20.27540	0.0019
		PC INC, $			0.0057
		Fat, g			0.0199
		#CHO, g			0.0123
		Phosphorus, mg			0.2778
		#CHO, % kcal			0.0143
		*Sugars, % kcal			0.1611
		Sucrose, % kcal			0.3934
		*Sugars (Meals/Snacks)			0.1022

* Total mono- and disaccharides

\# Carbohydrate

APPENDIX E

PEARSON CORRELATION COEFFICIENTS

#PEARSON'S CORRELATION COEFFICIENTS FOR 1981, 1983, AND LONGITUDINAL (1981-1983) DMFT AND DMFS SCORES BY DIETARY VARIABLES

Demographic, Dietary Variables	1981		1983		Longitudinal 1981-1983	
	DMFT	DMFS	DMFT	DMFS	DMFT	DMFS
Age, months	+0.28306*	+0.19735*	+0.30675*	+0.26570*	--	--
Race	--	--	--	--	--	--
PC INC, $	--	--	+0.24078*	+0.25071*	--	+0.21506*
Protein, g	--	--	--	--	--	--
Fat, g	--	--	--	--	-0.21871*	-0.24347*
CHO, g	--	--	--	--	--	-0.21131
Sugars, g	--	--	--	--	--	-0.19545
Phosphorus, mg	--	--	--	--	--	--
Calcium, mg	-0.20216*	-0.16606	--	--	+0.20139	--
Sucrose, g	--	--	--	--	--	-0.19792
Ca:P	-0.25471*	-0.21562*	--	--	+0.31363*	+0.19098
Protein, % kcal	-0.24998*	-0.26198*	--	--	+0.33049*	+0.21893*
Fat, % kcal	+0.16161	+0.18254*	--	-	-0.19728	--
##CHO, % kcal	--	--	--	--	--	--
**Sugars, % kcal	-0.15557	-0.15819	--	--	--	--
Sucrose, % kcal	--	--	--	--	--	--

Includes all variables with P < 0.10
Carbohydrate

* P < 0.05
** Total mono- and disaccharides

APPENDIX F

INDIVIDUAL DATA

OBS	SUBJECT	AGE	RACE	FCINC	DDS	DDS3	DMF	DMFS	DMF3	DMFS3	DMF2	DMFS2	BR	FW	FTRT	FTRT3	NPI	NPI3	NPI2	CEXT	CPERM	CSURF	FPERM	FSURF	CEXT3	CPERM3	CSURF3	FPERM3	FSURF3	DFT	NDFT3
1	1	146	1	2200	2	2	2	2	5	6	3	4	2	0.30	2	2	0.080	.	.	0	2	2	0	0	0	5	5	1	1	0	1
2	2	189	1	6580	1	.	11	17	.	.	.	.	2	1.00	1	.	.	.	.	0	1	1	10	16	.	.	.	.	.	0	.
3	3	168	1	1833	1	2	1	1	1	2	0	1	1	1.00	2	2	.	.	.	0	0	0	1	1	0	0	0	1	2	0	0
4	4	187	1	9333	1	2	4	4	5	6	1	2	1	1.00	2	2	.	.	.	0	0	0	4	4	0	1	1	4	5	0	0
5	5	162	1	8500	1	2	3	4	4	5	1	1	1	1.00	1	2	.	.	.	0	0	0	3	4	0	1	1	3	4	0	0
6	6	139	1	4030	1	2	4	5	9	15	5	10	.	1.00	2	2	.	.	.	0	3	3	1	2	0	2	2	8	13	0	1
7	7	166	1	846	1	.	2	2	.	.	.	.	.	1.00	2	.	.	.	.	0	2	2	0	0	.	.	.	.	.	0	.
8	8	193	1	4167	1	2	2	2	4	6	2	4	2	1.00	2	2	.	.	.	0	0	0	2	2	0	1	1	4	5	0	1
9	9	174	1	3800	.	.	.	.	.	.	.	.	.	1.00	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
10	10	163	1	20000	1	2	8	8	6	10	-2	2	2	0.45	.	2	.	.	.	0	0	0	8	8	0	0	0	6	10	0	0
11	11	189	1	10000	1	.	15	27	.	.	.	.	1	1.00	1	.	.	.	.	0	0	0	15	27	.	.	.	.	.	0	.
12	12	193	1	2500	1	.	3	6	.	.	.	.	1	1.00	2	.	.	.	.	0	0	0	3	6	.	.	.	.	.	0	.
13	13	172	1	6400	1	.	2	2	.	.	.	.	2	1.00	2	.	.	.	.	0	0	0	2	2	.	.	.	.	.	0	0
14	14	165	1	10000	1	2	2	2	7	7	5	5	1	1.00	1	1	.	.	.	0	0	0	2	2	0	3	3	4	4	0	0
15	15	164	1	10000	1	2	0	0	6	7	6	7	2	0.16	2	2	.	.	.	0	0	0	0	0	0	6	7	0	0	0	0
16	16	162	1	10354	1	.	3	3	.	.	.	.	.	1.00	2	.	.	.	.	0	2	2	1	1	.	.	.	.	.	0	.
17	17	175	1	1580	1	.	0	0	.	.	.	.	.	1.00	2	.	.	.	.	0	0	0	0	0	.	.	.	.	.	0	.
18	18	162	1	8000	1	2	4	4	7	13	3	9	1	1.00	2	2	.	.	.	0	0	0	4	4	0	5	6	4	7	0	2
19	19	149	1	3500	3	2	0	0	1	1	1	1	2	0.20	2	2	0.000	.	.	0	0	0	0	0	0	0	0	1	1	0	0
20	20	165	1	3240	2	2	5	10	6	11	1	1	2	0.90	2	2	0.180	.	.	0	2	2	4	8	0	4	4	4	7	1	2
21	21	193	1	4167	1	2	1	1	1	2	0	1	1	1.00	2	2	.	.	.	0	0	0	1	1	0	1	1	1	1	0	1
22	22	193	1	7200	1	2	2	2	4	6	2	4	2	1.00	2	2	.	.	.	0	0	0	2	2	0	1	1	3	5	0	0
23	23	179	1	5200	1	.	4	6	.	.	.	.	2	1.00	2	.	.	.	.	0	0	0	4	6	.	.	.	.	.	0	.
24	24	174	1	5750	1	.	2	2	.	.	.	.	.	1.00	2	.	.	.	.	0	0	0	2	2	.	.	.	.	.	0	.
25	25	173	1	5040	1	2	2	3	6	6	4	3	1	1.00	2	1	.	.	.	0	0	0	2	3	0	1	1	5	5	0	0
26	26	198	1	6000	2	.	8	9	.	.	.	.	1	0.90	2	.	0.000	.	.	0	1	1	8	8	.	.	.	.	.	1	.
27	27	173	1	8800	1	2	0	0	8	11	8	11	2	1.00	2	2	.	.	.	0	0	0	0	0	0	2	2	6	9	0	0
28	28	195	1	3960	1	2	5	6	3	3	-2	-3	1	1.00	2	2	.	.	.	0	0	0	5	6	0	0	0	3	3	0	0
29	29	164	1	8667	1	.	0	0	.	.	.	.	2	0.45	2	.	.	.	.	0	0	0	0	0	.	.	.	.	.	0	.
30	30	173	1	1167	.	2	.	.	7	10	.	.	2	1.00	.	2	.	.	.	.	.	.	.	.	1	5	7	2	2	.	1
31	31	143	1	6000	2	.	5	10	.	.	.	.	.	0.52	2	.	0.120	.	.	0	2	3	5	7	.	.	.	.	.	2	.
32	32	188	1	11250	3	2	0	0	3	3	3	3	1	0.90	2	2	0.000	.	.	0	0	0	0	0	0	3	3	0	0	0	0
33	33	148	1	3725	2	.	0	0	.	.	.	.	.	0.90	2	.	0.180	.	.	0	0	0	0	0	.	.	.	.	.	0	.
34	34	188	1	8571	2	2	8	10	8	9	0	-1	1	0.90	2	1	0.333	.	.	0	0	0	8	10	0	1	1	8	8	0	1
35	35	172	1	6052	3	2	4	4	6	7	2	3	2	0.52	2	2	0.140	.	.	0	1	1	3	3	0	3	3	4	4	0	1
36	36	144	1	5000	3	.	6	10	.	.	.	.	.	0.52	2	.	0.040	.	.	0	2	3	4	7	.	.	.	.	.	0	.
37	37	189	1	2857	3	2	8	9	11	12	3	3	2	0.45	1	1	0.000	.	.	0	1	1	7	8	0	2	2	9	10	0	0
38	38	146	2	1349	2	2	1	1	6	6	5	5	2	0.52	2	2	0.180	.	.	0	1	1	0	0	0	5	5	1	1	0	0
39	39	168	2	1349	2	2	5	7	5	6	0	-1	2	0.52	2	2	0.250	.	.	0	3	3	2	4	0	3	3	2	3	0	0
40	40	140	1	5100	2	2	1	1	1	1	0	0	2	0.90	2	1	0.230	.	.	0	0	0	1	1	0	0	0	1	1	0	0
41	41	147	1	4398	2	.	3	3	.	.	.	.	1	0.30	2	.	0.330	.	.	0	0	0	3	3	.	.	.	.	.	0	0
42	42	169	1	4667	2	2	8	8	8	8	0	0	2	0.52	2	2	0.460	.	.	0	3	3	5	5	0	4	4	4	4	0	0
43	43	140	1	8000	2	2	6	10	10	15	4	5	1	0.52	1	1	0.190	.	.	0	2	2	6	8	0	2	3	8	12	2	0
44	44	150	1	2567	2	.	4	6	.	.	.	.	.	0.90	2	.	0.520	.	.	0	0	0	4	6	.	.	.	.	.	0	.
45	45	188	1	7000	2	.	8	8	.	.	.	.	2	0.90	2	.	0.140	.	.	0	0	0	8	8	.	.	.	.	.	0	.
46	46	171	1	8500	2	2	9	10	12	14	3	4	1	0.90	2	2	0.130	.	.	0	0	0	9	10	0	1	1	11	13	0	0
47	47	191	1	8500	2	2	5	5	9	9	4	4	2	0.90	1	2	0.110	.	.	0	5	5	0	0	0	4	4	5	5	0	0
48	48	190	1	5917	2	.	8	14	.	.	.	.	2	0.90	1	.	0.130	.	.	0	4	6	6	8	.	.	.	.	.	2	0
49	49	196	1	5000	3	.	4	4	.	.	.	.	2	0.52	2	.	0.040	.	.	0	4	4	0	0	.	.	.	.	.	0	.
50	50	174	1	5800	3	2	6	15	6	23	0	8	.	0.52	1	1	0.000	.	.	0	5	8	3	7	0	1	1	5	22	2	0

DEMOGRAPHIC AND DENTAL VARIABLES 11:18 THURSDAY, APRIL 19, 1984

OBS	SUBJECT	AGE	RACE	PCINC	CDS	DDS3	DMF	DMFS	DMF3	DMFS3	DMF2	DMFS2	BR	FW	FTRT	FTRT3	NPI	NPI3	NPI2	CEXT	CPERM	CSURF	FPERM	FSURF	CEXT3	CPERM3	CSURF3	FPERM3	FSURF3	DFT	NDFT3
51	51	150	1	9667	3	2	2	2	5	5	3	3	1	0.52	1	2	0.00	.	.	0	0	0	2	2	0	3	3	2	2	0	0
52	52	148	1	6667	3	2	5	9	4	7	-1	-2	.	0.27	2	2	0.00	.	.	0	2	3	4	6	0	1	2	3	5	1	0
53	53	190	1	6250	3	.	3	3	.	.	.	.	1	0.52	1	.	0.00	.	.	0	3	3	0	0	.	.	.	.	.	0	.
54	54	186	1	5000	3	2	5	7	5	7	0	0	2	0.52	2	2	0.00	.	.	0	0	0	5	7	0	0	0	5	7	0	0
55	55	130	1	9000	3	2	0	0	6	7	6	7	2	0.90	2	1	0.00	.	.	0	0	0	0	0	0	4	4	2	3	0	0
56	56	187	1	8000	3	2	4	4	7	7	3	3	1	0.90	2	2	0.00	.	.	0	0	0	4	4	1	2	2	4	4	0	0
57	57	149	1	6000	2	.	7	12	.	.	.	.	.	0.90	2	.	0.12	.	.	0	1	2	6	10	.	.	.	.	.	0	.
58	58	141	1	7500	2	2	1	1	7	8	6	7	1	0.90	2	1	0.11	.	.	0	1	1	0	0	0	7	8	0	0	0	0
59	59	144	1	6250	2	.	4	5	.	.	.	.	.	0.90	2	.	0.45	.	.	0	3	3	1	2	.	.	.	.	.	0	.
60	60	158	1	7000	2	2	7	9	9	11	2	2	2	0.90	2	2	0.18	.	.	0	0	0	7	9	0	2	2	7	9	0	0
61	63	141	1	7000	2	2	0	0	0	0	0	0	2	0.90	2	1	0.17	.	.	0	0	0	0	0	0	0	0	0	0	0	0
62	64	168	1	7000	2	2	5	7	5	10	0	3	2	0.90	2	2	0.04	.	.	0	2	2	4	5	0	2	2	5	8	1	2
63	65	142	1	5000	2	2	0	0	1	2	1	2	.	0.90	2	2	0.25	.	.	0	0	0	0	0	0	0	0	1	2	0	0
64	66	150	1	2229	2	2	5	9	6	8	1	-1	2	0.90	2	2	0.29	.	.	0	5	9	0	0	0	6	8	0	0	0	0
65	67	173	1	9000	2	2	7	7	8	11	1	4	2	0.90	2	2	0.36	.	.	0	4	4	3	3	0	0	0	8	11	0	0
66	68	174	1	5520	2	2	3	3	5	6	2	3	1	0.90	2	1	0.00	.	.	0	3	3	0	0	0	5	6	0	0	0	0
67	69	148	1	4600	2	2	0	0	5	7	5	7	2	0.90	2	2	0.43	.	.	0	0	0	0	0	0	4	4	2	3	0	1
68	70	149	1	17500	.	.	.	.	.	.	.	.	.	0.90	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
69	71	143	1	17500	2	2	7	12	11	22	4	10	2	0.30	2	2	0.32	.	.	0	0	0	7	12	0	9	10	6	12	0	4
70	72	198	1	12500	2	.	3	3	.	.	.	.	2	0.90	2	.	0.21	.	.	0	1	1	2	2	.	.	.	.	.	0	0
71	73	142	2	1047	.	.	.	.	.	.	.	.	.	0.90	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
72	74	141	2	4800	2	2	4	5	3	3	-1	-2	2	0.90	2	2	0.29	.	.	0	4	5	0	0	0	3	3	0	0	0	0
73	75	197	1	3200	2	2	4	4	8	8	4	4	1	0.49	2	1	0.00	.	.	0	0	0	4	4	0	3	3	5	5	0	0
74	76	147	1	5520	2	.	5	10	.	.	.	.	1	0.90	2	.	0.21	.	.	0	2	3	4	7	.	.	.	.	.	1	.
75	77	156	1	4000	2	2	3	3	7	9	4	6	2	0.16	2	1	0.29	.	.	0	2	2	1	1	0	2	2	5	7	0	0
76	78	192	1	7200	2	.	0	0	.	.	.	.	.	0.16	.	.	0.33	.	.	0	0	0	0	0	.	.	.	.	.	0	.
77	79	144	1	1776	2	.	0	0	.	.	.	.	.	0.90	2	.	0.38	.	.	0	0	0	0	0	.	.	.	.	.	0	.
78	80	142	1	6000	2	.	4	7	.	.	.	.	.	0.16	2	.	0.25	.	.	0	0	0	4	7	.	.	.	.	.	0	.
79	81	163	2	3429	.	5	.	.	4	7	.	.	2	0.30	.	2	.	0.214286	.	.	.	.	.	.	0	0	0	4	7	.	0
80	82	170	2	4000	.	5	.	.	0	0	.	.	2	0.30	.	2	.	0.785714	.	.	.	.	.	.	0	0	0	0	0	.	0
81	83	171	1	3600	.	5	.	.	0	0	.	.	2	0.30	.	2	.	0.000000	.	.	.	.	.	.	0	0	0	0	0	.	0
82	84	145	1	2600	.	5	.	.	4	0	.	.	.	0.80	.	2	.	0.214286	.	.	.	.	.	.	0	0	0	4	6	.	0
83	85	157	2	3500	.	5	.	.	4	5	.	.	2	0.80	.	2	.	0.000000	.	.	.	.	.	.	0	0	0	4	5	.	0
84	86	170	2	3500	.	.	.	.	.	.	.	.	2	0.30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
85	87	168	1	9250	.	5	.	.	13	21	.	.	1	0.90	.	2	.	0.035714	.	.	.	.	.	.	0	0	0	13	21	.	0
86	88	171	1	3600	.	5	.	.	1	1	.	.	2	0.30	.	2	.	0.000000	.	.	.	.	.	.	0	0	0	1	1	.	0
87	89	171	1	3940	.	5	.	.	3	6	.	.	2	0.80	.	2	.	0.428571	.	.	.	.	.	.	0	1	1	2	5	.	0
88	90	140	2	2057	.	.	.	.	.	.	.	.	2	0.30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
89	91	144	2	6000	.	.	.	.	.	.	.	.	.	0.30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
90	92	168	2	3333	.	5	.	.	7	10	.	.	2	0.30	.	2	.	0.142857	.	.	.	.	.	.	0	1	1	6	9	.	0
91	93	142	1	11250	.	5	.	.	4	4	.	.	1	0.80	.	2	.	0.071429	.	.	.	.	.	.	0	0	0	4	4	.	0
92	94	140	1	8250	.	5	.	.	0	0	.	.	2	0.80	.	2	.	0.000000	.	.	.	.	.	.	0	0	0	0	0	.	0
93	95	146	1	2375	.	5	.	.	2	2	.	.	2	0.30	.	2	.	0.571429	.	.	.	.	.	.	0	1	1	1	1	.	0
94	96	149	2	4800	.	5	.	.	0	0	.	.	2	0.80	.	2	.	0.076923	.	.	.	.	.	.	0	0	0	0	0	.	0
95	97	151	2	6600	.	5	.	.	0	0	.	.	2	0.30	.	2	.	0.000000	.	.	.	.	.	.	0	0	0	0	0	.	0
96	98	146	1	4750	.	5	.	.	6	7	.	.	.	0.80	.	2	.	0.142857	.	.	.	.	.	.	0	5	6	1	1	.	0
97	99	170	2	5333	.	.	.	.	.	.	.	.	2	0.30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
98	100	140	1	5000	4	5	1	1	0	0	-1	-1	2	0.90	2	2	0.15	0.000000	-0.15000	0	0	0	1	1	0	0	0	0	0	0	0
99	101	170	1	5000	4	5	6	11	7	11	1	0	2	0.80	2	2	0.21	0.000000	-0.21000	0	1	1	5	10	0	0	0	7	11	0	0
100	102	151	1	.	4	.	1	1	.	.	.	.	2	0.30	2	.	0.00	.	.	0	0	0	1	1	.	.	.	.	.	0	.

OBS	SUBJECT	AGE	RACE	PINC	DDS	DDS3	DMF	DMFS	DMF3	DMFS3	DMF2	DMFS2	DR	FW	FTRT	FTRT3	NPI	NPI3	NPI2	CEXT	CPERM	CSURF	FPERM	FSURF	CEXT3	CPERM3	CSURF3	FPERM3	FSURF3	DFT	NDFT3
101	103	144	1	6800	4	5	0	0	0	0	0	0	1	0.80	2	2	0.140	0.000000	-0.14000	0	0	0	0	0	0	0	0	0	0	0	0
102	104	168	2	1538	4	5	4	6	7	8	3	2	2	0.80	2	2	0.000	0.480000	0.48000	0	4	6	0	0	3	4	5	0	0	0	0
103	105	150	1	6500	4	5	4	4	3	6	-1	2	1	0.30	2	2	0.170	0.000000	-0.17000	0	0	0	4	4	0	1	1	3	5	0	1
104	106	165	1	6250	4	5	4	4	6	7	2	3	2	0.80	2	2	0.210	0.321429	0.11143	0	2	2	2	2	0	3	3	4	4	0	1
105	107	150	2	7167	4	5	4	6	5	9	1	3	2	0.80	2	2	0.170	0.035714	-0.13429	0	0	0	4	6	0	0	0	5	9	0	0
106	108	144	1	10000	4	5	6	13	5	11	-1	-2	2	0.80	2	2	0.000	0.076923	0.07692	0	2	2	4	11	0	1	1	4	10	0	0
107	109	149	1	4500	4	5	0	0	3	3	3	3	2	0.80	2	2	0.000	0.000000	0.00000	0	0	0	0	0	0	0	0	3	3	0	0
108	110	168	1	10250	4	5	2	2	5	6	3	4	1	0.80	2	2	0.210	0.000000	-0.21000	0	0	0	2	2	0	0	0	5	6	0	0
109	111	164	2	2517	4	.	4	5	.	.	.	.	2	0.80	2	.	0.180	.	.	0	0	0	4	5	.	.	.	.	.	0	.
110	112	171	1	5340	4	.	6	16	.	.	.	.	.	0.80	2	.	0.430	.	.	0	6	16	0	0	.	.	.	.	.	0	.
111	113	169	2	5000	4	5	4	10	4	5	0	-5	1	0.80	2	2	0.170	0.500000	0.33000	0	0	0	4	10	0	0	0	4	5	0	0
112	114	151	1	9000	4	5	4	5	6	6	2	1	1	0.80	2	2	0.160	0.000000	-0.16000	0	0	0	4	5	0	0	0	6	6	0	0
113	115	149	1	6760	4	5	1	1	3	3	2	2	2	0.80	2	2	0.000	0.000000	0.00000	0	0	0	1	1	0	0	0	3	3	0	0
114	117	146	1	3750	4	5	2	2	2	3	0	1	2	0.80	2	2	0.000	0.000000	0.00000	0	0	0	2	2	0	0	0	2	3	0	0
115	118	153	2	5400	4	.	11	14	.	.	.	.	2	0.80	2	.	0.000	.	.	0	0	0	11	14	.	.	.	.	.	0	.
116	119	144	1	5100	4	5	1	1	1	1	0	0	2	0.80	2	2	0.000	0.000000	0.00000	0	0	0	1	1	0	0	0	1	1	0	0
117	120	193	2	1478	4	5	7	7	7	7	0	0	2	0.80	1	2	0.000	0.037037	0.03704	0	3	3	4	4	1	0	0	6	6	0	0
118	121	190	2	1500	2	.	6	8	.	.	.	.	2	0.80	2	.	0.390	.	.	0	5	7	1	1	.	.	.	.	.	0	.
119	142	196	2	5000	4	5	0	0	7	20	7	20	2	0.80	2	2	.	0.137931	.	0	0	0	0	0	0	0	0	7	20	0	0
120	143	162	2	13000	4	.	0	0	.	.	.	.	2	0.80	2	.	.	.	.	0	0	0	0	0	.	.	.	.	.	0	.
121	144	180	2	4572	4	.	8	9	.	.	.	.	2	0.80	2	.	.	.	.	1	2	3	5	5	.	.	.	.	.	0	0
122	145	158	2	3840	4	.	0	0	.	.	.	.	1	0.80	2	.	.	.	.	0	0	0	0	0	.	.	.	.	.	0	.
123	146	166	2	6800	4	5	3	3	3	5	0	2	2	0.80	2	2	.	0.000000	.	0	0	0	3	3	0	0	0	3	5	0	0
124	147	169	1	5714	4	5	4	4	7	8	3	4	2	0.80	2	1	.	0.000000	.	0	3	3	1	1	0	0	0	7	8	0	0
125	148	175	2	1606	4	5	0	0	0	0	0	0	2	0.80	.	2	.	0.448276	.	0	0	0	0	0	0	0	0	0	0	0	0
126	149	167	2	6250	4	5	6	6	9	11	3	5	2	0.80	2	2	.	0.000000	.	0	0	0	6	6	0	0	0	9	11	0	0
127	150	169	1	13500	4	5	2	2	5	5	3	3	1	0.80	2	2	.	0.035714	.	0	0	0	2	2	0	0	0	5	5	0	0
128	151	170	1	5750	4	5	6	6	9	9	3	3	2	0.80	2	2	.	0.000000	.	0	0	0	6	6	0	0	0	9	9	0	0
129	152	172	2	7000	4	.	3	7	.	.	.	.	2	0.80	2	.	.	.	.	0	0	0	3	7	.	.	.	.	.	0	.
130	153	177	2	5730	4	5	2	2	2	2	0	0	2	0.80	2	2	.	0.000000	.	0	0	0	2	2	0	0	0	2	2	0	0
131	154	173	2	5833	4	5	6	9	8	12	2	3	2	0.80	2	2	.	0.071429	.	0	0	0	6	9	0	0	0	8	12	0	0
132	155	189	2	800	4	5	3	6	3	6	0	0	2	0.80	2	2	.	0.000000	.	0	0	0	3	6	0	0	0	3	6	0	0
133	156	173	2	4509	4	5	0	0	0	0	0	0	1	0.80	2	2	.	0.466667	.	0	0	0	0	0	0	0	0	0	0	0	0
134	157	175	2	9220	4	5	6	7	7	10	1	3	2	0.80	2	2	.	0.000000	.	0	0	0	6	7	0	1	1	6	9	0	0
135	158	171	1	2443	4	.	9	11	.	.	.	.	2	0.80	2	.	.	.	.	2	3	3	4	6	.	.	.	.	.	0	.
136	159	192	2	.	4	.	15	23	.	.	.	.	2	0.80	2	.	.	.	.	1	10	17	4	5	.	.	.	.	.	0	.
137	161	143	1	7875	2	2	0	0	2	2	2	2	2	0.90	2	2	0.310	.	.	0	0	0	0	0	0	1	1	1	1	0	0
138	162	191	1	8250	2	2	1	1	4	4	3	3	2	0.90	2	1	0.210	.	.	0	0	0	1	1	0	1	1	3	3	0	0
139	163	146	1	6900	2	.	1	1	.	.	.	.	2	0.30	2	.	0.000	.	.	0	1	1	0	0	.	.	.	.	.	0	.
140	164	150	1	7000	.	.	.	.	.	.	.	.	1	0.90	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
141	165	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
142	166	156	1	8000	2	2	0	0	0	0	0	0	1	0.35	2	1	0.000	.	.	0	0	0	0	0	0	0	0	0	0	0	0
143	167	166	1	5000	2	2	3	3	4	6	1	3	2	0.35	2	2	0.110	.	.	0	1	1	2	2	0	4	5	1	1	0	1
144	168	140	1	3327	2	.	7	9	.	.	.	.	.	0.90	2	.	0.576	.	.	0	3	3	5	6	.	.	.	.	.	1	.
145	169	172	1	8100	2	2	4	8	7	11	3	3	2	0.90	2	1	0.330	.	.	0	1	1	3	7	0	3	3	4	8	0	0
146	170	168	1	4333	2	2	4	6	4	7	0	1	2	0.35	2	2	0.360	.	.	0	0	0	4	6	0	1	1	4	6	0	1
147	171	194	1	5400	2	.	4	5	.	.	.	.	1	0.30	2	.	0.250	.	.	0	2	2	3	3	.	.	.	.	.	1	.
148	172	178	1	7500	2	2	7	11	8	17	1	6	2	0.90	2	1	0.321	.	.	0	1	1	6	10	0	5	6	6	11	0	3
149	173	190	1	5000	2	.	6	8	.	.	.	.	1	0.20	2	.	0.000	.	.	0	1	2	6	6	.	.	.	.	.	1	.
150	174	191	1	4000	2	2	5	7	8	12	3	5	2	0.90	2	2	0.320	.	.	0	1	1	4	6	0	4	4	5	8	0	1

Legend for Demographic and Dental Variables

OBS = Observation
Race: 1 = White 2 = Black
PCINC = Per Capita Income
DDS = Examiners (Dentist) for 1981
DDS3 = Examiners (Dentist and Dental Assistant) for 1983
DMF = Decayed-Missing-Filled (permanent) teeth for 1981
DMFS = Decayed-Missing-Filled surfaces in permanent teeth for 1981
DMF3 = Decayed-Missing-Filled (permanent) teeth for 1983
DMFS3 = Decayed-Missing-Filled surfaces in permanent teeth for 1983
DMF2 = (DMF3 minus DMF) Longitudinal changes from 1981 to 1983
DMFS2 = (DMFS3 minus DMFS) Longitudinal changes from 1981 to 1983
Br = Braces
FW = Fluoride concentrations in drinking water
FTRT = Topical Fluoride Treatments for 1981
FTRT3 = Topical Fluoride Treatment for 1983
NPI = Periodontal Index for 1981
NPI3 = Periodontal Index for 1983
NPI2 = (NPI3 minus NPI) Longitudinal changes from 1981 to 1983
CEXT = Carious extraction for 1981
CPERM = Cavities in permanent teeth for 1981
CSURF = Cavities in surfaces of permanent teeth for 1981
FPERM = Fillings in permanent teeth for 1981
FSURF = Fillings in surfaces of permanent teeth for 1981
CEXT3 = Carious extraction for 1983
CPERM3 = Cavities in permanent teeth for 1983
CSURF3 = Cavities in surfaces of permanent for 1983
FPERM3 = Filling in permanent teeth for 1983
FSURF3 = Filling in surfaces of permanent teeth for 1983
DFT = Decay and fillings in the same tooth for 1981
NDFT3 = Decay and fillings in the same tooth for 1983

JBS	SUBJECT	E	FAT	PRO	N45	N46	SUCR	P	CA	CAPRAT	PPRO	PCHO	PFAT	PSUG	PSUCR	TCT	SN	SUG	F	SF	SP	SPF
1	1	2026	74	84	264.8	99.6	37	1324	731	0.55211	16.5680	52.2288	32.8402	19.6450	7.2978	5	2	3	3	2	1	1
2	2	2178	111	61	241.1	77.5	43	1517	1207	0.79565	11.2029	44.2792	45.8579	14.2332	7.8972	5	2	4	4	3	1	1
3	3	2281	98	90	265.0	121.2	74	1626	1397	0.85916	15.7826	46.4708	38.6673	21.2538	12.9768	4	1	4	2	2	2	1
4	4	2005	103	65	346.3	149.2	105	1481	884	0.59689	9.9608	53.1747	37.3129	22.9098	16.1228	6	3	5	3	3	2	2
5	5	1170	53	47	127.6	61.4	41	708	634	0.89548	16.0684	43.6239	40.7692	20.9915	14.0171	4	1	2	2	1	1	1
6	6	1622	75	60	173.3	91.9	37	1273	1131	0.88845	14.7965	43.9704	42.1702	22.6634	9.1245	5	2	4	2	2	3	2
7	7	2515	119	109	256.9	136.1	78	1682	1187	0.70571	17.3360	40.8588	42.5845	21.6461	12.4056	5	2	5	2	2	2	2
8	8	1078	45	33	134.6	74.5	48	488	300	0.61475	12.2449	49.9443	38.4045	27.6438	17.8108	5	2	3	2	2	0	0
9	9	1673	86	67	161.2	103.0	69	1152	772	0.67014	16.0191	38.5415	46.2642	24.6264	16.4973	5	2	3	3	2	2	2
10	10	1195	62	32	132.8	81.5	70	484	250	0.51553	10.7113	44.4519	46.6945	27.2803	23.4310	4	2	4	2	2	0	0
11	11	1109	68	32	94.6	33.0	30	554	326	0.58845	11.5419	34.1208	55.1849	11.9026	10.8206	4	1	1	2	1	0	0
12	12	1271	82	62	71.2	8.8	3	764	300	0.39267	19.5122	22.4076	58.0645	2.7695	0.9441	3	0	0	2	0	0	0
13	13	1572	70	53	184.6	86.6	41	998	934	0.93587	13.4860	46.9720	40.0763	22.0356	10.4326	4	1	4	2	2	2	2
14	14	2308	87	94	310.2	137.8	84	1895	1781	0.93984	15.8784	52.3986	33.0659	23.2770	14.1892	4	1	4	3	3	3	3
15	15	2124	106	90	206.2	91.3	53	1715	1395	0.81341	16.9492	38.8324	44.9153	17.1940	9.9812	5	2	3	2	2	3	3
16	16	1132	42	69	123.0	70.9	26	1149	1011	0.87990	24.3816	43.4629	33.3922	25.0530	9.1873	4	2	3	2	1	1	1
17	17	2188	91	105	234.3	84.5	72	1314	1007	0.76636	19.1956	42.8336	37.4314	15.4479	13.1627	4	1	1	3	3	2	2
18	18	1005	44	36	122.2	62.5	45	549	283	0.51548	14.3284	48.6368	39.4030	24.8756	17.9104	4	2	4	2	2	1	1
19	19	1628	77	59	180.9	73.7	36	1030	832	0.80777	14.4963	44.4472	42.5676	18.1081	8.8452	5	2	3	3	2	0	0
20	20	2915	149	102	301.9	163.7	107	1867	1418	0.75951	13.9966	41.4271	46.0034	22.4631	14.6827	7	4	5	4	4	4	4
21	21	1291	60	39	153.0	100.5	55	703	528	0.75107	12.0837	47.4051	41.8280	31.1387	17.0411	5	2	3	2	1	1	1
22	22	2035	85	80	243.2	106.3	53	1294	680	0.52550	15.7248	47.8034	37.5921	20.8943	10.4177	5	2	4	2	2	3	2
23	23	949	31	34	135.2	55.6	49	775	903	1.16516	14.3309	56.9863	29.3994	23.4352	20.6533	2	1	2	1	1	1	1
24	24	1198	61	34	131.1	98.5	58	554	270	0.48736	11.3523	43.7730	45.8264	32.8881	19.3656	4	1	3	1	1	1	1
25	25	1085	50	36	122.1	46.1	34	536	217	0.40485	13.2719	45.0138	41.4747	16.9954	12.5346	4	1	2	2	0	0	0
26	26	2488	105	85	301.5	143.5	90	1564	1238	0.79156	13.6656	48.4727	37.9823	23.0707	14.4695	5	2	4	4	4	3	3
27	27	818	33	42	86.6	28.6	15	705	721	1.02270	20.5379	42.3472	36.3081	13.9853	7.3350	5	2	1	1	1	1	1
28	28	2512	92	70	361.0	204.2	137	1236	641	0.51861	11.1465	57.4841	32.9618	32.5159	21.8153	5	2	5	4	4	2	2
29	29	1138	40	49	146.9	78.3	68	609	311	0.51067	17.2232	51.6344	31.6344	27.5220	23.9016	3	1	3	2	2	1	1
30	30	1483	59	56	180.5	88.9	42	928	541	0.58297	15.1045	48.6851	35.8058	23.9784	11.3284	4	1	2	3	2	2	2
31	31	2020	104	97	174.0	77.2	37	1551	1178	0.75951	19.2079	34.4554	46.3366	15.2871	7.3267	4	1	4	3	3	3	2
32	32	2067	96	82	219.7	94.3	41	1682	1325	0.78775	15.8684	42.5157	41.7997	18.2487	7.9342	6	3	3	3	1	2	1
33	33	2052	97	96	201.5	110.2	54	1788	1363	0.76230	18.7135	39.2788	42.5439	21.4815	10.5263	3	0	3	3	3	3	3
34	34	2458	100	64	331.7	183.4	125	1124	551	0.49021	10.4150	53.9788	36.6151	29.8454	20.3417	5	2	5	3	3	3	3
35	35	1673	75	59	183.3	61.1	31	995	868	0.87236	14.1064	45.2600	40.3467	14.6085	7.4118	5	2	3	2	1	1	1
36	36	2566	115	83	307.3	174.5	112	1726	1168	0.67571	12.9384	47.9034	40.3352	27.2019	17.4591	5	2	4	4	3	2	2
37	37	1976	125	61	152.0	56.1	16	1294	878	0.67852	12.3482	30.7692	56.9332	11.3563	3.2389	2	0	2	2	2	2	2
38	38	2373	124	74	245.7	97.7	59	1370	1200	0.87591	12.4737	41.4159	47.0291	16.4686	9.9452	5	2	3	3	3	2	2
39	39	2538	98	104	312.5	100.5	65	1666	944	0.56663	16.3909	49.2514	34.7518	15.8392	10.2443	6	3	3	3	3	2	2
40	40	1382	63	50	160.1	100.0	38	1133	979	0.86408	14.4718	46.3386	41.0275	28.9436	10.9986	5	2	1	2	1	1	1
41	41	1472	55	72	174.9	67.3	22	1310	1139	0.86947	19.5652	47.5272	34.2391	18.2880	5.9783	5	2	3	2	2	2	2
42	42	1657	88	75	142.3	28.3	14	969	540	0.55723	18.1050	34.3512	47.7972	6.8316	3.3796	4	1	2	3	2	2	2
43	43	2479	123	98	247.3	137.5	55	1819	1633	0.89775	15.8128	39.9032	44.6551	22.1864	8.8745	4	1	3	3	3	3	3
44	44	2727	105	98	363.2	234.2	99	2269	2291	1.00970	14.3748	53.2747	34.6535	34.3528	14.5215	6	3	5	3	3	3	5
45	45	1723	62	53	241.6	127.9	97	880	501	0.56932	12.3041	56.0882	32.3854	29.6924	22.5189	6	3	5	3	3	2	2
46	46	1043	67	66	196.2	100.1	69	1021	789	0.77277	16.0682	47.7663	36.7012	24.3701	16.7985	5	2	5	3	3	2	2
47	47	1739	70	68	208.7	104.0	55	1158	961	0.82988	15.6412	48.0046	36.2277	23.9218	12.6509	4	1	4	3	3	3	3
48	48	1418	74	32	153.5	35.0	53	623	297	0.47673	9.0268	43.3004	46.9676	11.0014	14.9506	3	1	2	1	1	1	1
49	49	822	35	20	111.8	85.8	61	493	434	0.88032	9.7324	54.4039	39.4161	41.7518	29.6837	5	3	4	1	1	0	0
50	50	948	36	27	130.3	35.3	42	606	444	0.73267	11.3924	54.9789	34.1772	14.8945	17.7215	4	1	2	2	1	1	1
51	51	2052	96	60	247.7	119.6	64	1356	1140	0.84071	11.6959	48.2846	42.1053	23.3138	12.4756	4	1	4	2	2	2	2
52	52	4478	246	163	423.5	243.4	175	2250	1690	0.75111	14.5601	37.8294	49.4417	21.7418	15.6320	5	2	5	4	4	3	3
53	53	1551	57	59	202.9	88.5	93	1328	792	0.59639	15.2160	52.3275	33.0754	22.8240	23.9845	4	1	3	2	2	2	1
54	54	1081	43	38	133.8	46.5	26	642	456	0.71028	14.0611	51.7299	35.8002	17.2063	9.6207	4	2	2	2	1	1	1
55	55	1690	53	62	223.8	100.7	38	1091	1646	0.97339	19.4083	52.9704	29.2899	23.8343	8.9941	4	1	4	3	3	4	3
56	56	1747	73	74	193.7	79.9	55	1218	993	0.81527	16.9433	44.3503	40.1832	18.2942	12.5930	5	2	2	3	2	1	1

OBS	SUBJECT	E	FAT	PRO	N45	N46	SUCR	P	CA	CAPRAT	FPRO	PCHO	PFAT	PSUG	PSUCP	TCT	SN	SUG	F	SF	SP	SPF
57	57	1419	56	62	171.5	95.6	55	1100	832	0.75636	17.4771	48.3439	35.5180	26.9486	15.5039	5	2	5	2	2	2	2
58	58	2123	80	70	297.7	165.8	111	1468	876	0.59673	13.1889	56.0904	33.9143	31.2388	20.9138	5	2	5	2	2	3	2
59	59	1280	45	50	175.5	106.1	81	1034	761	0.73598	15.6250	54.8437	31.6406	33.1562	25.3125	4	2	3	1	1	2	1
60	60	2298	111	80	253.8	165.5	77	1674	1526	0.91159	13.9252	44.1775	43.4725	28.8077	13.4030	5	2	4	3	3	3	2
61	63	1261	73	42	112.5	62.0	30	676	433	0.71450	13.3228	35.6860	52.1015	19.6669	9.5163	5	2	4	2	2	1	1
62	64	1647	75	49	201.7	108.3	91	795	594	0.74717	11.9004	48.9860	40.9836	26.3024	22.1008	4	2	2	2	1	1	1
63	65	3040	130	104	373.6	214.8	139	2134	2070	0.97001	13.6842	49.1579	38.4868	28.2632	18.2895	4	1	4	4	4	4	4
64	66	1429	44	44	224.8	104.4	70	1061	813	0.76526	12.3163	62.9251	27.7117	29.2232	19.5941	4	1	3	1	1	1	1
65	67	1634	65	45	220.6	109.1	80	738	499	0.67515	11.0159	54.0024	35.8017	26.7075	19.5838	5	2	3	2	1	0	0
66	68	1749	69	56	228.4	100.0	50	1211	869	0.71576	12.8073	52.2356	35.5060	22.8702	11.4351	4	1	3	2	2	2	2
67	69	1293	56	50	152.1	110.9	65	1060	1069	1.00849	15.4679	47.0534	38.9791	34.3078	20.1083	5	2	4	2	2	2	2
68	70	1306	69	46	124.5	42.6	37	580	198	0.34138	14.0888	38.1317	47.5498	13.0475	11.3323	4	1	1	2	0	0	0
69	71	2812	135	71	335.9	181.0	170	1047	337	0.32187	10.0996	47.7809	43.2077	25.7468	24.1821	4	1	4	3	3	2	2
70	72	483	25	17	48.2	13.9	8	234	199	0.85043	14.0787	39.9172	46.5839	11.5114	6.6253	3	0	0	1	0	0	0
71	73	1497	65	54	180.6	140.3	98	1071	1207	1.12698	14.4289	48.2565	39.0782	37.4883	26.1857	2	0	2	2	2	2	2
72	74	1904	127	49	146.7	73.0	33	924	700	0.75758	10.2941	30.8193	60.0315	15.3361	6.9328	4	1	3	3	3	2	2
73	75	1480	53	60	196.2	104.2	68	927	759	0.81877	16.2162	53.0270	32.2297	28.1622	18.3784	4	1	3	1	1	1	1
74	76	2432	95	71	334.7	193.7	129	1451	1271	0.87595	11.6776	55.0493	33.5263	31.8586	21.2171	4	1	4	3	3	3	3
75	77	999	32	42	135.4	67.9	42	747	760	1.01740	16.8168	54.2142	28.8288	27.1872	16.8168	4	1	4	1	1	2	1
76	78	1195	64	60	95.4	39.8	32	798	263	0.32957	20.0837	31.9331	48.2008	13.3222	10.7113	4	1	3	2	1	1	1
77	79	1874	76	45	256.0	102.3	90	888	459	0.51689	9.6051	54.6425	36.4995	21.8356	19.2102	4	1	4	3	3	2	2
78	80	1732	67	57	230.5	125.3	71	1187	938	0.79023	13.1640	53.2333	34.8152	29.9376	16.3972	5	2	3	3	3	3	3
79	81	1751	97	72	158.4	57.1	42	1151	709	0.61599	16.4477	36.1850	49.8572	13.0440	9.5945	5	3	2	4	2	1	1
80	82	1959	98	54	219.0	95.3	73	852	622	0.73005	11.0260	44.7167	45.0230	19.4589	14.9056	4	1	3	3	3	2	2
81	83	2074	77	72	278.4	128.1	90	1554	1222	0.78536	13.8862	53.6933	33.4137	24.7059	17.3578	5	2	5	3	3	4	2
82	84	4171	225	184	364.5	115.9	77	2657	1012	0.38088	17.6456	34.9556	49.5495	11.1148	7.3843	6	3	4	5	3	3	2
83	85	2353	97	69	310.0	206.4	161	965	534	0.55337	11.7297	52.6987	37.1016	35.0871	27.3693	5	2	5	3	3	2	2
84	86	2337	90	67	318.2	201.5	120	1116	718	0.64337	11.4677	54.4630	34.6598	34.4887	20.5392	4	1	4	4	4	2	2
85	87	1614	67	48	205.8	95.3	64	1015	737	0.77537	11.8959	51.0037	37.3606	23.6183	15.8612	4	1	4	2	2	2	2
86	88	1961	93	45	242.9	103.3	75	822	509	0.61922	9.1790	49.5461	42.6823	21.0709	15.2983	6	3	4	3	2	1	1
87	89	1996	81	68	257.2	163.8	110	1243	910	0.73210	13.6273	51.5431	36.5230	32.8257	22.0441	5	2	5	3	3	2	2
88	90	1049	43	43	111.1	25.9	136	623	373	0.59872	16.3966	42.3642	41.1821	9.8761	51.8589	4	1	1	2	1	0	0
89	91	2600	109	99	307.7	106.2	58	1731	1125	0.64991	15.2308	47.3385	37.7308	16.3385	8.9231	5	2	5	4	4	4	4
90	92	3676	187	66	438.3	100.3	79	1504	736	0.52926	7.1817	47.6931	45.7835	10.9140	8.5963	4	2	2	4	2	1	1
91	93	2119	78	78	289.3	183.2	110	1253	809	0.64565	14.7239	54.6107	33.1288	34.5824	20.7645	4	2	4	3	3	2	2
92	94	1832	74	58	233.1	92.5	58	1192	941	0.78943	12.6638	51.3319	36.3537	20.1965	12.6638	5	2	5	3	3	2	2
93	95	1431	65	53	162.0	57.9	40	838	398	0.47494	14.8148	45.2830	40.8805	16.1845	11.1810	4	1	2	1	1	1	1
94	96	2513	112	68	307.3	140.4	45	1338	763	0.57025	10.8237	48.9136	40.1114	22.3478	7.1628	5	2	5	3	3	3	3
95	97	965	40	47	103.6	41.0	13	616	339	0.55032	19.4819	42.9430	37.3057	16.9948	5.3886	3	0	2	2	1	1	1
96	98	2806	122	96	333.0	145.8	71	1912	1470	0.76883	13.6850	47.4697	39.1304	21.3542	10.1212	6	3	5	3	3	4	3
97	99	1668	74	51	200.4	98.3	73	822	526	0.63990	12.2302	48.0576	39.9281	23.5731	17.5060	4	1	3	3	3	1	1
98	100	3032	125	93	403.0	240.8	118	1907	1615	0.84688	12.2691	53.1662	37.1042	31.7678	15.5673	4	1	4	4	4	4	4
99	101	1824	87	62	201.0	91.7	50	1107	802	0.72448	13.5965	44.0789	42.9276	20.1096	10.9649	4	1	3	2	1	1	1
100	102	1935	85	85	214.0	125.5	59	1414	1121	0.79273	17.5711	44.2377	40.0000	25.9432	12.1964	4	1	4	3	3	3	3
101	103	1996	101	70	206.2	96.4	74	1070	687	0.64206	14.0281	41.3226	45.5411	19.3186	14.8297	5	2	3	3	2	0	0
102	104	2135	96	80	244.8	128.7	77	1381	932	0.71108	14.9883	45.8642	40.4684	24.1124	14.4262	5	2	4	3	2	2	1
103	105	2777	137	113	219.5	105.9	68	1798	1512	0.85762	16.2766	31.6169	44.4004	15.2539	9.7947	3	0	3	4	3	2	2
104	106	1095	45	50	122.4	59.0	41	749	494	0.65955	18.2648	44.7123	36.9863	21.5525	14.9772	4	2	2	2	1	0	0
105	107	2455	105	66	320.8	174.1	138	1088	959	0.88143	10.7536	52.2688	38.4929	28.3666	22.4847	5	2	5	2	2	1	1
106	108	831	33	19	120.6	79.1	54	578	484	0.83737	9.1456	58.0505	35.7401	38.0746	25.9928	3	0	2	2	1	1	0
107	109	2058	82	61	277.1	130.2	109	1115	792	0.71031	11.8562	53.8581	35.8601	25.3061	21.1856	5	2	5	2	2	2	2
108	110	2240	78	79	313.2	189.6	122	1557	1208	0.77585	14.1071	55.9286	31.3393	33.8571	21.7857	4	1	4	2	2	3	2
109	111	2467	101	62	336.1	172.6	131	1251	899	0.71863	10.0527	54.4953	36.8464	27.9854	21.2404	4	2	2	2	2	2	2
110	112	2002	89	66	242.5	127.1	105	1151	772	0.67072	13.1668	48.4515	40.0100	25.3946	20.9790	5	2	4	3	3	3	3
111	113	2206	107	71	246.7	134.9	112	1144	724	0.63287	12.8740	44.7325	43.6537	24.4606	20.3083	6	3	5	3	3	1	1
112	114	1957	83	44	252.7	155.6	105	722	563	0.77978	8.9934	51.6505	40.4701	31.8038	21.4614	5	2	5	3	3	1	1

DIETARY VARIABLES — 11:18 THURSDAY, APRIL 19, 1984

OBS	SUBJECT	E	FAT	PRO	N45	N46	SUCR	P	CA	CAPRAT	PPRO	PCHO	PFAT	PSUG	PSUCP	TOT	SN	SUG	F	SF	SP	SPF
113	115	1991	53	61	309.9	180.8	123	1123	848	0.75512	12.2551	62.2602	26.2180	36.3235	24.7112	6	3	5	2	2	2	2
114	117	1992	93	66	242.0	98.9	75	904	447	0.49447	13.2530	48.5944	39.7590	19.8594	15.0602	5	2	4	2	1	1	1
115	118	1315	54	57	151.0	53.2	42	829	538	0.70929	17.3384	45.9316	36.9582	16.1825	12.7757	2	0	2	2	2	1	1
116	119	1379	72	91	213.5	92.9	62	1238	524	0.42325	19.3720	46.5141	34.4864	19.7765	13.1985	4	1	3	2	1	2	1
117	120	2074	85	58	276.8	112.5	83	809	365	0.45117	11.1861	53.3848	36.8852	21.6972	16.0077	6	3	4	3	2	1	1
118	121	1640	83	60	164.6	96.9	73	964	871	0.90353	14.6341	40.1463	45.5488	23.6341	17.8049	5	2	4	3	2	2	2
119	142	1702	76	69	190.1	97.7	50	1063	959	0.90216	16.2162	44.6769	40.1880	22.9612	11.7509	4	1	4	2	2	2	2
120	143	1288	51	39	172.0	98.0	74	814	761	0.93489	12.1118	53.4161	35.6366	30.4348	22.9814	4	3	2	1	1	1	1
121	144	2219	84	55	314.6	168.4	148	1137	772	0.67898	9.9144	56.7102	34.0694	30.3560	26.6787	5	2	4	3	3	2	2
122	145	2187	104	74	242.0	105.4	55	1189	1127	0.94786	13.5345	44.2615	42.7984	19.2775	10.0594	5	2	3	3	3	2	2
123	146	2020	84	70	249.9	119.2	66	1039	634	0.62945	13.8614	49.4851	37.4257	22.8119	13.0693	4	1	4	4	4	1	1
124	147	1418	65	56	154.0	51.3	44	990	818	0.82626	15.7969	43.4415	41.2553	14.4711	12.4118	4	1	2	2	1	2	1
125	148	1072	35	30	160.0	66.2	40	464	510	1.09914	11.1940	59.7015	29.3843	24.7015	14.9254	4	2	2	1	1	1	1
126	149	2099	123	63	193.0	69.4	34	1292	912	0.70588	12.0057	36.7794	52.7394	13.2253	6.4793	4	2	2	3	3	3	3
127	150	2063	73	54	293.8	167.9	134	1026	768	0.74354	10.4702	56.9656	34.0281	32.5545	25.9816	5	2	5	4	4	1	1
128	151	1745	75	71	202.1	120.9	65	1122	635	0.56595	16.2751	46.3266	39.1977	27.7135	14.8997	5	2	4	4	3	1	1
129	152	748	31	25	95.0	44.4	21	315	218	0.69206	13.3690	50.8021	37.2995	23.7433	11.2299	3	0	3	2	2	0	0
130	153	2825	151	84	244.5	134.6	105	1468	989	0.67371	11.6938	34.6195	48.1062	19.0584	14.8673	5	2	4	3	3	2	2
131	154	1214	51	31	163.3	67.4	42	655	580	0.88550	10.2142	53.8056	37.8089	22.2076	13.8386	5	2	4	1	1	0	0
132	155	2482	119	107	249.5	114.0	74	1791	1324	0.73925	17.2442	40.2095	43.1507	18.3723	11.9259	5	2	5	4	4	2	2
133	156	1908	90	72	204.5	109.3	84	1249	955	0.76461	15.0943	42.8721	42.4528	22.9140	17.6101	6	3	5	3	2	1	1
134	157	1331	71	41	134.6	62.7	45	684	297	0.43421	12.3216	40.4508	48.0090	18.8430	13.5237	2	0	2	2	2	2	2
135	158	1852	71	62	250.8	84.3	39	1378	1006	0.73004	13.3909	54.1685	34.5032	18.2073	8.4233	5	2	4	2	2	3	2
136	159	1753	80	60	200.9	69.0	49	927	479	0.51672	13.6908	45.8414	41.0724	15.7444	11.1808	5	2	3	3	2	1	1
137	161	1118	36	50	152.7	90.1	33	1170	1112	0.95043	17.8891	54.6333	28.9803	32.2361	11.8068	5	2	4	1	1	2	1
138	162	1556	60	50	207.0	106.0	83	864	647	0.74884	12.8535	53.2134	34.7044	27.2494	21.3368	5	2	4	2	2	1	0
139	163	1807	86	66	197.5	108.1	77	1029	698	0.67833	14.6099	43.7189	42.8334	23.9292	17.0448	5	2	4	4	4	2	2
140	164	1300	51	32	173.7	109.7	78	643	469	0.72939	9.8462	53.4462	35.3077	33.7538	24.0000	6	3	4	1	1	2	1
141	165	2085	85	67	266.2	108.1	65	1483	1149	0.77478	12.8537	51.0695	37.1223	20.7386	12.4700	5	2	4	2	2	3	2
142	166	2375	117	72	266.4	136.2	102	1370	1017	0.74234	12.1263	44.8674	44.3368	22.9389	17.1789	4	1	4	3	3	3	3
143	167	2007	114	70	182.6	97.3	60	1036	677	0.65347	13.9512	36.3926	51.1211	19.3921	11.9581	6	3	4	3	3	2	2
144	168	2099	92	80	239.0	133.7	105	1018	440	0.43222	15.2454	45.5455	39.4474	25.4788	20.0095	5	2	4	3	3	2	2
145	169	2349	100	64	307.7	152.5	105	1290	1107	0.85814	10.8983	52.3968	38.3142	25.9685	17.8799	5	2	5	3	3	3	3
146	170	1638	83	83	129.7	27.9	13	1039	587	0.56497	20.2686	31.4286	48.3515	6.8132	3.1746	3	1	2	2	2	2	2
147	171	1844	87	63	206.4	99.5	72	1201	810	0.67444	13.6659	44.7722	42.4620	21.5835	15.6182	6	3	4	3	3	3	3
148	172	1481	68	41	186.5	82.5	55	863	556	0.64426	11.0736	50.3714	41.3234	22.2822	14.8548	5	2	4	2	2	2	1
149	173	1330	51	53	164.4	74.2	59	941	753	0.80021	15.9398	49.4436	34.5113	22.3158	17.7444	4	2	2	2	2	2	2
150	174	1205	58	38	135.8	73.0	42	687	543	0.79039	12.6141	45.0788	43.3195	24.2324	13.9419	4	1	3	2	2	2	2

Legend for Dietary Variables

OBS = Observation
E = Energy (Kcal)
Fat = Total Fats (g)
Pro = Total Proteins (g)
N45 = Total Carbohydrates (g)
N46 = Total Sugars (g)
Sucr = Sucrose (g)
P = Phosphorus (mg)
Ca = Calcium (mg)
CAPRAT = Ca:P ratio
PPro = Percent of Energy from Total Proteins
PCHO = Percent of Energy from Total Carbohydrates
PFat = Percent of Energy from Total Fats
PSug = Percent of Energy from Total Sugars
PSucr = Percent of Energy from Total Sucrose
Tot = Total number of meals/snacks per day in which any total sugars were eaten
Sn = Total number of snacks per day in which any total sugars were eaten
Sug = Total number of meals/snacks per day in which 10 g or more of total sugars were eaten
F = Total number of meals/snacks per day in which 12 g or more of fat was eaten
SF = Total number of meals/snacks per day in which at least 10 g of total sugars _and_ 12 g of fat were eaten together
SP = Total number of meals/snacks per day in which at least 10 g of total sugars and 250 mg of phosphorus were eaten together
SPF = Total number of meals/snacks per day in which at least 10 g total sugars, 12 g fat, and 250 mg _of_ phosphorus were eaten together

VITA[2]

Kathryn Louise Miller

Candidate for the Degree of

Master of Science

Thesis: RELATIONSHIPS BETWEEN DIET AND DENTAL CARIES IN ADOLESCENT FEMALES

Major Field: Food, Nutrition, and Institution Administration

Biographical:

Personal Data: Born January 6, 1948, in Detroit, Michigan, the daughter of Dr. and Mrs. T.W. Miller; married to Bruce B. Mays: children, Jennifer Ann and Laura Kathryn.

Education: Graduated as Valedictorian from Shattuck High School, Shattuck, Oklahoma, in May, 1966; attended Oklahoma University at Norman, Oklahoma, 1966-69; received Bachelor of Science from Oklahoma State University in July, 1970, with a major in Food, Nutrition, and Institution Administration; completed requirements for Master of Science degree at Oklahoma State University in December, 1984.

Profession Experience: Dental Assistant (during summers), Shattuck, Oklahoma, 1960-66; Dental Assistant, Portales, New Mexico, 1970-73; Graduate Teaching Assistant, Food, Nutrition, and Institution Administration, Oklahoma State University, Stillwater, Oklahoma, August to December, 1982; Graduate Assistant Nutritionist for Oklahoma State University Preschool Programs, Family Relations and Child Development, Oklahoma State University, Stillwater, Oklahoma, January to December, 1983.

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