INTRA-FAMILY PATTERNS OF DENTAL HEALTH STATUS AND BEHAVIOURS

A STUDY OF BRAZILIAN FAMILIES

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For Paul and Edésio

with whom
my path
has become
lighter and brighter
This study tested the hypothesis that because families shared similar patterns of behaviour, the children would reflect, in their own dental health status, the dental status of their parents.

The sample consisted of 164 randomly selected Brazilian nuclear families, equally distributed in four social classes. All family members were clinically examined (861 subjects), and those at the age of 10 and above (717 subjects) were interviewed. Dental status (DMFS) and oral hygiene (ODI-S) were assessed, and information on dental health related behaviours (sugar consumption, oral hygiene habits, and pattern of dental attendance) was collected. Data analyses included one-way analysis of variance, Pearson's correlation coefficient, Kruskal-Wallis analysis of variance, rank correlation tests, and path analysis.

Despite the homogeneous dental health status and related behaviours among families from different social backgrounds, statistically significant differences in dental health status and related behaviours were observed among the families from the four social classes.

Strong intra-family patterns of dental health status and related behaviours emerged. Path analyses revealed that familial aggregation explained 71% of the phenotypic variance (DMFS) in children, of which 54% was determined by biological inheritance and 17% by family environment; while the remaining 29% of the phenotypic variance was explained by environmental factors outside the family environment. For parents, environmental factors outside the family environment accounted for 68% of the phenotypic variance; while familial aggregation explained 32% of the variance, of which 15% was determined by biological inheritance and 17% by family environment.
It was concluded that dental caries experience fitted the liability and threshold model. For children, the environment had not had enough time to express itself, and the manifestation of dental caries was mainly determined by the biological factors. Since the environmental factors surrounding these children were fairly homogeneous, the biological determinant expressed itself more strongly. For parents, who have lived long enough in a 'hostile' environment above their threshold, environmental factors had enough time to manifest themselves, and the biological determinant became less important.
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PART I

THE STUDY
1.1. INTRODUCTION:

It is widely accepted that family members present similar patterns of oral health status. The reasons, however, for that resemblance seem to be still unsolved.

In the 1940's, a series of studies on the epidemiology of caries within members of the same family was carried out by Klein and co-workers. One of the first studies published analysed the pattern of disease between brothers and sisters (Klein and Palmer, 1940). An index child, aged 10 to 15 years, was allocated to a susceptible or immune group according to the number of decayed teeth that child would have. The brothers/sisters, aged 6 to 15, were then compared to the index child. A total of 184 'immune' families and 117 'susceptible' families were analysed. The brothers and sisters of susceptible children presented, on the whole, twice as many teeth and tooth surfaces attacked by caries as brothers and sisters of the immune child. Forty-six families contained two or more children who showed similarity in respect to caries immunity or susceptibility. Their results strongly suggested the existence of familial resemblance in caries experience for both dentitions among siblings.
The overall dental status of parents and offspring was also compared (Klein, 1946). The data were based on dental examinations of 5,400 individuals of Japanese ancestry residing in the USA, a total of 1,150 families. Individuals were divided in three groups according to their caries experience: low, medium, and high. The results showed a marked and consistent tendency for children to reflect, in their own dental health status, the status of their parents. When grouping families according to the caries experience of the parents, the 'like-mating' parents showing low DMF rates tended to have children with a DMF score 3 times lower than the children coming from a marriage whose parents were allocated to the high DMF group. Klein (1946) also reported that daughters from 'unlike-mating' parents resembled their mothers, whilst sons resembled the parent presenting the highest DMF. No explanation, however, was given to the pattern observed.

Klein (1947) investigated the pattern of dental caries within families coming from a community with fluoridated water for 19 years. The study population consisted of 123 fathers, 131 mothers and 205 children, aged 5 to 19 years. Parents and offspring were divided into low, medium and high DMFT. His findings confirmed his previous studies: children whose parents presented a high DMFT score had higher DMFT rates than those children whose parents showed a low caries experience. While exposure to fluoride since birth reduced the overall caries experience among children, the reduction was not sufficient to obscure the influence of a familial factor.

From these three studies Klein concluded that 'susceptibility to dental disease in children involves strong
familial vectors which very likely have a genetic basis ...' (Klein, 1946).

The dental health status of husbands and wives was also analysed (Klein and Shimizu, 1945). Their results were based on dental examinations of 3,490 Japanese married men and women. It was shown that the pattern of dental disease expressed in terms of DMFT was similar for husbands and wives. This similarity in dental status was present in young and old couples. Since the genetic explanation of the disease could not stand for biologically unrelated individuals, the theory of 'assortative mating' was raised, that is mates would tend to choose to marry those who were similar to them. This, in turn, could be an indirect expression of similar socio-economic origin of partners (Klein and Shimizu, 1945).

Thirty years later, a follow-up study of the children who participated in Klein and Palmer's (1940) study was carried out by Ringelberg and co-workers (1974). Forty-three percent of the then children were located, of which 65.5% consented to be re-examined: 110 propositi and 331 members of their families. The authors not only analysed their current dental status but also the dental status of their children and parents, making a three-generational study. A strong familial aggregation for age-adjusted DMFS scores was reported. Their results also showed that a child's dental health status was closely related to his/her mother's current dental status and the mother's dental experience as a child, rather than with their fathers. In spite of not being able to show a statistically significant association between grandchildren and grandmothers, a strong tendency towards an association between them was demonstrated.
The results also showed some merging of DMFS scores between spouses after marriage. The time during which the merging occurred, however, could not be defined. When trying to explain the strong family pattern in caries experience observed, and after considering several reasons for such a pattern, the authors seemed to believe that similarity was primarily consequent to a similar type of cariogenic oral flora family members might carry.

Similar results were reported by Garn and co-workers on a series of three papers on family resemblance in dental caries experience. Their studies were very similar to Klein's, comparing the dental status of husband and wives (Garn et al, 1977), parents and offspring (Garn et al, 1976a), and among siblings (Garn et al, 1976b).

Garn and co-workers (1976b) studied 16,000 pairs of siblings, 8,700 of which were blacks and 7,300 whites. Age ranged from 7 to 18 years. For each age, DMFT correlations were calculated for boys and girls separately, and for blacks and whites separately. The sibling correlations found were systematically positive, approximating 0.26 for whites and 0.40 for blacks. It was also observed that correlations among sibs increased with age.

Garn and co-workers (1976a) published a report on the similarities in caries experience in parents and offspring. Age-adjusted DMFT scores of 6,580 parent-child pairs, of which 4,050 were whites and 2,505 were blacks, were correlated. Their findings suggested that, for both racial groups, mother-child similarities in DMFT scores were higher than father-child similarities. It was also noted that correlation coefficients
between parents and offspring increased as the age of the child increased.

The last of Garn's studies on familial pattern of caries experience analysed similarities among 1,800 spouse pairs, 1,275 of which were whites and 525 were blacks (Garn et al, 1977). Husband-wife DMFT correlations were positive for both blacks and whites, increasing with the age of the spouses. The fact that very young couples (age midpoint 20 years) showed a positive correlation in DMFT scores seemed to suggest social homogamy with regard to dental caries experience. The findings of this study support the findings of Klein and Shimizu (1945) who have also observed social homogamy for DMF scores and an increase in association in caries experience for older couples.

Garn's studies confirmed the familial pattern of caries experience described in other family studies. Since spouses are not genetically related individuals, the authors considered that the degree of association observed among family members could not be explained solely on a genetic basis. They, therefore, suggested that a common dietary regimen shared by family members could be a possible explanation of their findings.

The findings of these three groups of studies confirm the existence of a clear resemblance in dental health status among family members. Each group of researchers, however, hypothesised different reasons for the observed pattern of dental health similarity within families: genetics, transmission of oral bacteria, and dietary habits.

There are several investigations in the dental literature of these three hypotheses. The next section of this chapter
describes and discusses the evidence available. The genetic evidence of dental caries is presented first, followed by the behavioural studies. The transmission of oral bacteria, in spite of not being a topic of study of the present investigation, will then be briefly discussed.

1.2. REVIEW OF THE LITERATURE:

1.2.1. GENETIC EVIDENCE:

When trying to determine the absence/presence or the degree of genetic influence a trait may have, the researcher may opt for several types of study. The range of options varies from laboratory studies using animal breeding techniques to population studies, using epidemiological data, family data, twin data or adoptee data (Bodmer and Cavalli-Sforza, 1976). In the following review of the literature the genetic influence on dental caries using different techniques will be presented and discussed.

1.2.1.1. Animal Studies:

Laboratory research relies on the production of 'pure lines', made up of individuals with almost identical genotypes, by inbreeding repeatedly for many generations. By setting up homogeneous conditions of growth, animal breeders may reduce the effect of environmental variation from one individual to
another. These studies, therefore, assume that individuals from different lines or crosses are grown in what is, on average, the same environment. As no breeder is likely to be that successful in standardising environmental conditions, it must be remembered that variations observed may be a consequence of these environmental differences (Bodmer and Cavalli-Sforza, 1976).

Laboratory studies to determine the genetic influences on the development of dental caries have used mainly rats as the study animal. The extrapolation of the results of laboratory studies to humans must be treated with caution due to the obvious differences between laboratory animals and humans. Bearing in mind the shortcomings in the interpretation of the results of laboratory studies, some of these studies will now be briefly reviewed.

One of the first laboratory studies on the genetics of dental caries was published by Hunt and co-workers (1944). A caries susceptible strain and a caries resistant strain of albino rats were produced by selection, progeny testing, and close inbreeding from a group of heterogeneous rats. By the 7th generation a significant difference in time of caries onset was established between the susceptible and the resistant strains of albino rats, fed on a cariogenic diet.

Rosen and co-workers studied the genetics of dental caries using the caries-resistant and caries-susceptible strains of rats developed by Hunt and co-workers (1944). These animals were fed ad libitum on a cariogenic diet, and the time of onset of carious lesions on occlusal fissure of molars was analysed. Each strain maintained their characteristics when exposed to
the oral environment of the opposite strain, that is when litters were reared by mothers of the opposite strain (Rosen et al, 1961a) or when litters were infected directly with the oral microflora of the opposite strain (Rosen et al, 1961b). Furthermore, the caries-breeding of caries-resistant with caries-susceptible strains produced a strain of animals presenting an intermediate time of onset of carious lesions (Rosen et al, 1962). In the light of their findings, Rosen and co-workers concluded that the genetic constitution controlled the resistance (susceptibility) to dental caries of these rats. Their results should not be misinterpreted as the genetic factor being 'the only influence in determining whether a rat will develop caries. Certain environmental conditions must be met before genes influencing caries can express themselves' (Rosen et al, 1962).

In a similar type of study, Shaw and Griffiths (1961) determined the relative influence of the father, the natural mother and the foster mother on dental caries of the crossbred of caries-susceptible and cross-resistant strains. The individual caries experiences within the crossbred groups covered a very broad and continuous spectrum varying from very low to very high caries experience. However, the average caries experiences of the crossbreds was significantly higher than for the purebred rats of the caries-resistant strain and significantly lower than for the purebred rats of the caries-susceptible strain. The male and female parent exerted equal influence on the caries experience of the offspring, while the foster mother had very little effect. Despite mentioning briefly the role of a cariogenic diet in the development of
dental caries, these authors seemed to believe that heredity was the main determinant of the dental caries experience of the purebred and crossbred strains since they concluded that '... the phenotypic evidences of caries activity under the standardized conditions of the experiment were true measures of the inherited tendencies toward various levels of caries-susceptibility' (Shaw and Griffiths, 1961).

In view of their conclusion it becomes important to stress once more the fact that 'no mouse breeder is likely to be that successful in standardizing environmental conditions. Some mice may find more food, others less. Many factors - including, for example, infections - that the breeder is unable to control may add to the variation' (Bodmer and Cavalli-Sforza, 1976 p.444). The spread of the distribution of caries experience in the crossbred rats (Shaw and Griffiths, 1961) raises, therefore, two hypotheses: this continuous variation could be a consequence of either environmental variation or polygenic systems (that is, many genes affecting a trait and their effect being cumulative) (Bodmer and Cavalli-Sforza, 1976). For dental caries both hypotheses seem to be a reasonable explanation for the range of observations.

In order to determine whether the variation is environmental or has a genetic basis, the researcher should partition the variance into fractions, each of which will have a specific meaning (Bodmer and Cavalli-Sforza, 1976). Path analysis is an example of such a procedure. Even the procedure of variance partitioning has its shortcomings, and a conscientious researcher should be very careful in drawing conclusions from this type of analysis.
Shaw and Griffiths' (1961) conclusion that their findings were 'true measures of inherited tendencies' should be considered with care because no attempt was made to analyse the variance in caries experience among crossbred offspring. This variation in turn could well be a consequence of some environmental variance that even the most careful breeders are unable to avoid.

The studies of Rosen and co-workers (1962) and Shaw and Griffiths (1961) showed very similar results. In fact both groups of researchers seemed to have developed that particular experiment as a reply to Keyes (1960). Keyes showed that caries could be induced in caries-inactive animals by exposure to the oral microflora of caries-active animals.

Still in the 1960's Larson published a series of articles on the genetic and environmental influences on dental caries in rats. Her work seems to be a defence of Keyes' earlier conclusion of the transmissibility of dental caries against the conclusion of the genetic role in the establishment of dental caries by Rosen and Shaw and Griffiths. Some of her studies will now be described.

In 1965, Larson and Simms published two reports on the genetic and environmental influences on dental caries in two strains of rats: caries-susceptible Osborne-Mendel (OM) and caries-resistant NIH black (BR) rats. Purebred and crossbred animals were obtained in two ways: a female was double mated with a male of its own strain and with a male of the opposite strain at the same time (Larson and Simms, 1965a), or by a simple crossbreeding (Larson and Simms, 1965b). The litters in both experiments were caged with like-mates and unlike-mates.
Caries recording was assessed not only by the number of teeth affected but by the location of the lesions. The results showed that purebred OM rats showed a higher caries activity than the BR rats under all experimental conditions. The total level of caries activity of all crossbred offspring, under all experimental conditions, was higher than that observed for the resistant BR strain but lower than that experienced by the susceptible OM strain. The authors considered two possible explanations for their findings. First, heritable factors may explain the difference in the location and number of lesions observed. Second, the experimental challenges could have been conducive to disease in one strain rather than in the other (Larson and Simms, 1965a, 1965b).

After the publication of these reports, several other similar studies on the genetics of dental caries, using rats, were published. Their results confirmed what had been published previously: different strains of rats displayed different susceptibility to dental caries, when caged with like-mate or unlike-mates (Huxley, 1968, 1969, 1970, 1974a) or when the oral microflora was controlled (Grenby and Owen, 1980).

The results of all the laboratory studies reviewed here are all very similar. Different strains of rats present different caries activity levels, but every one of the strains studied, given an adequate cariogenic diet, developed carious lesions. All the studies assumed that environmental conditions were similar for all experimental groups, but no attempt was made to measure dietary intake of the different strains.

In all the studies discussed here, caries-susceptibility or -resistance was measured either by the length of time for a
occlusal carious lesion to be diagnosed or by the number, extension and location of lesions. While in the susceptible strains, a lesion would be observed within a few days or in greater numbers and extension, the resistant strains would be characterised by fewer and smaller lesions or a longer time for their onset. It is important to note that in both groups dental caries was diagnosed. As stated by Rosen and co-workers (1961a), an 'absolute resistance has never been attained by breeding; and resistance can be at best only relative' (Rosen et al, 1961a). A new concept should be developed from these studies, what was under investigation was not the genetics of dental caries but the liability to it.

Liability expresses not only the individual's innate tendency to develop or contract a disease but also the whole combination of external circumstances that makes that individual more or less likely to develop the disease (Falconer, 1965; Hartl and Clark, 1989). For dental caries, the most important factor in the establishment of the disease is the consumption of a cariogenic diet. In the studies above, all rats were fed on a highly cariogenic diet, and all developed carious lesions, some taking longer than others for carious lesions to develop, or having some more lesions than the others. Therefore, it is not the susceptibility or resistance to a disease which is being investigated but the variation in liability or a threshold (Hartl and Clark, 1989). Given an adequate diet for a sufficient length of time, all animals developed dental caries, all of them being susceptible to it. The threshold, however, varied between the two strains.
The possible mechanisms suggested for the role of heredity on the dental caries liability of different strains were differences in morphology or chemistry of teeth; differences in the quality and quantity of saliva; and differences in eating and drinking habits of the strains. Besides, it has also been suggested that experimental challenges could have been more conducive to disease in one strain than in the other.

The latter explanation will be considered first. Genotype-environment interaction, that is, different reaction to various environments for different genotypes, is a possible bias when studying environmental and genetic determinants of a trait (Bodmer and Cavalli-Sforza, 1976). Bodmer and Cavalli-Sforza (1976) described an interesting experiment with rats in which the potential bias of genotype-environment interaction was shown. When maze-dull and maze-bright rats were raised in enriched and favourable conditions, both strains did equally well in the maze. Therefore, the genotypic difference between the two strains could only be revealed in specific environmental conditions. These findings confirm the fact that 'a heritability is strictly valid only for a given population under the particular conditions of measurement' (Bodmer and Cavalli-Sforza, 1976 p. 451).

Larson and Goss (1967) addressed this question in the following study. Three strains of rats; Osborne-Mendel (OM), NIH Black rats (BR) and Sprague-Dawley (SD); were fed on different cariogenic diets, and the caries activity and location of the lesions were analysed. The caries activity and location of lesions varied among the strains when similar diet was provided, the BR rats having the lowest caries activity.
Variation in caries activity and lesion location were observed within each strain as different dietary regimens were imposed.

A few years later Larson and co-workers (1968) studied the effect of different dietary regimens on Hunt-Hoppert caries-susceptible and -resistant rats. These were the two strains used in Rosen's experiments (Rosen et al., 1961a, 1961b, 1962). Their results showed that in one of the dietary regimens, the caries-resistant strain presented half as many lesions as the caries-susceptible strain, most of the lesions being located in the sulci of both strains. As the dietary regimen was altered, the total number of lesions in both strains was virtually the same; the location of the lesions, however, differed between them. For the caries-resistant strain most of the lesions were located on smooth surfaces, whereas for the caries-susceptible the carious lesions were mainly in the sulci.

These findings confirm the hypothesis of genotype-environment interaction in the determination of caries activity in rats. For this reason, the studies presented here should be considered with care. Genetic endowment to caries should not be regarded as the sole explanation for the development of caries in rats. Environment, mainly through dietary regimen, should be regarded as a strong determinant in the establishment of this disease.

Among the heritable factors that may determine the differences in dental caries liability in different strains are differences in eating and drinking patterns. This aspect was addressed by König and co-workers (1969), when the eating pattern of susceptible Osborne-Mendel (OM) and resistant NIH Black (BR) rats was analysed. OM rats, when fed ad libitum,
consumed more food and took more frequent meals than BR rats. When both strains were subjected to a high-frequency eating pattern (36 meals/day), there was a sharp increase in caries activity of BR rats. The authors concluded that the low caries activity of BR rats was not due to lack of implantation of a cariogenic oral flora or to the inadequacy of caries test diet, but to their inborn habit of short and infrequent eating pattern, which resulted in infrequent presence of substrate for the development of carious lesions (König et al, 1969).

When studying the perinatal and growth-associated factors influencing dental caries in rats, Larson and co-workers have shown that the development of dental caries was dependent in part upon the level of 'maturation' of teeth in the animal at the time the animal was exposed to a cariogenic diet (Larson and Fitzgerald, 1964). Therefore, if two strains with different tooth eruption times are compared, those rats with early eruption will have more mature teeth when exposed to a cariogenic diet and, consequently, show less caries. Besides, Larson's research team also showed that caries experience in rats was also related to initial body weight at the time of exposure to cariogenic diet and the rate of growth as measured by body weight (Chung et al, 1968). These factors may well explain the differences in dental caries liability experienced by different strain of rats.

In conclusion animal studies on dental caries have shown that given adequate environmental conditions for a sufficient length of time, animals tend to develop carious lesions. What varies among the different species is the threshold at which an animal will develop the disease. Therefore, not the
resistance/susceptibility to dental caries but the liability to it was the object of investigation. The possible mechanisms for such differences may be related to simple factors such as dietary patterns, tooth eruption time, and body growth.

The next section of this literature review will describe and discuss the genetic evidence of dental caries based on human population studies.

1.2.1.2. Population Studies:

In the late 1960's and throughout the 1970's, Jackson and co-workers published a series of reports on the patterns of site attack by dental caries. They studied the caries pattern on the mesial, distal and lingual pits of permanent maxillary incisors (Jackson, 1968; Jackson, 1971; Jackson and Fairpo, 1973), on the mesial and distal surfaces of permanent mandibular incisors (Jackson et al, 1972; Jackson et al, 1975), on permanent molars (Akpata and Jackson, 1978), amongst others. Their work emphasised the numbers of subjects having either one or both members of a pair of incisor sites decayed or filled. The pattern of caries attack was divided in 3 main categories: adjacent approximal surfaces (single/double attacks), mesial and distal surfaces of the same tooth (unilateral/bilateral attacks), and corresponding sites on the left and right sides of the mouth (asymmetric/symmetric attack).

It was observed that the ratio of subjects with single/double, unilateral/bilateral, or symmetrical/assymetri-
cal fell to a limiting value with age. This limiting value was always above zero, indicating that there were always some subjects with only one member of the pair of sites under study decayed or filled, whilst the other was sound. The authors showed that this limiting value was reached at different levels and at different ages according to the pair of sites under study. Once this limiting value was achieved, it remained stable throughout the lifetime of the subject.

The fact that one pair of the sites under study remained sound while the other succumbed to caries was then interpreted as evidence for two types of sites: caries-resistant and caries-susceptible. The susceptibility/resistance to caries, according to Jackson and co-workers, was dependent on the genotype of the subject. It was also proposed that the susceptibility of specific sites to caries attack was determined by 'auto-aggressive' attacks on odontoblasts, which in turn would make the associated hard tissue susceptible to the development of the carious lesion.

Jackson's work has been subjected to criticisms. Sofaer (1982) assessed Jackson's findings and showed that the commonly accepted theory on the aetiology of dental caries (environmental factors) easily explained the pattern of caries attack described by Jackson and co-workers. Sofaer (1982) raised the question that while evidence had yet to be demonstrated to prove Jackson's theory, the role of environmental factors in the development of dental caries had been demonstrated by independent reports.

Among other criticisms, the methodology of Jackson's works was first discussed by Sofaer (1982). In most of Jackson's
reports, the study population consisted of subjects, aged 15 years and above, drawn from three different geographical areas. Information on their dental status was obtained from the first-visit diagnosis NHS cards of different dental surgeries. Sofaer (1982) argued that this method was not adequate for drawing conclusions on the heritability of a trait. It was postulated that the study of inheritance demanded the use of related individuals; therefore, 'the only way to demonstrate a genetic basis for the observed difference would be to study the distribution of individuals with these particular patterns of site attack in families' (Sofaer, 1982). This view is also supported by Osborne (1963), who stated that 'when a disease is sufficiently common that the number of index cases that can be obtained will be in the hundreds, familial concentrations can be compared with population incidences, and larger incidences in families relative to the latter can be interpreted as evidence for some hereditary component' (Osborne, 1963).

The fact that Jackson's results showed some degree of symmetry in the pattern of dental caries attack, especially when a mirror image pattern of site attack was observed (Jackson and Fairpo, 1973; Jackson et al, 1975), cannot be considered as evidence for a genetic susceptibility to dental caries. On the contrary, common constitutional and local environmental factors such as tooth morphology, tooth position, salivary composition, diet, and oral hygiene practices can be used as a logical explanation for such a pattern of caries attack (Sofaer, 1982).

Another point that should be discussed about Jackson's studies is the limiting ratio value. The fact that this value
never reached zero, that is, in some subjects only one site became carious, can be explained by an increase in enamel resistance with increasing exposure to the oral environment (Sofaer, 1982). Therefore, there is no evidence from Jackson's findings to support the genetic determination of caries susceptibility/resistance.

Jackson's theory on the genetic aetiology of dental caries fits well into the 'biological determinism' of a trait, that is, the idea that the variation in human traits is due more to its biology than to its cultural history (Edlin, 1990). The dangers of such a philosophy is well described by Edlin (1990), using pellagra as an example. In the beginning of this century in the USA, Goldberg showed that pellagra was a disease of poverty. However, Davenport, an eugenicist who headed the Pellagra Commission, believed that this disease was totally determined by genes. Davenport's views greatly influenced public health policies in the USA in the first half of this century and prevented the dietary changes necessary to save the lives of many individuals who were too poor to afford adequate diets (Edlin, 1990). Therefore, 'biological determinism' can cause serious consequences for individual people and for society if such data are used to influence social attitudes and governmental policies.

A final point to raise about Jackson's 'biological determinism' of dental caries is that his views in no way explain the epidemiological evidence of the rapid increase in caries experience in some populations. With dietary changes brought about by the introduction of high sugar containing foods, low caries populations became high caries within one
generation as observed in the studies of Innuits (Bang and Kristoffersen, 1972) and Tristan da Cunhans (Fischer, 1968) among others. 'Biological determinism' also fails to explain the improvement in dental health status of children in different countries during wartime (Takeuchi, 1961; Alanen et al, 1985). Lastly it is important to stress that 'biological determinism' neither explains the differences in caries prevalence among Israeli workers: those working in a sweet factory showed a larger caries experience than those working in a textile factory (Anaise, 1978). Should we understand from this, if we are to believe in 'biological determinism', that workers in a sweet factory are genetically different from textile factory workers in regard to caries susceptibility? The assumption that dental caries is simply explained by genes should not only be refuted but also combatted due to the consequences it may bring to the society.

In an attempt to investigate caries experience in different populational groups, Chung and co-workers (1970) analysed nearly 10,000 Hawaii's school-children, aged 12 to 20 years, from different racial origins. Demographic data were collected for the schoolchildren including, among others, father's occupation, race of parents, birth order, maternal age at birth, illness during pregnancy, and labour. Caries was more prevalent among children of Japanese, Korean, or Hawaiian origins, followed by Chinese. Children of Caucasian, Puerto Rican, or Filipino origins had the lowest level of caries experience. No evidence of maternal influence and hybridity was demonstrated. In spite of the observed differences in caries prevalence among children of different races and since no
attempt was made to investigate dietary intake and eating habits of these children, the authors did not seem to believe that such differences were caused by genetic heritability.

The use of different races in the determination of the genetic component of a trait is based on the rationale that, due to a relative isolation in different environments, a particular race is formed by a group of individuals sharing common biological characteristics that distinguish them from other groups. This isolation makes it quite likely that the different races have different gene frequencies for the major genes controlling a trait. Some traits have been shown to be more common in certain races, for example sickle-cell anaemia and C haemoglobin anaemia, common among Africans, and thalassaemia, common among some European and Oriental populations. It is important to remember, however, that in addition to sharing common biological characteristics, individuals from similar races share common cultural characteristics, which probably develop through complex interactions with the biological characteristics (Cavalli-Sforza and Bodmer, 1971). For dental caries, a trait in which environmental factors are of utmost importance, the sole use of racial differences in the expression of the trait, without a thorough study of cultural and social differences among the races under study, in no instance can be used as evidence of the biological differences among them. As pointed out by Chung and co-workers (1970), biological differences in the prevalence of dental caries could not be proved since no attempt was made to measure cultural differences among the different races.
Another approach to demonstrating the role of genetic factors in the aetiology of a trait is to determine if there is any association with a genetic marker. The most common genetic markers in the literature are blood group systems (ABO or MN blood-group systems), HLA type, and phenylthiocarbamide (PTC) taste sensitivity. The assumption involving such studies is that if an association is observed, there may be a causal relationship, that is, the association may be due to multiple effects on the same gene (Emery, 1976).

There seems to be few dental studies involving genetic markers and dental caries experience. Among them it is worth mentioning the studies by Chung and co-workers (1964, 1965), using PTC taste sensitivity, and those of Aitchinson and Carmichael (1962) and Wilson and Green (1963), using the ABO blood-group system.

In 1964, Chung and co-workers investigated the caries prevalence in a racial isolate residing in southern Maryland, USA, with reference to PTC taste sensitivity. This isolate was composed of 5,000 strongly endogamous individuals. Fifteen surnames were common to that isolate (70% of the families), and before 1870 the majority of families had one of seven surnames. Due to the high degree of inbreeding the population was under intensive genetic, medical, and dental investigation. After collecting information of 2,200 subjects on DMFT, deft, PTC sensitivity, endogamy index among others, it was shown that inbreeding did not seem to influence deft and DMFT scores. When analysing the relationship between PTC sensitivity and caries prevalence, however, it was observed that in the deciduous dentition tasters of PTC exhibited significantly less caries.
(about 28%) than non-tasters. For the permanent dentition no association was found.

The possible explanations raised by the authors for the PTC effect on the primary dentition were different eruption times, different dietary patterns, and differences in the quality and quantity of salivary substances among tasters and non-tasters.

In an attempt to investigate these assumptions, Chung and co-workers (1965) conducted another study of the relationship between PTC taste sensitivity and caries prevalence. In this study they also investigated the secretor status of the ABO substances and the salivary thiocyanate level. The choice of analysing the salivary level of thiocyanate was based on the two facts. First, a similarity of the chemical structure of compounds that give the characteristic bimodal taste reactions like PTC and thiocyanate was observed. Second, thiocyanate was demonstrated to be a co-factor of bactericin of saliva (Chung et al, 1965). This study involved 137 deaf pupils aged 4 to 17 years. When two-tailed 't' tests were applied, no association between PTC taste sensitivity and dental caries experience in both dentitions was observed. However, when one-tailed 't' tests were used, their previous finding that PTC taste sensitivity was associated with a lower caries experience in the deciduous dentition was confirmed at the 5% level of significance. No relationship was observed between PTC taste sensitivity and caries experience in the permanent dentition. In relation to the other two variables studied: secretor status and salivary thiocyanate, no significant relationship was
observed among them and the caries experience in both dentitions.

As stated earlier, PTC taste sensitivity is a simple genetic marker commonly used in genetic investigations. Caution on the interpretation of the results from such studies is fundamental, however. If a large enough number of different studies are done between a particular genetic marker and a particular trait, the results of 1 in 20 of these studies might appear statistically significant by chance alone. This statistical problem is referred to as 'Bonferroni inequality'. One way to overcome this problem is the use of Bonferroni correction in the determination of the level of confidence: 
\[
\frac{(1 - \alpha)}{n}, \text{ where } (1 - \alpha) \text{ is the overall confidence probability and } n \text{ is the number of predictions.}
\]
Another approach would be to consider as a more appropriate level of statistical significance the value of 1% (p < .01) (Emery, 1976).

While in the first report of Chung and co-workers (1964) the p value observed was smaller than .01 (p < .01); in the second report (Chung et al, 1965), when a more accurate PTC threshold technique was applied, association was found significant at the 5% level (p < .05) using a one-tailed 't' test. In fact, when a two-tailed test is applied the significance level drops to 9% (t = 1.69, p > .09). Due to the 'Bonferroni inequality' (Emery, 1976), the results from Chung and co-workers should be treated with care: a positive association between PTC sensibility and caries prevalence in the deciduous dentition might have been observed merely by an effect of chance.
Blood-group system is another genetic marker frequently studied. Aitchinson and Carmichael (1962) studied 200 adult individuals from a hospital sample. Of these, 100 were caries-free and 100 had rampant caries. Rampant caries was diagnosed when all the teeth were carious. The blood type of the sample was determined, and $X^2$ was used in the data analysis. Their findings showed that less than expected number of blood A individuals were found among their caries-free individuals, while more than expected number of blood 0 individuals were found in the caries-free group. There seemed to be an association between the blood group and caries experience. However, since this study was confined strictly to blood grouping, no attempt was made to list any other observations. Therefore, to conclude that caries-experience is linked to blood-type group seems to be questionable.

Finally a report on the association of genetic markers and caries experience is that of Wilson and Green (1963), who studied the ABO blood-group, salivary secretion of agglutinogens and isogglutinins in 15 caries-immune and 17 caries-susceptible individuals. Age and caries prevalence were not given in the study. All blood groups were found in the caries immune; however, a large number of AB blood type individuals and a low number of A blood type individuals were found in the immune group. When $X^2$ analysis was performed, it was found a probability of .01 and .05 respectively of these observed frequencies occurring in a random sample. For the caries-susceptible subjects, only blood groups 0 and A were observed. This finding was not statistically significant. Secretors and non-secretors of agglutinogens and isogglutinins
were found in both caries-immune and caries-susceptible individuals.

Their results seemed to suggest that caries immunity was associated with AB blood group, while susceptibility was associated with A blood group. Before any discussion on a possible evidence of association between blood group and caries experience, considerations on the statistical technique employed should be developed.

The validity of the $X^2$ is dependent upon the expected frequencies in each cell. This is because the sampling distribution of $X^2$ approximates the chi-square distribution as the expected frequencies become large (infinite). Therefore, for practical purposes when the number of degrees of freedom is higher than 2, the $X^2$ test should not be used if more than 20% of the expected frequencies are less than 5 or when any expected frequency is less than 1 (Bland, 1987; Siegel and Castellan, 1988).

The sample size in the study by Wilson and Green (1963) was rather small - 15 for the immune group and 17 for the susceptible. Consequently, the expected frequencies were very low: more than 20% with less than 5 and 2 cells with less than 1, which invalidates the use of $X^2$. Their findings can only be confirmed by using a larger sample size. Besides, as the authors stated themselves, 'the importance of these findings should not be judged until a larger number of immunes is studied' (Wilson and Green, 1963).

Before closing the discussion on the population studies and dental caries, a final point, apart from philosophical or methodological aspects here discussed, should be made. All of
them seem to have overlooked the importance of the environment in the establishment of dental caries. All but one (Chung et al, 1970) did not even mention the possibility of environmental determination in caries development. All of them failed to measure such a role. Therefore, the population studies on caries experience should be viewed with extreme caution since some of their results may well be misleading, namely that biology is the major determinant of caries prevalence in a population.

1.2.1.3. Family Studies:

It is common knowledge that children resemble their parents. This resemblance can be detected in both physical and behavioural traits. This common knowledge can also be extended to dental health status. Many people seem to believe that 'Good/bad teeth run in families'. This is a common belief not only among the dental profession but also among lay people.

One way to investigate the heritability of a trait is to measure the similarity between relatives, mainly closely related subjects such as those in nuclear families. This approach was fostered in the last century by Sir Francis Galton, a cousin of Darwin (Bodmer and Cavalli-Sforza, 1976). With this aim in mind Galton developed statistical methods of analysis - regression coefficients. One of Galton's first studies was a comparison between fathers' and their son's height, using the regression coefficient as his statistical tool (Bland, 1987).
In the investigation of the oral health status, nuclear families have also been taken as the unit of study. This section will briefly review the most important investigations in this field.

Böök and Grahnén (1953) studied the dental health status among family members in Sweden. A group of 40 Swedish caries-free male conscripts for military service and 162 related individuals (fathers, mothers, brothers and sisters) formed the study group. As a control group, 23 Swedish susceptible male conscripts for military service and 91 related individuals were analysed. All the subjects had dental and medical examinations, and information on social and behavioural variables was also collected. The age-adjusted DMFT scores were smaller among family members of the caries-free propositi than among family members of the control group. Since the authors did not consider the environmental differences in the 2 groups as striking, they concluded that '... very likely the variability in caries resistance is appreciably determined by individual genetic factors' (Böök and Grahnén, 1953 p. 40). A polygenic mode of inheritance was suggested.

This study was carefully designed and the selection method, through military service which was compulsory for all Swedish males at the age of 20 years, provided a good sampling selection method. For logistic reasons the authors decided to concentrate their field work to high density population areas. Therefore, of the 55 caries-free propositi living in this area, forty subjects agreed to take part - a response rate of 73%. For the control group the authors failed to specify how many caries-susceptible individuals lived in this area and were
actually invited to participate in the study. However, from the description of the methodology, one assumes that 110 subjects were located in this area. If this was the case, of the 110 subjects that should have been invited to participate in the study, only 23 accepted to take part. A response rate as low as 21% for the group was obtained. As the authors themselves stated, it was difficult to get the cooperation of the control group and their families because they often did not understand why they had been selected. Therefore, a response rate of 21% is far too low for the control group to be considered unbiased. As no attempt was made to investigate the characteristics of the population who were not taking part in the study, the conclusions from this study are contentious.

When discussing the environmental characteristics of the two groups, Böök and Grahnén (1953) claimed that there were no major differences between them. However, a close look at the tables presented reveals that the two populations differed in two important ways. The first difference between the two groups is the geographic origin of the families: significantly more families from the caries-free group were raised in farming district than families from the caries-susceptible group. The second difference is related to sweet consumption: sibs of caries-susceptible families ate more sugar containing food than sibs of caries-free subjects (sweets and candy $p = .02-.05$; sweet desserts $p = .0027-.01$). The authors mentioned these findings and even stated that 'the findings might indicate that the diet of the A-families (caries-free) was less luxurious in comparison with the K-families (caries-susceptible)' (Böök and Grahnén, 1953, parentheses added by this author). Besides, Böök
and Grahnén (1953) seemed to suggest that such a difference was related to the different geographic origin of the two groups.

In spite of these differences in the two groups, Böök and Grahnén (1953) did not take them into consideration while discussing their results. Instead all the emphasis was given to biological differences, with no clear attempt to associate the pattern of caries experience to some of the environmental differences observed among the two groups. Besides, the homogeneity found between the two groups in relation to other environmental factors may well have been a consequence to the fact that individuals in the control group not being an unbiased sample of the susceptible group. On the whole, the genetic evidence provided by this study should not be considered irrefutable as sometimes it seems to be when this study is reviewed in the dental literature. The genetic assumption implied by this study, on the contrary, should be considered with caution due to the points raised in this discussion.

Another study of Swedish families was carried by Martinsson and Petersson (1972). Three-hundred and sixty 14-year-old children were chosen from schools according to their dental health status. From each class in sixty schools, the three children with the lowest number of decayed-filled surfaces were selected to form the low caries group (L-group). The high-caries group (H-group) was composed of the three children in each class having the highest number of decayed-filled surfaces. Information on dental status of 516 biological parents was collected through clinical and radiographic examinations. The oral health status of the parents of the L-
The dental status and the dietary habits of 44 'caries-resistant' and 37 'caries-susceptible' families were investigated by Shaw and Murray (1980). The families were chosen based on the caries experience of 13- to 15-year-old English school children. Data on social class, dietary habits,
oral hygiene performance and pattern of dental attendance were collected from 79 parents and 76 siblings of the 44 caries-resistant families, and from 68 parents and 56 siblings of the caries-susceptible families. A strong familial pattern in caries experience was observed. Their results showed that the dental status of parents of the caries-susceptible families was significantly different: more parents were edentulous and, in the dentate group, these parents showed a higher mean DMFS score. This finding confirmed the observations by Martinsson and Petersson (1972). When comparing the dental status of the siblings, their findings were similar to those of Klein and Shimizu (1945). Siblings of the caries-susceptible group showed a higher mean DMFS score than those from caries-resistant families.

An analysis of dietary habits between the groups showed that the index children from the susceptible group had a higher sweet and soft drink consumption. The parents and siblings of the susceptible families consumed more snacks, had a higher sweet consumption and added more sugar to their hot drinks. These findings are similar to Böök and Grahnén (1953). In relation to tooth-brushing habits and pattern of dental attendance, no statistically significant difference was observed among the two groups.

From these findings, Shaw and Murray (1980) came to a similar conclusion to Garn and co-workers (1976a, 1976b, 1977). They suggested that the similar pattern of dental experience among family members could be 'due to environmental influences rather than a strong genetic component' (Shaw and Murray, 1980).
The familial caries distribution in human permanent teeth was investigated by García-Godoy and Rossi (1985, 1986). Their studies were very much based on the studies of Jackson and co-workers, the main difference being the fact that, while the latter had population groups as their unit of study, García-Godoy and Rossi (1985, 1986) analysed family members. The caries distribution on the buccal and lingual pits of first molars (García-Godoy and Rossi, 1985) and on the lingual pits of maxillary incisors (García-Godoy and Rossi, 1986) was investigated in nearly 30 three-generation families. After pooling all subjects together, without any attempt to group individuals by families, concordance on the site of caries attack was calculated. Their results showed that 40.2% of the subjects had the same lingual pit of the upper incisors affected (García-Godoy and Rossi, 1986), while 65.5% of the subjects had the same buccal/lingual pit of first molars affected by caries (García-Godoy and Rossi, 1985). The authors claimed that the data gathered supported the hypothesis that caries experience followed a genetic pattern, and they even suggested an autosomal dominant pattern.

Before commenting on the results and conclusions reported above, several methodological aspects must be discussed. First, the sample studied was selected from children with a high caries experience (García-Godoy and Rossi, 1986). If one believes in the existence of a family pattern in dental caries experience, one may expect that close relatives of high-caries children will also have a high caries experience. In fact, this family pattern has been demonstrated in all family studies described so far. Besides, as it has been shown in many
epidemiological studies, pits of upper incisors and first molars are common sites of attack in high-caries subjects. Therefore, some concordance in the site of caries attack among family members would be more than expected.

Second, when analysing their data, the authors pooled all subjects into one single group and, apart from presenting three family-trees, no attempt was made to analyse the pattern of caries attack within families, among family members. Hence these individuals were treated as independent units; and if a genetic study is to be carried out, the concordance rates on the caries site should have been at least compared to a control group composed of unrelated high-caries individuals.

Third, the authors even suggested an autosomal dominant mode of inheritance. This conclusion not only goes against any other study on inheritance pattern of dental caries but has got no evidence to support it. The mode of inheritance in dental caries, if present, seems to be polygenic and this trait can be described as a threshold trait, that is, the liability to the disease may be inherited: while some may succumb to the disease at a low environmental challenge, others may be able to resist a stronger higher environmental challenge (Falconer, 1965). Besides, in the initial analysis of threshold traits, Bodmer and Cavalli-Sforza (1976) suggest that the incidence in siblings of the affected to be compared to the incidence in the general population. None of these methods have been used in Garcia-Godoy and Rossi's studies. Therefore, they do not have any evidence for the conclusions drawn.

In addition, the authors did not attempt to measure the environment under which their sample was living. Commonly
accepted behavioural variables in the development of dental caries were not analysed. Hence they are in no position to discard them and assume a purely genetic mode of inheritance to dental caries.

Intra-family patterns of dental health status were also assessed in French families (Roland and Floch, 1986). Among other variables the authors evaluated the 'carious risk' of 7,039 children aged 4 to 14 years and both of their parents. 'Carious risk' was defined as present when an individual showed 3 or more decayed tooth surfaces. 'Carious risk' was related to the social conditions of the subjects. Those consuming large amount of tobacco and alcohol were more negligent in relation to hygiene habits. In relation to the pattern of 'carious risk' among families members, their findings showed that children whose parents presented 'carious risk' were more likely to be described as a 'carious risk' child. Besides, for both sexes the maternal influence was stronger than the paternal influence. The pattern of familial aggregation observed was suggestive of an environmental effect associated with genetical effects.

From the studies mentioned in this review, it is clearly shown that, while the resemblance among family members is irrefutable, the reasons for such a resemblance remains still a subject of debate. Some authors claim that genetic inheritance is the main determinant of caries experience, whilst others imply that environmental factors, either dietary factors or microbiological factors, play the main role.

The family studies citing genetics as the main factor in caries experience have failed to measure environmental factors
properly. Those, which have measured the environment, did not take into account the environmental differences observed.

In order to clarify the role of genetics in dental caries, the next section of this review will discuss twin studies and dental health status.

As far as environmental factors are concerned, the last two sections in this review will cover the role of common patterns of behaviours within family members and the transmissibility of oral microflora among family members.

1.2.1.4. Twin Studies:

Sir Francis Galton was one of the first to emphasize the significance of twins for studies of human inheritance. One of his first articles on twins was published in 1875, in which similarities shared by twin pairs were presented. Several aspects were discussed, among others tooth eruption and toothache. The twinning method was a powerful tool used by Galton to promote his eugenic ideas, he said: 'There is no escape from the conclusion that nature prevails enormously over nurture when the differences of nurture do not exceed what is commonly to be found among persons of the same rank of the society and in the same country' (Galton, 1875).

Since then the twinning method has been used very extensively with a view to determine the relative importance of genetic and environmental factors on a variety of traits.

Twin births are not a particularly rare event. However, the incidence of twin births varies widely between different
populations. Even in the same population, the frequency of such births varies according to several variables, such as type of twinning (monozygotic vs dizygotic twins), maternal age, maternal contraceptive measures, among others. While monozygotic twins (MZ) are born with a frequency of about 1 to 200 gestations independent of race or maternal age, dizygotic twin (DZ) birth incidence varies much more. It increases in frequency with increasing age of the mother until about 38 years, when it drops sharply. Besides, the frequency of DZ twin births varies according to race, being the highest among Africans and the lowest among Orientals (Bodmer and Cavalli-Sforza, 1976).

In spite of not being a rare event, twin studies are more practical in the investigation of fairly common traits. The investigation of a rare trait with the twin method proves to be rather cumbersome due to the difficulties of obtaining an adequate sample size (Osborne, 1963).

The study groups in twin studies often are a comparison of MZ and DZ twins, either reared together or apart. The analysis of the results can comprise different approaches. Among the statistical methods used, the most common methods seem to be correlation coefficients, concordance/discordance methods, and analysis of intra-pair variances.

Since the basis of most twin studies lies on a comparison of MZ and DZ twins, every twin study requires a reliable method for zygosity diagnosis (Bodmer and Cavalli-Sforza, 1976; Vogel and Motulsky, 1982; Edlin, 1990). The diagnosis of twins can only be definitely ascertained with laboratory tests, and very few studies have used this method of diagnosis (Edlin, 1990).
However, Cavalli-Sforza and Bodmer (1971) stated that simple visual criteria for twin diagnosis have been found to be at least 90-95% efficient.

While for some authors the twin method proves to be the most efficient study on the heritability of a trait (Goodman, 1962; Osborne, 1963; Mandel and Zengo, 1973), the majority of authors reviewed seem to hold the view that the study of twins involves many complications that require very careful interpretation of results. Consequently, these studies can often only suggest, but not prove, biological inheritance (Bodmer and Cavalli-Sforza, 1976; Vogel and Motulsky, 1982; Hartl and Clark, 1989; Edlin, 1990).

In this review, the different methods of data analysis and the shortcomings of twinning studies will be discussed together with the presentation of the reports on the heritability of dental caries. For the purpose of clarity and to avoid repetition, the studies will be presented following two main sub-headings: twins reared together and twins reared apart. Within each of these two sub-headings, the studies will be grouped according to the statistical method applied.

1.2.1.4.1. Twins Reared Together:

As stated previously there are three main types of analysis of twin data: correlation coefficients, concordance/discordance estimates and analysis of variance within pairs. The first series of studies to be discussed here are those using correlation coefficients. This will be followed by the
studies which have used concordance/discordance estimates. The last series of reports to be discussed will be those using analysis of intra-pair variance.

Correlation Studies:

The first study on dental caries using twins as the unit of research was developed in 1927 by Bachrach and Young. Dental examinations were carried out in 301 pairs of twins, aged 3 to 14 years, selected from London County Council Schools. The majority of these children had never had any dental treatment. Of the total twin pairs, 130 were described as MZ, 93 as like-sexed DZ and 78 as unlike-sexed DZ. Since laboratory tests had not been developed by then, zygosity diagnosis was performed using the following criteria: similarity in sex, identical pigmentation of hair and iris, and striking facial and physical resemblance. The dental features under study were tooth eruption, presence or absence of tooth decay, hypoplasia and state of occlusion. The analysis for dental caries consisted of a comparison of the age-adjusted correlation coefficients of each study group. For MZ twins, the correlation coefficients were found to be 0.670, while for DZ twins it was 0.696 for like-sexed twins and 0.325 for unlike-sexed twins. These results were not statistically different for the MZ and like-sexed DZ twins. While hypoplasia in the permanent dentition did not differ among MZ and DZ twins, their results were suggestive of a more similar pattern of tooth eruption, occlusion and periodontal status among MZ twins than DZ. From their findings
on dental caries experience, the authors could not show an
evidence of a genetic pattern to dental caries experience.

One of the main criticisms for a lack of genetic evidence
in their study is the fact that the age group studied was too
low, not giving enough time for the 'time factor' to act (Böök
and Grahnén, 1953; Goodman, 1962). The fact that few subjects
in this study had undergone dental treatment can also be
another good reason for such a finding. As it is well known,
those individuals who are regular attenders tend to be over­
treated (Elderton and Nuttall, 1983; Dowell et al, 1983;
Elderton, 1984) and the natural history of the disease is
altered. Not going for dental treatment permits an observation
of the state of the oral cavity without any 'external'
interference which might undermine the true account of the
disease.

Finally if a disease is completely genetically determined,
the expected correlation coefficient for MZ twins is 1.0 while
for DZ is 0.5 (Bodmer and Cavalli-Sforza, 1976). In this study,
the MZ correlation was far from the value of 1.0 and the DZ
correlation was above the value of 0.5. These correlation
coefficients obtained are suggestive of the important role
played by the environmental factors. The common environmental
factors shared among twins are an important determinant in
their caries experience.
Concordance/Discordance Studies:

One of the commonest methods of data analysis used for twin studies is the use of concordance/discordance figures. Concordant twin pairs are those in which both twins have the trait, and discordant pairs are those in which one does and the other does not (Bodmer and Cavalli-Sforza, 1976; Emery, 1976; Vogel and Motulsky, 1982; Hartl and Clark, 1989; Edlin, 1990). The expected concordance frequency for a completely genetically determined trait in MZ twins is 100%. While equal concordances in MZ and DZ twins on the whole exclude genetic factors, the study of discordance frequency is a potential tool in the investigation of the role of environmental factors in a disease. Besides, the observation of how high or low concordance estimate is, may provide some clues about the importance of the environment in the establishment of a trait (Bodmer and Cavalli-Sforza, 1976).

In the dental literature, several studies have used this technique in the determination of the biological inheritance of dental caries. These studies will now be discussed.

Mansbridge (1959) examined 224 Scottish twin pairs, aged 5 to 17 years, of which 96 were MZ and 128 were like-sexed DZ. Zygosity diagnosis was based on physical resemblance and analysis of fingerprints. For control group, an age- and sex-matched child was chosen from a sample of 4,000 schoolchildren. By comparing corresponding teeth of a pair, concordance/discordance frequencies were estimated. These figures were grouped in the following classes: (1) concordance in twins, discordance in controls; (2) discordance in twins, concordance
in controls; (3) concordance in twins, concordance in controls; (4) discordance in twins, discordance in controls. The findings showed that concordance in MZ twins was higher than DZ twins; however, the differences between these two groups were very small and, consequently, not statistically significant (0.3 > \( p > 0.2 \)). Since discordance figures among the control group was much higher than those observed in both twin groups, the author concluded that 'the shared environment of the twins resulted in a greater similarity in their dental-caries experience ... From this evidence it can be concluded that environmental conditions constitute a major factor in the etiology of this disease.' (Mansbridge, 1959).

Fairpo (1968) studied the dental caries experience in 178 pairs of twins, aged 5 to 15 years. Zygosity diagnosis using physical resemblance and PTC taste sensitivity showed that 83 of these pairs were MZ twins and 95 were like-sexed DZ twins. While concordance frequency for tooth comparisons was not statistically different, concordance figures for surface comparisons were higher for the MZ group of twins. The author, however, did not give the concordance/discordance figures of the study. He concluded that 'genetic factors have some influence on the sites of caries attack.' (Fairpo, 1968).

Another study using concordance/discordance figures used 198 Polish twins pairs, aged 7 to 14 years (Knychalska-Karwan and Bieda, 1969). Of these, 73 pairs were MZ twins, 76 pairs were like-sexed DZ twins and 49 pairs were unlike-sexed DZ twins. Zygosity diagnosis was made using physical resemblance and ABO blood group. DMFT and DMFS scores were used as the basis for calculation of concordance/discordance frequencies,
taking into account similar and opposite individual teeth/surfaces, and symmetrical and opposite quadrants. Their results showed that concordance figures were higher in MZ twins, when isolate teeth/surfaces were taken into account. These concordance figures, however, were rather low, reaching the highest figure of 31.5% when opposite teeth were matched. For quadrants, concordance frequencies were slight higher but still reached 59% for DMFT when opposite quadrants were compared. It is important to state, however, that unlike-sexed DZ pairs obtained the highest concordance scores for all comparisons. As the authors themselves stated discordance frequencies were very high; and therefore, if some genetic influence was present, this influence would not determine the development of dental caries unless a favourable environment was also present.

Gedda and co-workers (1977) analysed the deciduous dentition of 91 Italian twin pairs, aged 3 to 8 years. Of these 27 were MZ twins, 31 like-sexed DZ and 33 unlike-sexed DZ twin pairs. The basis for zygosity diagnosis, however, was not mentioned. Analysis of the data was based on the presence/absence of caries in the twin pair. Concordance figures were statistically higher for the MZ twins. The authors concluded that hereditary causes explained 50% of the variance of caries experience in the primary dentition.

The four studies mentioned in this section appear to have come to different conclusions about the genetic role in dental caries development. While Mansbridge (1959) and Knychalska-Karwan and Bieda (1969) believed that there is little genetic effect on the development of carious process, Fairpo (1968)
suggested some genetic effect, and Gedda and co-workers (1977) give a figure of 50% to hereditary causes in the development of caries in the deciduous dentition. None of these studies analysed the environmental factors, and all of them seemed to have assumed that the environment for twin pairs, either MZ or DZ, was very much similar.

For most traits, MZ twins have a higher concordance than do DZ twins for the same trait, and this finding was also true for caries. These findings are interpreted to mean that variation in these traits has a genetic basis (Edlin, 1990). However, it is now well accepted that twin studies suggest, but not prove, biological inheritance (Bodmer and Cavalli-Sforza, 1976). The reason for this is the fact that researchers tend to assume that the environmental conditions, under which both types of twins are raised, are similar.

This assumption has been shown to be untrue. It is now clear that the environment for MZ twins are much more alike than the environment for DZ twins. Since MZ twins often have astonishingly similar facial features, they are often treated more similarly by parents, teachers, and peers than are DZ twins (Bodmer and Cavalli-Sforza, 1976; Vogel and Motulsky, 1982; Hartl and Clark, 1989; Edlin, 1990). Twins form a social group, depending less on exchange of information with outside world. Hence twins - especially MZ twins - do tend to spend most of their time together and certainly influence each other to a considerable extent (Bodmer and Cavalli-Sforza, 1976; Vogel and Motulsky, 1982). Today, however, educators and psychologists recommend that twins are encouraged to develop independent personalities, dress differently, and attend
different schools (Bodmer and Cavalli-Sforza, 1976; Vogel and Motulsky, 1982).

Due to the lack of control over the similarities of the environment of the twin pair, the twin-study approach to measurement of heritability tends to underestimate the extent of the environmental variation. For this reason, when using concordance/discordance figures, discordance in twins provides useful information about environmental factors (Bodmer and Cavalli-Sforza, 1976).

The studies of Mansbridge (1959) and Knychalska-Karwan and Bieda (1969) were very similar, not only the methodology employed (number of twin pairs, age group, comparison among pairs) but also the results and conclusions obtained. Concordance/discordance figures for MZ and DZ twins were not statistically different, which led to the conclusion of little genetic effect. Discordance figures for these two studies were significantly different, however. Mansbridge (1959) obtained values of up to 25%, while Knychalska-Karwan and Bieda (1969) found a 75% discordance. Such a large difference could be attributed to the different populations studied: Scottish and Polish, which certainly show behavioural and environmental differences. As it is well stressed in some textbooks on genetics and due to these obvious population differences, any genetic estimate of a trait obtained from a sample population is only valid to that particular group studied and should not be extrapolated to the whole population or to different populations (Bodmer and Cavalli-Sforza, 1976; Edlin, 1990).

The report by Fairpo (1968) appeared to support the idea of some genetic influence on the caries experience of the
population studied. The methods used (number of twin pairs, age group, comparisons made) were very much similar to the studies carried out by Mansbridge (1959) and Knychalska-Karwan and Bieda (1969). Despite stating the presence of a statistically significant difference between MZ and DZ twins, Fairpo (1968) failed to give the values for his concordance/discordance figures. Since these values may cast light on the possible role of environmental factors of a trait; analysing or discussing the role of possible biological and environmental factors in caries experience without them becomes rather difficult, if not, impossible.

Gedda and co-workers (1977) were alone in calculating heritability estimates of dental caries experience in the primary dentition. The authors estimated that 50% of the variance was due to hereditary causes. Despite the high heritability estimate obtained, it still leaves as much again explained by environmental effects. Moreover, it must also be borne in mind that heritability estimates, which were derived from twin data, assume similar environmental conditions for DZ and MZ twins. This has been shown to be untrue, leading to an overestimation of the biological component of a trait and an underestimation of the role of the environmental factors.

Continuing with the studies using twins reared together as their unit of study, those which have employed intra-pair variance as the statistical tool for their data analysis will now be presented.
Intra-pair Variance Studies:

An idea of the degree of genetic influence on a continuous variable trait may be gauged from intra (within)-pair and inter (between)-pair variances. When using twin data, the intra-pair variances obtained are compared by dividing the DZ intra-pair variance obtained by the MZ intra-pair variance, the ratio is referred to as 'F' value. Its statistical significance can then be determined from standard tables. Although the study of intra-pair variances can give some idea of the role of the genetic factors in aetiology, they are not in themselves a absolute measure of the degree of genetic determination (Emery, 1976). Besides, such an analysis does not overcome the problems raised earlier from twin study data in relation to the underestimation of environmental influences.

Bearing these concepts in mind, the studies on dental caries based on the intra-pair variance of twin data will now be described.

Horowitz and co-workers (1958) studied a group of 49 twin pairs, aged 18 to 55 years; of which, 30 were MZ twins and 19 like-sexed DZ twins. Zygosity diagnosis was based on serological and morphological criteria. As clinical criteria the authors developed the CER index (caries experience ratio), that is, the observed number of decayed, missing or filled surfaces divided by the total number of surfaces originally available for decay. In addition to the CER for the total dentition, ratios were computed separately for different groups of teeth: upper anterior, upper posterior, lower anterior and lower posterior. Analyses of the intra-pair variance were
statistically significant for all ratios but the upper anterior segment, where the MZ twins had the smallest intra-pair variance. The authors concluded that 'there is a hereditary factor in susceptibility to caries' (Horowitz et al., 1958).

Similar findings were reported by Goodman and co-workers (1959). Their study was based on data from 38 twin pairs, aged 14 to 38 years of age. Serological zygosity diagnosis revealed that 19 of them were MZ twins and 19 were like-sexed DZ twins. Analysis was comprised of a comparison of CER scores for the full mouth and four segments (anterior maxillary, anterior mandibular, posterior maxillary, posterior mandibular); microflora (streptococci and lactobacilli); and salivary flow, pH and amylase. The findings on intra-pair variance of CER scores showed that MZ twins formed a more homogeneous group than DZ twins whether the entire mouth or quadrants were considered. Heritability estimates of dental caries experience when all permanent teeth were considered together was as high as 85%.

Analysis of the oral microflora showed that variance was statistically smaller in the MZ twins in relation to streptococci and mixed flora, but not for lactobacilli, where no statistically significant difference was observed. Analysis of the saliva showed that MZ twins were a more homogeneous group for all the aspects analysed: flow, pH, and amylase. The authors suggested a possible role for genetics in the variables analysed, but they also addressed the point that the similarity observed in MZ twins might reflect a greater similarity of environment in MZ pairs as contrasted with DZ pairs, which would inflate the heritability estimates drawn.
A 2-year longitudinal study on 66 twin pairs, aged 7 to 15 years was carried out by Finn and Caldwell (1963). Serological and physical zygosity diagnoses indicated that 35 of these were MZ twins and 31 were like-sexed DZ twins. Data were collected from dental examinations, study models, dietary analysis, and oral hygiene efficiency. For the present report, however, only the results on caries increment, eruption time and caries experience are mentioned. Their findings suggested a greater variance between DZ twin pairs than MZ pairs relative to the total number of erupted permanent teeth and the total number of DMF teeth. It was also shown that DZ twins had a greater intra-pair variance than MZ twins in relation to smooth surface lesions, but such a difference was not detected for pits and fissures. Yearly and overall caries increments, when measured either by DMFT or DMFS scores, did not show any significant differences between the two groups. Unfortunately, no mention of dietary habits was made in this report. When trying to explain the possible reasons for a greater caries variance in caries experience of DZ twin pairs, the authors considered that it could have been due to a greater variance in the number of erupted permanent teeth observed in the DZ twins.

Bordoni and co-workers (1973) studied the prevalence of dental caries in the primary dentition of 17 Argentinian MZ twin pairs, aged 4 to 8.5 years. Zygosity was diagnosed on a phenotypic basis. The control group consisted of pairs that included a twin chosen at random and an unrelated child of the same sex and age. Analysis of the intra-pair variance of the two groups revealed that variance in the control group was statistically greater for all variables analysed - defs, ds,
The authors concluded that 'the genotype appeared to be a determining factor in caries susceptibility or resistance, although the environment played an important role as well' (Bordoni et al, 1973). Due to the design of their study the findings are not surprising at all: a comparison of closely related children (MZ twins) with unrelated children is most likely to show a closer relation in caries experience in the former group. Since twin pairs shared a similar biological constitution and common environment whereas the control pairs had neither, a distinction between the roles of heredity and environment becomes unreasonable. Hence their conclusion that genotype was a 'determining factor in caries' is doubtful.

The last report on the dental caries in twins to be discussed in this section was developed by Fairpo (1979). Two hundred and twenty twin pairs, aged 5 to 15 years, were examined. One-hundred of these were MZ twins and 120 were like-sexed DZ twins. Zygosity diagnosis was based on physical appearance and PTC taste sensitivity. When analysis of intra-pair variance for DMF and dmf for the two groups was performed, the findings revealed that DZ twins showed a greater variance than MZ twins. Based on the assumption that MZ and DZ twins shared a similar environment and consequently a smaller intra-pair variance in MZ would be indicative of a genetic factor, the author concluded that 'there is some genetic influence on the susceptibility in caries attack of both the deciduous and the permanent dentitions' (Fairpo, 1979).

The studies reported here, using a comparison of intra-pair variance between MZ twins and like-sexed DZ twins, seemed to have come to similar findings in spite of some differences
in the methodology employed, such as age group and caries experience measurements. While Horowitz and co-workers (1958) and Goodman and co-workers (1959) studied the caries experience ratio (CER) in adult twin pairs, Finn and Caldwell (1963) and Fairpo (1979) analysed DMF scores of young twin pairs. Their results showed that the intra-pair variance was smaller in MZ twin pairs than in like-sexed DZ twin pairs. Such a finding led these researchers to conclude that there was a genetic component in caries experience.

As explained earlier, the basis of the twinning method is the assumption that environmental conditions for both groups of twins are similar. This assumption may well be untrue, since MZ twins often search and create more similar environments than DZ twins. The interaction between heredity and environment as well as covariance between heredity and environment are usually neglected. From the reports here described, Goodman and co-workers (1959) were the only ones to mention the fact that a smaller intra-pair variance in MZ twins may not reflect purely genetic differences. Moreover, despite the assumption of a similar environment, none of the reports analysed the environment in which the twins were raised. Those which did go further than a simple comparison of caries experience have shown that the twins differed in microflora components (Goodman et al, 1959) and in eruption time (Finn and Caldwell, 1963). Therefore, all studies showed a more similar caries experience among MZ twins but the conclusion that such similarity is solely due to a common genetic factor becomes questionable.

The problem of a similar environment in twin studies can be overcome by studying twins that are reared apart, that is,
in different households. The next section of this review will deal with the advantages and shortcomings of such studies as well as describe the few studies on caries experience.

1.2.1.4.2. Twins Reared Apart:

To settle the problem of a similar environment shared by MZ twin pairs, studies on twin pairs reared apart have been developed. It is assumed that the separated twins experience different environments, whereas the twins raised together are assumed to share the same environmental factors. The comparison of individuals with identical genotypes, raised in different environments, is expected to provide a way to partition unequivocally the environmental and genetic sources of variations (Bodmer and Cavalli-Sforza, 1976; Vogel and Motulsky, 1982; Hartl and Clark, 1989; Edlin, 1990).

Many problems and uncertainties exist even with these twin studies. Ideally, one member of the twin pair should be raised by the 'biological' family, and the other in a totally unrelated family. However, separated twins are often raised by close relatives such as grandparents or uncles, and the environmental factors may be quite similar for each twin. This effect of correlated environment and the frequent contact between the twins would inflate the estimate of the degree to which traits are genetically determined. The age at which twins are separated is also important, particularly for traits which are strongly influenced by the environment. If twins are separated at an older age, the possibility of acquiring similar habits
increases and would overestimate the role of genetics in the development of a trait (Bodmer and Cavalli-Sforza, 1976; Vogel and Motulsky, 1982; Hartl and Clark, 1989; Edlin, 1990). For these reasons findings from studies on twins reared apart should be interpreted with caution.

Only one study of dental caries experience using twin pairs reared apart has been reported in the dental literature. Boraas and co-workers (1988) studied 97 subjects (44 twin pairs and 3 triplets), aged 12 to 68 years, reared apart. Serological zygosity diagnosis determined that 64 of them were MZ while 33 were DZ. The mean age of separation was 171 days (range = 1-1278 days), and no account was given of the homes these subjects were sent to as a child. Data were analysed by two-way analysis of variance, intraclass correlation coefficients and concordance estimates. There was a statistically significant larger resemblance within MZ twins than within DZ twins in relation to the dental health status as measured by the number of teeth present, percentage of teeth and surfaces restored, percentage of teeth and surfaces restored or carious. Tooth morphology (tooth size, presence and shape of Carabelli's cusp and groove configuration) was also shown to be more homogeneous in the MZ subjects. The authors concluded that there was a marked genetic component to dental caries experience. It was concluded that the mechanisms, through which genetics may express itself, might be a similar tooth morphology.

The conclusion that there was a genetic influence on dental caries experience should be treated with care because this study had some limitations, as stated by the authors.
themselves. Among these limitations it is worth mentioning, subjects showed various degrees of oral health care with an extensive restorative, prosthetic, or extraction therapy and a possible inaccurate recollection of dental history. In addition, no attempt was made to analyse the assumption of a possible equality in environmental factors between the two groups. Lastly, some methodological limitations were also present: a small sample size (for example, comparison through analysis of variance of a group containing 28 units with another containing 10, and at times with group containing less than 5 units), no investigation of pre-separation factors, and the lack of a control group formed by MZ and DZ subjects raised together.

In spite of not being considered a study of twins reared apart, Gedda and Brenci (1983) analysed MZ twins, who although they had been reared together, had subsequently lived apart for a period of at least 5 years. Ninety-two 35- to 45-year-old MZ twin pairs, 15 of which were still living together and 77 were separated for at least 5 years, were sent mailed questionnaires. Questions on several variables, such as height, weight, alcohol and tobacco consumption, dental caries among others, were asked. On the whole, for all the traits studied, twins who were still living together showed a higher correlation coefficient or concordance estimate. For dental caries, twins living together showed a concordance estimate of 58%, while those living apart had a concordance estimate of 54%. According to the authors these figures were too low suggesting 'powerful environmental influences' (Gedda and Brenci, 1983).
Most of the variables under discussion in this study have been shown to possess a strong environmental determinant. The environmental influences could be demonstrated when those individuals, who have always shared a common environment, showed slightly higher resemblance, either as measured by correlation coefficients or concordance estimates. As far as dental caries is concerned, a concordance estimate ranging between 54-58% is evidence that factors different from a common biological constitution and common environment do influence the caries experience of twins.

1.2.1.4.3. Concluding Remarks:

The adoption of the twinning method in the evaluation of a trait is an attempt to determine the biological and environmental factors in a trait. However, as it has been stressed earlier in this review, such a technique should always be viewed with care. The fact that MZ individuals resemble each other more than DZ subjects should not be considered an imperative to the conclusion of a marked genetic influence in the development of a characteristic. This is particularly true for those traits known to be highly influenced by the environment since MZ twins do share a more similar environment than DZ. Therefore, assuming that a higher similarity in MZ twins is a true account of the genetic basis of these traits is totally biased.

Dental caries experience is among these traits, which undoubtedly present a strong environmental determinant. The
results from the twinning methods showed a higher resemblance among the MZ subjects when compared with DZ subjects. While in some, the differences in caries experience between MZ and DZ twins was not statistically significant, leading the researchers to the conclusion of a stronger environmental factor (Bachrach and Young, 1927; Mansbridge, 1959; Knychalska-Karwan and Bieda, 1969; Gedda and Brenci, 1983); others found that resemblance in caries experience was higher in MZ twins than in DZ twins, leading the researchers to the conclusion that such a resemblance was a consequence of a genetic component (Horowitz et al, 1958, Goodman et al, 1959; Finn and Caldwell, 1963; Fairpo, 1968; Bordoni et al, 1973, Gedda et al, 1977; Fairpo, 1979; Boraas et al, 1988).

The reasons for the different findings and conclusions reached by the different reports may lie in the different methodological techniques employed, such as age groups, ethnic groups, variables analysed and statistical analyses employed.

It is also important to stress that none of the studies mentioned adequately measured the environment in which the twins were being raised. Therefore, the conclusion of a purely genetic explanation for the differences observed is difficult to accept.

The liability to dental caries may be inherited. The disease, however, will only develop provided environmental factors are present. These environmental factors may be related to behavioural factors, such as sugar consumption and oral microflora, or morphological aspects, such as tooth morphology and tooth eruption. Propensity for a similar diet (Forrai and Bánkövi, 1984) as well as oral microflora (Goodman et al, 1959)
have been demonstrated as to be stronger in MZ twins than in DZ twins. As far as morphological aspects are concerned, MZ twins seemed to present more similar characteristics than DZ twins in relation to tooth eruption time (Finn and Caldwell, 1963; Gedda and Brenci, 1966), tooth morphology (Biggerstaff, 1973; Boraas et al, 1988), dental occlusion traits (Corruccini and Potter, 1980; Potter et al, 1981), and facial anthropometric traits (Sharma et al, 1984). The resemblance shared by MZ twins in so many characteristics, known to determine the liability to caries, may explain the similarity in caries experience among these individuals. These factors warrant further investigation.

Within family patterns of behaviours known to influence the caries experience of an individual have been widely studied. Some of these studies will now be described in the next section of this review of literature.

1.2.2. BEHAVIOURAL EVIDENCE:

The studies reviewed so far have attempted to determine the importance of biological factors in dental caries experience of an individual. The evidence of biological determinants in the development of caries comes from studies which have used biological relatives as their unit of study. However, measuring the strength of biological inheritance on the basis of similarity between biological relatives may lead to serious errors. When doing so, an important factor is ignored or overlooked: parents and children, sibling and
sibling, often share a common environment - that within the family.

Many characteristics, in addition to genes, are shared by the family, such as food habits, customs, and income; and some of these are socially inherited. Thus similarities between biological relatives can be observed for traits even when the genetic determinants have been shown to play a minor role, but they arise indirectly, being mediated by the existence of cultural variation and inheritance of customs or preferred environment.

The effect of sharing a common environment, and therefore, the resemblance observed among family members, either biologically related subjects as parents-offspring and sib-sib, or genetically unrelated subjects as husband-wife, has been called the 'cohabitational effect' (Garn et al, 1979).

The family environment remains an important factor in the development of an individual, and many of its elements are transmitted through generations. The transmission of behavioural norms within families occurs in a variety of ways through the actions of those individuals who are most important to the person, generally a child, in the learning process. The process through which individuals gain the knowledge, skills and dispositions that enable them to participate in a group or society is called the socialisation process (Brim and Wheeler, 1966).

The process of socialisation is an ongoing and gradual one which continues throughout the lifetime of an individual (Brim and Wheeler, 1966). This concept as a life-long process has resulted in its division into different phases: primary and
secondary socialisation (Clausen, 1967). While the former occurs during the early years of life, having the nuclear family as the most important of its agents; the latter occurs later when the individual enters into institutions such as schools, colleges and centres of employment (Campbell, 1978; Mullen, 1983).

The values and norms learnt during the primary socialisation process are deeply ingrained and, therefore, tend to be resistant to changes (Blinkhorn, 1976). The behaviours, and health behaviours should be included among them, developed at this stage tend to be regarded as a social norm and become a routine, performed without conscious effort or decision (Blinkhorn, 1976; Lennon and Fieldhouse, 1982; Bateman, 1985). Consequently, the values and behaviours acquired during the secondary socialisation process, if they are to prevail, must be reconciled with those learnt at home, at an earlier stage of life (Blinkhorn, 1976; Bateman, 1985).

The health status of an individual - and oral health status is definitely among them - is directly determined by individual actions. These individual actions in turn will be dependent on the influence of the social environment as expressed in values, norms, habits and behaviours. These behaviours will involve processes of acquisition and maintenance of habits, in which the nuclear family plays an important role. Among these behaviours, dietary habits play a decisive role.

Food habits are characteristic and repetitive acts performed under the impetus of the need to provide nourishment and meet social and emotional goals. Children are highly
dependent on others for their food intake in early years, and many of the patterns of eating seen in adult life are established at this time (Lennon and Fieldhouse, 1982). Food habits are, therefore, learnt from parents, relatives and friends, being passed down through generations.

Food choice decisions are determined by a large spectrum of factors, among which are: availability, economy, acceptability, psycho-sociological and personal factors (Lennon and Fieldhouse, 1982). Schafer and Keith (1981) studied the influences on food decisions across the family life cycle, that is, family developmental stages from its inception to its dissolution. Three-hundred and thirty six married American couples were interviewed. Their data showed that over the family life cycle the external constraint of cost of food and the personal concerns for health and weight were the most important considerations in food decisions. Family members, in particular the spouse and children, also exerted an important influence, being constant over time. The influence of reference others, especially the spouses' parents, was particularly high in 'young' families and tended to diminish over the life cycle. This finding was suggestive of the transmission of food habits between generations within a society.

Meal-times have also been shown to play an important role in family life since the organisation of cooking and eating marks the roles of husband and wife, and parent and child (Graham, 1984). Since women are the shoppers and the cooks, they are most involved and committed to providing the best for the family. Hence cooking and eating indirectly express the control over a family women have (Graham, 1984).
Since food decisions within a family environment is so closely related to its members, it is reasonable to assume that individuals who live together are subject to the same dietary patterns. When studying dietary similarities of 104 American husband-wife pairs, using 7-day dietary diaries as measurement, Garn and co-workers (1979) reported a positive correlation for caloric and nutrient intake between spouses. Moreover, 18 out of the 21 meals were shared in common by spouses, and such resemblances were extended to selection of particular food items or particular sources of calories. The study of dietary similarities involving biologically related individuals (1,762 adolescent sib-sib pairs and mother-child comparisons) confirmed that such resemblances also characterised siblings, and parents with their children (Garn et al, 1979).

Similar findings were reported by Pérusse and co-workers (1988). Their results were based on the assessment of the total energy intake and intakes of carbohydrate, fat, and protein of 1,597 individuals living in 375 families of French origin. Path analysis was used to determine the contribution of genetic and non-genetic factors in the familial resemblance observed. Since no significant genetic effect was found in the intake of any nutrient tested, the authors concluded that familial resemblance was strongly associated with environmental conditions shared by family members.

The deleterious relationship between sugar (sucrose) and health, with emphasis on dental health and dental caries, has been well documented and reviewed (Newbrun, 1982; Sreebny, 1982a, 1982b; Rugg-Gunn and Edgar, 1984; White-Graves and Schiller, 1986; Yudkin, 1986; Sheiham, 1987; Cohen, 1989). In
today's society sugar is plentiful, cheap and available both as household sugar and as an additive to many prepared foods and drinks. Food systems can be regarded as a non-verbal communication system (Leonard, 1984), and sweet tasting foods can sometimes take on emotional significance, being often used as gifts, treats, and tokens of affection, as well as rewards and bribes (MacArthur, 1974; Lennon and Fieldhouse, 1982).

As with any other food habits, sugar consumption patterns are established within the family. Due to their emotional meaning and wide availability, sugar is most readily introduced into the diet of a child (MacArthur, 1974; King, 1976). The pattern of sugar consumption in early infancy was studied by King (1976), who interviewed 94 English mothers of first babies aged 8-11 months. Her data showed that a baby's sugar eating pattern was closely related to the mother's own behaviour. Babies with a high sugar consumption had mothers who were also high consumers; and sugar added to a baby's milk bottle was associated with mother adding sugar to her hot drink.

Sugar consumption habits are confined within family food choices. Once this habit is established in early infancy, it tends to maintain throughout the life of an individual. Rossow and co-workers (1990) did a 14-month follow-up study on sugar consumption over time of 231 Norwegian children, aged at first 10 months. The pattern of sugar consumption was established during the weaning period and the period of accommodation to the family diet. Sugar consumption increased in amount and frequency over time as the child grew older, that is, during the period of accommodation to the family diet (Rossow et al, 1990).
Sugar consumption pattern within a family is maintained even when a child becomes more independent in relation to its own food choices and more prone to external influences, as schools. A study of 443 Finnish families - both parents and a 14-year-old child - revealed a strong correlation between the amount of sugar parents added to their hot drinks and the amount of sugar a child added to its own hot drink or even a child's overall consumption of sweet-tasting items (Honkala et al, 1983). Moreover, it was shown that mothers were the strongest determinant in sugar consumption patterns of her daughter or son, while fathers seemed to influence the amount of sugar consumed by his son only (Honkala et al, 1983).

Further evidence of a family pattern in sugar consumption can be obtained by the comparison of the dental status of family members and the family sugar intake. Asher and co-workers (1986) investigated the relationship between a parents' dietary carbohydrate intake and the oral health of the child. Fifty children, aged 3 to 12 years, were examined and their parents or guardians were questioned on their dietary intake, using 24-hour-recall method. A correlation of parental/guardian carbohydrate intake and child DMFT/deft as high as 0.50 was observed.

This relationship between a family sugar consumption pattern and the child's dental health status has also been observed in slightly older children. Shaw and Murray (1980) studied the families of schoolchildren, aged 13 to 15 years. It was observed that the parents and the siblings of those schoolchildren with a high caries experience had a higher sugar consumption. Parents and siblings of these adolescents not only
consumed more snacks and sweets but also added more sugar to their drinks. Consequently, the parents and siblings of these adolescents also showed a high caries experience.

Not only food eating patterns but also hygiene habits are determined within a family framework. Oral hygiene habits are learnt in early childhood as part of the socialisation process. For this reason, parents are the primarily responsible for the initiation and frequency of tooth-brushing practices in the younger child and for its reinforcement as a child grows older (Blinkhorn, 1976; Silver, 1985). When analysing the tooth-brushing practices of 376 English adolescents, aged 13 to 16 years, from different social backgrounds, Hodge (1979) observed that regular brushers were more likely to come from families where parents and siblings brushed their teeth regularly. As far as reasons for brushing the teeth are concerned, it has been shown that parents and children tend to relate it to cleaning or grooming rather than a health-directed measure (Blinkhorn, 1976; Hodge, 1979; Bateman, 1985).

Seeking professional advice, either medical or dental, also seems to be related with the pattern established within a family. Mechanic (1964) interviewed 350 American adolescents, aged 13 to 14 years, and their mothers. His data showed that mother responded to their children's health and their own in a similar fashion. In spite of mothers being more likely to seek medical care and advice for their children than for themselves, those mothers with a high inclination to use medical facilities for themselves were more likely to take their children to a doctor (Mechanic, 1964). Similar findings were observed in relation to dental attendance. Metz and Richards (1967) showed
that frequency of preventive dental visits of children was highly associated with the frequency of preventive dental visits of their parents. Such a pattern was valid in all social classes and educational levels studied (Metz and Richards, 1967).

Health values and practices within a family are closely related to the social class a family belongs to. Due to social and economic constraints and factors derived from these, each social class tends to form a specific subculture in which a similar set of values, system of behaviour and lifestyle are shared by the members of the same social class (Blinkhorn, 1976). The social class of the mother was observed to be a strong determinant in family dental health practices (Rayner, 1970). However, when mothers were socially mobile through marriage, in spite of adopting behaviours and values more similar to the class they now belonged to, these behaviours and values fell between those of the mothers who were static in a 'lower' or 'upper' social class (Beal and Dickson, 1975). The change in values, attitudes and behaviours of these mobile mothers could be explained by the fact that an individual tends to adopt the concepts of the class he/she would like to belong (Lennon and Fieldhouse, 1982).

Social class differences in relation to dental health related behaviours have been reported. While individuals from a less privileged social class tend to consume more sweet-tasting items (Samuelson et al, 1971; Tee, 1987; Ruiken, 1989) and to be less likely to have regular preventive visits to the dentist (Beal and James, 1970; Blaxter and Paterson, 1982; Todd and Dodd, 1985; Ministério da Saúde, 1988); tooth-brushing
practices seem to have a widespread acceptance in which social class differences have not been demonstrated (Blinkhorn, 1976; Hodge, 1979).

This section of the review of literature has shown that the family acts as a unit in relation to the pattern of behaviours its members share. Therefore, to consider a positive association between biological relatives sharing a similar environment as an evidence of the biological inheritance of a trait becomes misleading. This is consequent to the fact that the inheritance studied may not be that transmitted by genes, but may be due to some of these other non-genetic forms of transmission.

The caries process is often seen as an infectious one and family members may be infected by common agents and develop the disease. In spite of not being the subject of this present study, this last section will briefly review the evidence for transmissibility of dental caries through family members as suggested by Ringelberg and co-workers (1974).

1.2.3. EVIDENCE OF TRANSMISSIBILITY:

The first evidence of the infectious and transmissible nature of dental caries was put forward by Keyes (1960) in his classic piece of work on rats and hamsters. In that same year, Fitzgerald and Keyes (1960) found that certain streptococci isolated from carious lesions in hamster teeth could be implanted in the oral cavity of 'caries-inactive' albino hamsters and induce caries.
The composition of the diet showed a decisive role in the implantation of the caries-inducing streptococci in the oral cavity of laboratory animals. Sucrose was generally acclaimed to facilitate the successful colonisation of teeth by streptococci in these animals. Its substitution by other carbohydrate, such as glucose and starch, resulted in a less successful implantation of streptococci and decreased the caries experience in animal models (Krasse, 1965; Guggenheim et al, 1966; Edwardsson and Krasse, 1967; Huxley, 1974b). It was also observed that sucrose was important in the maintenance of an already established population of streptococci since dietary restriction of sucrose was shown to reduce in numbers oral streptococci present in the oral cavity of monkeys (Bowen and Cornick, 1967).

Much of what has been reported for laboratory animals has been confirmed for human beings. These studies will now be reviewed.

During the 1960's, when the microbiological nature of dental caries was most emphasised, the first studies on human beings were developed. A number of reports documented the early appearance of bacteria in infants within a few hours of birth, and this contamination was streptococcal in nature (Joress et al, 1960; McCarthy et al, 1965). Carlsson and co-workers (1970) cultured *Streptococcus salivarius* from the mouths of day-old infants who were being fed water, glucose or sucrose solutions prior to the intake of milk. This organism has an affinity for shedding epithelial surfaces and, therefore, is one of the initial streptococcal species to colonise the mouth. In contrast, *Streptococcus mutans* colonise non-shedding oral
surfaces, and Catalanotto and co-workers (1975) reported its presence in the mouth of children by the time deciduous molars erupted.

With the use of a more reliable selective medium for *Streptococcus mutans*, Berkowitz and co-workers (1975) were able to isolate this microorganism from the mouths of infants 10 to 12 weeks after the eruption of the deciduous incisors. They also isolated this microorganism from the mouths of infants with cleft palate in a pre-dentate state wearing acrylic obturators, confirming the need of an unshedding surface for the colonisation by this microorganism.

The implantation of caries-inducing streptococci in the oral cavity of adult individuals was investigated by Krasse and co-workers (1967). Their results showed that both hamster and human streptococcal strains could be implanted, being the human strain more easily implanted. A resistance to implantation was observed since the recovery of these microorganisms died out as time elapsed. This resistance, however, could be largely overcome by multiple inoculations and a high sucrose consumption. Besides, the restriction of dietary sucrose reduced the number of streptococci present in the mouths of these individuals.

The decrease in numbers of an already established oral population of *Streptococcus mutans* by the restriction of dietary sucrose was later confirmed in adults (de Stoppelaar et al, 1970; Kristoffersen and Birkhed, 1987) and children (van Houte and Duchin, 1975). Sucrose was also shown to influence the extent and volume of the plaque covering the teeth, and the carbohydrate level in human plaque (Grenby et al, 1974).
As the human types of *Streptococcus mutans* are not widespread in nature, it is logical to assume that this species is transmitted within human populations. The first study on the transmission of streptococci within family members was reported in 1972 by Jordan and co-workers. One parent from each of 26 American Coast Guard families was reinfected with a strain of *Streptococcus mutans* that was isolated from his/her mouth and made resistant to streptomycin. Since implantation and establishment to the streptococci were rather weak, no uniform spread of microorganisms was observed within the family members (Jordan et al, 1972).

The first evidence of a possible intra-family transmission of oral streptococci was put forward by Berkowitz and Jordan (1975). The analyses of *Streptococcus mutans* serotypes in 4 mother-infant pairs showed a significant intra-pair homogeneity of strains.

These findings were later confirmed by Rogers (1977), when ten families (father, mother, and at least two children) were assessed for the serotype of *S. mutans* present in their mouths. Since these family members presented similar *S. mutans* serotypes, it was concluded that this microorganism could be transmitted intra-familiarly.

Perhaps the most convincing evidence was reported a few years later, when Köhler and Bratthal (1978) studied the levels of *Streptococcus mutans* of 36 children, aged 4.5 to 5 years, and their parents. A quantitative correlation was found between the number of *S. mutans* in the mothers and their children, but not between fathers and children. When adults with different levels of *S. mutans* contaminated metal spoons with saliva, a
A number of reports on the transmissibility of oral microorganisms within families have been published. Irrespective of the technique used — serotype identification or correlations of S. mutans levels — and the age group concerned — infants, children or adolescents; all of them supported the evidence of a family pattern with respect to Streptococcus mutans numbers and serotypes (van Houte et al, 1981; Berkowitz et al, 1981; Masuda et al, 1985; Alaluusua et al, 1989). All these studies indicated a closer relationship between mother-child pairs.

Based on the information from the studies reviewed here, it seems plausible to assume that life-style might determine the spread of Streptococcus mutans in the family. The infant may be infected by a person who is in frequent contact with him/her, and in our society the mother is most likely to be that person. The mode of transmission seems to be through saliva. Hence if a mother with high numbers of S. mutans in her saliva uses her own spoon to feed the infant, she may infect her infant, each time, with S. mutans. As that infant has not fully developed his/her own indigenous oral microflora, these streptococci can easily establish themselves in the oral cavity. Furthermore, since the presence of sucrose enables the establishment of streptococci in the mouth and a mother with a high sucrose consumption is likely to feed her infant in a high sucrose regimen, another basic requirement for the implantation
of this microorganism is being fulfilled. Once the infant is infected and enough sugar is given to him/her, that individual will carry these micro-organisms throughout his/her life.

1.2.4. CONCLUSIONS:

Intra-family patterns of dental health status have been demonstrated in all the studies reviewed here. This pattern was present irrespective of the time or the place the research was carried out.

The evidence of biological inheritance are based on studies which have only compared the dental health status amongst family members. However, all of these studies have failed to take into account the intra-family similarities of behaviour which are known to affect the dental health status.

Dental health is closely related to individual actions. These actions are behaviours formed as a result of a learning process developed from intra-family patterns of behaviour. There is enough evidence to support the fact that family members do exhibit similar patterns of behaviour in relation to sugar consumption habits, oral hygiene practices and patterns of dental attendance.

The evidence of similar microflora amongst family members is also strong. However, the implantation, establishment and maintenance of the oral microflora is dependent on sugar consumption patterns. These in turn are closely linked to intra-family dietary habits.
Apart from those studies, which aimed at evaluating behavioural patterns within families, none have truly separated the influences of behaviour from those caused by genetic inheritance or transmission of microorganisms.

This present investigation assesses not only the dental health status within families but also the behaviours conducive to good dental health: dietary habits, oral hygiene and attendance of dental services.

1.3. AIMS AND OBJECTIVES:

The aim of the present investigation was to study the pattern of dental health status and behaviours within families from different social backgrounds. It also aimed to elucidate the parental role in the establishment of three behaviours: attendance to dental services, oral hygiene and dietary habits. In addition, the importance of genetic and environmental factors in the dental health status within family members was assessed.

The study had the following objectives:

1. to compare the pattern of dental health of families from different social classes,

2. to compare the behaviours conducive to good dental health of families from different social classes,

3. to compare the dental health status within families,
4. to ascertain whether the behaviours shared by members of the same family are related in any way,

5. to identify the parental influences in the establishment of these behaviours, and

6. to quantify the genetic and environmental components that influence the dental health status within families.

1.4. HYPOTHESES:

There is a marked and consistent tendency for children to reflect, in their own dental health status, the dental health status of their parents. This is mainly due to family members sharing similar behaviours such as diet, oral hygiene and dental attendance. Since behaviours differ with social class, families with different social backgrounds present different behaviours and dental health status. Furthermore, brothers and sisters in the same family have similar patterns of behaviour and grades of dental health (standardised for age) and these, in turn, are related to the dental health status and behaviours of their parents.

The following sub-hypotheses were tested:

1. families from a 'more privileged' social class show a better dental health status than those from a 'less privileged' social class,
2. the behaviours conducive to good dental health (diet, oral hygiene, and dental attendance) are different among families from different social classes,

3. children tend to reflect, in their own dental health status, the dental health status of their parents,

4. the behaviours such as diet, oral hygiene, and dental attendance presented by children tend to be similar to their parents',

5. dental health status and behaviours of children and their mothers are more strongly related than fathers',

6. brothers and sisters in the same family have similar patterns of behaviours and grades of dental health (standardised by age), and

7. the similarity in dental health status observed among family members is mainly determined by the common environment these individuals share.

This present investigation has used nuclear families as its unit of study. A detailed description of the study design is given in Chapter 2. The pilot study is presented first, followed by the description of the main study, in which sampling methods and data collection are discussed. Data analyses are briefly described, and the research team personnel is then presented.

One of the aims of the present study was to investigate the pattern of dental health and behaviours according to social class. In Chapter 3, the statistical procedures used are fully
presented; the results obtained and the discussion of these 'social class differences' follow.

In Chapter 3 some aspects of the home environment in relation to dental health status and behaviours are also presented. However, the most thorough assessment of intra-family patterns of dental health status and behaviours was developed with the use of path analyses. A detailed description of the path analytic model and the statistical procedures involved are presented in Chapter 4. The results obtained are described in Chapter 5. In Chapter 6 these findings are discussed and the possible reasons for such findings are presented.

The final chapter (Chapter 7) draws together the principal conclusions of the present investigation.
2.1. INTRODUCTION:

This collaborative study was conducted in Belo Horizonte, where the researchers were based. Belo Horizonte is the state capital of Minas Gerais, Brasil, and is an industrial city with a population of about four million inhabitants, spread in a wide range of socio-economic backgrounds.

Belo Horizonte has had fluoridated water since 1975 (COPASA, 1987). The mean DMFT score of children aged 12 from Belo Horizonte was 4.7 (COPASA, 1987), which is 2 lower than the mean DMFT score for Brazilian 12-year-olds (Ministério da Saúde, 1988).

This study consisted of 164 randomly selected nuclear families. A nuclear family consisted of a father, a mother and at least one child (aged 13 years) living together. The families were randomly selected through the 13-year-old child (the index child) at school. All family members (father, mother, index child and siblings) were clinically examined. Interviews were conducted with all family members aged 10 years or more.

This chapter provides a description of the research design, and describes the pilot study, followed by the main
study. Data collection and data analysis will then be discussed, and the research team personnel will be presented.

2.2. PILOT STUDY:

2.2.1. Description:

The pilot study was designed to test the feasibility of the methods to be used in the main study, namely the sample selection methods; the questionnaires; the interviews; and the clinical examination criteria for assessing oral hygiene pattern, oral health status and treatment needs.

The sample consisted of 20 families, that is, a father, a mother and at least one child aged 13, living together. Ten of these families were from a 'more privileged' social class; the other ten were from a 'less privileged' social class.

The simplest method of identification of families is through the child, and the simplest and an efficient method of identification of children is through schools. Therefore, four schools: three state and one private school, were selected to participate in the pilot study. A school roster of all 13-year-old students, attending the school, was compiled at the four schools.

The children on this list were contacted in their classes, where a brief explanation of the research was given. Each 13-year-old child was then given an initial identification questionnaire and a letter addressed to their parents,
containing an explanation of the purpose of the research. This identification questionnaire was taken home by the child with the request for it to be answered by one of the parents. On the following two days the researchers returned to each class and collected the questionnaires. The purpose of the identification questionnaire was to select the families which would fulfil the basic requirements for taking part in the study, that is, parental age (35-44 years), marital status (father and mother living together) and employment status (father in paid job).

The families eligible for the study were listed and approached according to the home facilities. The procedure for those having a telephone involved an initial request, by telephone, to attend for a dental inspection and an interview on a date most suitable for the family. For those families not owning a telephone, invitation was made at the door. The interview and the dental examination were conducted at that time, if convenient.

Interviews and clinical examinations were conducted with 60 subjects: the parents and the 13-year-old child, at the participants' home. As this was a collaborative study, the families were visited twice. During the first visit, the families were first clinically examined and then interviewed by W.S.M. A few days later, the families were visited by this author, who conducted the interviews, collecting data pertinent to this study.

During the first visit to the families, both parents and the 13-year-old child were interviewed by W.S.M. Oral examinations were also carried out and always preceded the interviews. The criteria used for the clinical examination was
adapted from WHO (1987). Each exam took an average of 10 minutes. The clinical examination was recorded on a special form.

During the second visit to the families, this author interviewed each parent for an average of 90 minutes. One hundred and twenty questions on oral health behaviours (diet, oral hygiene habits, and pattern of dental attendance), oral health beliefs and family structure in relation to oral health behaviours were tested. The interview with the 13-year-old child lasted an average of 45 minutes. Sixty questions on oral health behaviours (diet, oral hygiene habits, and pattern of dental attendance), oral health beliefs and family structure in relation to oral health behaviours were tested.

All the interviews were tape-recorded.

2.2.2. Response Rate:

All the four schools selected to take part in the pilot study agreed to participate. Of the 262 13-year-old children registered at the schools, 29 were absent from class on the three days the schools were visited and, therefore, were not contacted. Of the 233 identification questionnaires handed out, 147 were returned, representing a response rate of 63%.

After analysis of these 147 identification questionnaires, 40 families were eligible to participate in the pilot study. Of the 21 families approached, only one declined to take part.
2.2.3. Discussion:

On the whole the research design proved to be satisfactory. However, some adjustments had to be made. These improvements will now be discussed.

Social Class

At first this study allocated families into two social classes: 'more privileged' (groups A and B) and 'less privileged' (groups C, D, and E). However, during the pilot study, it was noticed that families within each social class groups (A, B, C, and D) differed among themselves. In an attempt to detect these sub-group differences, it was decided to keep the more detailed social class division instead of a broad division of 'more privileged' and 'less privileged'. This procedure would enable a more detailed and accurate analysis of the data.

The social group E was not included in the main study. There were two main logistic reasons for excluding them. The first was the fact that since this social class group is synonymous to absolute poverty, it is mainly composed of homeless people, creating exceptional problems for interview and examination. The second reason was the difficulty in contacting this social class because the children did not attend school. Time and resources did not permit the special sampling and extra facilities that would have been required.
Questionnaires

This section of this discussion will cover the modifications carried out to the questionnaires designed to gather data pertinent to this investigation.

The identification questionnaire needed some minor changes. It was shortened and simplified. Simpler questions, containing the same variables, were developed. This was because most of the parents from the 'less privileged' social class had not more than 4 years of formal education and had difficulties in answering some of the questions. This may have been one of the explanations of the 'low' response rate in the return of the identification questionnaire to the schools by the 13-year-old students.

The questionnaire developed for the interview with the parents needed some small changes. A few questions were excluded, namely those which were included in order to check the validity of the main questions.

The changes of the questionnaire designed for the 13-year-old child were also minor. These changes were related to the exclusion of those questions which were developed to check the validity of the main questions.

A detailed description of the development of the questionnaires used in this study is given in Appendix 1.
Clinical Examination

The clinical examination did not need any modification. The clinical criteria, adapted from WHO (1987), proved to be most applicable to the purpose of the study.

A detailed description of the clinical criteria used in this study is given in Appendix 3.

Response Rate

Two aspects concerning the identification questionnaire should be discussed. First, the high number of absentees found. Second, the 'low' response rate encountered. These two aspects will be discussed together since the explanations for both are very similar.

The visits to the four schools elected to take part in the pilot study were carried out during the last two weeks of November and the first week of December/1987. This is the end of the school year in Brasil, a period when students are sitting final examinations or preparing for the supplementary exams. Therefore, it is not the most suitable time to contact students at schools. The high number of absentees found may have been due to the fact that some students were not attending classes any more because they had already passed their exams. The 'low' response rate in returning the identification questionnaire may also be explained by the stress students were going through during the final weeks of the school year.
The second explanation for the 'low' response rate to the identification questionnaire may have been the fact that the parents from the 'less privileged' social class had difficulties in understanding it. Parents from this social class showed very low literacy rates. The majority of them had up to only 4 years of formal education.

2.3. MAIN STUDY:

One hundred and sixty-four families took part in the main study. Since social background plays an important role in the determination of health status (Townsend and Davidson, 1982) and oral health status (Todd et al, 1980), the families were divided into four social classes: A, B, C, and D.

Each social class group was composed of 41 families. There were three main reasons for the selection of this sample size. First, the minimum accepted number of units/cell for an adequate statistical analysis is 30 units in each cell (Evans, 1983; Bland, 1987; Worthington, 1989). Hence the number of 41 units/cell was an adequate number for statistical purposes. Moreover, such a number would avoid working with exact minimum numbers. Second, the present study was initially designed to be able to detect statistically significant differences at the level of 5% (p < .05). The use of 41 units/cell would enable a detection of a statistically significant difference of 2 points in DMFS scores at the 5% level, with a 95% confidence limit.

\[ \Delta = 3.60 \times 2.60 \sqrt{\frac{2}{n}} \]

where \( \Delta \) is the difference to be detected
\( n \) is the number of units/cell
A difference of 2 points in DMFS scores between sample groups was considered to be clinically satisfactory by the researchers. Therefore, 41 units/cell was considered a reasonable sample size to detect statistically significant differences at the 5% level. Third, because the researchers had twelve months to do the fieldwork (selection of schools, permission to contact students, selection of families, development of pilot and main studies) and all the data were collected by the researchers themselves, time allowed the interviewing and examining of 164 families (861 clinical examinations and 717 interviews) for the main study.

As oral health is strongly related to age (Todd et al, 1980), this variable was controlled. For parents, the age ranged from 35-44 years. According to WHO (1987), 'This age group is the standard monitoring group for health conditions in adults. The full effect of dental caries, the level of periodontal involvement, and general effects of care provided can be monitored using data for this age group.' (WHO, 1987 p.8). Moreover, edentulousness rates are very low for this age group.

For the index child, the age of 13 years was chosen. WHO (1987) recommends that 12-year-old children should be used as a global monitoring age for caries for international comparisons and monitoring of disease trends because it is generally the age at which children leave primary schools. Thus in many countries this age group is the last age at which a reliable sample may be obtained easily through the school system (WHO, 1987). In this study, however, the age of 13 was selected for two main reasons. First, Brazilian children finish their
studies at the age of 14 and after this age, the children from families from the 'less privileged' social classes tend to stop schooling. Second, 13-year-old children provide a more accurate picture of caries prevalence for children since all the permanent teeth have been present in the mouth for at least 1 year - a period when teeth are most susceptible to developing dental caries (Takeuchi, 1961).

A detailed description of the social characteristics of the sample is presented in Appendix 6.

2.3.1. Sample Selection Methods:

The sample was selected from private and state schools in Belo Horizonte, where the researchers were based. Schools provide a practical and adequate approach for the identification of children in epidemiological survey (WHO, 1987).

Permission was obtained from the Department of Education for selecting the sample from schools. There were 236 schools in Belo Horizonte, 111 state and 125 private schools (CEDINE, 1985).

To select the sample according to social class, the area where the school was located was the first criterion to be taken into account. The areas were chosen according to the criteria developed by PLAMBEL (1984) to categorise the residential areas of the metropolitan region of Belo Horizonte by social class. These criteria are the result of several years of study of the development of the metropolitan region of Belo
Horizonte. The determination of these residential areas was based on several factors: historical aspects, physical environment, social class distribution, economic activities and cultural factors.

The metropolitan region of Belo Horizonte was divided into 8 areas (hereafter referred to as macro-units). These macro-units were then divided into sub-units (PLAMBEL, 1984).

The reasoning for the division of the metropolitan region of Belo Horizonte into these macro-units was based on the concept of 'centrality', that is, the central area showed a concentration of resources while a dispersion of resources was observed as the areas further away from the central area.

Since the purpose of this investigation was to study the population of the city of Belo Horizonte and not its whole metropolitan region, only five macro-units were selected: 'nucleo central', 'area pericentral', 'pampulha', 'eixo industrial' and 'periferias'. For this study, however, these macro-units were grouped into 2 areas - the central area and the suburban area. While the central area consisted of the 'nucleo central', the suburban area was composed of the 'area pericentral', 'pampulha', 'eixo industrial' and 'periferias'.

On the whole, the central area was composed of a 'more privileged' social class while a 'less privileged' social class resided in the suburban area. Therefore, as an initial rough division, it was considered that the central area represented the 'more privileged' area; while the suburban area represented the 'less privileged' area. However, as it would be expected, such a division was not so clear-cut and absolute,
showing some 'less privileged' pockets located in the central area and some 'more privileged' pockets in the suburban area.

As a rough guide for the selection of families according to social class, the schools located in the city of Belo Horizonte were divided into 2 groups: those located in the central area ('more privileged' area) and those located in the suburban area ('less privileged' area). The former group consisted of 52 schools, 13 state and 39 private; while the latter was composed of 184 schools, 98 state and 86 private.

The schools had an average of 100 13-year-old students (CEDINE, 1985). From the pilot study, only 19% of the students contacted in the schools were eligible to participate in the study: it was therefore assumed that at least 980 13-year-old children should be contacted, that is, at least 10 schools should be approached in order of get a sample of 164 children. All the 236 schools in the city of Belo Horizonte were then given a number. As it was decided to over-sample, sixteen schools were randomly selected - eight schools from each area: central and suburban. It was also decided that the schools would be contacted in the order established during the random selection. The schools randomly selected to participate in the study are listed in Appendix 5.

The total number of students and the number of 13-year-old students from each school was obtained from the records at the Information Centre of the Department of Education (CEDINE). As the most recent records in CEDINE were dated from 1985; the researchers, using information available at each school registrar's office, developed an updated list of all 13-year-
old students, with their full names, date of birth, class and school shift (morning, afternoon, or evening).

As the schools were visited following the order in which they were selected and as all the schools selected agreed to participate in the study, the first 6 schools located in the 'more privileged' central area and the 3 schools located in the 'less privileged' suburban area were sufficient for the sample. The schools which took part in the study, with the updated number of 13-year-old students attending the school, are listed in Appendix 5.

Permission to contact the students was obtained in two ways. For state schools, the Department of Education communicated directly with the state school headteachers. For private schools, a letter signed by the dean of the dental school where both researchers work (F.O.U.F.M.G.) was sent to the private school headteachers. In this letter the researchers were introduced, and a brief explanation of the purpose of the study was given.

A meeting was held with each school headteacher - from both state and private schools - at the school. The study as well as the role of the school in the study was elucidated. The final permission to contact the students was finally given by the headteacher.

The 13-year-old students were then contacted in their own classrooms, where a brief explanation of the study was given to all the students in the class. For the purpose of selecting the families and classifying them into social classes, an identification questionnaire (Appendix 2) was handed out to all 13-year-old students. This identification questionnaire
with a letter addressed to the parents, explaining the purpose of the study, was taken home with the request for it to be filled in by one of the parents. A total of 1,068 questionnaires were distributed, 465 in the 'more privileged' schools and 603 in the 'less privileged' schools. On each of the following three days, one of the researchers returned to the school and visited all the classrooms to collect the questionnaires.

A total of 233 families were selected, 123 from the schools located in the 'more privileged' area and 110 from those located in the 'less privileged' area. The criteria for selection were based upon: parental age (35-44 years of age), marital status (father and mother living together), employment (father in paid job) and social class (A, B, C and D).

The 'more privileged' area presented some pockets of 'less privileged' area, for example the slums; and the 'less privileged' area also contained some pockets of 'more privileged' area, for example around the lake in 'pampulha'. Hence some children from the 'less privileged' social class attended classes in schools located in 'more privileged' area and vice-versa. Refinement of the social class distribution of the families proved to be necessary. To this end, the ABA-ABIPEME (1978) criteria for socio-economic classification were used (Appendix 4).

The ABA-ABIPEME (1978) criteria are based on eight socio-economic indicators: number of television sets, radios, bathrooms, motor-cars, maids, vacuum cleaners and washing machines at home; and the educational level of the head of the family. A set of points is assigned to the socio-economic
indicators, and a final score defines the households' social class - A, B, C, D, and E.

The re-organisation of the families led to 15 of them being socially re-classified: 5 families from schools located in 'more privileged' area were re-classified in the 'less privileged' social classes (C and D); while 10 families from schools located in the 'less privileged' area were re-classified in the 'more privileged' social classes (A and B).

As a more detailed statistical analysis was to be done, the ABA-ABIPEME criteria were also used in the subdivision of the two socio-economic groups. The 'more privileged' socio-economic group was composed of the subgroups: social classes 'A' and 'B'. The 'less privileged' socio-economic group was subdivided into social classes 'C' and 'D'. Therefore, the 233 selected families were finally re-distributed as follows: 84 families in social class 'A', 44 families in social class 'B', 55 families in social class 'C', and 50 families in social class 'D'. From these, 41 families from each social class were included in the study.

The 233 eligible families were listed separately according to the school of origin. The families were approached at random and following the order established by the random selection of schools. Once a sufficient number in each of the four cells (A, B, C, and D) was obtained, the remaining families from the completed cell were not contacted.
2.4. DATA COLLECTION:

After sampling selection, the eligible families were contacted according to whether they had a telephone or not. For families from the 'more privileged' social classes (A and B), who often had a telephone, the purpose of the study was explained, and the request to participate in the study was made by telephone. If permission was obtained, an appointment for visiting the family was agreed. Attempts to interview and examine all family members on the same date were made.

Families from the 'less privileged' social classes (C and D), who often did not have a telephone, were visited, when the purpose of the study was explained and followed by an invitation to participate. If consent was given, the interview and the dental examination were conducted with the family members present at that time, if convenient. An appointment to interview and examine other family members was set up on a date most suitable for them. It was common to visit each family several times in order to interview and examine all members.

The data collected were of three types: clinical, socio-economical, and behavioural. Data collection used dental examinations combined with structured and standardised interviews. All the interviews and clinical examinations were carried out in the participants' home.

Interviews were conducted with the parents, the 13-year-old child, and all brothers and sisters aged 10 years and above - a total of 717 interviews were carried out. The clinical
examination was carried out on all the family members - 861 subjects were examined.

The following two sections will describe the collection of the data.

2.4.1. Socio-economical and Behavioural Data:

Socio-economical and behavioural data were collected through the identification questionnaires and interviews (for a detailed description of the development of the questionnaires, refer to Appendix 1).

At first, information to select the sample and determine the socio-economic classification of families was collected through the identification questionnaire. This questionnaire was distributed to the 13-year-old child at school and answered at home by one of the parents. It contained questions on family members' names, ages and kinship; family address; marital status; father's occupation; parents' educational level; and socio-economic indicators (number of television sets, radios, bathrooms, motor-cars, maids, vacuum-cleaners and washing machines at home) (Appendix 2).

As this was a collaborative study, the families were visited twice. During the first visit, carried out by W.S.M., the identification questionnaire was validated by the inclusion of a question on father's income. Since this is a delicate question to ask, it was not included in the identification questionnaire. Both parents were interviewed for an average of 30 minutes each.
Data on behavioural aspects relevant to this present study were collected during the second visit to the families. This author conducted an interview with both parents, the 13-year-old child, and siblings aged 10 and above. 717 interviews were carried out.

The parents and 13-year-old child were questioned on their oral health behaviours (diet, hygiene, and pattern of dental attendance), their oral health beliefs and the home environment in relation to the three previously mentioned oral health behaviours (Appendix 2 - Parents' Questionnaire and 13-year-old Child's Questionnaire). The parents' interviews were, on average, 30 minutes long; while the interviews with the 13-year-old child lasted 20 minutes on average.

A much shorter interview, lasting an average of 10 minutes, was conducted with all siblings aged 10 and above. Questions on their oral health behaviours (diet, hygiene, and pattern of dental attendance) were asked (Appendix 2 - Siblings' Questionnaire).

2.4.2. Clinical Data:

The oral examinations were carried out by W.S.M. during the first visit to the participants' home. These oral examinations were always conducted before the interviews and took an average of 10 minutes for each subject. All family members were clinically examined, a total of 861 clinical examinations were carried out.
The clinical criteria adopted were adapted from WHO (1987) (Appendix 3). The oral examination included an assessment of oral hygiene status, dental caries, periodontal and prosthetic status, and treatment needs. The clinical data were recorded on a special form (Appendix 3).

Consistency of clinical diagnostic criteria was assessed throughout the field work. Every tenth subject were re-examined, a total of 81 individuals.

2.5. DATA ANALYSIS:

After examining and interviewing the family members, the data were prepared for the analyses. Data from the clinical examinations were precoded according to WHO (1987). The coding of the behavioural data differed slightly. All the questions asked were in an open-ended format; however, some precoding of the answers had been carried out after the pilot study. Those answers which did not follow any of the precoded categories were written down in full. At the end of the field work, all the answers were then coded. Following the coding procedure, all the data, clinical and behavioural, were entered into a personal computer. This procedure was conducted by this author.

Data analyses were then developed. Due to the large number and nature of the variables under study as well as the number of hypotheses to be tested, numerous statistical procedures were required.

Data analyses used to describe the social class differences of the sample (Chapter 3) consisted of: one-way
analysis of variance (Anova) and related tests, Kruskal-Wallis one-way analysis of variance and related tests, and chi-square. The home environment was also assessed (Chapter 3). The analyses of the home environment comprised: Pearson's $r$ correlation coefficient, Spearman's $\rho$ correlation coefficient, lambda association coefficient, and Kappa coefficient of agreement. For the study of intra-family patterns of dental health status and behaviours (Chapters 4, 5 and 6), path analysis was performed. These procedures are fully described in Chapters 3 and 4.

Three computer programmes were used in the calculation of the statistical procedures: Statistical Package for Social Science: SPSS/PC+ Version 2.0 (Norušis, 1988) and SPSSX (Norušis, 1986); and Pathmix Method 3 - PC Version (Rao et al, 1984; Russel, 1988). All the statistical analyses were conducted by this author.

This study did not use all the data collected. Only the data related to the hypotheses-testing were analysed.

2.6. RESEARCH TEAM PERSONNEL:

This was a collaborative study, conducted with Dr. W.S. Marcenes (W.S.M.). Both researchers visited each family, W.S.M. on the first visit and this author on the second visit.

During the first visit to the families, validation of the identification questionnaire (Appendix 2) was obtained, and oral examinations were conducted (Appendix 3).
During the second visit to the families, this author interviewed the parents, the 13-year-old child, and all siblings at the age of 10 and above (Appendix 2). Data pertinent to the present investigation were then collected.

After all the clinical and behavioural data had been collected from all family members, this author handed out a pamphlet, which contained explanations on the aetiology of dental caries and periodontal disease as well as some suggestions on preventive measures against these two oral diseases. All family members were invited to participate in an open discussion on oral health issues. The majority of the families showed a clear interest and participated enthusiastically in the discussion. These discussions lasted an average of 45 minutes. Such a discussion was an attempt to provide the families, who so promptly participated in the study, with some immediate reward.
PART II

THE FINDINGS
3.1. INTRODUCTION:

It is well accepted that dental status varies according to social class (Koch and Martinsson, 1970; Todd et al, 1980; Hausen et al, 1982; Todd and Dodd, 1985; Ministério da Saúde, 1988). Some of the behaviours conducive to a good/bad oral health also show variation by social class. While individuals from a 'less privileged' social class tend to consume more sugary items (Beal and James, 1970; Samuelson et al, 1971; Beal and Dickson, 1974; Tee, 1987; Ruiken, 1989) and less often seek medical/dental assistance (Beal and James, 1970; Blaxter and Paterson, 1982; Todd and Dodd, 1985), there seems to be no evidence of a difference between tooth-brushing habits among individuals from different social classes (Blinkhorn, 1976; Hodge, 1979).

This chapter aims to describe the sample in relation to dental health status: DMFS (and its components) and oral hygiene, as well as in relation to three behaviours known to influence the dental status of an individual: sugar consumption, oral hygiene habits and pattern of dental attendance. The home environment in relation to these three behaviours is also described.
3.2. STATISTICAL PROCEDURES:

Due to the large number and varied nature of variables under study, the data analyses comprised several statistical procedures. These procedures will now be described. For the purpose of clarity this section will be divided according to the nature of the variables being analysed.

3.2.1. CLINICAL DATA:

3.2.1.1. Consistency of Clinical Examinations:

The need for consistent, standardised diagnosis of oral health status of populations is recognised (WHO, 1987). Nevertheless, there appears to be no generally approved method of assessing examiner reproducibility (Bulman and Osborne, 1989). Therefore, techniques, such as Students's t-test, Pearson's correlation coefficient and percent agreement, are often applied in the assessment of intra-examiner reliability. These test statistics have some shortcomings when applied for that purpose (Hunt, 1986; Bulman and Osborne, 1989). These shortcomings will now be discussed.
Students's t-test and Pearson's correlation coefficient use the mean and the variance of the samples under study in the calculation of their statistical values, ignoring individual observations or differences (Bland, 1987). In doing so, systematic differences between examiners/exams cannot be properly detected (Hunt, 1986; Bulman and Osborne, 1989). Considering that in the assessment of intra-examiner reproducibility, the point of study is the difference between paired individual observations, these two test statistics, perfectly acceptable in other contexts, are misapplied when used as measurements of consistency.

Percent agreement is another test statistic which is used as a measure of examiner reliability. In spite of taking into account agreement/disagreement in diagnostic criteria, it fails to correct overall agreement for the chance agreement, that is, agreement that could have been attained had the decisions been made at random (Hunt, 1986). Therefore, this test statistic overestimates the observed agreement between examiners/exams, giving higher reproducibility results.

Cohen's Kappa Coefficient of Agreement is a measure of agreement proposed for variables which follow at least a nominal scale (Siegel and Castellan, 1988). Since it relates the actual measure of agreement with the degree of agreement that would have been obtained had the diagnoses been made at random, it can be interpreted as a measure of agreement beyond that due solely to chance. For this reason, this test statistic is probably the most reliable method of assessing intra-examiner reliability (Hunt, 1986; Nuttall and Paul, 1985; Bulman and Osborne, 1989).
For the interpretation of Kappa values, Landis and Koch (1977) proposed a six-point scale. Kappa values below zero were termed as poor agreement; 0.00-0.20 slight agreement; 0.21-0.40 fair agreement; 0.41-0.60 moderate agreement; 0.61-0.80 substantial agreement; and values above 0.81 indicate almost perfect agreement beyond chance.

The calculation of Kappa values was performed by this author. Since no statistical package available included this test statistic, the calculations were done by hand. First, with the use of SPSS/PC+ Version 2.0 (Norušis, 1988), frequency tables were obtained, having the results of the original exams as columns and the results of the duplicate exams as rows. Observed frequencies and expected frequencies were then calculated. The calculation of Kappa values followed the description in Siegel and Castellan (1988 p.284-291).

Every calculation was performed at least twice. If identical results were obtained for the first and second calculations, that value was considered correct. If results differed, the calculation was repeated as many times as necessary until two identical results were obtained. In the few cases such a procedure was necessary, an identical result was obtained at the end of the third calculation.

3.2.1.2. Dental Status:

The dental status was evaluated with the use of DMFS and its components (DS, MS, and FS) (Appendix 3). The analysis of these data comprised the one-way analysis of variance (Anova)
and an 'a posteriori' multiple comparison test, Tukey's T-method. The material presented in this section is largely based on Wetherill (1981) and Snedecor and Cochran (1989). For this reason references will be added only when the information mentioned was derived from another source.

Anova was developed in the 1920's by Fisher. Among other uses, Anova enables the comparison of more than two independent groups. In addition, the type of observation being made should be considered. Anova is indicated when the dependent variable follows an interval scale (continuous variable), while the independent variable follows at least a nominal scale. In the present investigation, DMFS scores (dependent variable) of four social classes (independent variable) were being compared, which indicated the use of Anova.

There are three assumptions underlying the use of one-way analysis of variance: independence, normality, and homoscedasticity (homogeneity of variance). These assumptions are now discussed.

Anova assumes that the subjects in each of the independent sample groups are randomly and independently drawn so that an observed value in any one group has no effect or influence on any other observed value in that group or any of the other groups. The independence assumption is valid for the evaluation of social class differences among fathers and mothers.

For children, however, since some of them came from the same family, being therefore related, this assumption is violated. To overcome this problem, it would be advisable to use the random effect or hierarchical model. For such an analysis, due to the large sample size (164 families), the
capacity of a computer should be large. However, since the computer facilities available were not adequate for the development of the hierarchical model (random effect model), it was decided to present the results of the analyses performed on the data from the 13-year-old children (index children). For the description of the children taking part in the study, please refer to Appendix 7.

The assumption of normality implies that the observed responses are continuous and come from a Gaussian distribution. However, Anova is quite robust to small departures of normality, provided the sample size in each of the groups is above 30 (Evans, 1983; Worthington, 1989). Since in all sample cells, there were more than 30 units, this assumption, if violated, did not compromise the statistical inferences obtained through Anova.

Anova assumes that the variances of each of the groups under comparison are homogeneous (homoscedasticity). However, when sample sizes are equal, Anova is also quite robust to violations of this assumption. Moreover, for unequal sample sizes, Box (1954) has shown that Anova is robust if sample size is positively correlated with the size of the variance, that is, the smallest sample size showing the smallest variance and so forth.

There are several tests for homogeneity of variance: Bartlet's, Cochran's, and Hartley's. All of them, however, are oversensitive to small departures of normality and their results become then questionable. In the present study, Cochran's test was applied (Winer, 1971). When the homogeneity test was rejected at the 0.1% level (p = .001) (Anderson and
McLean, 1974), a non-parametric test statistic (Kruskal-Wallis) was applied to the data. The results of both analyses are given.

Anova only indicates whether real differences among group means may exist without specifying which sample means are responsible for it. Since doing several two sample tests (Student's t-test) increases the possibilities for a Type I error, that is, rejecting a true null hypothesis, 'a posteriori' comparison tests are recommended. These tests were designed to maintain the alpha (\( \alpha \)) value constant.

In the present investigation a pair-wise multiple comparison test was used: Tukey's T-method. This method is indicated for balanced cases (equal sample sizes) and the presence of homoscedasticity (Winer, 1971; Stoline, 1981).

It is important to state that, according to the literature reviewed (Winer, 1971; O'Neill and Wetherill, 1971; Carmer and Swanson, 1973; Ury, 1976; Stoline, 1981) there does not appear to exist an adequate 'a posteriori' pair-wise multiple comparison test that overcomes the problem of heteroscedasticity (heterogeneity of variance). Therefore, Tukey's T-method, in spite of not being 'ideal' for such cases, was used in the present analysis. In an attempt to overcome this shortcoming, a non-parametric multiple comparison test was calculated and its results are also presented.

All the calculations of Anova and related tests were performed, using SPSS/PC+ Version 2.0 (Norušis, 1988).
3.2.1.3. Oral Hygiene Index:

Oral hygiene was assessed using the simplified oral debris index (ODI-S) (Greene and Vermillion, 1964) (Appendix 3). ODI-S falls into an ordinal scale, that is, the categories are ranked in some way but the differences between them have no meaning. However, nominal scales enable the researcher to order subjects, from that with the lowest value to that with the highest (Siegel and Castellan, 1988; Worthington, 1989).

The analysis of ordinal variables requires the use of non-parametric tests. Statistical tests based on rank order are used to analyse group differences. Since this study comprised the comparison of four groups, Kruskal-Wallis one-way analysis of variance was used.

Kruskal-Wallis is a highly efficient non-parametric test because it uses most of the information available in the observation. Instead of converting scores to pluses (+'s) or minuses (-'s) depending on whether the data fall above or below the median, it converts the scores into ranks. Thus it preserves the magnitude of the observed data more fully than other non-parametric tests, for example median test (Siegel and Castellan, 1988). Compared with the most powerful parametric test, Anova, and under conditions where the assumptions associated with the statistical model of parametric analysis of variance are met, Kruskal-Wallis test has an efficiency of 95.5% for large sample sizes (Siegel and Castellan, 1988).

As with any other non-parametric test, assumptions of normality, homoscedasticity or additiveness are not relevant.
The only two assumptions made when using Kruskal-Wallis one-way analysis of variance are: the variable under study falls into at least an ordinal scale; and the independent sample groups are randomly and independently drawn so that the observed values in any of the groups are independent from each other. As with Anova, the assumption of independence is valid in the analyses of the data from fathers and mothers, for the children, however, this assumption is violated. Due to the lack of non-parametric tests to overcome this problem, the analyses were performed on the data from the index-children. In Appendix 7, the results of the analyses on the children's data are presented.

The variance of the sampling distribution of Kruskal-Wallis, however, is influenced by ties, that is, when two or more scores (regardless of the group) are given the same rank order. There are methods of adjusting for ties (Siegel and Castellan, 1988), and in this study all the results from Kruskal-Wallis given are corrected for ties.

As with Anova, when the obtained value of Kruskal-Wallis is significant, it indicates that at least one of the groups is different from at least one of the other groups. In order to determine which group/s differ, multiple comparisons test were performed (Siegel and Castellan, 1988).

Kruskal-Wallis one-way analysis of variance was performed using SPSS/PC+ Version 2.0 (Norušis, 1988). The multiple comparison test, however, was not available in computer packages. Thus it was performed by this author by hand, following the description in Siegel and Castellan (1988 p.213-214). All the hand calculations were performed at least twice.
When identical results were obtained for the first and second calculations, that value was considered correct. If results differed, the calculation was repeated as many times as necessary to obtain two identical results.

3.2.2. BEHAVIOURAL DATA:

The analysis of the behavioural data followed what has been described so far for the clinical data. For the sake of brevity, only differences in data analysis will be fully described in this section.

3.2.2.1. Dietary Habits:

Dietary habits were assessed by means of the 24-hour recall method (Appendices 1 and 2). In spite of all food intakes during the previous 24 hours having been recorded, in the present discussion dietary habits focused on sugar consumption intake. The intake frequency was estimated by counting the number of sugary items consumed during the previous 24 hours (Varveri and Bellagamba, 1986). The total sugar intake frequency was then sub-divided into intake at meals and intake in-between meals.

For the children, another analysis was performed. Sugar intake frequency was analysed according to the source of the sugary item, that is, if it was available at home, if it was
given to the child or if it was purchased by the child (Croucher and Rodgers, 1985).

The analysis of these data comprised the one-way analysis of variance (Anova) and Anova-related tests. If any of the assumptions underlying the use of Anova did not hold true, Kruskal-Wallis test was performed, and the results from both analyses are given.

### 3.2.2.2. Oral Hygiene Habits:

In the present investigation the assessment of oral hygiene habits comprised tooth-brushing frequency (Appendices 1 and 2). This information was collected during the interviews as the number of times the interviewee reported brushing per day. For the data analysis tooth-brushing frequency was recoded (less than once/day, once/day, more than once/day) and, therefore, transformed into an ordinal variable. Kruskal-Wallis one-way analysis of variance and related tests were then performed on the data.

### 3.2.2.3. Pattern of Dental Attendance:

Data on the pattern of dental attendance consisted of the frequency of dental attenders and non-attenders among interviewees. Attenders were defined as subjects who had visited a dentist at least once, either for a symptom-related visit or a check-up. From dental attenders, further information
was collected: the usual type of dentist, the time interval since last visit to the dentist, and the usual reason for dental attendance.

The usual type of dentist was recoded into three categories during data analysis: private, NHS, and 3rd-party co-payment. A private dentist was defined as the one whose fees were totally paid by the client, whereas a NHS dentist was defined as the one whose fees were fully paid by the state. This latter type comprised, therefore, school dentists and INPS dentists (that is, Brazilian equivalent to NHS). A 3rd-party co-payment was understood to be a dentist whose fees were partly paid by the client and partly by either the state or the company/industry where a family member worked.

The time interval from the last visit to the dentist was also recoded into three categories during data analysis: less than 6 months, 6 to 24 months, and more than 24 months ago. The usual reason for dental attendance fell into two categories: symptom-related visit and check-ups.

Most of the variables in this section follow a nominal or categorical scale. Therefore, the chi-square test was used during data analysis. Proper application of this procedure requires that the expected frequencies in each cell are not too small. When this requirement is violated, the results cannot be interpreted because the sampling distribution of $X^2$ does not approximate well enough the $X^2$ distribution. It is recommended, therefore, that in chi-square tests for which the degrees of freedom are greater than 1, no more than 20% of the cells should have an expected frequency of less than 5, and no cell should have an expected frequency of less than 1 (Bland, 1987;
Siegel and Castellan, 1988). In order to conform to this recommendation, recoding of some variables (as described above) was performed.

The chi-square test statistic was calculated using SPSS/PC+ Version 2.0 (Norušis, 1988).

3.2.3. HOME ENVIRONMENT:

The first step in the analysis of the home environment was an assessment of intra-family patterns of oral health status (DMFS and ODI-S) and dental health related behaviours (dietary habits, tooth-brushing frequency, and pattern of dental attendance). To this end, correlation coefficients were calculated for all intra-family pairs: mother-father, index child-siblings, mother-children, and father-children.

For the continuous variables (DMFS and dietary habits), Pearson's $r$ correlation coefficients are given (Wetherill, 1981; Snedecor and Cochran, 1989). For the ordinal variables (ODI-S and tooth-brushing frequency), Spearman's rho correlation coefficients were calculated (Siegel and Castellan, 1988). For the nominal variables (pattern of dental attendance), lambda association coefficients were developed (Siegel and Castellan, 1988).

In an attempt to improve the understanding of any possible intra-family patterns of dental behaviours, a series of questions were asked on the home environment in relation to the three behaviours under study: sugar consumption, oral hygiene practices, and pattern of dental attendance (Appendices
1 and 2). To this end, the questions covered the control of the habit when the index child was younger and at the present time. These questions were based on the studies of King (1976) and Hodge (1979).

In order to standardise the answers, the questions were always related to the 13-year-old child's habits. In addition, for the purpose of assessing the opinions of different family members, these series of questions were asked to both parents and to the 13-year-old child.

The agreement between the respondents (fathers, mothers and 13-year-old children) was assessed using Kappa Coefficient of Agreement. As described earlier (Section 3.2.1.1.), this test statistic corrects the actual measure of agreement for chance agreement. Hence it provides a reliable measure of agreement beyond that due solely to chance (Siegel and Castellan, 1988).

After determining the value of the Kappa statistic, calculations were made in order to determine whether the observed value was greater than the value which would be expected by chance. To this end, variance estimates were first calculated in order to obtain the p values.

The calculation of the correlation coefficients was performed with the aid of SPSS computer package. Pearson's r correlation coefficient and Lambda association coefficient were calculated using SPSS/PC+ Version 2.0 (Norušis, 1988), while the values of Spearman's rho correlation coefficients were obtained using SPSSX (Norušis, 1986). The p values for the Lambda association coefficient, however, were calculated by
hand by this author, following the description in Siegel and Castellan (1988 p. 300-301).

The calculation of Kappa values as well as their variance estimates and their p values were performed by hand by this author, following the description in Siegel and Castellan (1988 p.284-291). Every calculation was performed at least twice. If identical results were obtained for the first and second calculations, that value was considered correct. If results differed, the calculation was repeated as many times as necessary for two identical results to be obtained.

All the p values given in the data analyses of any of the variables here described are two-tailed values.

3.3. RESULTS:

The sample was randomly selected through private and state schools located in the central area of Belo Horizonte. Nine randomly selected schools were approached, of which five were private and four were state schools.

All the 13-year-old students at these schools were contacted in class and given an identification questionnaire (Appendix 2). 1,068 identification questionnaires were distributed; 920 questionnaires (86%) were returned to the school by the student.
Of the 920 questionnaires returned, only one-quarter (233) of the families fulfilled the basic requirements established and were eligible to participate in the study. Of these, 175 families were actually invited to participate in the study. This was due to the fact that as the sample cells were filled (41 families in each cell), other families from that social class (cell) were not contacted.

Of the 175 families approached, 164 agreed to take part, representing a response rate of just over 93%. The response rate, in spite of being high in all social classes, varied from one cell to another. Social class A showed the lowest response (85.5%), while the highest was observed in social class D (100%). Social classes B and C had responses of 97.6% and 93.2%, respectively.

3.3.1. CLINICAL DATA:

3.3.1.1. Consistency of Clinical Examinations:

Throughout the development of the field work, every tenth individual was clinically re-examined, a total of 81 clinical re-examinations. Original and duplicate clinical exams were assessed for agreement using Kappa Coefficient of Agreement. Each clinical index was considered separately: DMFS, ODI-S, presence/absence of bleeding, presence/absence of calculus, and periodontal pocketing.

According to WHO (1987), it is not always possible to determine what an 'acceptable consistency' should be. However,
it is suggested that agreement for most assessments should be in the range of 80-95% (WHO, 1987). In the present study, for all the consistency assessments made, the Kappa Coefficient was above 0.95 (95%) indicating almost perfect agreement beyond chance.

For both DMFS and pocketing, Kappa Coefficient was 0.99 (99%); for presence/absence of bleeding, 0.98 (98%); for both ODI-S and presence/absence of calculus, 0.96 (96%). These figures showed a highly consistent diagnostic criteria throughout the field work, implying a high intra-examiner reliability.

3.3.1.2. Dental Health Status:

In this section the dental health status of parents and children according to social class will be described. The dental health status of parents will be presented first, followed by the dental health status of their children.

Fathers:

Despite the low edentulousness figures observed amongst fathers (9), social class differences were clear. All the edentulous fathers came from the 'less privileged' social classes: 5 from social class C and 4 from social class D. Since edentulousness was so low the analysis presented includes all the fathers - dentulous and edentulous.
The mean DMFS score of fathers from all social classes was 64.8 (s.d. 31.2). Fathers from social classes A and B had virtually equivalent DMFS scores, 57.3 (s.d. 21.5) and 57.8 (s.d. 22.7), respectively. Fathers from social class C had a mean DMFS of 75.1 (s.d. 36.3), while those from social class D had a mean DMFS score of 68.9 (s.d. 37.9) (Table 3.1.).

Although the age of the subjects was standardised (45-44 years), a possible influence of this variable was tested. DMFS scores were regressed on a cubic polynomial on age (age, age\(^2\), age\(^3\)) in a stepwise manner. The inclusion of higher-order terms in the polynomial equation permitted the removal of non-linear effects (Wetherill, 1981). The higher-order age terms were retained in the regression equation only if they were significant at the 5% level (p < .05). The regression equation for fathers' DMFS scores was

\[
DMFS = -94.81 + 3.88 \text{(age)}
\]

This equation explained 8% of the variance (r\(^2\) = .075). The scores predicted from this equation were then subtracted from the original scores to derive residual scores, which would be used in the assessment of social class differences in dental caries experience.

Prior to the performance of the one-way analysis of variance (Anova) to detect any social class differences, the residuals were assessed for normality and homoscedasticity. A histogram of the residuals was obtained and it was observed that the residuals were normally distributed. The scatterplot
of residuals against predicted values showed that the residuals were randomly distributed, indicating homogeneity of variance. Hence the multiple regression equation was accepted.

One-way analysis of variance (Anova), having age as a co-variate, was then performed. Statistically significant differences were observed ($F = 4.96; p = .003$). Tukey's T multiple comparison test was applied, and a difference in DMFS scores amongst fathers of social class C versus fathers of social classes A and B emerged (Table 3.1.).

Before accepting the results of Anova, a possible violation of the assumption of homoscedasticity was assessed. In spite of the fact that Anova is robust for heteroscedasticity with equal sample sizes, Cochran's C test for homogeneity of variance was applied to the data. The four groups were considered homogeneous ($C = .38; p = .03$) (Anderson and McLean, 1974), and the results of Anova were accepted.
Table 3.1. - Father's DMFS, DS, MS, FS, (mean and standard deviation) by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>DMFS</th>
<th>DS</th>
<th>MS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>57.3 (21.5)*</td>
<td>1.3 (3.6)</td>
<td>7.9 (9.9)</td>
<td>48.2 (18.7)</td>
</tr>
<tr>
<td>B</td>
<td>57.8 (22.7)</td>
<td>2.3 (3.9)</td>
<td>20.4 (20.9)</td>
<td>35.1 (16.7)</td>
</tr>
<tr>
<td>C</td>
<td>75.1 (36.3)</td>
<td>3.8 (5.3)</td>
<td>55.1 (40.4)</td>
<td>16.2 (17.4)</td>
</tr>
<tr>
<td>D</td>
<td>68.9 (37.9)</td>
<td>5.4 (6.8)</td>
<td>58.3 (41.1)</td>
<td>5.2 (10.0)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>64.8 (31.2)</td>
<td>3.2 (5.2)</td>
<td>35.4 (37.7)</td>
<td>26.2 (23.0)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations

DMFS - F = 4.96  p = .003  (Tukey = A, B vs C)
DS - F = 4.95  p = .003  (Tukey = A vs D)
MS - F = 31.70  p = .000  (Tukey = A, B vs C, D)
FS - F = 56.20  p = .000  (Tukey = A vs B,C,D; B vs C,D; C vs D)

The analysis of the components of fathers' DMFS (DS, MS, and FS) followed the same procedure described above. However, when testing for a possible influence of age, the regression equation of each of the components on the cubic polynomial on age did not reveal any influence of this variable in any of the components. One-way Anova was then applied to the data. The results obtained are now presented.
The mean number of **decayed surfaces** for all the fathers was 3.2 (s.d. 5.2). Fathers from the 'more privileged' social classes showed the smallest mean number of decayed surfaces, 1.3 (s.d. 3.6) for social class A and 2.3 (s.d. 3.9) for social class B. Fathers from social class D had the largest mean number for untreated disease, 5.4 decayed surfaces (s.d. 6.8). Those fathers from social class C had a mean DS score of 3.8 (s.d. 5.3) (Table 3.1).

Social class differences in the mean number of decayed surfaces were confirmed through Anova (F = 4.95; p = .003). Tukey's T multiple comparison test showed that these differences were significant amongst fathers from social classes A and D. Since homoscedasticity among the four groups was not rejected (C = .44; p = .001), the results of the Anova were accepted.

The mean number of **missing surfaces** of all fathers was 35.4 (s.d. 37.7). The social class distribution followed the same pattern found for decayed surfaces: fathers from the 'less privileged' social classes showed a larger mean number of missing surfaces than fathers from the 'more privileged' social classes. Fathers from social class A had a mean number of missing surfaces of 7.9 (s.d. 9.9), fathers from social class B 20.4 (s.d. 20.9), fathers from social class C 55.1 (s.d. 40.4), and fathers from social class D 58.3 (s.d. 41.1) (Table 3.1.)

Anova revealed that social class differences were present amongst the four groups (F = 31.70; p = .000). These differences were due to the lower mean values observed for fathers from the 'more privileged' social classes when compared
to the mean values observed for fathers from the 'less privileged' social classes (Tukey = A, B vs C, D). Cochran's C test accepted the hypothesis of homogeneity of variance among the four groups (C = .44; p = .001) (Anderson and McLean, 1974).

The mean number of filled surfaces of all fathers was 26.2 (s.d. 23.0). A distinct pattern for the four social classes was observed: fathers from the 'more privileged' social classes had the largest mean number of filled surfaces. Fathers from social class A had a mean FS of 48.2 (s.d. 18.7), followed by fathers from social class B (35.1; s.d. 16.7), C (16.2; s.d. 17.4), and D (5.2; s.d. 10.0) (Table 3.1.).

Social class differences were confirmed through the Anova (F = 56.20; p = .000). These differences were due to the differences amongst the following groups: A vs B, C, D; B vs C, D; and C vs D. Homogeneity of variance was accepted at the 17% level (C = 34; p = .17).

**Mothers:**

Edentulosity was also low amongst mothers: 10 mothers were edentulous. Social class differences were a striking finding since the majority of the edentulous mothers came from the 'less privileged' social classes: 4 from social class C; 5 from social class D; and 1 from social class A. Because few mothers were edentulous, data analyses comprised both dentulous and edentulous mothers.
Before performing statistical tests on the dental health status scores, the possible influence of age was assessed. Each score was then regressed on a cubic polynomial on age (age, \( age^2 \), \( age^3 \)) in a stepwise manner. It was observed that the dental health status of mothers (aged 35 to 44 years), as expressed in terms of DMFS and its components, was not influenced by age. Data analyses were then conducted on the plain values of the scores.

When mothers from all social classes were grouped together, the mean DMFS score found was 75.6 (s.d. 27.5). An increase in mean DMFS was observed as mothers moved down to the 'less privileged' social classes. The mean DMFS of mothers from social class A was 66.6 (s.d. 23.7), from social class B 71.7 (s.d. 26.0), from social class C 79.0 (s.d. 30.9), and from social class D 85.2 (s.d. 26.3) (Table 3.2.).

The results of Anova indicated a statistically significant difference among the four social classes (\( F = 3.80; p = .01 \)), while Tukey's T multiple comparison test pinpointed a difference between mean DMFS score of mothers from social classes A and D. The assumption of homogeneity of variance was confirmed by Cochran's test (\( C = .33; p = .21 \)).
Table 3.2. - Mother's DMFS, DS, MS, FS, (mean and standard deviation) by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>DMFS</th>
<th>DS</th>
<th>MS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>66.6 (23.7)*</td>
<td>0.4 (1.1)</td>
<td>8.3 (20.9)</td>
<td>57.9 (21.9)</td>
</tr>
<tr>
<td>B</td>
<td>71.7 (26.0)</td>
<td>1.9 (3.5)</td>
<td>19.6 (25.7)</td>
<td>50.2 (18.4)</td>
</tr>
<tr>
<td>C</td>
<td>79.0 (30.9)</td>
<td>2.6 (4.3)</td>
<td>56.8 (37.7)</td>
<td>19.7 (16.8)</td>
</tr>
<tr>
<td>D</td>
<td>85.2 (26.3)</td>
<td>6.7 (13.3)</td>
<td>66.8 (34.2)</td>
<td>11.7 (14.0)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>75.6 (27.5)</td>
<td>2.9 (7.5)</td>
<td>37.9 (38.9)</td>
<td>34.9 (26.5)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations

DMFS - F = 3.80  p = .012  (Tukey = A vs D)

DS - F = 5.77  p = .001  (Tukey = A, B vs D)

MS - F = 35.60  p = .000  (Tukey = A, B vs C, D)

FS - F = 64.79  p = .000  (Tukey = A, B vs C, D)

The mean number of decayed surfaces for all mothers when grouped together was 2.9 (s.d. 7.5). Mothers from social class A showed the lowest mean number of decayed surfaces: 0.4 (s.d. 1.1), being followed by mothers from social class B with 1.9 (s.d. 3.5), social class C with 2.6 (s.d. 4.3), and social class D with 6.7 (s.d. 13.3) (Table 3.2.).

Anova revealed that the differences in the mean number of decayed surfaces of mothers from different social classes were
statistically significant \((F = 5.77; \ p = .001)\). These differences were attributed to the differences between the two 'more privileged' social classes when compared to social class D (Tukey = A, B vs D). When testing for homogeneity of variance, however, Cochran's test showed that the variances among the four groups differed \((C = .85; \ p = .000)\). Therefore, Kruskal-Wallis one-way analysis of variance was also performed.

Results obtained for the Kruskal-Wallis confirmed the findings obtained with Anova. A statistically significant difference was observed amongst the four social classes \((KW = 27.04; \ p = .000)\), and this difference was due to existing mean differences between mothers from social classes A and B when compared to mothers from social class D (mean ranking values: A = 58.07; B = 77.94; C = 88.90; D = 105.09). This finding confirmed the robustness of the procedure of Anova for inequality in variance when the groups under study have equal sample sizes.

The mean number of missing surfaces for all mothers was 37.9 (s.d. 38.9). Mothers from social class A presented the lowest mean number of missing surfaces, 8.3 (s.d. 20.9); followed by mothers from social class B, 19.6 (s.d. 25.7). Mothers from the two 'less privileged' social classes showed the largest mean number of mean missing surfaces: 56.8 (s.d. 37.7) and 66.8 (34.2) for social class C and D, respectively (Table 3.2.).

These differences in the mean number of missing surfaces were shown to be statistically significant \((F = 35.60; \ p = .000)\). Mothers from social classes A and B had a lower mean number of missing surfaces than those from social classes C and
D (Tukey = A, B vs C, D). Homogeneity of variance among the four groups was confirmed (C = .38; p = .019).

When mothers were grouped together, the mean number of filled surfaces was 34.9 (s.d. 26.5). Social class differences were obvious at first sight, with mothers from the 'more privileged' social classes presenting the largest mean number of filled surfaces: 57.9 (s.d. 21.9) and 50.2 (18.4) for social class A and B, respectively. Mothers from social class C showed a mean number of filled surfaces of 19.7 (s.d. 16.8), while those from social class D had the lowest mean number of filled surfaces: 11.7 (s.d. 14.0) (Table 3.2.).

The analysis of variance confirmed a statistically significant difference amongst the four social classes (F = 64.79; p = .000). These differences were consequent to the high mean number of filled surfaces mothers from social classes A and B had when compared to the mothers from social classes C and D (Tukey = A, B vs C, D). Cochran's C test confirmed the assumption of homogeneity of variance (C = .37; p = .041).

Index Children:

Due to the reasons described in Section 3.2. (Statistical Procedures), the analyses of the dental health status comprised the index children (13-year-old children) only. A total of 164 children were, therefore, analysed: 67 boys and 97 girls (For a description of all the children, aged 10 and above, refer to Appendix 7).
The number of caries-free children was low: 27 children (16%). These children were fairly equally distributed in the four social classes: 3 from social class A (7%), 7 from social class B (17%), 8 from social class C (20%), and 9 from social class D (22%). Since the proportion of children affected by dental caries was far above 20% of them, analyses of dental caries experience comprised all the index children and were developed on the plain values of DMFS scores and its components (Worthington, 1989).

The mean DMFS score of children from all social classes was 7.4 (s.d. 6.7). Children from social class A had the lowest DMFS score, 6.2 (s.d. 4.2). Children from social classes A and C showed the lowest mean DMFS scores, 6.2 (s.d. 4.2) and 6.8 (s.d. 6.0), respectively. The index children from social classes B and D had a mean DMFS scores of 8.7 (s.d. 6.7) and 8.1 (s.d. 9.0).

One-way analysis of variance was performed, and no statistically significant differences in dental health status were detected at the 5% level (F = 1.24; p = .298) (Table 3.3.). Cochran's C test for homogeneity of variance rejected the hypothesis of homoscedasticity (C = .45, p = .000). Therefore, Kruskal-Wallis one-way analysis of variance was also performed on the data. Similar results were observed: no statistically significant difference among the four groups at the 5% level (K.W. = 2.59; p = .460) (mean ranking: A = 78.15; B = 92.73; C = 79.80; D = 79.32).
Table 3.3. - Index children's DMFS, DS, MS, FS, (mean and standard deviation) by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>DMFS</th>
<th>DS</th>
<th>MS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.2 (4.2)*</td>
<td>0.5 (1.5)</td>
<td>0.0 (0.0)</td>
<td>5.6 (4.1)</td>
</tr>
<tr>
<td>B</td>
<td>8.7 (6.7)</td>
<td>1.2 (2.6)</td>
<td>0.1 (0.8)</td>
<td>7.4 (5.8)</td>
</tr>
<tr>
<td>C</td>
<td>6.8 (6.0)</td>
<td>1.6 (4.7)</td>
<td>0.7 (2.4)</td>
<td>4.5 (4.2)</td>
</tr>
<tr>
<td>D</td>
<td>8.1 (9.0)</td>
<td>2.7 (4.1)</td>
<td>1.2 (3.7)</td>
<td>4.2 (4.9)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>7.4 (6.7)</td>
<td>1.5 (3.5)</td>
<td>0.5 (2.3)</td>
<td>5.4 (4.9)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations

DMFS - F = 1.24  p = .298
DS  - F = 2.73  p = .046  (Tukey = A vs D)
MS  - F = 2.66  p = .050  (Tukey = no differences)
FS  - F = 3.65  p = .014  (Tukey = B vs C, D)

The total mean number of decayed surfaces was 1.5 (s.d. 3.5). Index children from social class A had 0.5 (s.d. 1.5) decayed surfaces; social class B 1.2 (s.d. 2.6); social class C 1.6 (s.d. 4.7); and social class D 2.7 (s.d. 4.1) (Table 3.3.).

Anova revealed a statistically significant difference among the four groups (F = 2.73; p = .046). When Tukey's T-method was applied, a difference in mean DS was observed among
the index children from social classes A and D, with the former showing fewer decayed surfaces (Table 3.3.).

Since the hypothesis of homoscedasticity was rejected ($C = .46; p = .000$), Kruskal-Wallis one-way analysis of variance was carried out. The results obtained confirmed Anova ($KW = 9.55; p = .023$). Differences emerged among the index children from social classes A and D (mean ranking: $A = 73.18; B = 78.44; C = 80.37; D = 98.01$)

The mean number of missing surfaces when all the index children were grouped together was 0.5 (s.d. 2.3). While the index children from social class A had no extracted teeth, the index children from social class D had a mean number of missing surfaces of 1.2 (s.d. 3.7). Index children from social class B had a mean MS of 0.1 (s.d. 0.8) and from social class C 0.7 (s.d. 2.4) (Table 3.3.).

In spite of the Anova showing a statistically significant difference among the four groups ($F = 2.66; p = .050$), Tukey's T multiple comparison test did not detect any difference (Table 3.3.). A possible explanation for this is the conservative nature for alpha ($\alpha$) of multiple comparison tests in general.

Since the hypothesis of homogeneity of variance was rejected ($C = .68; p = .000$), Kruskal-Wallis was performed ($KW = 7.32; p = .063$), confirming the result obtained from the Tukey's T-method (mean ranking: $A = 77.50; B = 79.44; C = 85.45; D = 87.61$).

The mean number of filled surfaces for all the index children was 5.4 (s.d. 4.9). The index children from social class A had a mean FS score of 5.6 (s.d. 4.1), from social
class B 7.4 (s.d. 5.8), from social class C 4.5 (s.d. 4.2), and from social class D 4.2 (s.d. 4.9) (Table 3.3.).

One-way Anova revealed statistically significant differences in the FS scores among the four groups \( (F = 3.65; p = .014) \). This finding was due to the differences among the index children from social class B when compared with social class D. Cochran's C test for homogeneity of variance accepted the assumption of homoscedasticity \( (C = .36; p = .048) \).

3.3.1.3. Oral Hygiene Index:

Assessment of oral hygiene used the simplified oral debris index, ODI-S (Greene and Vermillion, 1964) (Appendix 3). Analyses comprised Kruskal-Wallis one-way analysis of variance and a multiple comparison test. The results of fathers will be presented first, followed by the mothers and the index children.

Fathers:

The mean ODI-S score when all fathers were grouped together was .42 (s.d. .42). Fathers from the 'more privileged' social classes showed the lowest ODI-S scores: .30 (s.d. .28) and .44 (s.d. 30) for social classes A and B, respectively. Fathers from social class C had a mean ODI-S of .64 (s.d. .47) and those from social class D .73 (s.d. .50) (Table 3.4.).

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In spite of mean ODI-S scores being clinically low in all social classes, statistically significant differences emerged among the four groups (KW = 25.29; p = .000). Fathers from social class A had a lower mean ODI-S score when compared to fathers from social classes C and D, and fathers from social class B showed lower scores than those from social class D (Table 3.4.).

The differing sample size in each social class is consequent to how the calculations are made. At least 2 of the 6 assessed surfaces must be present for the computation of the ODI-S score (Greene and Vermillion, 1964).
Table 3.4. - ODI-S (mean and standard deviation) by social class

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>FATHERS</th>
<th>MOTHERS</th>
<th>CHILDREN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEAN (.SD)</td>
<td>MEAN (.SD)</td>
<td>MEAN (.SD)</td>
</tr>
<tr>
<td>A</td>
<td>.30 (.28)*</td>
<td>.28 (.25)</td>
<td>.30 (.34)</td>
</tr>
<tr>
<td></td>
<td>(n = 41)</td>
<td>(n = 40)</td>
<td>(n = 41)</td>
</tr>
<tr>
<td>B</td>
<td>.44 (.30)</td>
<td>.36 (.33)</td>
<td>.56 (.40)</td>
</tr>
<tr>
<td></td>
<td>(n = 40)</td>
<td>(n = 40)</td>
<td>(n = 41)</td>
</tr>
<tr>
<td>C</td>
<td>.64 (.47)</td>
<td>.45 (.30)</td>
<td>.67 (.44)</td>
</tr>
<tr>
<td></td>
<td>(n = 34)</td>
<td>(n = 31)</td>
<td>(n = 41)</td>
</tr>
<tr>
<td>D</td>
<td>.73 (.50)</td>
<td>.80 (.74)</td>
<td>.82 (.56)</td>
</tr>
<tr>
<td></td>
<td>(n = 29)</td>
<td>(n = 31)</td>
<td>(n = 41)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>.42 (.42)</td>
<td>.45 (.47)</td>
<td>.59 (.48)</td>
</tr>
<tr>
<td></td>
<td>(n = 144)</td>
<td>(n = 142)</td>
<td>(n = 164)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations.

**Fathers** - KW = 25.29  p = .000  (A vs C,D; B vs D)

**Mothers** - KW = 15.58  p = .001  (A,B vs D)

**Index Children** - KW = 31.63  p = .000  (A vs B,C,D)
Mothers:

The mean ODI-S score for all the mothers was 0.45 (s.d. 0.47). Mothers from social class A showed the lowest mean ODI-S score: 0.28 (s.d. 0.25), followed by mothers from social class B: 0.36 (s.d. 0.33) and by mothers from social class C: 0.45 (s.d. 0.30). Mothers from social class D showed the highest mean ODI-S score: 0.80 (s.d. 0.74) (Table 3.4.).

For all social classes the mean ODI-S scores were clinically low, but statistically significant differences were observed (KW = 15.58; p = .001). This finding was attributed to the lowest ODI-S mean scores of mothers from social classes A and B as compared with those from social class D.

As for fathers, the different sample sizes in each cell is consequent to the computation of ODI-S scores (Greene and Vermillion, 1964).

Index Children:

As in the analyses of dental health status, the ODI-S scores of index children (13-year-old children) were analysed.

The mean ODI-S score for all the index children when grouped together was 0.59 (s.d. 0.48). The same pattern observed for mothers and fathers emerged for the children: lowest scores were found amongst children from the 'more privileged' social classes. Children from social class A had a mean ODI-s score of 0.30 (s.d. 0.34), and those from social class B 0.56 (s.d. 0.40).
Mean ODI-S score for children from social class C was .67 (s.d. .44), and for children from social class D .82 (s.d. 56) (Table 3.4.).

Mean ODI-S scores in all social classes were clinically low. Statistically significant differences among the four social classes were observed (KW = 31.63; p = .000). Children from social class A had a lower mean ODI-S score than children from the other three social classes: B, C, and D.

3.3.2. BEHAVIOURAL DATA:

In this section social class differences in relation to the habits that influence dental health status are presented first: sugar consumption, tooth-brushing habits, and dental attendance. This presentation will then be followed by a description of the home environment in relation to these three habits.

3.3.2.1. Dietary Habits:

Dietary habits were assessed by means of the 24-hour recall method (Appendices 1 and 2). In spite of information on all food intakes in the previous 24 hours having been collected, this section will only cover sugar consumption habits. Sugar intake of fathers will be presented first, followed by the intake of mothers. Sugar consumption of the index children will then be described.
Fathers:

On the whole the mean number of total sugary items consumed in the previous 24 hours was high. The mean number of sugary items was 6.6 (s.d. 4.5). Fathers from social class A consumed a mean number of 5.0 sugary items/day (s.d. 3.5), followed by fathers from social class B, who had a mean consumption of 6.2 sugary items/day (s.d. 3.8). Fathers from the 'less privileged' social classes consumed the largest mean number of sugary items/day: those from social class D consumed a mean of 7.1 items/day (s.d. 5.3) followed by those from social class C with 8.3 sugary items/day (s.d. 4.8) (Table 3.5.).

These mean differences among the four groups emerged as being statistically significant (F = 4.26; p = .006), and due to the differences observed among fathers from social class A when compared with fathers from social class C (Table 3.5.). Cochran's C test for homogeneity of variance was performed, and the null hypothesis was accepted (C = .36; p = .077).

The mean number of sugary items consumed at meals for all fathers was 2.4 (s.d. 1.6). At meals intake of sugary items was fairly equal among the four social classes: social class A 2.5 (s.d. 2.1), social class B 2.1 (s.d. 1.4), social class C 2.8 (s.d. 1.4), and social class D 2.3 (s.d. 1.6). These groups were not found to be statistically different among themselves (F = 1.26; p = .288). The assumption of homoscedasticity was accepted (C = .42; p = .003).
Table 3.5. - Frequency of sugary items intake/day (mean and standard deviation) of fathers by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>TOTAL NUMBER OF SUGARY ITEMS</th>
<th>SUGARY ITEMS AT MEALS</th>
<th>SUGARY ITEMS IN-BETWEEN MEALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.0 (3.5)*</td>
<td>2.5 (2.1)</td>
<td>2.4 (2.6)</td>
</tr>
<tr>
<td>B</td>
<td>6.2 (3.8)</td>
<td>2.1 (1.4)</td>
<td>4.1 (3.2)</td>
</tr>
<tr>
<td>C</td>
<td>8.3 (4.8)</td>
<td>2.8 (1.4)</td>
<td>5.5 (4.3)</td>
</tr>
<tr>
<td>D</td>
<td>7.1 (5.3)</td>
<td>2.3 (1.6)</td>
<td>4.8 (5.2)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6.6 (4.5)</td>
<td>2.4 (1.6)</td>
<td>4.2 (4.1)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations

TOTAL NUMBER - F = 4.26  p = .006 (Tukey = A vs C)
AT MEALS - F = 1.26  p = .288
IN-BETWEEN MEALS - F = 4.48  p = .005 (Tukey = A vs C,D)

In-between meals intake of sugary items on the previous 24 hours was 4.2 (s.d. 4.1), when all the fathers were grouped together. The mean in-between meals consumption differed statistically among the four social classes (F = 4.48; p = .005). Fathers from social class A consumed less sugary items in-between meals on the previous 24 hours (2.4, s.d. 2.6) than fathers from social class C (5.5; s.d. 4.3) and D (4.8; s.d. 5.2) (Table 3.5.). Homogeneity of variance was accepted (C = .43; p = .002).
The mean number of total sugary items consumed in the previous 24 hours was 5.6 (s.d. 4.5), when all mothers were analysed together. As for fathers the total intake of sugary items was high. The lowest mean intake was found for mothers from social class A (4.0; s.d. 3.6), whilst the highest was observed in mothers from social class C (6.4; s.d. 4.2). Mothers from social class B consumed a mean number of 5.7 sugary items/day (s.d. 4.7), and the mean intake for mothers from social class D was 6.3 (s.d. 5.0) (Table 3.6.)

While statistically significant differences were found among the four social classes when one-way Anova was applied to the data (F = 2.63; p = .052), Tukey's multiple comparison test did not detect any differences (Table 3.6.). The possible reason for that is the conservative nature for alpha of all multiple comparison tests. Cochran's C test for homoscedasticity showed that the variance amongst the four groups was homogeneous (C = .32; p = .306).

The mean intake of sugary items at meals for all mothers was 2.1 (s.d. 1.5). Sugar intake at meals was fairly evenly distributed among the four social classes. Mothers from social class A consume a mean number of 1.9 (s.d. 1.9) sugary items at meals and those from social class B had an intake of 2.0 (s.d. 1.5). At meals intake of mothers from social class C was 2.4 (s.d. 1.5) and from social class D 2.1 (s.d 1.0) (Table 3.6.). No statistically significant differences emerged among the four social classes (F = .92; p = .431) (Table 3.6.).
Hosscedasticity was confirmed by the use of Cochran's C test ($C = .40; p = .009$).

**Table 3.6.** - Frequency of sugary items intake/day (mean and standard deviation) of mothers by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>TOTAL NUMBER OF SUGARY ITEMS</th>
<th>SUGARY ITEMS AT MEALS</th>
<th>SUGARY ITEMS IN-BETWEEN MEALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.0 (3.6)*</td>
<td>1.9 (1.9)</td>
<td>2.1 (2.2)</td>
</tr>
<tr>
<td>B</td>
<td>5.7 (4.7)</td>
<td>2.0 (1.5)</td>
<td>3.7 (4.2)</td>
</tr>
<tr>
<td>C</td>
<td>6.4 (4.2)</td>
<td>2.4 (1.4)</td>
<td>4.0 (3.7)</td>
</tr>
<tr>
<td>D</td>
<td>6.3 (5.0)</td>
<td>2.1 (1.0)</td>
<td>4.2 (4.7)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5.6 (4.5)</td>
<td>2.1 (1.5)</td>
<td>3.5 (3.9)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations

TOTAL NUMBER - $F = 2.62$  $p = .052$ (Tukey = no differences)

AT MEALS - $F = .92$  $p = .431$

IN-BETWEEN MEALS - $F = 2.55$  $p = .057$ (Tukey = no differences)

In-between meal intake of all mothers was 3.5 items (s.d. 3.9). The consumption of sugary items in-between meals of mothers from social class A was the lowest, 2.1 (s.d. 2.2),
being followed by mothers from social class B with a mean intake of 4.0 (s.d. 3.7). Mothers from social class C had an intake of 4.0 items (s.d. 3.7), and for those mothers from social class D the intake on the previous 24 hours was 4.2 items (s.d. 4.7) (Table 3.6.)

One-way Anova depicted statistically significant differences among the four groups of mothers ($F = 2.55; p = .057$), but Tukey's multiple comparison test could not detect any differences (Table 3.6.). A possible explanation for that is the fact that the significance level obtained in Anova was at the 'borderline' level of significance ($p = .057$), and multiple comparison tests due to their conservative nature tend not to pin-point differences at a 'borderline' significance level. The assumption of homogeneity of variance was accepted ($C = .38; p = .021$).

**Index Children:**

On the whole the total amount of sugary items intake was very high: the mean intake for all the index children was 7.4 items (s.d. 4.1). Children from social class A and D consumed a lowest mean number of sugary items: 7.0 (s.d. 2.7) and 6.2 (s.d. 3.0), respectively. Children from social class B and D showed very similar mean number of sugary items intake, both extremely high, 8.5 (s.d. 5.8) and 7.9 (s.d. 4.0), respectively (Table 3.7).

No statistically significant differences emerged among the four groups at the 5% level ($F = 2.49; p = .062$) (Table 3.7).
Homoscedasticity was rejected ($C = .51; p = .000$). Therefore, Kruskal-Wallis one-way analysis of variance was also carried out on the data. The results from Anova were confirmed: no statistically significant difference among the four groups was observed ($KW = 5.82; p = .121$) (mean ranking: $A = 82.28$, $B = 89.16$, $C = 90.49$, $D = 68.07$).

Table 3.7. - Frequency of sugary items intake/day (mean and standard deviation) of index children by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>TOTAL NUMBER OF SUGARY ITEMS</th>
<th>SUGARY ITEMS AT MEALS</th>
<th>SUGARY ITEMS IN-BETWEEN MEALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7.0 (2.7)*</td>
<td>2.7 (1.6)</td>
<td>4.2 (2.7)</td>
</tr>
<tr>
<td>B</td>
<td>8.5 (5.8)</td>
<td>2.4 (1.1)</td>
<td>6.1 (5.5)</td>
</tr>
<tr>
<td>C</td>
<td>7.9 (4.0)</td>
<td>2.4 (1.2)</td>
<td>5.4 (4.1)</td>
</tr>
<tr>
<td>D</td>
<td>6.2 (3.0)</td>
<td>2.1 (1.2)</td>
<td>4.1 (2.3)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>7.4 (4.1)</td>
<td>2.4 (1.3)</td>
<td>5.0 (3.9)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations

TOTAL NUMBER - $F = 2.49$  $p = .062$

AT MEALS - $F = 1.74$  $p = .159$

IN-BETWEEN MEALS - $F = 2.49$  $p = .062$
At meals sugary items intake on the previous 24 hours was 2.4 (s.d. 1.3) for all index children. Children from the different social classes showed a very similar pattern of intake: children from social class A consumed 2.7 items (s.d. 1.6), from social class B 2.4 (s.d. 1.1), from social class C 2.4 (s.d. 1.2), and from social class D 2.1 (s.d. 1.2). No social class differences were detected at the 5% level of significance ($F = 1.74; p = .159$) (Table 3.7). Homogeneity of variance among the four groups was accepted ($C = .37; p = .033$).

The mean number of sugary items consumed in-between meals was 5.0 (s.d. 3.9). The mean in-between meals intake of index children from social class D was 4.1 (s.d. 2.3), followed by children of social class A, with a mean intake of 4.2 (s.d. 2.7). Children from social class B consumed 6.1 items (s.d. 5.5) and from social class C 5.4 (s.d. 4.1). Social class differences were not detected at the 5% level ($F = 2.49; p = .062$) (Table 3.7). Homogeneity of variance was rejected ($C = .50; p = .000$), and Kruskal-Wallis was performed on the data. Similar results emerged ($KW = 2.92; p = .405$): no statistically significant differences were found among the index children from the four social classes (mean ranking: A = 77.15, B = 89.20, C = 88.32, D = 75.34).

The source of sugary items of the index children was also investigated. To this end, children were asked the origin of the sugary items: if got at home, if given to the child or if bought by the child.

The main source of sugary items was home. The mean value of sugary items got at home was 4.7 (s.d. 3.0) for all index
children. Children from social class D had 3.8 sugary items (s.d. 2.0) got from home. Children from social classes A, B and C had 4.7 (s.d. 2.7), 4.9 (s.d. 3.1), and 5.5 (s.d. 3.8) sugary items got from home, respectively (Table 3.8). No social class differences emerged at the 5% level (F = 2.41; p = .069) (Table 3.8). Homoscedasticity was confirmed (C = .41 p = .004).

Table 3.8. - Index Children's source of sugary items (mean and standard deviation) by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>SUGARY ITEMS GOT AT HOME (Mean and Standard Deviation)</th>
<th>SUGARY ITEMS BOUGHT BY CHILD (Mean and Standard Deviation)</th>
<th>SUGARY ITEMS GIVEN TO CHILD (Mean and Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.7 (2.7)*</td>
<td>1.9 (2.4)</td>
<td>0.3 (0.9)</td>
</tr>
<tr>
<td>B</td>
<td>4.9 (3.1)</td>
<td>2.6 (4.0)</td>
<td>1.0 (3.6)</td>
</tr>
<tr>
<td>C</td>
<td>5.5 (3.8)</td>
<td>1.9 (2.6)</td>
<td>0.5 (1.1)</td>
</tr>
<tr>
<td>D</td>
<td>3.8 (2.0)</td>
<td>1.5 (2.0)</td>
<td>0.9 (1.9)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4.7 (3.0)</td>
<td>2.0 (2.8)</td>
<td>0.7 (2.1)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations

GOT AT HOME - F = 2.41  p = .069
BOUGHT BY CHILD - F = 1.18  p = .318
GIVEN TO CHILD - F = .96  p = .411
The mean number of sugary items bought by the child was 2.0 (s.d. 2.8). Social class differences were not detected at the 5% level (F = 1.18; p = .318). The mean number of sugary items bought by children from social class A was 1.9 (s.d. 2.4), from social class B 2.6 (s.d. 4.0), from social class C 1.9 (s.d. 2.6), and from social class D 1.5 (s.d. 2.0) (Table 3.8). Homogeneity of variance was rejected (C = .49; p = .000). The result from Kruskal-Wallis was similar, with no statistically significant differences being detected among the index children from the four groups (KW = .93; p = .818) (mean ranking: A = 83.61; B = 86.63; C = 82.61; D = 77.15).

Overall a small number of sugary items were given to the children in this present study: 0.7 items (s.d. 2.1). Social class differences were not detected at the 5% significance level (F = .96; p = .411). Children from social class A bought a mean number of 0.3 (s.d. 0.9) of the sugary items they consumed; from social class B 1.0 (s.d. 3.6); from social class C 0.5 (s.d. 1.1); and from social class D 0.9 (s.d. 1.9). Since heteroscedasticity was observed (C = 49; p = .000), Kruskal-Wallis one-way analysis of variance was carried out. As with Anova, no statistically significant difference at the 5% level emerged among the four groups (KW = 5.56; p = .135) (mean ranking: A = 77.74; B = 76.43; C = 82.27; D = 93.56).
3.3.2.2. Oral Hygiene Habits:

Oral hygiene habits were assessed by means of the reported tooth-brushing frequency (Appendices 1 and 2). During the interviews this information was recorded as the reported number of times/day tooth-brushing was carried out. During data analyses, however, this variable was recoded into less than once/day, once/day, more than once/day.

This section first describes the reported tooth-brushing frequency of fathers, followed by the tooth-brushing frequency of mothers. Reported tooth-brushing frequency of the index children will then be presented.

Fathers:

The reported tooth-brushing frequency was very high: while 2.1% of the fathers reported brushing their teeth less than once a day, 11.6% brushed their teeth once a day, and the overwhelming majority of fathers (82.2%) stated that they brushed their teeth more than once a day.

Kruskal-Wallis one-way analysis of variance detected statistically significant social class differences among the four groups of fathers. This finding was due to the differences in reported tooth-brushing frequency of fathers from social class A when compared with fathers from social classes C and D (Table 3.9.).
Mothers:

The majority of mothers reported brushing their teeth more than once/day (93.7%), while none of them stated brushing their teeth less than once a day. Mother's reported behaviour did not differ among the four social classes (KW = 3.71; n.s. at the 5% level)(Table 3.9).

Children:

As with their parents the majority of the index children (87.8%) in this study reported a tooth-brushing frequency of more than once a day. Only 1.8% of them stated brushing their teeth less often than once a day. Social class differences emerged among the children from social class A when compared with those from social class D (KW = 7.72; p = .052). However, when a multiple comparison test was calculated, no statistically significant difference was observed among the four social classes at the 5% level (Table 3.9.).
### Table 3.9 - Frequency and relative frequency of distribution of reported brushing frequency by social class

<table>
<thead>
<tr>
<th>RESPONDENT</th>
<th>BRUSHING FREQUENCY</th>
<th>SOCIAL CLASS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>&lt;1/DAY</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(3.7)*</td>
<td>(4.9)</td>
<td>(2.1)</td>
</tr>
<tr>
<td>1/DAY</td>
<td>2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(4.9)</td>
<td>(12.2)</td>
<td>(14.6)</td>
</tr>
<tr>
<td>&gt;1/DAY</td>
<td>39</td>
<td>36</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>(95.1)</td>
<td>(88.8)</td>
<td>(78.1)</td>
</tr>
<tr>
<td>&lt;1/DAY</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(2.4)</td>
<td>(2.4)</td>
<td>(2.4)</td>
</tr>
<tr>
<td>1/DAY</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(2.4)</td>
<td>(9.8)</td>
<td>(9.8)</td>
</tr>
<tr>
<td>&gt;1/DAY</td>
<td>40</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>(97.6)</td>
<td>(87.8)</td>
<td>(87.8)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages*

Fathers - $KW = 11.29$  $p = .010$ (A vs C,D)

Mothers - $KW = 3.71$  $p = .311$

Index Children - $KW = 7.72$  $p = .052$ (no differences)

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3.3.2.3. Pattern of Dental Attendance:

Information on the pattern of dental attendance consisted of the frequency of attenders and non-attenders. For dental attenders, further data were gathered: time interval since last visit to the dentist, the usual reason for going to the dentist and the usual type of dentist.

This section first describes the pattern of dental attendance of fathers. Mothers' dental attendance is then presented, followed by the pattern among the index children.

**Fathers:**

All the fathers but one had been to the dentist. The only father who reported having never been to the dentist was a caries-free subject from social class D. The data discussed here, therefore, comprise the reported behaviour of 163 fathers: 41 from social class A, 41 from social class B, 41 from social class D, and 40 from social class D.

The majority of fathers (70%) usually visited a private dentist, 22% of them were in a 3rd-party co-payment basis, and only 8% attended a NHS dentist. Statistically significant differences were not detected by the chi-square method. However, it is important to stress that this result should be treated with care since 33% of the cells had an expected frequency of less than 5 (Table 3.10.).
The usual reason for dental attendance reported by all fathers was symptom-related visits (61%). Social class differences emerged as statistically significantly ($X^2 = 36.61; p = .000$). More fathers from the two 'more privileged' social classes stated that check-ups were their usual reason for visiting a dentist. On the other hand, more fathers from the 'less privileged' social classes reported that their usual reason for dental attendance was symptom-related (Table 3.11).

Social class differences were also detected for the time interval since the last visit to the dentist ($X^2 = 43.29; p = .000$) (Table 3.12.). Fathers from the 'more privileged' social classes were three times more likely to have been to a dentist within the previous 6 months than fathers from social classes C and D. These two groups showed a majority of fathers reporting that they had not been to a dentist for more than 24 months.

**Mothers:**

Mothers from all social classes reported having been at least once to the dentist. The majority of mothers stated they usually attended a private dentist (67%), 20% were on a 3rd-party co-payment basis, and 14% had a NHS dentist (Table 3.10).

Social class differences were detected: more mothers from social class A stated that they usually visited a private dentist, while more mothers from social class D reported having a NHS dentist ($X^2 = 13.45; p = .036$) (Table 3.10).
When all mothers were considered together, the majority of them stated visiting a dentist for symptom-related reasons. Social class differences were statistically significant ($X^2_3 = 62.19; .000$). Mothers from the two 'more privileged' social classes reported check-ups being their usual reason for dental attendance, while more mothers from the two 'less privileged' social classes visited a dentist for symptom-related reasons (Table 3.11.).

The time interval since the last visit to a dentist as reported by 43% of the mothers was less than 6 months. While for all social classes one-third of the mothers stated having been to a dentist in the previous 6 to 24 months, more mothers from the 'more privileged' social classes reported having been to a dentist within the previous 6 months. More mothers from social classes C and D had not paid a visit to a dentist for more than 24 months (Table 3.12.). These differences were statistically significant ($X^2_6; p = .000$).

**Index Children:**

The majority of the index children had been to a dentist. All the index children from social classes A and B had been to a dentist. Nearly all the children (95%) from social class C had visited a dentist (39 children). Eighty-five percent of the index children from social class D stated having attended a dentist (35 children).

Most of the index children (58%) had a private dentist, 25% went to a NHS dentist, and 17% were on a 3rd-party co-
payment. Statistically significant differences emerged among the four groups ($X_5^2 = 58.33; p = .000$). More index children from social class A visited a private dentist (95%), while the majority of children from social class D had a NHS dentist (60%) (Table 3.10.).

The usual reason for visiting a dentist as reported by the majority of the index children was check-ups (70%). Statistically significant differences were observed among the four social classes ($X_3^2 = 56.85; p = .000$). While the majority of the children from social classes A (100%) and B (81%) reported visiting a dentist for check-ups, 69% of the children from social class D stated having symptom-related reason as their usual reason for dental attendance (Table 3.11.).

Forty-five percent of the index children stated having been to a dentist within the last 6 months. Forty-three of them reported having visited a dentist within the previous 6 to 24 months, and one-fifth of them had not been to a dentist for more than 24 months. Statistically significant differences were detected ($X_6^2 = 65.42; p = .000$). While more children from the two 'more privileged' social classes reported having paid a visit to a dentist in the previous 6 months, children from the two 'less privileged' social classes were more likely not to have been to the dentist for more than 24 months.
Table 3.10. - Frequency distribution of type of dentist by social class

<table>
<thead>
<tr>
<th>RESPONDENT</th>
<th>TYPE OF DENTIST</th>
<th>SOCIAL CLASS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRIVATE</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>(80.5)*</td>
<td>(68.3)</td>
<td>(65.9)</td>
</tr>
<tr>
<td>FATHERS</td>
<td>NHS</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(9.8)</td>
<td>(7.3)</td>
<td>(15.0)</td>
</tr>
<tr>
<td></td>
<td>3rd-PARTY CO-PAYMENT</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(19.5)</td>
<td>(22.0)</td>
<td>(26.8)</td>
</tr>
<tr>
<td></td>
<td>PRIVATE</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>(82.9)</td>
<td>(70.7)</td>
<td>(63.4)</td>
</tr>
<tr>
<td>MOTHERS</td>
<td>NHS</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(4.9)</td>
<td>(7.3)</td>
<td>(17.1)</td>
</tr>
<tr>
<td></td>
<td>3rd-PARTY CO-PAYMENT</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(12.2)</td>
<td>(22.0)</td>
<td>(19.5)</td>
</tr>
<tr>
<td></td>
<td>PRIVATE</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>(95.1)</td>
<td>(65.9)</td>
<td>(41.0)</td>
</tr>
<tr>
<td>INDEX</td>
<td>NHS</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(9.8)</td>
<td>(35.9)</td>
<td>(60.0)</td>
</tr>
<tr>
<td>CHILDREN</td>
<td>3rd-PARTY CO-PAYMENT</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(4.9)</td>
<td>(24.4)</td>
<td>(23.3)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

**Fathers** - \( X^2_6 = 7.46 \) \( p = .281 \) (33.3% cells with E.F <5)

**Mothers** - \( X^2_6 = 13.45 \) \( p = .036 \) (no cells with E.F. <5)

**Children** - \( X^2_6 = 58.33 \) \( p = .000 \) (no cells with E.F. <5)
Table 3.11. - Frequency distribution of usual reason for dental attendance by social class.

<table>
<thead>
<tr>
<th>RESPONDENT</th>
<th>USUAL REASON</th>
<th>S</th>
<th>O</th>
<th>C</th>
<th>I</th>
<th>A</th>
<th>L</th>
<th>C</th>
<th>L</th>
<th>A</th>
<th>S</th>
<th>S</th>
<th>D</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SYMPTOM-RELATED</td>
<td>14</td>
<td>18</td>
<td>33</td>
<td>34</td>
<td>99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(34.1)*</td>
<td></td>
<td></td>
<td>(80.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FATHERS</td>
<td>CHECK-UPS</td>
<td>27</td>
<td>23</td>
<td>8</td>
<td>6</td>
<td>64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(65.9)</td>
<td>(56.1)</td>
<td>(19.5)</td>
<td>(15.0)</td>
<td>(39.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SYMPTOM-RELATED</td>
<td>8</td>
<td>12</td>
<td>29</td>
<td>39</td>
<td>88</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(19.5)</td>
<td>(29.3)</td>
<td>(70.7)</td>
<td>(95.1)</td>
<td>(53.7)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOTHERS</td>
<td>CHECK-UPS</td>
<td>33</td>
<td>29</td>
<td>12</td>
<td>2</td>
<td>76</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(80.5)</td>
<td>(70.7)</td>
<td>(29.3)</td>
<td>(4.9)</td>
<td>(46.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDEX</td>
<td>SYMPTOM-RELATED</td>
<td>0</td>
<td>8</td>
<td>15</td>
<td>24</td>
<td>47</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(19.5)</td>
<td>(38.5)</td>
<td>(68.6)</td>
<td>(30.1)</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>CHILDREN</td>
<td>CHECK-UPS</td>
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<td>33</td>
<td>24</td>
<td>11</td>
<td>109</td>
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<tr>
<td></td>
<td></td>
<td>(100.0)</td>
<td>(80.5)</td>
<td>(61.5)</td>
<td>(31.4)</td>
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</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

Fathers - $X^2_3 = 33.61$  $p = 0.000$ (no cells with E.F. < 5)
Mothers - $X^2_3 = 62.19$  $p = 0.000$ (no cells with E.F. < 5)
Children - $X^2_3 = 56.85$  $p = 0.000$ (12.5% cells with E.F. < 5)
Table 3.12. - Frequency distribution of time interval since last visit to dentist, by social class.

<table>
<thead>
<tr>
<th>RESPONDENT</th>
<th>TIME INTERVAL</th>
<th>SOCIAL CLASS</th>
<th>SOCIAL CLASS</th>
<th>SOCIAL CLASS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;6 MONTHS</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
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<tr>
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<td>22</td>
<td>7</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>(53.7)*</td>
<td>(53.7)</td>
<td>(17.1)</td>
<td>(17.5)</td>
<td>(35.6)</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>11</td>
<td>8</td>
<td>5</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>(31.7)</td>
<td>(26.8)</td>
<td>(19.5)</td>
<td>(12.5)</td>
<td>(22.7)</td>
</tr>
<tr>
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<td>6</td>
<td>8</td>
<td>26</td>
<td>28</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>(14.6)</td>
<td>(19.5)</td>
<td>(63.4)</td>
<td>(70.0)</td>
<td>(41.7)</td>
</tr>
<tr>
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<td>22</td>
<td>17</td>
<td>8</td>
<td>71</td>
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<td>(58.5)</td>
<td>(53.7)</td>
<td>(41.5)</td>
<td>(19.5)</td>
<td>(43.3)</td>
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<td>10</td>
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<td>54</td>
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<td></td>
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<td>3</td>
<td>14</td>
<td>18</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>(9.8)</td>
<td>(7.3)</td>
<td>(34.1)</td>
<td>(43.9)</td>
<td>(23.8)</td>
</tr>
<tr>
<td>INDEX</td>
<td>29</td>
<td>28</td>
<td>8</td>
<td>5</td>
<td>70</td>
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<td>(68.3)</td>
<td>(20.5)</td>
<td>(14.3)</td>
<td>(44.9)</td>
</tr>
<tr>
<td>CHILDREN</td>
<td>6-24 MONTHS</td>
<td>12</td>
<td>19</td>
<td>10</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>(26.9)</td>
<td>(29.3)</td>
<td>(48.7)</td>
<td>(28.6)</td>
<td>(43.3)</td>
</tr>
<tr>
<td></td>
<td>&gt;24 MONTHS</td>
<td>1</td>
<td>12</td>
<td>20</td>
<td>34</td>
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<tr>
<td></td>
<td>(2.4)</td>
<td>(2.4)</td>
<td>(30.8)</td>
<td>(57.1)</td>
<td>(21.8)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

Fathers - $X^2 = 43.29$  \( p = .000 \) (no cells with E.F. < 5)
Mothers - $X^2 = 27.06$  \( p = .000 \) (no cells with E.F. < 5)
Children - $X^2 = 65.42$  \( p = .000 \) (no cells with E.F. < 5)
3.3.3. HOME ENVIRONMENT:

Correlations coefficients were obtained among family members. A strong intra-family pattern of dental health status (sex-age-adjusted DMFS) and oral health status (ODI-S) emerged.

DMFS scores of husbands and wives showed a correlation of .24 (p = .001). For ODI-S scores spouses were also correlated (Spearman's rho = .27; p = .01).

The pattern of dental health among the offspring was also correlated. For age-sex-adjusted DMFS scores, the index children and their siblings showed a Pearson's r correlation coefficient of .34 (p = .001). The same pattern emerged for ODI-S scores among the offspring (Spearman's rho = .22; p = .001).

Association among the children and parents was also present. This association, however, was somewhat higher for mothers than for fathers. When age-sex-adjusted DMFS scores of children were correlated with mothers' DMFS scores, a Pearson's r coefficient of .27 (p = .001) was obtained, for fathers the correlation was of .23 (p = .001). Spearman's rho correlation coefficients obtained for ODI-S scores were not so strong as for dental health status. Mothers and children had a correlation of .19 (p = .001), and for fathers and children a correlation coefficient of .18 (p = .001) was found.

Considering that oral health status (DMFS and ODI-S) is closely related to an individual's behaviour and that behaviours run in families, intra-family patterns of dietary
habits, oral hygiene practices and dental attendance were assessed. The results will now be described.

First correlation coefficients obtained for dietary habits, tooth-brushing practices and dental attendance among family members (fathers, mothers, index children, and siblings aged 10 and above) are provided.

Data on the person responsible for controlling the performance of the three habits will follow. This information was obtained during the interviews of fathers, mothers, and index children (Appendices 1 and 2).

Dietary Habits:

The total number of sugary items intake in the previous 24 hours of fathers and mothers showed a correlation coefficient of .17 (n.s. at the 5% level). The pattern of sugar consumption among the children, as measured by Pearson's r correlation coefficient between the index children and their siblings, was .31 (p = .001). When the children were correlated with their parents, a stronger association was observed between mothers and children (Pearson's r = .22; p = .001) than among fathers and children (Pearson's r = .14; p = .01).

The source of sugary items consumed by the children was then correlated with the total number of sugary items intake of parents. A stronger association was observed between the number of sugary items obtained from home by the children and the mothers' total sugary items intake (Pearson's r = .24; p =
than the fathers' total sugary items consumption (r = .06; n.s. at the 5% level).

The amount of sugary items bought by the children, however, was more strongly correlated with the fathers' sugar intake (Pearson's r = .15) than the mothers' (Pearson's r = .07). The association was not statistically significant at the 5% level though.

No association was observed between the number of sugary items given to the child and the mothers' sugar intake (Pearson's r = .01; n.s. at the 5% level) and the fathers' (Pearson's r = -.04; n.s. at the 5% level).

During the interviews the fathers, the mothers and the index children were asked about who was the person, if any, controlling the amount of sugar intake of the 13-year-old child at present. The mothers and fathers were also asked if anyone controlled sugar consumption of the 13-year-old child when he/she was younger. The answers obtained were then compared so that different views about the home environment could be assessed.

Sugar consumption did not seem to have been controlled at any stage of the 13-year-old children's development. When some control was exerted, this was performed by the mothers (Tables 3.13 and 3.14). Moreover, concordance on answers of the different respondents was moderate to high, indicating a consensus among them (Tables 3.13. and 3.14.).
Table 3.13. - Frequency distribution of answers to question: 'Who is the person controlling the amount of sugary items eaten now by _____?' by fathers, mothers, and 13-year-old children; and Kappa coefficient of agreement on the answers.

<table>
<thead>
<tr>
<th>PERSON CONTROLLING SUGAR</th>
<th>RESPONDENTS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FATHERS</td>
<td>MOTHERS</td>
<td>13-YEAR-OLDS</td>
<td></td>
</tr>
<tr>
<td>MOTHER</td>
<td>27</td>
<td>36</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(16.5)*</td>
<td>(22.0)</td>
<td>(17.7)</td>
<td></td>
</tr>
<tr>
<td>FATHER</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.0)</td>
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<td>(3.0)</td>
<td></td>
</tr>
<tr>
<td>BOTH PARENTS</td>
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<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.9)</td>
<td>(4.3)</td>
<td>(3.7)</td>
<td></td>
</tr>
<tr>
<td>NOBODY</td>
<td>124</td>
<td>121</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(75.6)</td>
<td>(73.8)</td>
<td>(75.6)</td>
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</tr>
<tr>
<td>TOTAL</td>
<td>164</td>
<td>164</td>
<td>164</td>
<td></td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages.

Fathers and mothers - K = .61 p = .000
Fathers and 13-year-olds - K = .55 p = .070
Mothers and 13-year-olds - K = .65 p = .030
Table 3.14. - Frequency distribution of answers to question: 'Who was the person controlling the amount of sugary items eaten by ___ when young?' by fathers and mothers; and Kappa coefficient of agreement on the answers.

<table>
<thead>
<tr>
<th>PERSON CONTROLLING SUGAR</th>
<th>RESPONDENTS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FATHERS</td>
<td>MOTHERS</td>
<td></td>
</tr>
<tr>
<td>MOTHER</td>
<td>31</td>
<td>39</td>
<td>(18.9)*</td>
</tr>
<tr>
<td>FATHER</td>
<td>2</td>
<td>1</td>
<td>(1.2)</td>
</tr>
<tr>
<td>BOTH PARENTS</td>
<td>9</td>
<td>9</td>
<td>(5.5)</td>
</tr>
<tr>
<td>NOBODY</td>
<td>121</td>
<td>115</td>
<td>(73.8)</td>
</tr>
<tr>
<td>CANNOT REMEMBER</td>
<td>1</td>
<td>0</td>
<td>(0.6)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>164</td>
<td>164</td>
<td></td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

Fathers and mothers - K = .59  p = .000
Oral Hygiene Habits:

The reported tooth-brushing frequency of fathers and mothers showed a Spearman's rho correlation coefficient of .25 (n.s. at 5% level). The reported behaviour of the index children and their siblings was strongly correlated, and a correlation coefficient of .49 (p = .001) was found. The degree of correlation of reported behaviour of children and mothers was higher (Spearman's rho = .22; p = .001) than the correlation among fathers and children (Spearman's rho = .13; p = .01).

The control at home of the tooth-brushing habit of the 13-year-old children, if any, was mainly performed by the mother. Nearly 45% of the respondents answered that there was no control over tooth-brushing at present, while one-third of them replied that the mother was the person in charge of controlling tooth-brushing behaviour at present (Table 3.15.). While concordance on answers was moderate among fathers and mothers, and among fathers and 13-year-old children; mothers and 13-year-old seemed to agree more often in their replies (Table 3.15).

The control of tooth-brushing frequency of the 13-year-old children when young was mainly performed by the mothers. The concordance among fathers and mothers was moderate (Kappa = .42; p = .000) (Table 3.16).
Table 3.15. - Frequency distribution of answers to question: 'Who reminds _____ to brush the teeth now?' by fathers, mothers, and 13-year-old children; and Kappa coefficient of agreement on the answers.

<table>
<thead>
<tr>
<th>PERSON CONTROLLING BRUSHING</th>
<th>RESPONDENTS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FATHERS</td>
<td>MOTHERS</td>
<td>13-YEAR-OLDS</td>
<td></td>
</tr>
<tr>
<td>MOTHER</td>
<td>43 (26.2)*</td>
<td>68 (41.5)</td>
<td>69 (42.1)</td>
<td></td>
</tr>
<tr>
<td>FATHER</td>
<td>13 (7.9)</td>
<td>8 (4.9)</td>
<td>13 (7.9)</td>
<td></td>
</tr>
<tr>
<td>BOTH PARENTS</td>
<td>19 (11.6)</td>
<td>17 (10.4)</td>
<td>15 (9.1)</td>
<td></td>
</tr>
<tr>
<td>NOBODY</td>
<td>80 (48.8)</td>
<td>70 (42.7)</td>
<td>65 (39.6)</td>
<td></td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>8 (4.9)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>164</td>
<td>164</td>
<td>164</td>
<td></td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

Fathers and mothers - $K = .49$  $p = .000$
Fathers and 13-year-olds - $K = .48$  $p = .010$
Mothers and 13-year-olds - $K = .69$  $p = .000$
Table 3.16. - Frequency distribution of answers to question: 'Who used to remind ______ to brush the teeth when young?' by fathers and mothers; and Kappa coefficient of agreement on the answers.

<table>
<thead>
<tr>
<th>PERSON CONTROLLING BRUSHING</th>
<th>FATHERS</th>
<th>MOTHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTHER</td>
<td>94</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>(57.3)*</td>
<td>(69.5)</td>
</tr>
<tr>
<td>FATHER</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(6.7)</td>
<td>(4.9)</td>
</tr>
<tr>
<td>BOTH PARENTS</td>
<td>33</td>
<td>22</td>
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<td></td>
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<td>13</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>(7.9)</td>
<td>(12.2)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

Fathers and mothers - $K = 0.42\ p = .000$
Dental Attendance:

The type of dentist visited by family members was correlated. The degree of association as measured by the lambda association coefficient among fathers' and mothers' type of dentist was .29 (p = .001). Children, however, were strongly correlated among themselves, showing a lambda association coefficient of .54 (p = .001). When children were compared to their parents, a stronger association emerged among the mothers and children (lambda = .34; p = .001) than among fathers and children (lambda = .20; p = .01).

Intra-family patterns were also observed for the time interval since their last visit to the dentist. Fathers and mothers showed an association of .26 (p = .001), while the children among themselves had a correlation of .36 (p = .001). Lambda association coefficient for mothers and children, and for fathers and children were very similar: .36 (p = .001) and .38 (p = .001), respectively.

Family members also shared an association in relation to the usual reason for seeking dental care. Mothers and fathers had a lambda association coefficient of .26 (p = .001), and the children among themselves showed a strong association of .57 (p = .001). While the association among fathers and children was nearly non-existent (lambda = .01; n.s. at 5% level), a strong association emerged among mothers and children (lambda = .41; p = .001).

The process of deciding when the 13-year-old children should go to the dentist seemed to be in the hands of the
mothers. The majority of the respondents replied that, both at present and when the index children were younger, mothers are the ones to make the decision of when to look for dental care for the 13-year-old children (Table 3.17. and 3.18). The agreement among the respondents was moderate to high (Tables 3.17 and 3.18).
Table 3.17. - Frequency distribution of answers to question: 'Who decides when _____ should go to the dentist now?' by fathers, mothers, and 13-year-old children; and Kappa coefficient of agreement on the answers.

<table>
<thead>
<tr>
<th>PERSON CONTROLLING ATTENDANCE</th>
<th>FATHERS</th>
<th>MOTHERS</th>
<th>13-YEAR-OLDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTHER</td>
<td>96</td>
<td>98</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>(58.5)*</td>
<td>(59.8)</td>
<td>(56.7)</td>
</tr>
<tr>
<td>FATHER</td>
<td>7</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(4.3)</td>
<td>(3.7)</td>
<td>(7.3)</td>
</tr>
<tr>
<td>BOTH PARENTS</td>
<td>13</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(7.9)</td>
<td>(2.4)</td>
<td>(5.5)</td>
</tr>
<tr>
<td>13-YEAR-OLDS</td>
<td>16</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>(9.8)</td>
<td>(8.5)</td>
<td>(11.0)</td>
</tr>
<tr>
<td>OTHER</td>
<td>27</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>(16.4)</td>
<td>(21.9)</td>
<td>(17.0)</td>
</tr>
<tr>
<td>NOBODY</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(2.4)</td>
<td>(2.4)</td>
<td>(2.4)</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(0.6)</td>
<td>(1.2)</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>164</td>
<td>164</td>
<td>164</td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

Fathers and mothers    -  $K = .63$  \( p = .000 \)

Fathers and 13-year-olds -  $K = .43$  \( p = .020 \)

Mothers and 13-year-olds -  $K = .59$  \( p = .020 \)
Table 3.18. - Frequency distribution of answers to question: 'Who used to decide when ______ should go to the dentist when young?' by fathers and mothers; and Kappa coefficient of agreement on the answers.

<table>
<thead>
<tr>
<th>PERSON CONTROLLING ATTENDANCE</th>
<th>RESPONDENTS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FATHERS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOTHER</td>
<td>115</td>
<td>(70.1)*</td>
<td>120</td>
</tr>
<tr>
<td>FATHER</td>
<td>5</td>
<td>(1.2)</td>
<td>6</td>
</tr>
<tr>
<td>BOTH PARENTS</td>
<td>13</td>
<td>(7.9)</td>
<td>4</td>
</tr>
<tr>
<td>OTHER</td>
<td>29</td>
<td>(17.8)</td>
<td>34</td>
</tr>
<tr>
<td>CANNOT REMEMBER</td>
<td>2</td>
<td>(1.2)</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>164</td>
<td></td>
<td>164</td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages

Fathers and mothers - $K = .49$  $p = .000$
3.4. DISCUSSION:

3.4.1. CLINICAL DATA:

This study was set up to assess the oral health status of family members from different social classes. The dental health status comprised the caries experience as measured by DMFS scores and its components (DS, MS and FS). Oral hygiene status was evaluated with ODI-S scores (Greene and Vermillion, 1964).

3.4.1.1. Dental Health Status:

As expected for this age group, low edentulousness figures were observed amongst parents (19 parents). Social class differences were clear, however. The majority of the edentulous parents came from the 'less privileged' social classes, 18 of them (11% of the parents from the 'less privileged' social classes). It is interesting to state that the only case of edentulousness observed among the parents from the 'more privileged' social classes was an upward socially mobile mother, whose father was a tailor and she was now married to a businessman. Gender differences were not so striking: 10 mothers and 9 fathers were edentulous.

Overall DMFS scores were very high in this population: parents and their children. Social class differences in DMFS scores emerged among fathers and mothers. The most striking differences were found when DMFS components were assessed.
Parents from the 'less privileged' social classes had far more decayed and missing surfaces than those from the 'more privileged' social classes. These in turn emerged as having a greater mean number of filled surfaces than parents from the 'less privileged' social classes. These differences were not only statistically significant but also of clear clinical significance.

Dental caries experience among the index children was also high. The mean DMFS score for the 13-year-old children was 7.4 (s.d. 6.7), which is high for this age group. No statistically significant difference was detected in the overall DMFS scores. However, statistically significant differences emerged when its components were analysed separately. The children from the 'more privileged' social classes showed a larger mean number of filled surfaces, while the children from the 'less privileged' social class had more untreated disease (DS). The missing component (MS) did not differ among the four social classes.

A number of studies have evaluated the relationship between social status and dental caries experience. Different measures have been used in these assessments, such as edentulousness figures and DMF or dmf scores. Nevertheless, in spite of the clinical indices used, a clear-cut and consistent association between socio-economic status and dental caries have been shown.

One of the largest dental surveys in this country was the national study of adult and child dental health (Todd et al, 1980; Todd and Dodd, 1985). For adults, it was shown that despite the decrease in edentulousness figures from 1968 to 1978, social class differences were still present: those from
the 'more privileged' social classes (I, II, IIINM) with a lower frequency (7%) than those from the 'less privileged' social classes (IIIM, IV, V), with 14% of them being edentulous (Todd et al, 1980). This finding is very similar to what has been observed in the parents of the present investigation. While only one mother from social class A was edentulous, 11% of the parents from the 'less privileged' social classes were edentulous.

The adult dental health survey has also shown that the dentulous subjects at the age of 35-44 years from the 'more privileged' social classes presented fewer decayed teeth (DT = 1.4) when compared to those subjects at the same age group from the 'less privileged' social classes (DT = 2.1) (Todd et al, 1980). The number of missing teeth was also found to be lower in those subjects from the 'more privileged' social classes when compared to those from the 'less privileged' social classes. Moreover, this latter group present a lower number of filled teeth than those from the 'more privileged' social classes (Todd et al, 1980).

These same findings can be extended to the dental health status of children (Todd and Dodd, 1985). In spite of the low caries experience as measured by DMFT scores, caries experience has shown to be lower for the children from the 'more privileged' social classes at all ages. At the age of 12, for example, the children from social classes I, II and IIINM had a mean DMFT of 2.8, while those from social classes IIIM, IV and V had a mean DMFT of 3.3. When the components were analysed separately, it was shown that the children at the age of 12 from the 'less privileged' social classes had twice as many
decayed and missing teeth then those from social classes I, II, and IIINM. The number of filled teeth, however, did not differ by social class (Todd and Dodd, 1985).

Similar findings have been observed for the caries experience in the deciduous dentition. Children from the 'less privileged' social classes had higher mean dmft or dmfs scores at all ages than children from the 'more privileged' social classes. The former experienced decay at an earlier age, and greater rate of attack, and were less likely to be caries-free (Beal and James, 1970; Hausen et al, 1982; Todd and Dodd, 1985; Tee, 1987).

In Brasil, social class differences in dental caries experience have also been reported. The only dental national survey was carried out in 1986, covering the urban population only. The findings were appalling: the mean DMFT score at the age of 12 was 6.7. Only 20% of the children at the age of 12 examined had a DMFT lower than 3, and 35% of them had a DMFT score above 8. DMFT scores differed by social class, children from the 'less privileged' groups showing a mean DMFT at the age of 12 of 7, while those from the 'more privileged' social classes had a mean DMFT of 5.9 (Ministério da Saúde, 1988).

The most striking differences, however, emerged when DMF components were analysed. The children, aged 6 to 12 years, from the 'less privileged' social classes had 20% of their teeth filled, and 67% of them were decayed; while those from the 'more privileged' had 55% of their teeth filled and 40% were decayed (Ministério da Saúde, 1988).

For adults, the same pattern was observed. 16.3% of the subjects at the age of 35 to 44 years were edentulous. Adults
at the age of 35 to 44 years had a mean DMFT score of 22.5, and those from the 'less privileged' social classes had a higher DMFT score (mean 23.0) than those from the 'more privileged' social classes (mean 21.3) (Ministério da Saúde, 1988).

3.4.1.2. Oral Hygiene Status:

The mean ODI-S scores were very low in this population: parents and their children. For all of them the highest mean ODI-S never exceeded the figure of .82 (index children from social class D), which is extremely low.

Statistically significant differences were detected, however, when Kruskal-Wallis one-way analysis of variance was performed to the data. The family members from the 'more privileged' social classes showed lower ODI-S scores than those from social classes C and D.

The findings of the present investigation are in agreement with other studies, which have shown that individuals, either adults or children, from the 'more privileged' social classes have a better oral hygiene status than those from 'less privileged' social classes (Beal and James, 1970; Samuelson et al, 1971; Reisine and Bailit, 1980).

It is important to stress, however, that since the mean ODI-S scores were so low, the clinical significance of these statistical differences becomes questionable.
3.4.2. BEHAVIOURAL DATA:

This study evaluated the pattern of behaviours conducive to good/bad dental health among family members from different social classes. The behaviours assessed were dietary and oral hygiene habits, and the pattern of dental attendance.

3.4.2.1. Dietary Habits:

Sugar consumption was extremely high in this population: parents and their children. As an example, the mean number of sugary items consumed in the previous 24 hours of the index children was as high as 7.4 items; and the index children from social class B showed the highest mean number among all the subjects here assessed: 8.5 sugary items in the previous 24 hours!

It was thought that there would be strong evidence to show that the family members from different social classes would present different levels of sugar consumption. However, while statistically significant differences in total number of sugary items intake were detected for the fathers from different social classes, no statistically significant difference emerged among the mothers and the index children. The fathers from social class A reported a lower sugar consumption in the previous 24 hours than those from social class C.

This finding contradicts most of the literature reviewed, which has shown that subjects from the 'less privileged' social classes tend to consume more sugary items than those from the
'more privileged' social classes (Beal and James, 1970; Samuelson et al, 1971; Beal and Dickson, 1974; Tee, 1987; Ruiken, 1989). It is important to remember, however, the country of origin this sample was drawn from: Brasil. 'Per capita' sugar consumption in Brasil, one of the world's leading sugar producers, is notoriously high - 130g/head/day in 1987 (Pinto, 1990). Bearing this in mind, it can be concluded that these family members only reflect the high sugar consumption reported for the country they come from. Moreover, it becomes easy to understand the reason for such a high caries experience in this population: world data have demonstrated that countries with a 'per capita' sugar availability above 120g/head/day were associated with average DMFT scores of 6 or more (Sreebny, 1982b).

The mean sugar consumption at meals was around two to three items. Statistically significant differences were not found among the parents and index children from the different social classes. Similar findings have been obtained for Israeli children aged 2 to 6 years, a mean at meals sugar consumption of 2.7 units. Social class differences, due to not being subject of study, were not assessed (Sgan-Cohen and Salinger, 1982).

Most of the sugar intake was in-between meals. Social class differences emerged among fathers only. Overall those from social class A reported a lower in-between sugar intake than the other three social classes.

As far as the origin of sugary items is concerned, most of the sugar consumed by the index children was obtained from home: 4.7 items. Sugar was widely available at home for all
social classes, and no statistically significant difference was obtained for the four social classes.

Food habits are determined within the family. Therefore, family members show very similar patterns of food consumption (Garn et al, 1979; Lennon and Fieldhouse, 1982; Perusse et al, 1988). Children are highly dependent on others, especially their mothers, for their food intake (Lennon and Fieldhouse, 1982; Graham, 1984).

Sugar consumption does not seem to be an exception to this pattern. The pattern of sugar consumption among children has been shown to be closely related to the pattern of sugar consumption of their parents. This fact seems to be true independent of the age group the child is. In addition, the mothers seem to be the strongest determinant of the pattern of sugar consumption children present (King, 1976; Shaw and Murray, 1980; Honkala et al, 1983; Rossow et al, 1990).

The family members in the present investigation, the mothers inclusive, had a high sugar consumption. Due to the age of the children (13 years old), one would expect that home would be the main source of food availability for these children. Since sugar consumption was so widespread, it seems reasonable to assume that its availability at home was also very high. Therefore, it is not surprising that most of the sugary items consumed was obtained from home.
3.4.2.2. Oral Hygiene Habits:

Reported tooth-brushing frequency was very high among all the individuals: parents and children. The majority of them reported brushing their teeth at least once a day.

It was thought that there would be strong evidence to show that family members from different social classes would present different tooth-brushing frequencies. However, for mothers and children statistically significant differences were not detected. For fathers, however, statistically significant differences in reported tooth-brushing frequency emerged. Fathers from social class A reported a higher brushing frequency when compared to those from social class C and D. Since the majority of the subjects in this study reported a high tooth-brushing frequency (more than once/day), the clinical significance of the statistical difference obtained among the social classes seems to be questionable.

Tooth-brushing practices have been reported to have widespread acceptance. While some studies have shown that children and adolescents from different social classes did not differ in their reported tooth-brushing habits (Blinkhorn, 1976; Hodge, 1979), others have shown that mothers of children from the 'more privileged' social classes reported a more frequent behaviour for their children than mothers from the 'less privileged' social classes (Beal, 1989).

It is important to remember, however, that one of the criticisms often raised against investigations involving questionnaires and interviews is the influence of the 'halo'
effect, that is, the respondent may feel guilty about his/her behaviour and may, therefore, give an 'ideal' answer. In the present study the low oral debris scores observed among these individuals somewhat reflect the reported tooth-brushing frequency of the sample. It seems reasonable, therefore, to accept that the reported tooth-brushing frequency was a true account of their behaviours.

3.4.2.3. Pattern of Dental Attendance:

The pattern of dental attendance observed among this sample clearly reflects the state of dental care available to the Brazilian population. Dental health care in Brasil is almost entirely run privately. Only 41% of the money spent on dental care in Brasil come from the state-run sector, which in turn is mainly concentrated in schools (Pinto, 1990).

The private sector consisted of a 'formal' and an 'informal' sector. The 'formal' sector comprises the qualified dentists, while the 'informal' is composed of 25,000 'practical' dentists. These 'practical' dentists serve the population from the 'less privileged' social classes (Pinto, 1990). The 'formal' sector consists mainly of individual clinical practices. However, some companies/industries provide their workers and his/her dependants with some financial support for dental care.

Dental care in Brasil is treatment-oriented. The state-run dental care service for the adult working population provide either minor dental treatment or emergency treatment, which
consists of extractions mainly. For the children school dentists provide treatment of permanent teeth only.

The highly sophisticated private 'formal' sector provides all sorts of treatment, having a curative emphasis. The 'informal' sector consists of extractions, dentures and minor treatment (Pinto, 1990).

The majority of the individuals (parents and children) in the present study had a private dentist. Social class differences were observed. It was found statistically significant that more family members from the 'more privileged' social classes had a private dentist. As for children those from the 'less privileged' social class would see a NHS dentist, that is, the school dentist.

Statistically significant differences emerged in relation to the reported usual reason for seeking dental care. Family members from the 'more privileged' social classes stated that check-ups were the usual reason for seeking dental assistance.

The time interval since the last visit to a dentist also differed among family members from the four social classes. The majority of fathers, mothers and children from the 'more privileged' social classes reported having been to a dentist within the previous 24 months.

Very similar observations have been made with respect to the quality and quantity of dental care received by subjects from different social classes. Data from the UK showed that the 'more privileged' social class visited the dentist more regularly than the 'less privileged' social class, they were also less likely to visit a dentist only in pain, and they took
their children for dental check-ups at an earlier age. Even the choice of dental service was found to differ among social classes. Mothers from the 'more privileged' social classes took their children to their own general dental practitioner. In contrast many more mothers from the 'less privileged' social classes, who were less likely to go to a dentist themselves, but sent their children to the School Dental Service (Todd, 1975; Todd and Dodd, 1985).

This variation in pattern of attendance and type of dentist was also extended to the type of treatment received. Subjects from the 'more privileged' social classes received more restorative work and fewer extractions than those from the 'less privileged' social classes (Todd et al, 1980; Todd and Dodd, 1985).

3.4.3. HOME ENVIRONMENT:

One of the objectives of the present study was to assess the dental health status and the behaviours conducive to good/bad dental health status within families. Strong intra-family patterns of oral health status (as expressed by age-sex-adjusted DMFS and ODI-S scores) and dental health related habits were observed. While spouses resembled each other, overall the strength of association was not as high as the one found for the children. When the strength of association among fathers and children, and mothers and children were compared, the children tended to be more strongly correlated with their mothers. These findings are in agreement with several studies,
which have confirmed the presence of intra-family patterns in health status and behaviours (Klein and Palmer, 1940; Klein and Shimizu, 1945; Klein, 1946; Ringelberg et al, 1974; Garn et al, 1976a, 1976b, 1977, 1979; Shaw and Murray, 1980; Honkala et al, 1983).

Parental influences in the establishment of dental health behaviours were investigated. Interviews were carried out with both parents and the index children for the assessment of the home environment in relation to these habits. It was observed that mothers tended to be the person to decide or control the habit at home. For sugar consumption, there seemed to be little control at home, but when present, the mothers were responsible to control it. For tooth-brushing mothers were the ones to remind their children to perform the habit. The same was true for deciding when to go to the dentist: mothers were the ones deciding when their children should visit a dentist.

The assessment of agreement among the respondents' replies to the questions showed a moderate to high consensus among family members. Therefore, the role of mothers in the determination of habits was considered to be a true account.

There are several studies which stress a strong association between the dental health status and behaviours of children and their mothers (Klein, 1946; Ringelberg et al, 1974; Garn et al, 1976a, 1979; Shaw and Murray, 1980; Honkala et al, 1983). In our society mothers are responsible for the establishment of behaviours within a family (Mechanic, 1964; Blinkhorn, 1976; King, 1976; Graham, 1984; García-Godoy, 1986). Therefore, it is not surprising that children and mothers show such a close association.
3.5. CONCLUSIONS:

Dental caries experience (DMFS scores) was very high in this population. While statistically significant differences emerged among family members from different social classes, DMFS scores were very high in all social classes. The most striking differences were obtained in the assessment of DMFS components. Family members of the 'more privileged' social classes tended to show more treated disease (FS) while those from the 'less privileged' social classes had more untreated disease (DS) and more missing surfaces (MS).

Oral hygiene status was very good in spite of the statistically significant differences observed among family members from the four social classes. Those individuals from the 'more privileged' social classes had a lower mean ODI-S scores than those from the 'less privileged' social classes. The clinical significance of this finding is questionable though.

Sugar consumption was very high among this population. Social class differences were observed among fathers only. However, on the whole, the mean number of sugary items intake in the previous 24 hours was above 6 units/day, which is considered a high risk intake (Varveri and Bellagamba, 1986).

Tooth-brushing frequency was high in all social classes. The majority of family members reported brushing their teeth at least once a day. Statistically significant differences emerged among the four social classes, with those family member from the 'more privileged' social classes reporting a higher...
frequency. Once again the clinical significance of this statistical difference is questionable.

Family members tended to seek private dental care. For the children from the social class D, however, over 50% of them reported seeing a NHS dentist. This was due to the fact that the majority of them were seen by the school dentist. Family members from the 'more privileged' social classes more often stated seeking dental care for check-ups, and most of them had been to a dentist within the last 24 months. Those family members from the 'less privileged' social classes more often reported seeking dental care for symptom-related reasons, and a large number of them stated not having sought dental care for more than 24 months.

Strong intra-family patterns were observed in relation to oral health status (DMFS and ODI-S) and dental health related behaviours. Father and mothers, parents and children, and children among themselves were correlated. When the strength of association between mothers and children, and fathers and children were compared, correlation coefficients tended to be higher for mothers and children than for fathers and children.

The control or decision on the uptaking of all three habits by the children was mainly done by mothers. While for sugar consumption most of the respondents did not report a control at home but, when present, this was exerted by mothers. For tooth-brushing and dental attendance, a control was always reported as present, and the mother seemed to be the one in charge of them.

In an attempt to assess intra-family patterns more thoroughly, path analysis was performed on the data. The next
chapter describes some basic concepts on path analysis and the model used. The results obtained will be described in Chapter 5, and a discussion of the results will be presented in Chapter 6.
4.1. INTRODUCTION:

Determining the existence of significant familial aggregation is usually not difficult and, in fact, can often be assessed with an examination of the correlations of pairs of relatives. Determining the reasons for that aggregation, however, becomes a more important issue since it addresses the classic question of 'nature' versus 'nurture'.

Path analytic methods and related structural equation models allow a more comprehensive study of the contribution of environmental variance, either transmissible or non-transmissible, as well as the genetic variance in diseases. Path analysis is a flexible method which enables the quantification of genetic and environmental causes of variations in multifactorial phenotypes. For this reason path analysis has been extensively used in the field of genetic epidemiology since the latter approaches the causation of a disease in an integrated fashion, giving equal attention to the roles of genetic, cultural and environmental factors in its determination.

The method of path analysis was developed by Wright (1921) when it was used in the studies of piebald spotting and birth
weight in guinea pigs to resolve the genetic and environmental sources of variation. This method has been introduced and developed for human quantitative genetics by Morton (1974), when the introduction of 'environmental indices' enabled the resolution of models of transmission in nuclear families, and by Rao and co-workers (1974), when the introduction of an associated statistical method of analysis allowed hypotheses testing. Path analysis has been extensively applied in estimating parameters and testing hypotheses about the nature and sources of familial resemblance for behavioural (Morton, 1974), allergic (Gerrard et al, 1978), pulmonary (Lewitter et al, 1984), anthropometric (Devor et al, 1986; Hutchinson and Byard, 1987) and cardiovascular (Pérusse et al, 1989b) data.

The cranio-facial complex, however, has not been so widely studied with this method. Byard and co-workers (1985) and Devor (1987) analysed the family resemblance for components of cranio-facial size and shape, while Potter and co-workers (1983) assessed the dental size traits within families. Dento-facial variation (facial height and facial depth as well as tooth morphology and occlusion) in twins was assessed by Lundström (1984). For oral diseases, the genetic and environmental determinants of periodontal disease was studied by Chung and co-workers (1977) and Rao and co-workers (1979a).

The purpose of the present investigation was to assess the nature and sources of familial resemblance for dental caries in a group of 164 randomly selected Brazilian nuclear families.

In this chapter the path analytic model and diagram will be explained followed by a brief explanation of the statistical method used. Data manipulation and the results will then be
described, followed by a discussion and conclusion of the results obtained.

4.2. PATH ANALYTIC MODEL:

Path analysis of familial resemblance examines the transmissibility of traits by partitioning the correlations among family members into components described by standardised partial regression coefficients, known as path coefficients (Wright, 1921). It seeks to identify hereditary and environmental sources of familial aggregation for quantitative traits through analysis of the observed correlations among family members. Therefore, this model enables a distinction to be made between the genetic and cultural components of inheritance from other environmental influences that are not transmitted between generations (Péruesse et al, 1989a, 1989b).

The basic model of phenotypic determination used in this study is illustrated, as a path diagram, in Figure 1. This model was based on Rao and co-workers (1982) and the description, now presented, follows Rao and co-workers (1982).

In a path diagram the variables, observed or latent, are designated as effects or causes. An observed variable, as the name implies, is a variable that has been measured. A latent variable, however, is a construct and, therefore, is unobserved or not measured (Pedhazur, 1982). There are two main reasons for including latent variables in a model. First, measurement, even of relatively straightforward quantities, such as social class and home environment, can not be
considered perfect. Second, a variable may be unmeasurable, such as genotype (Fox, 1984). Since the relevance of these components is great, they are included in the model. It is important, however, to stress the model in no way attempts to quantify these components, but only to enable the creation of a logical causal model.

By convention the observed, or measured, variables are shown in the diagram as squares and the latent, or unobserved, variables as circles (Namboodiri et al, 1985; Hutchinson and Byard, 1987).

The arrows connecting the variables in the model denote inferred causality. Single-headed arrows indicate that one variable is thought to cause another, while double-headed arrows denote correlation between two variables, neither of which is necessarily the cause of the other.

Associated with each path is a coefficient (standardised partial regression coefficient or path coefficient) relating to the variables at both ends of the path. The correlation between any two variables in the diagram can be determined through connecting paths according to standard rules of path analysis (Li, 1975; Pedhazur, 1982).

The model assumes that a quantitative trait $P$ can be partitioned as $P = G + C + E$, where $G$ and $C$ denote additive genetic factors and cultural factors transmitted from parent to offspring, respectively, and $E$ (which for convenience is not depicted) represents all other environmental factors not transmitted between generations. Interactions between these three factors are assumed to be non-existent or negligible (Vogler et al, 1987). While the transmission of cultural
factors (cultural inheritance) may be learned or acquired when parents teach their children certain customs, non-transmitted environmental factors (E) express other environmental influences acquired outside the home environment such as in schools and neighbourhood (Pérusse et al, 1988).

For each member of the nuclear family, the trait under study, the 'phenotype' (P) and an approximate measure of the familial environment called 'index' (I) can be observed. The suffixes F, M, C1 and C2 in the diagram pertain to father, mother, and children one and two, respectively. The illustration of the model depicting only two children was used for ease of explanation. The present study, however, was based on nuclear families with variable sibship size. However, due to the statistical procedure here applied - maximum likelihood estimate and its z-transformations - this method is robust for variable sibship size provided the sample is large enough, that is, at least 100 families (Wette et al, 1988).

The definitions of the ten parameters specified by the model are given in Table 4.1. The magnitudes of the effects of the genetic and familial environmental factors upon a child phenotype are taken to be h and c, respectively. For adults, the magnitude of these are hz and cy, respectively; and, in this way, intergenerational differences are incorporated into the path model.
Fig. 1. Path diagram showing cultural and biological inheritance in nuclear families. The subscripts F, M, C1 and C2 denote father, mother and 2 children, respectively. P is the phenotype, G is the genotype, C is the familial environment, which is estimated by the index I, and B is non-transmitted common sibship environment (after Rao et al, 1982).
Table 4.1. - Definition of the Parameters of the Model (Fig.1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>effect of genotype on offspring phenotype (square root of genetic heritability)</td>
</tr>
<tr>
<td>hz</td>
<td>effect of genotype on parent phenotype</td>
</tr>
<tr>
<td>c</td>
<td>effect of environment on offspring phenotype (square root of cultural heritability)</td>
</tr>
<tr>
<td>cy</td>
<td>effect of environment on parent phenotype</td>
</tr>
<tr>
<td>u</td>
<td>correlation between parental environment</td>
</tr>
<tr>
<td>b</td>
<td>effect of non-transmitted common sibship environment on offspring environment</td>
</tr>
<tr>
<td>fF</td>
<td>effect of father's environment on that of an offspring he rears</td>
</tr>
<tr>
<td>fM</td>
<td>effect of mother's environment on that of an offspring she rears</td>
</tr>
<tr>
<td>i</td>
<td>effect of environment on offspring index</td>
</tr>
<tr>
<td>iv</td>
<td>effect of environment on parent index</td>
</tr>
</tbody>
</table>

With nuclear families, genetic and familial sources of familial resemblance can only be discriminated if, in addition to phenotype, at least one of these factors (genetic or familial environmental) is measured (Rao et al, 1976). For this reason, Morton (1974) first introduced the notion of an 'environmental index' (I), which is an estimate of the familial environment. The environmental index is computed for each family member and is defined by regression of phenotype on relevant environmental factors (Morton, 1974). This 'indexed environment' is, therefore, a constellation of relevant variables that affect the phenotype. It is assumed that the
'environmental index' is a function of environmental factors only, that is, it is unaffected by genotype (Rao and Wette, 1990). The magnitude of this effect is $i$ for children and $iv$ for adults.

The familial environment of a child is assumed to be determined partly by cultural transmission or factors shared in common with his/her parents, and partly by non-transmitted environmental factors (B) which are shared in common by the multiple siblings in a family. The latter reflects the environmental similarity of siblings beyond that due to factors transmitted by their parents. The model also allows cultural transmission to differ according to parent sex. In this way the effect of mother's familial environment upon child's familial environment ($f_{M}$) may differ from the effect of father's familial environment ($f_{F}$). Maternal environmental effects are then incorporated.

This model also incorporates the concept of marital resemblance. Resemblance between spouses could be due to the effects of cohabitation and/or assortative mating. Assortative mating is a system in which either like individuals (positive assortative mating) or unlike individuals (negative assortative mating) preferentially mate with one another. Assortative mating can be classified into two major types: phenotypic homogamy (under which, mates choose one another on the basis of their phenotypic appearance) or social homogamy (under which, mates choose one another on the basis of their group membership) (Rao et al, 1979b)). Under this model, marital resemblance is assumed to be due to a correlation ($u$) between the familial environments of the two spouses.
The model under study can be described as a non-recursive and over-identified model. When the causal flow of a model is unidirectional, or rather, when at a given point of time a variable cannot be both a cause and an effect of another variable, such a model is defined as non-recursive. A model is described as over-identified when it contains more equations (represented by correlations) than are necessary for the estimation of parameters (Li, 1975; Pedhazur, 1982).

Over-identification was obtained by setting up a number of modelling assumptions, that is, certain constraints or restrictions were applied to the model. This was obtained by assuming that certain path coefficients are equal to zero (Pedhazur, 1982). This model assumes the absence of both correlation between parental genotypes \( (\mathbf{m} = 0) \) and of correlation between parental phenotype through phenotypic homogamy \( (\mathbf{p} = 0) \). It also assumes that the effect of child's genotype on child's index and the effect of adult's genotype on adult's index are both nil \( (j = 0; jw = 0) \) (Rao et al, 1982).

These assumptions were made based on the nature of the phenotype (DMFS) under study. There does not seem to be any evidence against any of the four constraints imposed on the model in the dental literature. In other words, in this study, none of the parents were genetically related \( (\mathbf{m} = 0) \); and for DMFS, there is no evidence that mates choose each other under phenotypic homogamy \( (\mathbf{p} = 0) \) or that genetics plays a role in the determination of the index used (sugar consumption and social class)\( (j = 0; jw = 0) \).
Over-identification is, therefore, a consequence of 16 equations (correlations) being drawn from the model (Table 5.1.) These correlations are, then, used to estimate the 10 parameters (Table 4.1.).

The final modelling assumption made in application of this model is that all genetic effects are additive, that is, the heterozygote is exactly an intermediate between the two homozygotes (Bodmer and Cavalli-Sforza, 1976). This final assumption seems to be reasonable since for most quantitative traits, and dental caries can be included in this group, there is little evidence for dominance or epistasis (Morton, 1982). While dominance can be described as the capacity of a gene to express its effect whether present either upon one or both chromosomes of the pair concerned, epistasis can be defined as the masking of effect of one gene by an allele at another locus (Goodenough, 1984).

4.3. STATISTICAL PROCEDURE:

The statistical method of analysis fits the model directly to the family data, under the assumption that the phenotypes and indices in a nuclear family follow a multivariate normal distribution (Rao et al, 1982). The analysis then proceeds in two steps, first by estimating the familial correlations by maximum-likelihood methods from nuclear family data; and second by fitting the path models to familial correlations, estimating parameters, and testing hypotheses using the likelihood ratio criterion.
To compute familial correlations for each class of relative pair by the method of maximum-likelihood, the overall likelihood function is formulated. For a given family, the covariance matrix of such a distribution is a function of some or all familial correlations. The logarithms of the likelihoods are summed over all families to get an overall log likelihood (LL). The correlation coefficients are estimated by maximising the LL using GEMINI, a numerical optimization package (Rao et al, 1982; Morton et al, 1983). As pointed out by Sharma and co-workers (1984), this method of computing correlations is able to accommodate variable sibship size without the loss of information suffered by other methods such as the use of only one randomly selected child per family in calculating parent-child correlation coefficients. Under this method the effective sample sizes are estimated by inverting the large (or asymptotic) variance of the estimated correlation coefficients (Rao et al, 1982; Sharma et al, 1984). Estimation is preferred since, with variable sibship size, not all parent-offspring and sibpairs are independent and simply counting these pairs would overestimate the true 'sample size' (Rao et al, 1982).

Using this procedure, estimates of the pair-wise correlations are obtained for 15 possible pairs of phenotype and indices on nuclear family members, $P_F$, $I_F$, $P_M$, $I_M$, $P_C$, $I_C$, and for the three sib-sib pairs, $P_C$-$P_C$, $I_C$-$I_C$, and $P_C$-$I_C$. This defines a total of 18 correlation coefficients. However, considering that certain marital correlations have identical expectations under the general linear model ($P_FI_F = P_MI_M$ and $P_MI_M = P_MI_F$), the total number of correlation coefficients with
distinct expectations is reduced to 16 (Table 5.1.) (Rao et al, 1984).

For the second step involving the model fitting, the estimation of parameters and hypotheses testing are achieved using the procedure described by Rao and co-workers (1979b). The sample correlations are transformed using Fisher's Z-transformation to normalise their distribution. Considering that $Z_i$ is the $i$th Z transform, then $Z_i$ is assumed to follow a normal distribution with mean $z_i$, the Z transform of the expected correlation, and variance $1/n_i$, the inverse of the effective sample size.

If all the correlation estimates are independently distributed, the log likelihood (LL) is taken to be

$$LL = -\frac{X^2}{2} + \text{constant}$$

where

$$X^2 = \sum n_i (Z_i - z_i)(Rao \ et \ al, \ 1982)$$

The residual $X^2$, after estimating $k$ parameters, is assumed to follow a $X^2$ distribution with $16 - k$ degrees of freedom. The value of $X^2$ with appropriate degrees of freedom is used to assess the fit of the model and to test different hypotheses.

In an attempt to clarify this technique, two examples are now given. The goodness-of-fit for the general general model is assessed by subtracting the log likelihood value (LL) obtained from the path analysis from the log likelihood value (LL) for the familial correlations. The degrees of freedom are determined by subtracting the number of parameters estimated in the path model (10) (Table 4.1.) from the number of unique familial correlations (16) (Table 5.1.), totalling 6.
Therefore, the goodness-of-fit test for the general model is based on 6 degrees of freedom ($X^2_6$). The goodness-of-fit for hypothesis testing follows the same rationale. To this end, the parameters under testing are set to a predetermined value, and the log likelihood (LL) of this reduced model is subtracted from the log likelihood of the general model. The degrees of freedom are determined by the subtraction of the number of estimated parameters in the reduced model from the number of estimated parameters in the general model (10). Therefore, if one parameter is set to a value, nine parameters are being estimated, and the number of degrees of freedom is 1 ($10 - 9 = 1$, $X^2_1$).

In this way, several hypotheses were tested: no genetic effect ($h = 0$), no familial environmental effect ($c = 0$), no intergenerational difference in genetic effect ($z = 1$), no intergenerational difference in familial environmental effect ($y = 1$), no marital resemblance ($u = 0$), no sibling shared environmental effect ($b = 0$), no interparental differences ($f_F = f_M$), no effect of father's environment on the offspring's environment ($f_F = 0$), and no intergenerational difference in the effect of the environment upon index ($v = 1$) (Table 5.2.).

Finally, combination of these hypotheses were tested to arrive at a most parsimonious model of family resemblance. The hypotheses incorporated in this parsimonious model are selected based on the $X^2$ values obtained when each of them was tested separately. Those hypotheses which were not rejected at the 5% level of significance became part of the most parsimonious model, a model which incorporates the lowest number of parameters estimates.
4.4. MATERIAL AND METHODS:

4.4.1. DESCRIPTION OF THE SAMPLE:

The subjects of this study belonged to 164 Brazilian families living in Belo Horizonte, M.G. As described previously, these families were randomly selected through private and state schools having the 13-year-old child as the index child.

Here, however, since behavioural and clinical data were required for analysis, only those family members who were interviewed and clinically examined were included. The sample, therefore, consisted of all family members at the age of 10 and above. Of the 861 family members, the data on 717 subjects were analysed: 164 fathers, 164 mothers, 164 index children, and 225 siblings.

For a detailed description of the oral health status and behaviours of the family members who were included in the path analyses, please refer to Chapter 3 and Appendix 7.

4.4.2. MEASUREMENTS:

4.4.2.1. Age-sex adjusted DMFS:

The variable under study was dental status as measured by DMFS. Since age and sex have substantial effects on dental
status, DMFS scores were corrected for the effects of these two variables.

The effects of these covariates were removed using multiple regression by regressing DMFS on a cubic polynomial on age and sex (sex, age, age\(^2\), age\(^3\), sex \times age, sex \times age\(^2\), and sex \times age\(^3\)) in a stepwise manner. The inclusion of higher-order terms in the polynomial permitted the removal of nonlinear age effects (Wetherill, 1981). Higher-order age terms were retained in the regression only if they were significant at the 5% level (p < .05).

The regression equation for DMFS in the present study was

\[
\text{DMFS} = -2.71533 + 0.47644(\text{age}) - 0.00586(\text{age}^2) + 0.00055(\text{sex} \times \text{age}^2)
\]

This equation explained 75% of the variation \((r^2 = .748)\) and was applied in adults and children together. Scores predicted from this equation were subtracted from original scores to derive residual scores, which were submitted to further analysis. In other words, from this equation, the age-sex-adjusted DMFS was defined as

\[
\text{DMFS*} = \text{DMFS} - f(A,S)
\]

where \(\text{DMFS*}\) is the age-sex adjusted DMFS, \(\text{DMFS}\) is the original DMFS value, and \(f(A,S)\) is the polynomial equation involving the age and sex.
4.4.2.2. Environmental Index:

As described above, in the formulation of path analysis used by Morton (1974) and Rao et al. (1974), the effect of family environment should be measured. Since the familial environment (C) cannot be directly observed, it is estimated by an index (I). The incorporation of such an index in the analysis increases the number of observed correlations for the given relationships and improves the determinancy of the system and hence the power to resolve the relative contributions of the causal factors.

Clearly, the exact choice of index variables is not an easy task and depends on the phenotype under study. Ideally, an index should be based on a complete set of all index variables pertinent to the familial environment. In practice, however, it may not be known which variables constitute such a complete set, and, even if this is known, not all the index variables may have been observed in a particular study.

For the present analysis, four variables - social class, total sugar consumption, tooth-brushing frequency, and pattern of dental attendance - were used to construct the environmental index for DMFS. The following procedure was used to create the index. The age-sex-adjusted DMFS was regressed on the four index variables mentioned above in a stepwise manner. The index variables were retained as part of the environmental index only if they were significant at the 5% level (p < .05).
In the present analysis, only two of the index variables were retained - social class and total sugar consumption. The following equation was obtained

\[ \text{DMFS}^* = -0.94993 + 0.09197 \text{(totsug)} + 0.11468 \text{(sc)} \]

where \( \text{DMFS}^* \) is the age-sex-adjusted DMFS, \( \text{totsug} \) is the total sugar consumption, and \( \text{sc} \) is the social class. This equation explained 8% of the variance \( (r^2 = 0.080) \).

The index was then calculated for each family member using the linear function of social class and total sugar consumption described above. The part of the environment so estimated by the index is called family environment, and the remainder is the residual environment (Rao et al., 1982).

As a summary, the observed DMFS was regressed on sex, age, age\(^2\), age\(^3\), sex x age, sex x age\(^2\), sex x age\(^3\), social class, total sugar consumption, tooth-brushing frequency, and pattern of dental attendance, retaining only the terms significant at the 5% level:

\[ X = f(A,S) + g(Z) + e \]

where \( X \) is the observed DMFS, \( f(A,S) \) is the polynomial in age and sex, \( g(Z) \) is the linear function of social class and total sugar consumption, and \( e \) is the residual. After fitting this equation, age-sex-adjusted DMFS (phenotype, \( P \)), and an estimate
of the familial environment (environmental index, I) were defined as

\[ P = X - f(A, S) \]

and

\[ I = g(Z) \]

4.4.3. PATH ANALYSES:

Family data on \( P \) and \( I \) were analysed using PATHMIX - Method 3, a FORTRAN computer programme written on HARRIS computers and based on GEMINI and ALMINI (Rao et al, 1984). This programme was adapted for IBM computers and applied to the data in the present study.

PATHMIX - Method 3 is formed collectively by two programmes, PATH3A and PATH3B. With this method, models are fitted directly to the family data. Standardisation of \( P \) and \( I \) are performed automatically by the programme.

First, all the 18 familial correlations were estimated using PATH3A. The different hypotheses under study were, then, tested using PATH3B.

In hypotheses testing, a parameter was set to a value, either zero or one, and the model was run using this constraint. The following hypotheses were tested: no genetic effect (\( h = 0 \)), no familial environmental effect (\( c = 0 \)), no intergenerational difference in genetic effect (\( z = 1 \)), no intergenerational difference in familial environmental effect.
(y = 1), no marital resemblance (u = 0), no sibling shared environmental effect (b = 0), no interparental differences (f_F = f_M), no father's familial environment effect (f_F = 0) and no intergenerational difference in the effect of the environment upon index (v = 1) (Table 5.2.).

Goodness-of-fit tests, determination of degrees of freedom, and development of the most parsimonious model were developed according to the description developed in section STATISTICAL PROCEDURE (Section 4.3 in this chapter).
The 16 unique correlation coefficients for DMFS estimated using the maximum likelihood method are presented on Table 5.1., together with the estimated sample size. While the mother-child and sibling correlations were considerably significant, father-child resemblance appeared weak. Similar results were found when Pearson's $r$ correlation coefficient, Spearman's rho correlation coefficient, and lambda association coefficient were applied to the data.

The results of the path analysis are presented in Table 5.2. The general model in 10 parameters fitted the data extremely well ($X_6^2 = 2.20; p > .90$).

Results confirmed strong intra-family patterns of dental status (DMFS) for children ($h^2 + c^2 = 0.716$), while for adults, family aggregation explained almost one-third ($0.295$) of the variance (Table 5.3.). The sources of phenotypic variation within families were as follows: in offspring, the genetic heritability ($h^2$) was $0.557 \pm (s.e. .105)$, and cultural heritability ($c^2$) was $0.159 \pm (s.e. .057)$; in parents, genetic heritability ($h^2z^2$) is $0.159 \pm (s.e. .071)$, and cultural heritability ($c^2y^2$) was $0.136 \pm (s.e. .051)$ (Table 5.3.). The remainder of the variance, which is due to residual environmental influences that are unique to the individual ($E$), also varied for the children and for the parents. For children,
it was equivalent to 0.284 \pm 0.098, while for the parents, it was 0.705 \pm 0.082). This result showed that the environment outside the family played an important role in the determination of the variance, especially in adults (Table 5.3).

The results of hypotheses testing for DMFS are shown in Table 5.2. When assessing biological and environmental influences on the phenotype (DMFS), it was observed that both additive genetic (\( h = 0; X_1^2 = 43.66; p < 0.000 \)) and familial environmental factors (\( c = 0; X_1^2 = 57.30; p < 0.000 \)) were significant. There was no evidence for intergenerational difference in familial environmental effect (\( y = 1; X_1^2 = 0.13; p > 0.70 \)), whereas the genetic effect upon phenotype was significantly greater for children than adults (\( z = 1; X_1^2 = 7.49; p < 0.00 \)).

Marital resemblance was highly significant (\( u = 0; X_1^2 = 16.23; p < 0.000 \)), implying a correlation between marital non-random environment and representing social homogamy.

The familial environment of a child can be determined partly by cultural transmission from parents and partly by non-transmitted environmental factors shared by siblings. Significant evidence was lacking for sibship environmental effect (\( b = 0; X_1^2 = 1.11; p > 0.25 \)), indicating that all the cultural inheritance came from the parents. When assessing if cultural transmission differed according to parent sex, the hypothesis of no interparental differences (\( f_F = f_M; X_1^2 = 4.23; p < 0.05 \)) was rejected at a borderline level of significance. It was observed, however, that the parameter \( f_M \) was consistently estimated to be larger than \( f_F \) (Table 5.2.)
and mother-offspring correlations were consistently larger than the corresponding father-offspring correlations (Table 5.1). For this reason, the hypothesis of no father's environmental effect was tested and accepted under this model ($f_F = 0; \chi^2_1 = .01; p > .90$).

Finally, no evidence was found for intergenerational differences in the effect of the environment upon index ($y = 1; \chi^2_1 = 2.13; p > .15$) (Table 5.2.).

Based on the results of the individual hypotheses testing and on the results of the general model, a parsimonious reduced model was selected to provide the summary parameter estimates (Table 5.2.). This was achieved by combining those hypotheses which were not rejected. In the parsimonious reduced model, generational differences were assumed to be absent ($y = 1$ and $v = 1$), except for genetic heritability. It was also assumed that there was no sibling shared environmental effect ($b = 0$), and that father's environment effect on the offspring's environment was absent ($f_F = 0$).

The overall fit of the parsimonious reduced model in relation to the general model was high ($\chi^2_4 = 6.07; p > .25$) (Table 5.2.).

The parsimonious reduced model confirmed the strong intra-family pattern of dental status (DMFS), especially in children (Table 5.3). Familial aggregation explained 71% of the phenotypic variance in children, while for parents 32% of the phenotypic variance was explained. Estimates for intra-family phenotypic variance were as follows: genetic heritability explained 54% (s.e. 10%) of variance in children ($h^2$), but only 15% (s.e. 7%) of the variance in parents ($h^2z^2$); cultural
heritability estimates were similar for parents \((c^2y^2)\) and children \((c^2)\), 17% \((s.e. 4\%)\) (Table 5.3).

Estimates for environmental factors outside the family environment in the parsimonious reduced model were much greater for adults than children. While adults had 68% \((s.e. 7\%)\) of their phenotypic variance explained by environmental factors outside the family, an estimate of 29% \((s.e. 10\%)\) was observed for the children (Table 5.3).
Table 5.1. - Expected Correlations Derived from Path Diagram, Maximum Likelihood Estimated Correlations with their standard errors (s.e.), and Sample Sizes Estimated for DMFS in Nuclear Families *

<table>
<thead>
<tr>
<th>Relation</th>
<th>Variables</th>
<th>Expected Correlation</th>
<th>Estimated Correlation (+ s.e.)</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>((P_F, I_F) ) or ((P_M, I_M))</td>
<td>cyiv</td>
<td>.25 + .05</td>
<td>334</td>
</tr>
<tr>
<td></td>
<td>(P_C, I_C)</td>
<td>ic</td>
<td>.32 + .05</td>
<td>332</td>
</tr>
<tr>
<td>Marital</td>
<td>(P_F, P_M)</td>
<td>((cy)^2) (u)</td>
<td>.17 + .07</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td>(I_F, I_M)</td>
<td>((iv)^2) (u)</td>
<td>.32 + .07</td>
<td>182</td>
</tr>
<tr>
<td></td>
<td>((P_F, I_M)) or ((P_M, I_F))</td>
<td>ucyl</td>
<td>.09 + .06</td>
<td>310</td>
</tr>
<tr>
<td>Full-sibs</td>
<td>(P_{C1}, P_{C2})</td>
<td>(h^2/2 + c^2) (@)</td>
<td>.36 + .05</td>
<td>265</td>
</tr>
<tr>
<td></td>
<td>(I_{C1}, I_{C2})</td>
<td>@(i^2)</td>
<td>.37 + .06</td>
<td>233</td>
</tr>
<tr>
<td></td>
<td>(P_{C1}, I_{C2})</td>
<td>(c @i)</td>
<td>.15 + .05</td>
<td>386</td>
</tr>
<tr>
<td>Father-</td>
<td>(P_F, P_C)</td>
<td>(h^2z/2 + c^2y (f_F + u_{f_M}))</td>
<td>.19 + .06</td>
<td>264</td>
</tr>
<tr>
<td>Offspring</td>
<td>(I_F, P_C)</td>
<td>civ ((f_F + u_{f_M}))</td>
<td>.07 + .06</td>
<td>282</td>
</tr>
<tr>
<td></td>
<td>(P_F, I_C)</td>
<td>cyi ((f_F + u_{f_M}))</td>
<td>.12 + .06</td>
<td>273</td>
</tr>
<tr>
<td></td>
<td>(I_F, I_C)</td>
<td>(i^2v) ((f_F + u_{f_M}))</td>
<td>.22 + .06</td>
<td>291</td>
</tr>
<tr>
<td>Mother-</td>
<td>(P_M, P_C)</td>
<td>(h^2z/2 + c^2y (f_M + u_{f_F}))</td>
<td>.29 + .05</td>
<td>280</td>
</tr>
<tr>
<td>Offspring</td>
<td>(I_M, P_C)</td>
<td>civ ((f_M + u_{f_F}))</td>
<td>.20 + .06</td>
<td>282</td>
</tr>
<tr>
<td></td>
<td>(P_M, I_C)</td>
<td>cyi ((f_M + u_{f_F}))</td>
<td>.21 + .06</td>
<td>279</td>
</tr>
<tr>
<td></td>
<td>(I_M, I_C)</td>
<td>(i^2v) ((f_M + u_{f_F}))</td>
<td>.33 + .05</td>
<td>300</td>
</tr>
</tbody>
</table>

* \(P\) = phenotype, \(I\) = index. Subscripts \(F\), \(M\) and \(C\) refer to father, mother and child, respectively. \(C1, C2\) denote sibs. \(@ = b^2 + f_F^2 + f_M^2 + 2u_{f_F}f_M\)
Table 5.2. - Goodness-of-fit $X^2$ Values of Various Hypotheses and the Estimates of Parameters under Various Hypotheses for DMFS ($j = 0$, $w = 1$, $p = 0$, and $m = 0$)

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>LL</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>h</th>
<th>c</th>
<th>y</th>
<th>z</th>
<th>u</th>
<th>$f_F$</th>
<th>$f_M$</th>
<th>b</th>
<th>i</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>706.85</td>
<td>6</td>
<td>2.20</td>
<td>.75</td>
<td>.40</td>
<td>.93</td>
<td>.53</td>
<td>.64</td>
<td>.01</td>
<td>.63</td>
<td>.33</td>
<td>.84</td>
<td>.79</td>
</tr>
<tr>
<td>h = 0</td>
<td>750.51</td>
<td>1</td>
<td>43.66**</td>
<td>(0)</td>
<td>.55</td>
<td>.83</td>
<td>(−)</td>
<td>.64</td>
<td>.00</td>
<td>.86</td>
<td>.22</td>
<td>.59</td>
<td>.95</td>
</tr>
<tr>
<td>c = 0</td>
<td>764.15</td>
<td>1</td>
<td>57.30**</td>
<td>.83</td>
<td>(0)</td>
<td>(−)</td>
<td>.60</td>
<td>.73</td>
<td>.00</td>
<td>.61</td>
<td>.42</td>
<td>.82</td>
<td>.81</td>
</tr>
<tr>
<td>z = 1</td>
<td>714.34</td>
<td>1</td>
<td>7.49**</td>
<td>.58</td>
<td>.43</td>
<td>.84</td>
<td>(1)</td>
<td>.64</td>
<td>.00</td>
<td>.65</td>
<td>.36</td>
<td>.80</td>
<td>.84</td>
</tr>
<tr>
<td>y = 1</td>
<td>706.98</td>
<td>1</td>
<td>.13</td>
<td>.75</td>
<td>.38</td>
<td>(1)</td>
<td>.53</td>
<td>.64</td>
<td>.00</td>
<td>.63</td>
<td>.33</td>
<td>.85</td>
<td>.78</td>
</tr>
<tr>
<td>u = 0</td>
<td>723.08</td>
<td>1</td>
<td>16.23**</td>
<td>.75</td>
<td>.39</td>
<td>1.05</td>
<td>.51</td>
<td>(0)</td>
<td>.23</td>
<td>.60</td>
<td>.26</td>
<td>.84</td>
<td>.72</td>
</tr>
<tr>
<td>b = 0</td>
<td>707.96</td>
<td>1</td>
<td>1.11</td>
<td>.74</td>
<td>.41</td>
<td>.91</td>
<td>.53</td>
<td>.64</td>
<td>.00</td>
<td>.71</td>
<td>(0)</td>
<td>.83</td>
<td>.75</td>
</tr>
<tr>
<td>$f_F = f_M$</td>
<td>711.08</td>
<td>1</td>
<td>4.23*</td>
<td>.75</td>
<td>.37</td>
<td>.92</td>
<td>.53</td>
<td>.60</td>
<td>.30</td>
<td>.30</td>
<td>.43</td>
<td>.86</td>
<td>.81</td>
</tr>
<tr>
<td>$f_F = 0$</td>
<td>706.85</td>
<td>1</td>
<td>.00</td>
<td>.75</td>
<td>.40</td>
<td>.93</td>
<td>.53</td>
<td>.64</td>
<td>(0)</td>
<td>.63</td>
<td>.33</td>
<td>.84</td>
<td>.79</td>
</tr>
<tr>
<td>v = 1</td>
<td>708.76</td>
<td>1</td>
<td>2.13</td>
<td>.73</td>
<td>.41</td>
<td>.83</td>
<td>.54</td>
<td>.51</td>
<td>.12</td>
<td>.52</td>
<td>.46</td>
<td>.78</td>
<td>(1)</td>
</tr>
<tr>
<td>b=0, y=1,</td>
<td>712.92</td>
<td>4</td>
<td>6.07</td>
<td>.73</td>
<td>.41</td>
<td>(1)</td>
<td>.52</td>
<td>.60</td>
<td>(0)</td>
<td>.76</td>
<td>(0)</td>
<td>.71</td>
<td>(1)</td>
</tr>
</tbody>
</table>

The first entry under $X^2$ provides a goodness-of-fit test of the general model with 10 parameters to the 16 correlation estimates. Subsequent entries provide likelihood ratio tests of reduced models, relative to the general model.

* $p < .05$  ** $p < .001$
Table 5.3. - Estimates of Relative Variance Components under the General and Most Parsimonious Hypotheses

<table>
<thead>
<tr>
<th>Source</th>
<th>General Hypothesis</th>
<th>Most Parsimonious Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Children</td>
<td>Adults</td>
</tr>
<tr>
<td>Heritability (G)</td>
<td>.557 ± .105</td>
<td>.159 ± .071</td>
</tr>
<tr>
<td>Cultural (C)</td>
<td>.159 ± .057</td>
<td>.136 ± .051</td>
</tr>
<tr>
<td>Residual Environment (E)</td>
<td>.284 ± .098</td>
<td>.705 ± .082</td>
</tr>
</tbody>
</table>
6.1. INTRODUCTION:

The introduction of path analysis by Wright (1921) and its development for human quantitative genetic analysis by Morton (1974) and Rao and co-workers (1974) permitted the study of the transmissibility of a trait among family members. The family is taken as the unit of analysis and by analysis of the observed correlation among family members, this model attempts to distinguish genetic and cultural components of inheritance from other environmental influences that are not transmitted between generations.

Before proceeding to the discussion of the results obtained with path analysis, the following chapter covers first the measurements used (phenotype and environmental index), followed by a discussion of heritability estimates. A discussion of the model will then be presented.

6.2. MEASUREMENTS:

A more accurate and reliable resolution of different sources of a trait (that is, the contribution of environmental variance, either transmissible or non-transmissible, as well as
the genetic variance) requires more than the observation of phenotypes on each family member of a nuclear family. In addition to phenotype, at least one of these factors - genetic or familial environmental - should be measured. It is clear that the estimation of the family environment is much 'simpler' than an assessment of the genetic composition by molecular biology.

As familial environment is not directly measurable, an estimate is developed - 'environmental index' (I). This 'environmental index' is created from a set of observable and relevant measures of the family environment for a particular phenotype (Morton, 1974).

In the present investigation, the phenotype under study was DMFS scores. The 'environmental index', in turn, comprised sugar consumption and social class. This section of the discussion covers the validity of both variables in the assessment of dental caries experience of family members.

6.2.1. Phenotype: DMFS scores:

The first point to be considered is how well DMFS scores provide an accurate picture of the disease under study: dental caries. It is accepted that DMFS scores are an expression of the amount of successfully treated disease (FS), unsuccessfully treated disease (MS), and untreated disease (DS). DMFS scores, therefore, provide an assessment of the treatment of dental caries an individual has experienced.
One of the criticism of the use of DMFS scores in the assessment of an individual caries experience is that it is being assumed that both missing and filled teeth/surfaces were once carious. However, after a critical age, about 25 years, an increasing proportion of extractions is due to the impact of periodontal disease (Sheiham et al, 1987). In addition a certain proportion of fillings may be preventive rather than restorative, thus inflating the DMFS scores in relation to caries experience. Hence individuals with the same DMFS value score may have quite different patterns of caries experience (Sheiham et al, 1987).

Dentists seem to have been trained in the past on a intervention philosophy. Changes have occurred recently, however, which have caused this philosophy to be challenged. Two developments have emphasised the preventive philosophy: appreciation that the progress of caries through enamel is slow and not inevitable, and the realisation that preventive measures (for example, topical fluoride and reduction in sugar consumption) can arrest or even reverse the carious lesion (Dowell et al, 1983). Nevertheless, despite these recent developments, DMFS scores are considered a measure of past treatment experience and may not be an accurate measure of caries experience.

Treatment variations among dentists are well-recognised (Elderton and Nuttall, 1983; Dowell et al, 1983; Elderton, 1984). Elderton (1984) has shown not only that there is a wide variation among dentists in treatment decisions but also that these decisions were idiosyncratic. These findings led him to
suggest that better criteria for determining treatment needs should be developed.

It has been suggested that paying dentists on a fee-per-item basis encourages them to fill teeth unnecessarily (Gordon, 1982). These findings were confirmed by Elderton and Nuttall (1983), who have shown that dentists who worked within the general dental services (GDS) tended to plan more restorative treatment than the dentists who worked in a dental hospital.

This evidence is based upon British research. In Brasil, the intervention philosophy is widespread because dental care is mainly privately funded and fee-per-item service. Even the state-run dental service is treatment oriented (Pinto, 1983). Therefore, the DMFS scores of the sample under study reflect, in some ways, not only the true account of the disease but also the 'external' interference imposed by dentists and the services they offer.

Despite the shortcomings of the index DMFS, there does not appear to be a better system to assess dental caries as a disease. However, it must be borne in the mind that the DMFS may not be an accurate measure of the disease experience itself.

6.2.2. Environmental Index: Social Class and Sugar Consumption:

In order to distinguish between the genetic and the environmental (either transmissible or non-transmissible) sources of familial resemblance, Morton (1974) introduced the notion of an 'environmental index', which is an estimate of the
familial environment. This index is created from a group of observable and relevant measures ('index variables') of the family environment. The exact choice of the 'index variables' is clearly not an easy task and is closely dependent upon the phenotype under study.

The 'environmental index' is computed for each family member and is constructed by the multiple regression of the phenotype on the 'index variables'. In the present study four 'index variables' were selected to compose the 'environmental index': social class, total sugar consumption, oral hygiene frequency, and pattern of dental attendance. When the age-sex-adjusted DMFS scores were regressed on these four 'index variables' in a stepwise manner, only two of these variables (social class and total sugar consumption) were statistically significant at the 5% level and retained. These two variables explained 8% of the variance in DMFS scores in the population ($r^2 = .080$).

Two problems may arise when using 'environmental indices'. First, an index is not assumed to be a perfect estimator of the family environment. Therefore, it should be questioned what would happen to the results obtained when only a 'partial', that is, not complete, set of 'index variables' is used. Second, it is assumed by the model that the 'index variables' should be a function of the environmental factors only, without being affected by the genotype. Therefore, it should be questioned what would happen if a potential genetic correlation between the phenotype and index is ignored (Karlin et al, 1983).
Both questions have been addressed. When assessing the influence of a genetic correlation between phenotype and 'environmental index', McGue and co-workers (1989) showed that such a correlation resulted in an underestimation of genetic heritability ($G = h^2$) and an overestimation of the cultural heritability ($C = c^2$), with the sum of the two remaining fairly constant. When analysing the consequences of the use of a 'partial' set of pertinent index variables as a measure of the family environment, Rao and Wette (1990) showed that distorted estimates of cultural and genetic heritabilities were obtained. When the same 'partial' indices were used for all family members, it was shown that cultural heritability ($C = c^2$) was underestimated whilst genetic heritability ($G = h^2$) was overestimated, with the sum of the two remaining constant.

When addressing the two controversial points in the use of the 'environmental index' in the present investigation, the assumption that there is little genetic correlation between the phenotype and this index variables seems to be acceptable for the index. Pérusse and co-workers (1988), when studying family resemblance in energy intake (carbohydrate, fat, and protein), showed that non-genetic factors were the major determinants of energy intake in the population under study. Moreover, Garn and co-workers (1979) have shown that family members, either biologically related (parents-offspring, sib-sib) or unrelated (husband-wife) share a common dietary regimen due to sharing a common environment. Based on these results, it seemed reasonable to assume in the present study that the 'environmental index' constructed to represent family environment was not genetically correlated with the phenotype.
When the question of use of 'partial' index is addressed, however, it must be considered that the 'environmental index' used explained only 8% of the variance in the phenotype. When reviewing the literature on path analysis, it was also noticed that none of the studies except two (Lewitter et al, 1984; Pérusse et al, 1989b), mentioned the value of the $r^2$ obtained for the index used.

Pérusse and co-workers (1989b) used 103 'index variables', of which 21 were retained in the index. These variables accounted for 18%, 20%, and 21% of the explained variance for systolic blood pressure, diastolic blood pressure and mean blood pressure, respectively. The authors assumed that the index obtained explained well the traits under study.

Lewitter and co-workers (1984), however, in a study of levels of pulmonary function, obtained an index which explained 6-11% of the variance in adults, but only 1-3% of the variance in children. These results are more similar to the results obtained in the present investigation. These authors, when discussing their results, expressed some concern about the magnitude of the $r^2$ obtained, by putting forward the idea that if the 'environmental index' had explained more of the phenotypic variance, the common familial environment would have been ascribed a higher estimate in their path analyses (Lewitter et al, 1984).

In the present investigation, the results of $r^2$ were very similar to Lewitter and co-workers (1984). Before discussing the consequences of the results obtained from path analysis, it is important to understand the possible reasons for the
magnitude of the $r^2$ from the regression of 'index variables' on the phenotype.

The families participating in the present study formed a very homogeneous group in relation to the factors which are known to influence the dental caries experience of an individual: fluoride availability, oral hygiene status and habits, and sugar consumption.

The sample was drawn from a large industrial city, Belo Horizonte, M.G.. Belo Horizonte has had its water fluoridated since 1975 (COPASA, 1987). The majority of children in the present study were under the age of 14 and were, therefore, brought up in an environment where fluoride is at its optimal level. Those children over 13 years were not exposed to fluoride from birth but had spent most of the lives in contact with fluoride. Hence the homogeneity of exposure to fluorides was a common feature of all these families.

As discussed in Chapter 3 and in Appendix 7, the families under investigation in the present study had very low oral debris and reported a high tooth-brushing frequency. Despite the statistically significant differences among the family members from different social classes, the clinical significance of these differences is highly questionable. The highest mean ODI-S score obtained was 0.80 for mothers from social class D. Such a value is very low, indicating a reasonable oral hygiene status among this sample. Reported tooth-brushing frequency was also very high: most of the family members stated that they brushed their teeth more than once a day. It would be fair to assume, therefore, that these families
were quite homogeneous in relation to oral hygiene status and habits.

Sugar consumption was very high among family members, for example, the children reported a mean intake of 7.9 sugary items within the previous 24 hours (Appendix 7). In spite of the statistically significant differences in sugar consumption among the four social classes which emerged (Chapter 3 and Appendix 7), these families were very homogeneous in relation to the amount of sugar intake. As stated by Varveri and Bellagamba (1986), an individual is considered to be high risk if his/her sugar consumption exceeds 6 sugary items a day. In this study only the parents from social class A reported a sugar consumption of less than 6 sugary items. Therefore, these families can be considered high-risk families due to their high sugar intake.

The pattern of sugar consumption found in the families reflects the high sugar consumption of the Brazilian population. The 'per capita' sugar consumption of the Brazilian population in 1987 was 130g/head/day, that is, approximately 47kg/head/year (Pinto, 1990).

Brazilians are high sugar consumers for various historical, political and economic reasons. In 1500 Portugal took possession of the Brazilian territory and made it its colony. Since then Brasil has been one of the world's leading producers of sugar. The introduction of sugar cane to Brasil is attributed to Martim Affonso de Souza, a navigator who, in 1533, established the first sugar factory in São Vicente, in the state of São Paulo. By 1583 there were nearly 150 factories in Brasil: 66 in the state of Pernambuco, 56 in the
neighbourhood of Olinda, and 36 in the state of Bahia. The annual production then was 5,000 tons (Sreebny, 1982a). At present, Brasil is the second sugar producer in the world (Pinto, 1983), with a production of 8 to 9 million tons in 1987 (Coote, 1987). Most of the industry is privately owned, but is state controlled in respect to production levels, prices and subsidies. It provides direct employment for between 3 to 4 million people although about 40% of these are seasonal workers (Coote, 1987).

The deleterious relationship between sugar (sucrose) and dental health has been well documented and reviewed (Newbrun, 1982; Sreebny, 1982a, 1982b; Rugg-Gunn and Edgar, 1984; White-Graves and Schiller, 1986; Yudkin, 1986; Sheiham, 1987; Cohen, 1989). Yet some studies have failed to show a strong correlation between individual sugar consumption and caries increment (Timjstra, 1981; Rugg-Gunn et al, 1984; Hacket et al, 1984).

Rose's (1985, 1987) observations on the determinants of disease in individual cases and in populations can be directly applied to the epidemiology of dental caries and sugar intake. The ability of a study to determine the risk factors among individuals in a population relies on the distribution of these factors in that particular population. This approach requires heterogeneity of exposure to the causative factor. Therefore, the more widespread a causative factor is, the less it explains the distribution of a disease (Rose, 1985, 1987). Therefore, if everyone is exposed to large amounts of sugar, the distribution of the individual cases becomes wholly determined by individual
susceptibility, and one may come to the wrong conclusion that dental caries is solely a genetically determined disease.

To assess the causes of differences in a disease prevalence amongst populations, the determinants of the population mean must be investigated (Rose, 1985). To determine the reason why certain populations present high levels of dental caries, one should look for those characteristics of the national diet which have so elevated the whole caries distribution.

Both approaches to aetiology, population- and individual-based, have been applied to dental caries. Sreebny (1982b) analysed sugar availability, sugar consumption and dental caries experience of children from 47 nations. A significant positive correlation between the 'per capita' availability of sugar and dental caries experience in 12-year-old children was observed ($r = .72$). Moreover, he also concluded that a sugar consumption level of less than 50g/head/day was associated with three or less attacked teeth, while a consumption of 120g/head/day was associated with six or more attacked teeth. Therefore, he proposed that 50g/head/day (approximately 18kg/head/year) should be taken as a 'safe' limit of sugar consumption.

Sheiham (1983, 1987) has interpreted the data from Japanese studies (Takeuchi, 1962) and shown that the relationship between sucrose consumption and dental caries experience follows a S-shaped dose-response curve. There is a level of sugar consumption (below 10kg/head/year) which is compatible with dental health. Beyond this level caries risk increases sharply, depending on the frequency of sugar
consumption and availability of fluorides. Beyond a certain level of sugar intake (above 35kg/head/year), no further increase in caries experience occurs - the curve flattens out. This is the saturation point in which all the vulnerable tooth sites have been attacked and the decay index cannot increase any further. Therefore, Sheiham (1983) has suggested that the 'safe' sucrose consumption limit should be 30g/head/day (11kg/head/year) in non-fluoridated areas and 50g/day (18kg/head/year) in fluoridated areas.

When extrapolating the findings of the studies by Sreebny (1982b) and Sheiham (1983, 1987) to the Brazilian data available, one can notice that the same pattern can be observed: with a 'per capita' sugar consumption of 130g/head/day (approximately 47kg/head/year) (Pinto, 1990) the Brazilian population has reached the upper limit of the S-shape dose-response curve. This finding is confirmed by the high mean DMFT score of 6.7 for 12-year-old children (Ministério da Saúde, 1988). For Belo Horizonte, a city with fluoridated water, the mean DMFT score for 12-year-old children is still very high: 4.7 (COPASA, 1987). A possible explanation for this is that at high sugar intake levels, prevention has less chance to be effective since the challenge is too strong. Therefore, the benefits from fluoride are low (Sheiham and Joffe, 1991).

The family members participating in the present investigation reported a generally high level of sugar intake. Due to the aspects discussed above, this may have been one of the reasons why the 'environmental index' used in the present investigation explained only 8% of the variance in DMFS scores of these family members.
The consequences of the use of such an index in the determination of intra-family patterns using path analysis are presented in the next section of this discussion.

6.3. HERITABILITY ESTIMATES:

Path analysis of familial resemblance seeks to identify, through the partitioning of the covariance among family members, the genetic and cultural components of inheritance from other environmental sources which are not transmitted between generations.

Heritability estimates, however, are valid only for the population it was derived from and at that particular time (Rao et al, 1975, 1983; Bodmer and Cavalli-Sforza, 1976; Falconer, 1989; Edlin, 1990). The reasons for heritability estimates being applicable to a particular population at a particular point in time are briefly and clearly explained by Falconer (1989). He said:

'... heritability is a property not only of a character but also of the population, of the environmental circumstance to which the individuals are subjected, and the way in which the phenotype is measured. Since the value of heritability depends on the magnitude of all the components of variance, a change in any one of these will affect it. All the genetic components are influenced by genes frequencies and may therefore differ from one population to another... The environmental variance is dependent on the...
conditions of culture or management: more variable conditions reduce heritability; more uniform conditions increase it. And, finally, if the phenotype is the mean of two or more measurements the heritability will differ according to the number of measurements ... So, whenever a value is stated for heritability of a given character it must be understood to refer to a particular population under particular conditions.'

(Falconer, 1989 p.164)

A heritability estimate for a given population should not be seen as a fixed value. Since it is dependent on the magnitude of all the variance components, a change in the environmental factors for example may well lead to a change in the heritability estimate. Moreover, heritability estimates do not imply that a change in environmental conditions will not produce a change in the disease experience (Rao et al, 1975, 1983; Falconer, 1989).

Phenylketonuria (PKU) provides a good example. It is an autosomal recessive trait, in which affected individuals cannot synthesize tyrosine from phenylalanine due to an inactivation of the enzyme phenylalanine hydroxylase. Phenylalanine, which is in part transformed to phenylpyruvic acid and excreted in the urine, accumulates in the brain cells. If enough is accumulated, serious impairment of brain cell metabolism occurs, leading to permanent brain damage. However, if a PKU child has his/her diet controlled, that is, a phenylalanine deficient diet, at an appropriate stage of life, brain damage can be avoided (Cavalli-Sforza and Bodmer, 1971).
Several epidemiological studies on the aetiology of dental caries are also suggestive of how dramatic changes in the environment can alter the dental caries experience of a population, within such a short period of time that a biological explanation (genetics) could not be maintained. The most well-known and extensively documented of such studies were those related to the inhabitants of Tristan da Cunha, an island off the west coast of Africa (Fischer, 1968). In the 1940's Tristan da Cunhans were first introduced to a high sugar diet. Dental caries, which was nearly absent, started to rise. A dramatic increase in caries incidence was observed during their temporary evacuation from the island to Britain by mid-1960's due to a volcanic eruption. The caries prevalence, for example, in first molars of children was reported to have increased from almost none in 1930's to 80% in 1966 (Fischer, 1968). Similarly, Innuits have been reported to have experienced marked increases in caries of both primary and permanent dentitions as a result of the increasing availability of sugar-containing food from stores established in their villages (Bang and Kristoffersen, 1972).

Perhaps the most elegant of the studies on the dramatic changes in caries experience due to changes in the environment come from the war-studies in Japan (Takeuchi, 1960, 1961, 1962; Takahashi, 1961; Koike, 1962; Shimamura, 1974). Japan probably experienced the most marked changes in sugar availability: from pre-war level of 15kg/head/year, sugar availability declined to 0.2kg/head/year by 1946, and only recovered the pre-war time levels in 1952 (Takeuchi, 1960, 1961). Caries experience, as measured by post-eruptive life of each individual tooth-type,
dropped dramatically. Moreover, they were also able to analyse the rate of attack at different sugar levels: rate of attack increased as sugar levels were above 10kg/head/year, and a further increase was detected at levels 15-21kg/head/year (Shimamura, 1974). At sugar availability levels exceeding 35kg/head/year, a saturation point was reached, and the rate of attack was reduced (Takeuchi, 1962).

Takeuchi's findings have received further support from Finland. Alanen and co-workers (1985) observed systematic difference in the number of caries-free premolars and second molars in subjects examined in the 1980's who were born in 1931-1933 (a period when sugar availability was at its lowest levels) as compared to those who were members of younger or older cohorts.

Having considered how dramatic environmental changes lead to almost immediate change in dental caries experience, it is adequate to mention Falconer's theory on liability and threshold characters (Falconer, 1965, 1989). The term liability expresses not only the individuals's innate tendency to develop or contract a disease, but also the whole combination of external circumstances that make him/her more or less likely to develop the disease. The point on the scale of liability above which an individual becomes 'affected' and below which he/she is 'normal' is called a threshold. To develop this theory further, I would quote Falconer's own explanation:

'The clue to understanding the inheritance of such characters lies in the idea that the character has an underlying continuity with a threshold which imposes a discontinuity on the visible expression
... When the underlying variable is below this threshold level the individual has one form of phenotypic expression, e.g. 'normal'; when it is above the threshold the individual has the other phenotypic expression, e.g. 'affected'. The underlying continuous variable has been called liability ... The continuous variation of liability is both genetic and environmental in origin ...'

(Falconer, 1989 p.300)

Based on the evidence on the epidemiology of dental caries mentioned so far, the dental caries experience of an individual fits the liability and threshold model. Below the sugar consumption of 10kg/head/year, little dental caries is observed: only those individuals with a low threshold manifest the disease. As sugar consumption increases, more individuals reach their own threshold and the relationship of sugar and dental caries is clearly established. Above the limit of 35kg/head/year of sugar intake, nearly all the individuals have reached their own threshold and again it becomes difficult to find an association between sugar and dental caries.

The evidence from the present investigation reflects this concept (Table 5.3.). Path analysis assumes that a phenotype can be divided into: genetics (heritability - $G = h^2$), transmitted environment (cultural - $C = c^2$), and non-transmitted environment which is particular to an individual (residual environment - $E$). Intra-family patterns of a trait can be obtained by the summing up of the variances due to heritability and transmitted environment ($G + C$), while the role of the environment can be assessed by the sum of the
transmitted environment and the non-transmitted environment \((C + E)\).

When analysing the variance estimates obtained from the most parsimonious model (Table 5.3.), one sees that strong intra-family patterns in dental caries experience emerged for the children \((G + C = 71\%)\), while for parents, family patterns were somewhat lower \((G + C = 32\%)\). For the children heritability explained 54\% of the variance, and for adults only 15\% of their phenotypic expression could be explained by heritability. The home environment explained, for both children and parents, 17\% of the variance.

The partitioning of the variance obtained in the most parsimonious model (Table 5.3.) shows that for the children the environment \((C + E)\) explained 46\% of the variance, while for adults, 85\% of the phenotypic expression could be accounted for by environmental factors.

For the children, the environment has not had enough time to act and express itself, therefore, the manifestation of the trait (dental caries) was mainly determined by biological factors \((G = 54\%\) of the variance). Those individuals with a lower threshold have experienced different levels of dental caries. For parents, though, the environment has had enough time to manifest itself, the biological component becomes less important \((G = 15\%\) of the variance), since most of the individuals have lived long enough in a 'hostile' environment and above their threshold.

It is important to stress once again the fact that the calculation of heritability estimates depends on the particular environmental conditions the population was living...
under. The fact that the 'environmental index' explained so little of the phenotypic expression \((r^2 = .080)\), may have overestimated the heritability figures and underestimated the role of the family environment, while the sum of the two (intra-family patterns) remains constant. This finding is supported by Rao and Wette (1990). As stated by Lewitter and co-workers, one of the very few researchers to provide the value of its own \(r^2\), 'If the \(r^2\) had been greater, ..., more phenotypic variability would have been ascribed to the common environment in our path analyses' (Lewitter et al, 1984).

It is also important to emphasize once again that the findings of the present investigation fit well into Rose's theory of aetiology of a disease. He said: 'The cause that is universally present has no influence at all on the distribution of a disease, and may be quite unfindable' and 'since everyone is exposed to the necessary external agent then the distribution of cases become wholly determined by the individual susceptibility' (Rose, 1987).

Considering the points raised in this discussion and through the experience gained during the development of the present investigation, future research should compare family members with different sugar consumption levels, and assess, through path analysis, the role of biological and environmental factors in the development of dental caries. Moreover, since the biological and environmental factors seem to manifest themselves differently at different times, it would be also interesting to assess 'temporal trends' in the manifestation of dental caries. Path analytical models have recently been extended to incorporate temporal effects, so that the
influences may be allowed to be a function of time, in such a way that it becomes possible to estimate and test hypotheses about the significance of the temporal variation in biological and environmental effects (Province and Rao, 1985, 1988). In doing so, some light may be shed on the manifestation of dental caries of an individual at different ages.

The next section of the discussion covers the intra-family patterns in dental caries experience. First the correlations obtained through the maximum likelihood method are described. The final section discusses the results from the hypotheses testing of the path analytical model developed.

6.4. INTRA-FAMILY PATTERNS:

6.4.1. Correlations Amongst Family Members:

Path analysis is based on correlation coefficients among family members' phenotype and environment using the maximum likelihood method. This method of computing correlations among dependent individuals surpasses other methods. When having nuclear families as the unit of study, the estimation of correlation coefficients using traditional methods overestimates the value of the correlation coefficient obtained because family members cannot be considered independent samples. With the maximum likelihood method, however, sample sizes are estimated by inverting the asymptotic variance of the correlation estimate. Therefore, the reported sample size of parent-child or siblings correlations should be between the
total number of sibships and total number of children. Hence the coefficients obtained reflect in an unbiased way the correlation among family members (Rao et al, 1982; Sharma et al, 1984). Wette and co-workers (1988) have assessed the validity of this method under variable sibship size. It was shown that the estimates obtained are feasible and reliable, provided the sample size exceed 100 families. Therefore, this method is capable of handling variable sibship size correctly without loss of information.

An examination of the correlations obtained in this study (Table 5.1.) showed a clear pattern of the behaviour and disease within nuclear families. Marital correlations (Table 5.1.) showed that the 'indexed environment' of parents are highly correlated \( (I_F I_M = .32) \), followed by a moderate correlation between parents' phenotype (DMFS) \( (P_F P_M = .17) \). The weakest correlation was observed among the parent's phenotype and spouse's 'indexed environment' \( (P_F I_M = P_M I_F = .09) \).

These results may at first seem inconsistent since one may expect a higher correlation between parent's phenotype and spouse's 'indexed environment'. In fact they seem to confirm the different meaning of the variables being correlated because these variables are measurements of different lifespans. On the one hand, DMFS score is a cumulative expression of an individual's dental caries experience throughout a lifetime. On the other hand, the 'indexed environment' is an expression of a present habit, which may have changed markedly throughout a lifetime (Shaw and Murray, 1980; Tijmstra, 1981). Therefore, if strong correlation coefficients were to be obtained, the 'index environment' should comprise information on the past...
behaviour, which would not be easy and furthermore could be inaccurate (Tijmstra, 1981). Consequently, when a cumulative trait (DMFS) is correlated with the present behaviour ('indexed environment') and with the spouse's present behaviour, the low correlation coefficient obtained is a reflection not only of the different lifespan of the two measurements but also of different life-experiences the spouses have had, and should not be considered inconsistent.

Studies show that the longer spouses shared the same environment, the more their caries experience would converge to a similar value (Ringelberg et al, 1974; Garn et al, 1977). Ringelberg and co-workers (1974), however, were unable to specify the precise reason why this merging of DMFS occurred, but presented a hypothesis of a change in diet after marriage. The findings of the present investigation seem to confirm this view as two present measurements \( \text{I}_\text{F} \text{I}_\text{M} \) were strongly correlated, while two cumulative measures \( \text{P}_\text{F} \text{P}_\text{M} \) showed a moderate correlation.

Parent-offspring correlations were also suggestive of intra-family patterns of dental health status and related behaviours (Table 5.1.). When age-sex-adjusted DMFS scores of children were compared with those of their parents, the highest correlation was observed for mother-offspring \( \text{P}_\text{P} \text{P}_\text{C} = .19; \text{P}_\text{M} \text{P}_\text{C} = .29 \). This same pattern was observed in all the other three types of correlations studied: parent's phenotype and child's environment \( \text{P}_\text{F} \text{I}_\text{C} = .12; \text{P}_\text{M} \text{I}_\text{C} = .21 \), parent's environment and child's phenotype \( \text{I}_\text{F} \text{P}_\text{C} = .07; \text{I}_\text{M} \text{P}_\text{C} = .20 \) and parent's environment and child's environment \( \text{I}_\text{F} \text{I}_\text{C} = .22; \text{I}_\text{M} \text{I}_\text{C} \).
with mother-child correlations showing a stronger association.

These findings are in close agreement with what has been described in the dental literature. Parents and offspring share similar dental health status (Klein, 1946, 1947; Böök and Grahnén, 1953; Martinsson and Petersson, 1972; Ringelberg et al, 1974; Garn et al, 1976a; Shaw and Murray, 1980; Tijmstra, 1981; Roland and Floch, 1986). Parents and children also share similar patterns of behaviour (King, 1976; Garn et al, 1979; Hodge et al, 1982; Honkala et al, 1983). Moreover, an association between parents' habits and their child's dental status has been reported (Shaw and Murray, 1980; Asher et al, 1986), and an association between parents' dental status and child's behaviour have also been found (Hodge et al, 1982).

When comparisons were made between the strength of association which fathers and mothers have with their respective offspring, the association of mother-children was often reported as higher than father-children (Klein, 1946; Ringelberg et al, 1974; Garn et al, 1976a, 1979; Shaw and Murray, 1980; Honkala et al, 1983). This finding supports the role of mothers in industrialised society in the establishment of health practices of their children (Mechanic, 1964; Blinkhorn, 1976; King, 1976; García-Godoy, 1986). In addition, as described in Chapter 3, in the present investigation it was common to find similarities among the dental status among parents and index children. Moreover, both parents and the index children reported that the mothers were the agents controlling dental health related habits at home, when such controls were present.
Full-sibs correlations were also strong and showed the highest values (Table 5.1.). The highest associations were between siblings' 'indexed environment' ($I_{C1}-I_{C2} = .37$) and between phenotypes ($P_{C1}-P_{C2} = .36$). These findings confirm previous studies describing a similar pattern of dental status among children of the same family (Klein and Palmer, 1940; Book and Grahnen, 1953; Ringelberg et al, 1974; Garn et al, 1976b; Shaw and Murray, 1980), and a similar pattern of behaviours amongst siblings, especially in relation to dietary regimen (Garn et al, 1979). The correlation coefficient obtained for dental status of a child and the 'indexed environment' of his/her siblings ($P_{C1}-I_{C2}$) was 0.15, which is in agreement with the finding of an association of dental status of a child and his/her sibling's behaviour reported by Shaw and Murray (1980).

Overall siblings' correlations were always higher when compared with their parents' equivalent correlations. The correlations observed between siblings' 'indexed environment' ($I_{C1}-I_{C2}$) and between siblings' phenotypes ($P_{C1}-P_{C2}$) support the hypothesis that the similarity in siblings' caries experience deserves more than a genetic explanation (Garn et al, 1976b), when siblings' indexed environments were so highly correlated. As Province and Rao (1988) pointed out, siblings tend to resemble each other more than might be expected by virtue of the fact that they share common biological and home environmental factors, and because siblings also share some environment extrinsic to the parental one.
6.4.2. Path Analytic Model:

In this section the results from hypotheses-testing are discussed (Table 5.2.). When assessing the biological and environmental influences on the phenotype (DMFS), both genetic ($h = 0; \chi_1^2 = 43.66; p = .000$) and familial environmental factors ($c = 0; \chi_1^2 = 57.30; p = .000$) were statistically significant. No evidence for intergeneration differences in familial environmental effect ($y = 1; \chi_1^2 = 0.13; p = .70$) was observed, while the genetic effect upon phenotype was statistically greater for the children than parents ($z = 1; \chi_1^2 = 7.49; p = .00$).

As previously described in the discussion of heritability estimates (Section 6.4.), the genetic factor was stronger for the children than for their parents. Dental caries is a trait in which environmental factors are known to play an important role. Since parents and children are being observed at different ages, the measured traits are not the same. Therefore, for the children, the environment has not had enough time to express itself, so the caries experience of the children was mainly determined by the biological inheritance, that is, the children having a lower threshold were more vulnerable and expressed the disease. For the parents, however, environmental factors become more important since the parents have been exposed to these factors for long enough to allow them to manifest themselves.

The familial environmental effect, on the other hand, was similar for parents and their children. This is in close agreement with the studies of Schafer and Keith (1981), who
have shown that food decisions within a family environment are very closely related to its members. Moreover, family members (spouses and parent-offspring) shared similar patterns of eating behaviour not only in relation to caloric and nutrient intake, but also the selection of particular food items or particular sources of calories (Garn et al, 1979). Cohabitational effect was also reported by Perusse and co-workers (1988), who have shown that the food intake and energy intake of 375 French families was mainly determined by the common environmental conditions these family members share.

The assessment of the family environment shared by spouses ($u = 0; \chi_1^2 = 16.23; p = .000$) showed strong marital resemblance, which represented the presence of social homogamy. Social homogamy may be premarital, postmarital or both. The cause of premarital social homogamy is the fact that mates tend to choose each other on the basis of their group membership, that is, due to division by social class, religion, geography, amongst other factors. Postmarital social homogamy may be consequence of cohabitation or observer bias or both (Morton, 1982).

Other studies have confirmed the presence of social homogamy. Furthermore, it has been shown that the correlation between spouses tended to increase as the couples grew older (Klein and Shimizu, 1945; Ringelberg et al, 1974; Garn et al, 1977), which is a strong indication of postmarital social homogamy.

The familial environment of the children can be divided into two components: partly transmitted from parents to children ($f_F, f_N$), and partly non-transmitted common sibship

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environment (b). The latter reflects the environmental similarity of siblings beyond that due to factors transmitted by their parents, that is, through schools, neighbourhood, so on.

In the present investigation, significant evidence was lacking for the sibship environmental effect (b = 0; \( X_1^2 = 1.11; p = .25 \)), indicating that the familial environment was determined by the environment transmitted from parents. When assessing the role of each parent in the transmission of a family environment, mothers played a more decisive role (\( f_F = f_M; X_1^2 = 4.23; p = .05 \) and \( f_F = 0; X_1^2 = .00; p = .90 \)).

This finding is in close agreement with several studies, which directly or indirectly provide evidence of mothers being the strongest determinant of the dental health status of their children (Klein, 1946; Ringelberg et al, 1974; Garn et al, 1976a, 1979; Shaw and Murray, 1980; Honkala et al, 1983). This supports the role that mothers play in our society in the establishment of behaviours within a family (Mechanic, 1964; Blinkhorn, 1976; King, 1976; García-Godoy, 1986).

This study set up to assess the home environment by asking the parents and the index children who would be the person, if any, to control or have control over three habits: sugar consumption, oral hygiene practices, and pattern of dental attendance. While for sugar consumption, most of the family members reported a lack of control; for oral hygiene practices and pattern of dental attendance, mothers were reported to be the person in charge of controlling these behaviours. This agrees with the results obtained from path analysis. Mothers
were the most influential person in the transmission to their offspring of habits.

It is important to stress, however, that in today's society the composition of families is changing as well as the role of women within family life, with more women entering the workforce. This leads to different responsibilities shared among members of today's families. In the future, therefore, the nuclear family and the family in itself may exert a less powerful influence on their children's behaviour (Mullen, 1983; Höllund, 1987).

The families participating in the present investigation were all composed of the biological parents and their children, all living together in the same household. While all the fathers were in paid employment, most of the mothers had no paid work (Appendix 6). This may well be the reason why mothers showed such a strong influence upon their children's family environment. In addition it would be wrong to say that Brazilian families have a more liberal composition. On the contrary, it is patriarchal, with most of the routine family life under the responsibility of the mothers.

The last hypothesis tested was the possible intergenerational differences in the effect of the environment upon the index. No statistical evidence was found for intergenerational differences ($\chi^2 = 21.3; p = .15$). Therefore, one can conclude that the index used for parents and children was a good estimate of the familial environment for both of them.

The most parsimonious model was built using the statistically accepted hypotheses. Therefore, the final model
was built for this group of Brazilian families: no inter-generational differences for cultural heritability and effect of 'environmental index' \((y = 1, v = 1)\), no sibship environmental effect \((b = 0)\), with mothers being the strongest determinant in the transmission of the family environment \((f_F = 0)\).

6.5. CONCLUSIONS:

Strong intra-family patterns in dental caries experience have emerged. For the children 71% of the variance in DMFS scores were explained by family aggregation; and for the parents, family aggregation explained 32% of the phenotypic variance.

While for the children genetic heritability explained over 50% of the variance, the transmitted and non-transmitted environment accounted for 46%. For the parents, however, environmental factors were the strongest determinant of DMFS scores (85%), with genetic heritability explaining 15% of the variance. It is important to remember, however, that estimates of heritability and common environment are valid only to a particular population at a particular point in time, and extrapolation to other populations are not applicable. This is due to the fact that several unknown parameters (for example, genetics and home environment) are estimated from the sample, and these parameters may vary across populations.

The family environment explained 17% of the phenotypic variance of both children and their parents. Social homogamy
for parents was confirmed. For the children, the determination of the family environment depended solely on the parents. Among the two parents, mothers were a stronger determinant than fathers.
7.1. INTRODUCTION:

The present investigation aimed to investigate the pattern of dental health status and behaviours of families from different social classes. It also aimed to assess the intra-family patterns of dental health status and behaviours.

This chapter draws together the final conclusions from the present study. The first section covers the social class differences, and the second section presents the conclusions on the intra-family patterns of dental health status and behaviours.

7.2. THE FAMILIES AND SOCIAL CLASS:

It was at first hypothesized that the dental health status and behaviours of the families would differ according to social class. However, while some statistically significant differences were obtained, the practical significance of some of these is questionable.

Dental caries experience (DMFS scores) was very high among these families. The most striking difference, however, was
observed when the different components (DS, MS, and FS) were analysed separately. Those family members from the 'more privileged' social classes presented more treated disease (FS), while those from the 'less privileged' social classes experienced more untreated disease (DS) and missing surfaces (MS).

Oral hygiene status was very good among all families. The clinical significance of the statistical differences obtained when oral debris scores were assessed according to social class is questionable since the mean ODI-S scores were so low in all social classes.

These families showed a high sugar intake within the previous 24 hours. Sugar availability at home was widespread, and for the children, their own homes provided the main source of sugary items.

The reported tooth-brushing frequency was very high among these families. The majority of family members stated that they brushed their teeth at least once a day. Statistically significant differences were observed according to social class. The clinical significance of such differences, however, is questionable.

The most striking difference in behaviour was related to the pattern of dental attendance. Families from the 'more privileged' social classes were more likely to visit a private dentist, stated seeking dental care for check-ups, and reported having been to a dentist within the previous 24 months. On the other hand, the families from the 'less privileged' were more
likely to seek dental care when in pain, and their children were seen by the school-dentist.

A close analysis of the behaviours described provides an insight to the actual dental health status of these families. Dental caries experience was very high, as was sugar consumption. Oral hygiene status was very good, and tooth-brushing habit was widespread.

The most striking differences were related to the pattern of dental attendance and the components of DMFS scores. The 'more privileged' families, who were wealthy enough to pay for their dental treatment, had a larger number of filled teeth. The 'less privileged' families, who could not afford dental care, showed more decayed and missing surfaces.

These findings are a reflection of the enormous social gap in the Brazilian society. Moreover, they reflect the 'poor' social and medical services offered to the majority of the population. To overcome these social differences, drastic changes must be accomplished in the society. David Locker summarised these changes in a single sentence, he said: 'In this regard inequalities in health are a social and political problem which can only be resolved by fundamental changes in the distribution of income and material resources' (Locker, 1989 p. 55).

7.2. INTRA-FAMILY PATTERNS:

Strong intra-family patterns of dental health experience were observed. For the children family aggregation explained
71% of the phenotypic variance observed. For the parents 32% of the phenotypic variance were attributed to family aggregation.

The assessment of the dental caries experience in children according to the possible sources of phenotypic variance showed that 54% of the variance was due to hereditary causes, and 46% to environmental factors. These, in turn, could be divided into transmitted, which accounted for 17% of the variance, and non-transmitted, which explained 29% of the variance.

For the parents heritability estimates were much lower (15%). Most of the phenotypic variation was explained by environmental factors (85%). The home transmitted environment explained 17% of the variance, while the non-transmitted environment accounted for 68% of the variance.

Heritability estimates, and consequently the environmental influences, differed among parents and children. This finding casts light on the 'liability and threshold model' and dental caries experience. For the children, the environment has not had enough time to express itself, the manifestation of dental caries, therefore, is mainly determined by the biological factors. Moreover, since the environmental factors surrounding these children were fairly homogeneous (fluoridated water, low oral debris scores, high tooth-brushing frequency, high sugar consumption), the biological determinant expresses itself more strongly (Rose, 1985, 1987).

For the parents, the environmental factors have had enough time to manifest themselves, and the biological determinant becomes less important. This is particularly true in this
population, since most of the individuals have lived long enough in a 'hostile' environment above their threshold.

It is important to bear in mind two important points when heritability estimates are discussed. First, the heritability estimate obtained for a population is valid only for the population it was derived from and at that particular point in time. Therefore, a heritability estimate should not be extrapolated to other populations. Second, a heritability estimate for a given population should not be seen as a fixed value. Since estimates are dependent on the magnitude of all the variance of the components, a change in the environmental conditions for example may well lead to a change in heritability estimate.

The transmitted environment, which reflects the familial environmental effect, explained 17% of the phenotypic variance of parents and children. The family environment shared by spouses revealed strong marital resemblance, which represented the presence of social homogamy. For the children, the determination of the family environment was solely on the parents. Among the parents, mothers were the strongest determinant of the familial environment.

In the present study the family emerged as a strong determinant of the dental health status and behaviours of an individual. Environmental factors were of particular importance, especially in adults, in the determination of dental caries experience. Therefore, if changes in dental caries experience are to occur, they must be first introduced into the family life. Families, however, are one of the units that form our society. Hence if changes within the family life
are to prevail, the social conditions these families live under should be the first major improvement for a better health status.


*The abbreviations of journals used follow the specifications of:

ALKIRE, L.G., Jr. (1986). Periodical Title Abbreviations: by Abbreviations. Volume 1. 5ed., Detroit, Gale Research Co.


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APPENDICES
1. INTRODUCTION:

Designing a questionnaire is a complex and time-consuming task. For this reason a valid and reliable questionnaire that already exists may be considered as at least a starting point. However, one must bear in mind that the information provided by a questionnaire constructed elsewhere might not be applicable to all societies. Besides, every language has its particular meanings regarding the phrasing of questions, and an apparently identical question in a different language might lead to a completely different perception, by the interviewee, of what is being asked. Therefore, when using a questionnaire, this must be carefully developed and tested in the population under study. Such an approach was used in the development of the questionnaires used in this present investigation.

This appendix describes the development of the questionnaires used in this current study. First, the development of the identification will be discussed. The questionnaires used in the interviews for parents, 13-year-old child and siblings (aged 10 or more) will then be described, following this respective order.
In Appendix 2, all the questionnaires used as well as their English translations are presented.

2. DEVELOPMENT OF THE IDENTIFICATION QUESTIONNAIRE:

A short and simple questionnaire was designed to collect the information needed for selecting, contacting and allocating the families in the social class groups. This questionnaire was distributed to every 13-year-old at the randomly selected schools. It was taken home by the child with a request to be answered at home by one of the parents.

The questions designed to select the participants were related to the three criteria for participating in the study: marital status (biological father and biological mother living together), father's economic position (father in paid job), and parental age (35-44 years). Besides, information on other family members living in that household as well as their age and kinship was gathered.

Home address and telephone number were collected in order to allow for the future contact with the selected families.

For the purpose of socially allocating families, all the questions used in the ABA-ABIPEME (1978) questionnaire were included (Appendix 4).

The validation of the ABA-ABIPEME (1978) social class criteria was obtained during the first interview with the families, when a question on father's income was asked. This
question was based on the criteria of socio-economic classification used by IBGE (1986).

3. DEVELOPMENT OF THE PARENTS' QUESTIONNAIRE:

This questionnaire aimed to collect information on dietary habits, oral hygiene and pattern of dental attendance. There were two main areas of interest: the first gathered information on the parent's habits and knowledge, while the second focused on the transmission of these habits to their children.

The development of this questionnaire extended over a period of one year. The process initially involved a review of the literature and a selection of relevant material from other oral health studies. Following this review, some questions were selected and a semi-structured questionnaire was developed. The questions were then translated into Portuguese and tested on a Brazilian sample during the pilot study.

When piloting the questionnaire in Brasil, the first objective was to check the applicability of the questions to the Brazilian society as well as to different social classes. The questions were selected from studies carried out on sectors of the British and American societies (Bagramian, 1969; Gray et al, 1970; King, 1976; Hodge, 1979; Freeman, 1984; Bateman, 1985; Croucher and Rodgers, 1985; Silver, 1985; Hendricks, 1986), which would not reflect the Brazilian society, especially the 'less privileged' social class.

The second objective of the pilot study was to assess question-wording and question-sequence. Since questions were
translated into Portuguese and were used in different social classes, the wording of the questions should be clear and meaningful to all respondents. Question-sequence was assessed in order to make the questionnaire attractive and interesting to the participants. Each question-sequence started with a series of factual questions on the respondent's own habits, followed by some attitudinal questions and, finally, by some questions on the home environment.

The third and last objective was to check if the questions used were adequate for the measurement of the variables this study set out to evaluate. Validity of the questions was assessed by a succession of sets of questions, each set containing the variables under study, and by the use of cross-check questions.

The questionnaire was modified in the light of the respondents' replies and reactions to the questions. No changes were made in the sequencing or wording of questions.

The major change involved the elimination of the questions following the method for questionnaire design developed by Fishbein and Ajzen (1975). At first, it was planned to assess knowledge and beliefs using the framework of Fishbein's Theory of Reasoned Action (Fishbein and Ajzen, 1975). However, it was noticed that the respondents, especially those from the 'less privileged' social classes, had difficulties in understanding the instructions and answering the questions. Moreover, when cross-checking these questions with open-ended questions, it was observed that the answers did not correspond since most of the participants tended to answer positively to all questions presented. It was then decided to precode the open-ended
questions, designed at first as cross-checks, and to use them in the assessment of knowledge and beliefs.

From the pilot study, it was concluded that the questions used were applicable to the Brazilian population. The respondents were able to understand the wording of questions and all of them showed a clear interest and co-operation throughout the interview. In relation to the validation of the questionnaire, the questions proved to be adequate in measuring the variables under study.

The following sections will describe the methodology used for the collection of information on the variables under study.

3.1. Dietary Habits:

In recent years there has been an increasing interest in the study of the effects of diet on health/disease. In spite of an extensive literature on methods of dietary assessment (Young and Trulson, 1960; Pekkarinen, 1970; Block, 1982; Bingham, 1987; Willet, 1990), there is still uncertainty about the validity of existing methods and, therefore, about the results obtained from them.

The most commonly used methods of dietary assessment are: history method; 24-hour recall method; 7-day recall method; 3-, 5- or 7-day record method, food-weighing and a number of other methods called 'short-cut' methods (Block, 1982; Bingham, 1987; Willet, 1990). More recently more advanced methods have been developed such as the biological markers of food consumption (Bingham, 1987).
Assessment of the different methods is a notoriously difficult procedure. Systematic differences in results obtained from one method of dietary assessment compared to another are often reported. This is due to the fact that the most commonly used methods rely on individuals giving accurate and truthful reports of their food consumption. Therefore, no method can be said to be indisputably valid in routine use (Bingham, 1987).

The choice of a particular method is largely dependent on the purpose of the study, the item being measured, the resources (financial and others) available, the practicability of the use of a given method in a given population, and the type of population being investigated (whether free-living or institutionalised; whether young or old; whether literate or not).

In this present investigation the 24-hour recall method was used to evaluate dietary habits. The main reasons for selecting this method were: the purpose of the study and logistic reasons. This study aimed to analyse the pattern of sugar consumption among family members and to relate this pattern of sugar consumption with caries experience. Therefore, rather than focussing on precise and accurate numbers of milligrams of nutrients, it was more important to place individuals into broad categories along the distribution of intake. For this purpose a single 24-hour recall gives a fairly good estimation of the food intake in a group of individuals, provided the sample is large, even if the individual variation is wide (Young and Trulson, 1960; Pekkarinen, 1970; Greger and Etnyre, 1978; Persson and Carlgren, 1984; Fanelli and Stevenhagen, 1986). Some studies (Madden et al, 1976; Persson
and Carlgren, 1984; Bull and Wheeler, 1986), however, showed that the 24-hour recall method tends to underestimate the dietary intake when compared to other methods - weighed record, food purchase record, dietary history and 7-day record.

One of the main criticisms of one 24-hour recall lies on the fact that this method of dietary assessment does not take into account day-to-day variation or seasonal variations (Young and Trulson, 1960; Block, 1982; Bingham, 1987; Witschi, 1990). For dental caries and other chronic diseases, however, if one wishes to assess accurately the relationship between diet and disease, a longitudinal study is recommended. Such an approach was far from the scope of this present investigation and, therefore, a 24-hour recall was considered adequate. In addition, most people tend to have a quite regular pattern of sugar consumption (Yudkin and Roddy, 1966).

Among the logistic reasons for selecting this method, it is worth mentioning the following three reasons. First, the 24-hour recall may be administered by persons with less training, in a shorter time (Block, 1982; Persson and Carlgren, 1984; Witschi, 1990). Second, it is the method of choice for populations with limited literacy (Witschi, 1990), and it can be confidently used for young children and adolescents (Emmons and Hayes, 1973; Greger and Etnyre, 1978; Persson and Carlgren, 1984). Third, the lack of extra resources for the supervision of more sophisticated methods of assessment of dietary habits and for several home visits indicated the use of the 24-hour recall method.

From the point of view of capacity for an individual to recall his/her food intake, the 24-hour recall has in its
favour the fact that memory of recent intake may be more precise and quantities may be estimated with greater accuracy (Block, 1982). However, there seems to be some concern over the accuracy an individual can recall his/her food intake. To this end, Witschi (1990) has suggested the use of probing questions and checklists of easily forgotten foods.

This aspect has been subject of concern in this study. In an attempt to help participants recall their food intake on the previous 24 hours, a checklist of items (adapted from Bagramian, 1969) was used. During the interview, after collecting the 24-hour dietary recall, this author read the items included in the list aloud. The respondent would then specify if the item was eaten, when it was eaten, and the quantity eaten. During the pilot study, the 24-hour recall was tested with and without this checklist. It was observed that the use of a checklist helped the respondent give a more accurate picture of what had been eaten during the previous 24 hours.

3.2. Oral Hygiene and Dental Attendance Habits:

The assessment of oral hygiene and dental attendance habits was based on commonly used questions.

The oral hygiene habits assessed were tooth-brushing habits, use of dental floss, and type of toothpaste. Questions on tooth-brushing habits focused on brushing frequency and brushing times (Gray et al, 1970; Silver, 1985). Respondents were also questioned on their dental flossing habits (Cushing,
1986) and type of toothpaste used (Silver, 1985; Cushing, 1986).

Type of dentist, last visit to the dentist and pattern of dental attendance were selected to assess the dental attendance habits. The options to the type of dentist were adapted to the Brazilian context, being formed by the groups: private, public sector (schools and NHS), third-party co-payment, and military services.

When evaluating the last visit to the dentist, respondents were asked how long ago they had visited a dentist and the reason for the visit. Finally, respondents were questioned on the frequency of going to the dentist (Gray et al, 1970; Cushing, 1986).

3.3. Knowledge and Beliefs:

Knowledge and beliefs regarding sugar consumption, oral hygiene habits and dental attendance were assessed with the use of open-ended questions. In order to avoid any bias in the estimation of habits, these questions were always asked after the evaluation of the habit under questioning had been made.

These questions were precoded accordingly to the answers obtained during the pilot study. Field coding was the technique used for recording the answers given. Besides, if an answer could not be categorised in the precoded options, a space was left for the writing up of such an answer. At the end of the field work, when the data were entered into the personal computer, this author coded all such answers.
3.4. Transmission of Habits:

The purpose of this section was to evaluate the home environment in relation to the three dental behaviours. There were two objectives for developing this section of this questionnaire. The first objective was to find out who was the person in charge of introducing and controlling the execution of these behaviours. The second objective was to assess if the person in charge of the execution of these habits within the family environment would be the one who would most strongly influence the transmission of such habits to the offspring.

Habits were evaluated through a set of five questions, adapted from two authors (King, 1976; Hodge, 1979). Two questions focused on the introduction of the habit. Respondents were asked about the child's age when the habit was first incorporated into the child's life and about the person responsible for the introduction of the habit (King, 1976). The first question was used as an introductory question, while the second was used in the data analysis.

Two questions focused on finding out who was the person in charge of controlling or reminding the child to perform the habit (Hodge, 1979). Two points in time were evaluated: the present time and in the past when the child was younger.

The fifth and last question in this section assessed who would be the person most concerned within the family environment about the execution of the three dental habits.
4. DEVELOPMENT OF THE 13-YEAR-OLD CHILD'S QUESTIONNAIRE:

The aim of this questionnaire was to gather information on dietary habits, oral hygiene and pattern of dental attendance of the index child. There were two areas of interest. The first collected information on the index child's habits, knowledge and beliefs; while the second focused on the acquisition of these habits by the child.

Considering that one of the objectives of this study was to compare behaviours of a child with those of his/her parents, similar questions were asked to the child. Therefore, this questionnaire was based on the Parents' Questionnaire described above. Its development and testing followed the same steps already described. Here only the differences between these two questionnaires will be described.

4.1. Dietary Habits:

The 24-hour recall method was used to assess the dietary habits of the index child. This method has been shown to provide fairly accurate estimates of food intake on the previous 24 hours as reported by young children and adolescents (Emmons and Hayes, 1973; Greger and Etnyre, 1978; Persson and Carlsgren, 1984). In addition, a checklist of easily forgotten food items was read to the child as an attempt to remind him/her of food intake consumed in the previous 24 hours (Witschi, 1990).
In order to determine the origin of sugary items consumed, the index child was prompted if the sugary item mentioned was 'got at home', 'given to the child', or 'bought by the child' (Croucher and Rodgers, 1985).

4.2. Oral Hygiene and Dental Attendance Habits:

The evaluation of oral hygiene and dental attendance habits was based on commonly used questions in the dental literature. The index child was asked the same questions posed to his/her parents.

4.3. Knowledge and Beliefs:

Questions on knowledge and beliefs held by the index child in relation to sugar consumption, oral hygiene habits and dental attendance followed what was previously described for Parents' Questionnaire.

4.4. Acquisition of Habits:

The objective of this section was to assess the home environment in relation to the three dental behaviours under study. As described for the Parents' Questionnaire, the main idea was to find out who would be the person in charge of controlling the execution of these behaviours by the index child and to evaluate if the person in charge of the
performance of these habits would be the one to most strongly influence the pattern observed in the index child.

Differently from the parents, and for obvious reasons, the index child was asked neither about the age of incorporation of the habit in his/her life nor about the person to introduce these habits into his/her life.

5. DEVELOPMENT OF THE QUESTIONNAIRE FOR SIBLINGS' (AGED 10+):

The aim of this questionnaire was to collect information of the dietary habits, oral hygiene and pattern of dental attendance of all siblings aged 10 years or more. The development and testing of this questionnaire followed the same steps described for the Parents' Questionnaire and 13-year-old Child's Questionnaire.

This questionnaire used the same questions described for the 13-year-old child. The only difference was the omission of those questions on knowledge and acquisition of habits.
This appendix contains the questionnaires used for the collection of data relevant to this study. The original questionnaire, in Portuguese, is presented first, followed by its translation into English. The following questionnaires are included here:

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<th>Questionnaire</th>
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<td>7. Siblings' Questionnaire (Original)</td>
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<td>8. Siblings' Questionnaire (Translation)</td>
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SENHORES PAIS

Os Professores da Faculdade de Odontologia, Wagner Segura Marcenes e Isabela Almeida Pordeus, estão elaborando um projeto de pesquisa sobre prevenção das doenças da boca, cuja aplicação trará grandes benefícios à saúde bucal da população de Belo Horizonte. Como início deste trabalho, serão colhidas algumas informações básicas para a seleção de 500 famílias, que representem a população como um todo. Estamos lhes enviando um questionário, pedindo que seja respondido por um dos pais e devolvido à escola de seu/sua filho/filha o mais breve possível.

As doenças bucais mais comuns, cárie dentária e doença periodontal (gengiva) podem ser evitadas. Alguns fatores exercem grande influência sobre o aparecimento destas doenças e, sua identificação é extremamente importante para elaboração de programas preventivos. Portanto, sua colaboração será fundamental para o êxito desta pesquisa e melhoria das condições de saúde bucal de sua família, assim como de toda a população de Belo Horizonte.

Desde já, agradecemos sua colaboração.

Wagner Segura Marcenes & Isabela Almeida Pordeus
INFORMAÇÕES GERAIS:
Nome do pai ou da mãe: ..............................................................
Data de nascimento: .../.../.....  Estado civil .....................

ENDERECO RESIDENCIAL:
Rua ............................................................... Número.....
Apto ....  Bairro ............................... Telefone ............

FAMÍLIA:
Por favor, escreva no quadro abaixo o nome, o grau de parentesco
(exemplo: marido, esposa, companheiro, companheira, filho,
filha, irmão, tia, etc) e a idade das pessoas que moram em sua
casa.

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PROFISSÃO:
Por favor, responda as seguintes perguntas relacionadas ao
trabalho em sua família.

Qual a profissão do pai? ...............................  
Ele está empregado ou trabalhando atualmente?
  a) sim
  b) não
NIVEL EDUCACIONAL:

Qual é o seu nível educacional? (marido)
   a) não sabe ler nem escrever
   b) sabe ler e escrever
   c) escola primária (4 anos)
   d) ginásio (8 anos)
   e) científico
   f) universidade
   g) pós-graduação

Qual é o seu nível educacional? (esposa)
   a) não sabe ler nem escrever
   b) sabe ler e escrever
   c) escola primária (4 anos)
   d) ginásio (8 anos)
   e) científico
   f) universidade
   g) pós-graduação

Finalmente, você poderia responder a estas perguntas?

Quantas televisões você tem na sua casa? .......
   e radios? .......
   e banheiros? .......
   e carros? .......
   e empregadas? .......
   e aspiradores de pó? .......
   e máquinas de lavar? .......

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Dear Parents,

The researchers, Wagner Segura Marcenes and Isabela Almeida Pordeus, are developing a research project on the prevention of oral diseases. As a start to this project, some basic information is being collected for the selection of families to compose a sample representing the population of Belo Horizonte as a whole.

The most common oral diseases, tooth decay and gum diseases, can be prevented. Some factors show a marked influence over the establishment of such diseases. The identification of such factors is crucial to the development of preventive programmes. Therefore, your participation is essential to the success of this project and to the improvement of the oral health status of your family as well as of the population of Belo Horizonte as a whole.

Please find enclose a questionnaire to be filled in by one of the parents and returned to the school.

We would like to thank you in advance.

Yours sincerely,

Wagner Segura Marcenes & Isabela Almeida Pordeus
GENERAL INFORMATION:

Name (father or mother) ..................................................

Date of birth ....../....../..... Marital status.............

RESIDENTIAL ADDRESS:

..........................................................................

FAMILY: Please, write the name, kinship, and age of those living in your house.

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OCCUPATION: Please, answer the following questions related to the occupation of the head of the family.

What is the father's occupation? ..........................

Is he working or employed?

a) yes  
b) no
EDUCATIONAL LEVEL:

What is your educational level? (husband)

a) none (cannot read or write)
b) none (can read and write)
c) primary school (4 years)
d) primary school (8 years)
e) secondary school
f) University
g) Post-graduation

What is your educational level? (wife)

a) none (cannot read or write)
b) none (can read and write)
c) primary school (4 years)
d) primary school (8 years)
e) secondary school
f) University
g) Post-graduation

Finally, would you please answer the following questions?

How many T.V. sets have you got at home? ..... 
And radios? ..... 
And bathrooms? ..... 
And motocars? ..... 
And maids? ..... 
And vacuum cleaners? ..... 
And washing machines? ..... 

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Durante este questionário, serão discutidos assuntos diretamente relacionados com a saúde da sua boca, por exemplo: escovar os dentes, ir ao dentista e alimentação. Como você já deve ter notado, os dentistas parecem ter diferentes opiniões a respeito do melhor modo para manter a sua boca saudável – dentes e gengiva. Para que possamos chegar a um acordo e muito importante que se saiba o que as pessoas estão fazendo para cuidar de seus dentes e gengiva.

E esta pesquisa é exatamente sobre isto! Deste modo, eu gostaria de fazer algumas perguntas a respeito desses 3 hábitos: alguns alimentos que você come, a escovação de seus dentes e ir ao seu dentista.

Eu gostaria de lembrar que NÃO existe uma resposta certa ou errada. O que importa é que você responda a TODAS as perguntas tentando lembrar o que você realmente faz.

É importante dizer também que todas as respostas são de caráter CONFIDENCIAL. Sua identificação só sera conhecida pelo entrevistador.
ETIOLOGIA DAS DOENÇAS BUCALIS

1. A carie dentária é uma doença que ataca e destroia seus dentes. Ela geralmente inicia como uma mancha branca e, nos estágios mais avançados, pode-se observar uma grande destruição do dente frequentemente acompanhada por dor. Existe muita discussão em relação às suas causas. Para você, quais seriam as causas da carie dentária?

   a. escovacao
   b. ingestão de alimentos acucarados
   c. microorganismos
   d. falta de ir ao dentista
   e. outro (especifique)
   f. não sei

2. O que pode ser feito para evitar a carie dentária?

   a. escovar os dentes
   b. diminuir a ingestão de alimentos acucarados
   c. ir ao dentista
   d. não pode ser evitada
   e. outro (especifique)
   f. não sei


   a. sim, meu dentista
   b. sim, minha mãe
   c. sim, meu pai
   d. sim, meus pais
   e. sim, um/a amigo/a
   f. sim, minha professora
   g. sim, outro (especifique)
   h. não

4. Você já conversou com _____ sobre o que pode ser feito para evitar a carie dentária?

   a. sim
   b. não
   c. não me lembro
5. A doença periodontal - conhecida por alguns por piorreia - é uma doença que ataca e destroem a gengiva e o osso que seguram os dentes. As pessoas que apresentam esta doença queixam de sangramento da gengiva ao escovarem os dentes e, nos casos mais avançados, a gengiva pode estar inflamada e os dentes podem se tornar abalados (bambos). Existe muita discussão a respeito de suas causas. Para você, quais seriam as causas desta doença?

a. escovacao
b. falta de ir ao dentista
c. ingestao de alimentos acucarados
d. outro (especifique)
e. nao sei

6. Para você, o que poderia ser feito para evitar esta doença?

a. ir ao dentista
b. escovar os dentes
c. evitar alimentos acucarados
d. outro (especifique)
e. nao sei


a. sim, meu dentista
b. sim, minha mãe
c. sim, meu pai
d. sim, meus pais
e. sim, um/a amigo/a
f. sim, meu professor
g. sim, outro (especifique)
h. não

8. Você já conversou com _____ sobre o que pode ser feito para evitar esta doença?

a. sim
b. não
c. não me lembro
ALIMENTAÇÃO

9. Agora eu gostaria de fazer algumas perguntas a respeito dos hábitos alimentares na sua família: Eu gostaria de te fazer algumas perguntas sobre o que você comeu e bebeu ontem.

PROBE: alimentos que contenham açúcar, forma dos alimentos.

DIA DA SEMANA: ____________________

CAFE DA MANHA: ____________________

______________________________

ALMOÇO: ____________________

______________________________

JANTAR: ____________________

______________________________

10. Você comeu ou bebeu algum alimento ENTRE AS REFEIÇÕES?

PROBE: horário (manhã, tarde e noite), alimentos acucarados, quantos e quantas vezes, forma dos alimentos.

MANHÃ: ____________________

______________________________

TARDE: ____________________

______________________________

NOITE: ____________________

______________________________

11. Você comeu ou bebeu algum desses itens ontem entre as refeições? NOS CASOS AFIRMATIVOS, PROBE: quando, quantos e quantas vezes.

chicletes - ____________________

______________________________

balas/drops - ____________________

______________________________

chocolate/bombom - ____________________

______________________________

biscoito doce/salgado - ____________________

______________________________

bolo/torta/doce - ____________________

______________________________

sorvete/picole/chup-chup - ____________________

______________________________

pão doce/sal - ____________________

______________________________

fruta - ____________________

______________________________

queijo - ____________________

______________________________

leite com/sem acúcar - ____________________

______________________________

chocolate (Nescau, Toddy, etc) - ____________________

______________________________

refrigerante - ____________________

______________________________

sucos de fruta com/sem acúcar - ____________________

______________________________

café com/sem acúcar - ____________________

______________________________

cha com/sem acúcar - ____________________

______________________________
12. Os hábitos de uma pessoa podem mudar de uma época para outra. Em algumas fases, alguns podem aumentar a quantidade de doces e açúcar que comem, enquanto que outros podem resolver diminuir a quantidade desses. E você? Você sempre comeu esta quantidade de doces e açúcar?

a. sim, ingerindo a mesma quantidade de sempre (va p/ q.15)
b. não, ingerindo maior quantidade agora
c. não, ingerindo menor quantidade agora

(SE A OU B FOR SELECIONADO,)

13 - desde quando você mudou? _________________________

14 - porque você decidiu mudar? _________________________

OPINIÕES (ALIMENTAÇÃO)

Existe bastante discussão a respeito da relação entre alimentos e saúde. Enquanto que algumas pessoas acreditam que o que você come exerce uma influência direta sobre a saúde, outras acham que não existe nenhuma relação.

15. Eu gostaria de discutir com você sobre alimentos que contêm açúcar e a saúde das pessoas. Você vê algum motivo pelo qual você deveria evitar alimentos que contêm açúcar?

a. sim
b. não (va para questão 17)
c. não sei

16. CASO AFIRMATIVO, você poderia me dizer porque?

a. problema de sangue (diabete)
b. dentes
c. engordar
d. verme
e. espinhas e cravos
f. rins
g. coração
h. outro (especifique)
17. Você acredita que exista algum motivo pelo qual você deveria comer açúcar?

a. sim
b. não (va para questão 19)
c. não sei

18. CASO AFIRMATIVO, você poderia me dizer porque?

a. gostoso
b. sustenta o sangue (energia)
c. outro (especifique)

CONSUMO DE ALIMENTOS ACUCARADOS - CONTROLE PELOS PAIS


a. sim, mãe
b. sim, pai
c. sim, ambos
d. sim, outro (especifique)
e. não, ninguém

20. E quando _____ era mais jovem, vamos dizer, lá pelos seus 2-3 anos? Existia algum controle sobre o consumo de alimentos acucarados por _____? SE AFIRMATIVO, quem.

a. sim, mãe
b. sim, pai
c. sim, ambos
d. sim, outro (especifique)
e. não, ninguém

21. Existe uma grande variação de quando uma criança é introduzida, pela primeira vez, a um alimento que contenha açúcar. Você saberia me dizer que idade que _____ tinha na primeira vez que ela/ele teve o primeiro contato com um alimento que contivesse açúcar? _________________________________________

22. Quem decidiu que esta seria uma boa idade para que _____ começasse a comer alimentos doces?

a. mãe
b. pai
c. ambos
d. pediatra
e. outro (especifique)
f. não me lembro
23. Em uma família as pessoas apresenta diferentes níveis de preocupação sobre alimentação. Quem seria a pessoa, em sua família, mais preocupada se está ingerindo alimentos que contêm açúcar?

a. mãe
b. pai
c. ambos
d. ninguém
e. outro (especifique)
f. não sei

HIGIENE BUCAL

Eu agora gostaria de fazer algumas perguntas sobre o hábito de escovar os dentes na sua família.

Escovar os dentes talvez pareça ser algo simples, entretanto existe muita discussão a seu respeito, por exemplo, frequência, horário, métodos e técnicas.

24. Enquanto que algumas pessoas escovam os dentes depois de cada refeição, outras escovam com menor frequência, digamos, nem todos os dias. Você poderia me dizer a frequência com que você escova os seus dentes? ____________________________

25. A que horas do dia você normalmente escova os seus dentes?

a. ao acordar
b. após café da manhã
c. após almoço
d. após jantar
e. ao se deitar
f. outro (especifique)

26. As pessoas têm motivos diferentes para escovar os dentes. Quais seriam os motivos pelos quais você escova os seus dentes?

a. evita a carie
b. aparência: dentes bonitos
c. higiene, limpeza, higiene
d. aparência: limpeza
e. halito
f. evitar problemas de gengiva
g. evitar ter que ir ao dentista
h. outro (especifique)
i. não sei

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27. Algumas pessoas usam fio dental, outras não. E você? Você usa fio dental?
   a. sim, sempre/quase sempre
   b. sim, raras vezes
   c. não

28. CASO AFIRMATIVO, porque você usa fio dental?
   a. para limpar entre os dentes
   b. para tirar alimentos entre os dentes
   c. costume
   d. outro (especifique)
   e. não sei

28. CASO NEGATIVO, porque você não usa fio dental?
   a. falta de hábito
   b. não tem tempo
   c. não gosta
   d. não foi orientado/desconhece
   e. não ve importância
   f. não tem em casa
   g. outro (especifique)
   h. não sei

29. Qual a pasta de dente que você normalmente usa?
   a. contendo fluor
   b. não contendo fluor
   c. não uso
   d. não sei/nao me lembro

30. Porque você usa esta pasta de dente?
   a. preço
   b. hábito
   c. gosto
   d. combate a carie por ter fluor
   e. limpa melhor
   f. mais conhecido
   g. sem motivo
   h. outro (especifique)
Eu gostaria de fazer algumas perguntas a respeito do hábito de escovar dentes de _______. Como você verá, algumas perguntas serão a respeito do que ela/ele fazia quando criança, enquanto que outras serão sobre o que ______ está fazendo atualmente. Vamos começar pelo que ______ está fazendo atualmente?

   a. sim, a mãe lembra
   b. sim, o pai lembra
   c. sim, pai e mãe lembram
   d. sim, outro (especifique)
   e. não precisa ser lembrado/a
   f. não sei

Eu gostaria de te fazer algumas perguntas a respeito de quando ______ era mais nova/o.

32. Existe uma grande variação na época em que os dentes de uma criança começam a ser limpos. Algumas vezes, os pais começam a limpar a boca de seus filhos antes mesmo dos dentes nascerem. Outras vezes, eles podem esperar um pouco mais até que a criança esteja um pouco maior. E ______? Com que idade seus dentes começaram a ser limpos? _______________________________

33. Quem decidiu que esta seria a época para que os dentes de ______ começassem a ser escovados?
   a. mãe
   b. pai
   c. ambos
   d. outro (especifique)
   f. não sei/nao me lembro

34. Quando ______ começou a escovar os dentes sozinho, vamos dizer ela pelos seus 6-7 anos, precisava que alguém o/a lembresse de escovar os seus dentes? CASO AFIRMATIVO, quem.
   a. sim, a mãe lembra
   b. sim, o pai lembra
   c. sim, ambos lembravam
   d. sim, outro (especifique)
   e. não precisava de ser lembrado/a
   f. não sei/nao me lembro

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35. Em uma família, as pessoas podem ter diferentes graus de preocupação se as crianças escovaram os dentes. Quem, na sua família, seria mais preocupado com isto?

a. mãe
b. pai
c. ambos
d. outro (especifique)
e. ninguém
f. não sei

---

ATENDIMENTO ODONTOLOGICO

Finalmente, eu gostaria de te fazer algumas perguntas a respeito de ir ao dentista.

36. Você já foi ao dentista?

a. sim
b. não (va para questão 42)

---

CASO AFIRMATIVO,

37. Qual o tipo de dentista que você normalmente vai?

38. Quando foi a última vez que você foi ao dentista?

a. em tratamento no momento
b. há menos de 6 meses
c. há 7-12 meses
d. há 12-24 meses
e. há mais de 24 meses
f. não me lembro

39. Qual foi o motivo pelo qual você procurou o seu dentista desta última vez que você esteve lá?

a. dor
b. extrair dente
c. para tratar dos dentes
d. revisão
e. fazer limpeza, aplicar flúor, etc.
f. dentista mandou lembrar
g. outro (especifique)
40. As pessoas vão ao dentista por diversos motivos. Enquanto que alguns vão somente quando tem dor, outros vão regularmente para uma revisão. Qual seria o motivo mais frequente pelo qual você vai ao dentista?

a. na maioria, para revisões
b. na maioria, para tratamento
c. não vou
(dar para q.42)
d. não sei

41. Se revisões, qual a frequência com que você vai?

a. a cada 6 meses
b. uma vez por ano
c. uma vez a cada dois anos
d. com menor frequência
e. não vou
f. não sei/ não lembro

42. As pessoas têm diferentes motivos pelo quais elas acham importante ir ao dentista regularmente. Quais seriam as vantagens em ir ao dentista regularmente?

a. ver se precisa de tratamento (revisão)
b. consertar os dentes (manter dentes na boca)
c. tratar das caries no seu início/evitar dor
d. econômico
e. executar procedimentos preventivos: limpeza, fluor, escovação
f. ter dentes bonitos
g. extrair dentes
h. evitar a carie
i. evitar a doença periodontal
j. evitar dor
k. não ve motivo para fazê-lo
l. outro (especifique)
m. não sei
ATENDIMENTO ODONTOLOGICO - CRIANCA pelos PAIS

As proximas perguntas que eu gostaria de fazer serao ainda a respeito de ir ao dentista so que em relacao a ____.

43. Primeiro, eu gostaria de saber se ____ ja foi ao dentista.
   a. sim
   b. nao (va para questao 53)
   c. nao sei

 CASO AFIRMATIVO,

44. Quando foi a ultima vez que ____ foi ao dentista?
   a. sob tratamento no momento
   b. ha 6 meses
   c. ha 7-12 meses
   d. ha 13-24 meses'
   e. ha mais de 24 meses
   f. nao sei

45. Qual o motivo que ____ vai ao dentista? Seria mais para revisoes ou quando tem algum problema?
   a. na maioria, para revisoes
   b. na maioria, quando com algum problema (va p/q.47)
   c. nao sei

46. SE REVISÕES, qual e a frequencia com que ____ vai ao dentista?
   a. a cada 6 meses
   b. uma vez ao ano
   c. uma vez a cada 2 anos
   d. com menor frequencia
   e. nao sei

47. A decisao sobre quando uma crianca deve ir ao dentista pode variar bastante de uma familia para outra. Enquanto que em algumas, a propra crianca pede para ir, em outras, o dentista envia um lembrete. E na sua familia? Quem decide quando ____ deve ir ao dentista?
   a. ela/ele mesma/o
   b. mae
   c. pai
   d. ambos
   e. outro (especifique)
   f. nao sei
48. Quem seria a pessoa, em sua casa, mais preocupada se ___ esta indo ao dentista?
   a. mae
   b. pai
   c. ambos
   d. outro (especifique)
   e. ninguem
   f. nao sei

AGORA EU GOSTARIA DE FAZER ALGUMAS PERGUNTAS A RESPEITO DE QUANDO ___ ERA MAIS NOVA/O.

49. Qual a idade que ___ tinha na primeira vez que ela/ele foi ao dentista? _________________________________

50. Teve algum motivo especial que voce se lembre pelo qual ___ precisou de ir? ________________________________

51. Quem achou que seria uma boa ideia leva-la/o ao dentista nesta idade?
   a. mae
   b. pai
   c. ambos
   d. outro (especifique)
   e. nao sei/nao me lembro

52. A partir de entao, quem decidia quando ___ deveria ir ao dentista?
   a. mae
   b. pai
   c. ambos
   d. dentista enviava um lembrete
   e. professora
   f. outro (especifique, por favor)
   g. nao me lembro
Para finalizar, eu gostaria de fazer algumas perguntas sobre a sua família.

IDENTIFICACAO DOS PAIS

PAI:

53. Que curso o seu pai concluiu?
   
   a. nenhum ( não sabe ler nem escrever)
   b. nenhum ( sabe ler e escrever)
   c. grupo escolar
   d. ginasio
   e. segundo grau ( científico, normal ou tecnico)
   f. superior (universidade)
   g. pos-graduacao (especializacao, mestrado, doutorado)

54. Qual a profissao do seu pai? __________________________

MAE:

55. Que curso o sua maé concluiu?
   
   a. nenhum ( não sabe ler nem escrever)
   b. nenhum ( sabe ler e escrever)
   c. grupo escolar
   d. ginasio
   e. segundo grau ( científico, normal ou tecnico)
   f. superior (universidade)
   g. pos-graduacao (especializacao, mestrado, doutorado)

56. Qual a profissao da sua maé? __________________________

57. Ha quanto tempo voce mora em Belo Horizonte? __________

58. Ha quanto tempo ____ mora em Belo Horizonte? __________

MUITO OBRIGADA PELA SUA COLABORACAO!
The following questionnaire will deal with your oral health habits, for example: eating, tooth cleaning and going to the dentist. As you may have realised, dentists do not seem to agree on what is the best way to keep your mouth healthy. In order to come to an agreement, knowledge on what people are actually doing becomes of great importance.

This is what this research is all about. Therefore I would like to ask you some questions on your eating, tooth cleaning habits as well as on your going to the dentist.

I would like to stress that this is NOT a test. Therefore there is no right or wrong answer. Answering ALL the questions accurately is what really matters.

It is also important to remind you that all the answers are CONFIDENTIAL. Your identification will only be known by the interviewer.

Shall we start?
AETIOLOGY OF ORAL DISEASES

First I would like to ask you a few questions on the causes of two most common oral diseases: tooth decay and gum disease.

1. Tooth decay is the major disease affecting the tooth itself. One of its first signs is generally a white spot on the tooth surface. If the disease progresses, you may see a cavity on the tooth surface which, in more advanced cases, is commonly accompanied by toothache. There is much debate on the causes of tooth decay. For you what causes tooth decay?
   a. lack of brushing
   b. ingestion of sugary food
   c. microorganisms
   d. not going to the dentist
   e. other (specify)
   f. don’t know

2. What can be done in order to avoid tooth decay?
   a. brush the teeth
   b. avoid sugary food
   c. go to the dentist
   d. cannot be avoided
   e. other (specify)
   f. don’t know

3. Has anyone ever explained to you what can be done to prevent tooth decay? IF YES, who
   a. yes, my dentist
   b. yes, my mother
   c. yes, my father
   d. yes, my parents
   e. yes, a friend of mine
   f. yes, a teacher of mine
   g. yes, other (specify)
   h. no

4. Have you ever talked to _____ about what can be done to prevent tooth decay?
   a. yes
   b. no
   c. cannot remember
5. Periodontal (gum) disease affects the gum and bone supporting the teeth. The condition begins as an inflammation of the gums with redness, swelling and bleeding on brushing. This may lead, in more advanced cases, to the loosening and finally loss of the tooth. There is much debate on the causes of gum disease. What causes gum disease for you?

   a. lack of brushing
   b. not going to the dentist
   c. ingestion of sugary food
   d. other (specify)
   e. don’t know

6. What can be done in order to prevent gum disease?

   a. go to the dentist
   b. brush the teeth
   c. avoid sugary food
   d. other (specify)
   e. don’t know

7. Has anyone ever explained to you what can be done to prevent gum disease? IF YES, who.

   a. yes, my dentist
   b. yes, my mother
   c. yes, my father
   d. yes, my parents
   e. yes, a friend of mine
   f. yes, a teacher of mine
   g. yes, other (specify)
   h. no

8. Have you ever talked to _____ about what can be done to prevent gum disease?

   a. yes
   b. no
   c. cannot remember
9. I would like to ask you a few questions on eating habits within your family now. I will start with what you ate and drank yesterday. Please tell me what you ate and drank at the main meals yesterday.

PROBE: sugary food and its form.

DAY OF THE WEEK: __________________________

BREAKFAST: __________________________________________________________

LUNCH: ______________________________________________________________

DINNER: ______________________________________________________________

10. Please tell me what you ate and drank in between the main meals yesterday.

MORNING: ____________________________________________________________

AFTERNOON: __________________________________________________________

NIGHT: ________________________________________________________________

11. Did you eat or drink any of the following items yesterday? IF YES, probe: when and how many.

chewing gum - _________________________________________________________

sweets/toffees - ________________________________________________________

chocolate - ____________________________________________________________

crackers - _____________________________________________________________

sweet biscuits - ________________________________________________________

cakes/buns - __________________________________________________________

ice cream/iced lollies - _________________________________________________

bread - ______________________________________________________________

fresh fruit - __________________________________________________________

cheese - ______________________________________________________________

milk with/without sugar - ______________________________________________

chocolate drinks - _____________________________________________________

soft drink - __________________________________________________________

fruit juice with/without sugar - __________________________________________

coffee with/without sugar - _____________________________________________

tea with/without sugar - ______________________________________________
12. Food habits may change from time to time. While we may sometimes eat more of one type of food, we may also eat less of one type of food at other times. Would you say you have always eaten the amount of sugary food you now eat?
   a. yes, I have always eaten this amount (go to question 15)
   b. no, I am eating more
   c. no, I am eating less

IF B or C IS CHOSEN,

13. When did you change?

14. Why did you decide to change?
17. Do you see reasons why we should eat sugary food?
   a. yes
   b. no
   c. don't know

   (go to question 19)

   IF YES,

18. Could you tell me why?
   a. taste
   b. good for the blood (energy)
   c. other (specify)

CHILD SUGAR CONSUMPTION - CONTROL BY PARENTS:

19. Some parents seem to control the amount of sweet-tasting food their children eat while others do not control it. What about your family? Is there any control of the amount of sugary food ____ eats nowadays? IF YES, ask who.
   a. yes, the mother controls it
   b. yes, the father controls it
   c. yes, both parents control it
   d. yes, other controls it (specify)
   e. no, there is none

20. When ____ was younger, let's say, by the age of 2-3, would there be any control over the amount of sugary food she/he would eat? IF YES, ask who.
   a. yes, the mother controlled it
   b. yes, the father controlled it
   c. yes, both parents controlled it
   d. yes, other controlled it (specify)
   e. no, there was none

21. Children tend to start eating sweet tasting food at different ages. Could you tell how old ____ was when she/he first tasted sugary food or drink? ___________________________
22. Who first gave _____ her/his first sweet-tasting food or drink?
   a. mother
   b. father
   c. both parents
   d. pediatrician
   e. other (specify)
   f. cannot remember

23. Within a family people seem to have different levels of concern about different issues. Who would you say is the person in your family who is most concerned about the amount of sugary food ____ eats?
   a. mother
   b. father
   c. both parents
   d. nobody
   e. other (specify)
   f. don't know

ORAL HYGIENE

Now I would like to ask you a few questions on tooth cleansing behaviour within your family.

Toothbrushing may seem to be quite a simple procedure. However, there is much debate going on about it, for example: its frequency, techniques and methods.

24. While some people brush their teeth after each meal, others do it less often such as not every day. And you? How often do you usually clean your teeth? ______________________________

25. At what time of the day do you usually clean your teeth?
   a. before breakfast
   b. after breakfast
   c. after lunch
   d. after dinner
   e. before going to bed
   f. other (specify)
26. People seem to have different reasons for brushing their teeth. Which would be your reasons for cleaning your teeth?

a. to avoid tooth decay
b. appearance: beautiful teeth
c. cleanliness, hygiene
d. appearance: cleanliness
e. to have good breath
f. to avoid gum problems
g. to avoid going to the dentist
h. other (specify)
i. don’t know

27. Some people use dental floss while others don’t. What about you? Do you floss your teeth?

a. yes, every day/almost every day
b. yes, seldom
c. no

28. IF YES, why do you use dental floss?

a. to clean in between the teeth
b. to remove food stuck in between the teeth
c. habit
d. other (specify)
e. don’t know

28. IF NO, why don’t you use dental floss?

a. not used to it
b. do not have time
c. do not like it
d. do not know it
e. see no reason why should do it
f. do not have at home
g. other (specify)
h. don’t know

29. What brand of toothpaste do you use?

a. with fluoride
b. without fluoride
c. don’t use
d. don’t know/cannot remember
30. Why do you use this one?
   a. price  
   b. habit  
   c. taste  
   d. avoids tooth decay because of fluoride  
   e. cleans teeth better  
   f. most known  
   g. no reasons  
   h. other (specify)

CHILD ORAL HYGIENE BY PARENT:

I would like to ask you a few questions on _____'s tooth cleansing behaviour. As you shall see some questions will be about what he/she used to do when younger, while others will be about what he/she is doing now. Shall we start with what ____ is doing nowadays?

31. Some children have to be reminded to brush their teeth while others do not need so. What about ____? Does anyone have to remind her/him to brush the teeth? IF YES, by whom.
   a. yes, mother does  
   b. yes, father does  
   c. yes, both parents do  
   d. yes, other does (specify)  
   e. no, does not need to be reminded  
   f. don’t know

Now I would like to ask some questions about when ____ was younger.

32. Children tend to start having their teeth brushed at different ages. Some parents start cleansing their children’s mouth before the teeth come out, others may wait until the child is older. What about ____? At what age did she/he start having the teeth cleaned? __________________________

33. Who decided the age at which ____ should start having the teeth cleaned?
   a. mother  
   b. father  
   c. both parents  
   d. other (specify)  
   e. don’t know/cannot remember
34. Once ____ was older and brushed the teeth on her/his own, let's say, by the age of 6-7, would anyone remind her/him to brush the teeth? IF YES, who.

   a. yes, mother would
   b. yes, father would
   c. yes, both parents would
   d. yes, other would (specify)
   e. no need to be remembered
   f. don’t know/cannot remember

35. Within a family people tend to have different levels of concern about children cleaning their teeth. Who in your family would be more concerned about ____ cleaning her/his teeth?

   a. mother
   b. father
   c. both parents
   d. other (specify)
   e. nobody
   f. don’t know

PATTERN OF DENTAL ATTENDANCE

I would like to ask you some questions about going to the dentist now.

PARENTAL PATTERN OF ATTENDANCE:

36. Have you ever been to the dentist?

   a. yes
   b. no (go to question 42)

   /--------------------------------------------------------------------------/
   IF YES,
   |
   |
   37. What kind of service do you usually use? (e.g. private, public) ________________________________
   |
   |
   38. When did you last go to the dentist?

   a. under treatment at present
   b. within 6 months
   c. within 7-12 months
   d. within 13-24 months
   e. over 24 months
   f. can’t remember

   /--------------------------------------------------------------------------/
39. This last course of treatment, why did you initially go to the dentist?
   a. pain
   b. tooth extraction
   c. for treatment
   d. for check up
   e. for preventive procedures: polishing, fluoride, etc)
   f. dentist sent a reminder
   g. other (specify)

40. People have different patterns of going to the dentist. Some go mainly for check ups while others mainly when in trouble. What about you? What is your usual pattern of going to the dentist?
   a. check ups mainly
   b. in trouble mainly
   c. no longer go (go to question 42)
   d. don't know

41. IF CHECK UPS, how often do you usually go?
   a. every 6 months
   b. once a year
   c. once every 2 years
   d. less often
   e. don't go
   f. don't know/cannot remember

42. People give different reasons for going to the dentist regularly. Are there any reasons you can think of why you should go to the dentist regularly?
   a. check ups
   b. keep teeth healthy
   c. treat early tooth decay
   d. more economic
   e. for preventive procedures: polishing, fluoride, check brushing, etc
   f. have beautiful teeth
   g. extract tooth
   h. avoid tooth decay
   i. avoid gum disease
   j. avoid pain
   k. see no reason in doing that
   l. other (specify)
   m. don't know
CHILD'S PATTERN OF ATTENDANCE BY THE PARENT:

I would like to talk to you about ____'s going to the dentist.

43. I would like to start by asking you if ____ has ever been to the dentist.
   a. yes
   b. no
   c. don't know

   (go to question 55)

IF YES,

44. When did ____ last go to the dentist?
   a. under treatment at present
   b. within 6 months
   c. within 7-12 months
   d. within 13-24 months
   e. over 24 months
   f. don't know

45. What is ____'s usual pattern of going to the dentist?
   Is it mainly for check ups or mainly when in trouble?
   a. check ups mainly
   b. in trouble mainly
   c. don't know

   (go to question 47)

46. IF CHECK UPS, how often does she/he go?
   a. every 6 months
   b. every year
   c. every 2 years
   d. less often
   e. don't know

47. Deciding when a child should go to the dentist varies between families. While in some families the child may ask to go, in others the dentist may send a reminder. And in your family? Who decides when ____ should go to dentist?
   a. she herself/ he himself
   b. mother
   c. father
   d. both parents
   e. other (specify)
   f. don't know
48. Within a family people may have different levels of concern if the children are going to the dentist. Who would be more concerned if ___ is not going to the dentist?
   a. mother
   b. father
   c. both parents
   d. other (specify)
   e. nobody
   f. don't know

I WOULD LIKE TO ASK YOU A FEW QUESTIONS ON ____'S GOING WHEN SHE/HE WAS YOUNGER.

49. At what age did ___ first go to the dentist? ______

50. Was there any special reason you may recall why ___ went to the dentist at this particular age? ______

51. Whose decision was it that ___ should go to the dentist?
   a. mother
   b. father
   c. both parents
   d. other (specify)
   e. don't know

52. From then on, throughout childhood, who would decide when ___ should go to the dentist?
   a. mother
   b. father
   c. both parents
   d. dentist would send a reminder
   e. teacher
   f. other (specify)
   g. don't know/cannot remember
FAMILY IDENTIFICATION

Finally I would like to ask you a few questions on your family.

FATHER:

53. What educational qualifications does your father have?
   a. none (cannot read or write)
   b. none (can read and write)
   c. primary school
   d. secondary school
   e. high school
   f. first degree
   g. higher degree (specialisation, MSc, PhD, etc.)

54. What is/was your father's occupation? ____________________________

MOTHER:

55. What educational qualifications does your mother have?
   a. none (cannot read or write)
   b. none (can read and write)
   c. primary school
   d. secondary school
   e. high school
   f. first degree
   g. higher degree (specialisation, MSc, PhD, etc.)

56. What is/was your mother's occupation? ____________________________

57. How long have you lived in Belo Horizonte? ________________

58. How long has ____ lived in Belo Horizonte? ________________

THANK YOU VERY MUCH FOR YOUR COLLABORATION!
As perguntas que eu gostaria de te fazer agora estão mais relacionadas com a saúde da sua boca, por exemplo: escovar os seus dentes, ir ao seu dentista e o que você gosta de comer.

É muito importante, para os dentistas, que saibamos o que você, como um adolescente, faz e pensa em relação a esses 3 hábitos.

Eu gostaria de te lembrar que NÃO se trata de um teste e, portanto, NÃO existe uma resposta certa ou errada. Eu simplesmente gostaria que você respondesse a TODAS as perguntas dizendo o que você realmente faz e pensa.

É importante dizer ainda que todas as respostas são de caráter CONFIDENCIAL. Sua identificação só será conhecida pelo entrevistador.
ETIOLOGIA DAS DOENÇAS BUCAIS

1. A carie dentaria é uma doença que ataca e destroem seus dentes. Ela geralmente inicia como uma mancha branca e, nos estágios mais avançados, pode-se observar uma grande destruição do dente frequentemente acompanhada por dor. Existe muita discussão em relação às suas causas. Para você, quais seriam as causas da carie dentaria?

   a. escovacao
   b. ingestao de alimentos acucarados
   c. microorganismos
   d. falta de ir ao dentista
   e. outro (especifique)
   f. nao sei

2. O que pode ser feito para evitar a carie dentaria?

   a. escovar os dentes
   b. diminuir a ingestão de alimentos acucarados
   c. ir ao dentista
   d. nao pode ser evitada
   e. outro (especifique)
   f. nao sei


   a. sim, meu dentista
   b. sim, minha mãe
   c. sim, meu pai
   d. sim, meus pais
   e. sim, um/a amigo/a
   f. sim, minha professora
   g. sim, outro (especifique)
   h. nao

4. Algum de seus pais já conversou com você sobre o que fazer para evitar a carie dentaria? CASO AFIRMATIVO, qual deles.

   a. sim, minha mãe
   b. sim, meu pai
   c. sim, ambos
   d. nao, nenhum deles
   e. nao me lembro
5. A doença periodontal — conhecida por alguns por piorreia — é uma doença que ataca e destroea a gengiva e o osso que seguram os dentes. As pessoas que apresentam esta doença queixam de sangramento da gengiva ao escovarem os dentes e, nos casos mais avançados, a gengiva pode estar inflamada e os dentes podem se tornar abalados (bambos). Existe muita discussão a respeito de suas causas. Para você, quais seriam as causas desta doença?

   a. escovação
   b. falta de ir ao dentista
   c. ingestão de alimentos acucarados
   d. outro (especifique)
   e. não sei

6. Para você, o que poderia ser feito para evitar esta doença?

   a. ir ao dentista
   b. escovar os dentes
   c. evitar alimentos acucarados
   d. outro (especifique)
   e. não sei


   a. sim, meu dentista
   b. sim, minha mãe
   c. sim, meu pai
   d. sim, meus pais
   e. sim, um/a amigo/a
   f. sim, meu professor
   g. sim, outro (especifique)
   h. não


   a. sim, minha mãe
   b. sim, meu pai
   c. sim, ambos
   d. não, nenhum deles
   e. não me lembro
ALIMENTAÇÃO

9. Agora eu gostaria de fazer algumas perguntas a respeito dos hábitos alimentares na sua família: Eu gostaria de te fazer algumas perguntas sobre o que você comeu e bebeu ontem.

PROBE: alimentos que contenham açúcar, forma dos alimentos, se foi dado a ele/ela, se foi comprado por ele/ela, se foi pego em casa.

DIA DA SEMANA: ___________________

CAFE DA MANHA: ____________________________________________________________

ALMOÇO: ____________________________________________________________

JANTAR: ____________________________________________________________

10. Você comeu ou bebeu algum alimento ENTRE AS REFEIÇÕES?

PROBE: horário (manhã, tarde e noite), alimentos acucarados, quantos e quantas vezes, forma dos alimentos, se foi dado a ele/ela, se foi comprado por ele/ela, se foi pego em casa.

MANHA: ____________________________________________________________

TARDE: ____________________________________________________________

NOITE: ____________________________________________________________

11. Você comeu ou bebeu algum desses itens ontem entre as refeições? NOS CASOS AFIRMATIVOS, PROBE: quando, quantos e quantas vezes, se foi dado a ele/ela, se foi comprado por ele/ela, se foi pego em casa.

chicletes - ____________________________________________________________
balas/drops - __________________________________________________________
chocolate/ bombom - __________________________________________________
Biscoito doce/salgado - ________________________________________________
bolo/torta/doce - _____________________________________________________
sorvete/picole/chup-chup - ____________________________________________
pão doce/sal - _______________________________________________________
fruta - ______________________________________________________________
queijo - ______________________________________________________________
leite com/sem açúcar - ________________________________________________
chocolate (Nescau, Toddy, etc) - ________________________________________
refrigerante - _________________________________________________________
suco de fruta com/sem açúcar - ________________________________________
café com/sem açúcar - ________________________________________________
cha com/sem açúcar - _________________________________________________
OPINIOES (ALIMENTACAO)

Existe bastante discussão a respeito da relação entre alimentos e saúde. Enquanto que algumas pessoas acreditam que o que você come exerce uma influência direta sobre a saúde, outras achem que não existe nenhuma relação.

12. Eu gostaria de discutir com você sobre alimentos que contenham açúcar e a saúde das pessoas. Você ve algum motivo pelo qual você deveria evitar alimentos que contenham açúcar?

   a. sim  
   b. não  
   c. não sei

13. CASO AFIRMATIVO, você poderia me dizer porque?

   a. problema de sangue (diabete)  
   b. dentes  
   c. engordar  
   d. verme  
   e. espinhas e cravos  
   f. rins  
   g. coração  
   h. outro (especifique)

14. Você acredita que exista algum motivo pelo qual você deveria comer açúcar?

   a. sim  
   b. não  
   c. não sei

15. CASO AFIRMATIVO, você poderia me dizer porque?

   a. gostoso  
   b. sustenta o sangue (energia)  
   c. outro (especifique)  
   d. não sei
CONSUMO DE ALIMENTOS ACUCARADOS – CONTROLE PELOS PAIS


a. sim, minha mãe
b. sim, meu pai
c. sim, ambos
d. sim, outro (especifique)
e. não, ninguém
f. não sei

17. Em uma família as pessoas apresentam diferentes níveis de preocupação sobre alimentação. Quem seria a pessoa, em sua família, mais preocupada se você está ingerindo alimentos que contêm açúcar?

a. mãe
b. pai
c. ambos
d. ninguém
e. outro (especifique)
f. não sei

HIGIENE BUCAL

Eu agora gostaria de fazer algumas perguntas sobre o hábito de escovar os dentes na sua família.

Escovar os dentes talvez pareça ser algo simples, entretanto existe muita discussão a seu respeito, por exemplo, frequência, horário, métodos e técnicas.

18. Enquanto que algumas pessoas escovam os dentes depois de cada refeição, outras escovam com menor frequência, digamos, nem todos os dias. Você poderia me dizer a frequência com que você escova os seus dentes?

19. A que horas do dia você normalmente escova os seus dentes?

a. ao acordar
b. após café da manhã
c. após almoço
d. após jantar
e. ao se deitar
f. outro (especifique)
20. As pessoas tem motivos diferentes para escovar os dentes. Quais seriam os motivos pelos quais você escova os seus dentes? Por favor, coloque-os em ordem de importância.

a. evita a carie
b. aparência: dentes bonitos
c. asseio, limpeza, higiene
d. aparência: limpeza
e. halito
f. evitar problemas de gengiva
g. evitar ter que ir ao dentista
h. outro (especifique)
i. não sei


a. sim, sempre/quase sempre
b. sim, raras vezes
c. não

22. CASO AFIRMATIVO, porque você usa fio dental?

a. para limpar entre os dentes
b. para tirar alimentos entre os dentes
c. costume
d. outro (especifique)
e. não sei

22. CASO NEGATIVO, porque você não usa fio dental?

a. falta de hábito
b. não tem tempo
c. não gosta
d. não foi orientado/desconhece
e. não ve importância
f. não tem em casa
g. outro (específique)
h. não sei

23. Qual a pasta de dente que você normalmente usa?

a. contendo fluor
b. não contendo fluor
c. não uso
d. não sei/nao me lembro
24. Porque você usa esta pasta de dente?

a. preço
b. hábito
c. gosto
d. combate a carie por ter fluor
e. limpa melhor
f. mais conhecido
g. mãe compra
h. pai compra
i. pais compram
j. sem motivo
k. outro (especifique)

HIGIENE BUCAL - HABITOS - CONTROLE PELOS PAIS

25. Algumas pessoas mais velhas gostam de lembrar as mais novas que devem escovar os dentes, outras já não fazem isto. Tem alguém que está sempre te lembrando que você deve escovar os dentes? CASO AFIRMATIVO, quem.

a. sim, minha mãe lembra
b. sim, meu pai lembra
c. sim, meu pai e minha mãe lembram
d. sim, outro (especifique)
e. não, ninguém me lembra
f. não sei

26. Em uma família, as pessoas podem ter diferentes graus de preocupação se as crianças escovaram os dentes. Quem, na sua família, seria mais preocupado com isto?

a. mãe
b. pai
c. ambos
d. outro (especifique)
e. ninguém
f. não sei
ATENDIMENTO ODONTOLOGICO

Finalmente, eu gostaria de te fazer algumas perguntas a respeito de ir ao dentista.

27. Você já foi ao dentista?
   a. sim
   b. não (va para questão 33)

Caso afirmativo,

28. Qual o tipo de dentista que você normalmente vai?

29. Quando foi a última vez que você foi ao dentista?
   a. em tratamento no momento
   b. há menos de 6 meses
   c. há 7-12 meses
   d. há 12-24 meses
   e. há mais de 24 meses
   f. não me lembro

30. Qual foi o motivo pelo qual você procurou o seu dentista desta última vez que você esteve lá?
   a. dor
   b. extrair dente
   c. para tratar dos dentes
   d. revisão
   e. fazer limpeza, aplicar fluor, etc.
   f. dentista mandou lembrar
   g. outro (especifique)

31. As pessoas vão ao dentista por diversos motivos. Enquanto que alguns vão somente quando tem dor, outros vão regularmente para uma revisão. Qual seria o motivo mais frequente pelo qual você vai ao dentista?
   a. na maioria, para revisões
   b. na maioria, para tratamento
   c. não vou (va para q.33)
   d. não sei

32. Se revisões, qual a frequência com que você vai?
   a. a cada 6 meses
   b. uma vez por ano
   c. uma vez a cada dois anos
   d. com menor frequência
   e. não vou
   f. não sei/nao lembro

-329-
33. As pessoas tem diferentes motivos pelo quais elas acham importante ir ao dentista regularmente. Quais seriam as vantagens em ir ao dentista regularmente?

a. ver se precisa de tratamento (revisão)
b. conservar os dentes (manter dentes na boca)
c. tratar das caries no seu inicio/evitar dor
d. economico
e. executar procedimentos preventivos: limpeza, fluor, escovacao
f. ter dentes bonitos
g. extrair dentes
h. evitar a carie
i. evitar a doença periodontal
j. evitar dor
k. nao ve motivo para fazer-lo
l. outro (especificite)
m. nao sei

ATENDIMENTO ODONTOLOGICO - CONTROLE PELOS PAIS

34. A decisão sobre quando os filhos devem ir ao dentista pode variar bastante de uma família para outra. Enquanto que em algumas, o próprio filho pede para ir, em outras, o dentista envia um lembrete. E na sua família? Quem decide quando você deve ir ao dentista?

a. ela/ele mesma/o
b. mae
c. pai
d. ambos
e. outro (especificite)
f. nao sei

35. Quem seria a pessoa, em sua casa, mais preocupada se você esta indo ao dentista?

a. mae
b. pai
c. ambos
d. outro (especificite)
e. ninguem
f. nao sei

MUITO OBRIGADA PELA SUA COLABORACAO!
The questions I am going to ask you are about your oral health habits, for example: eating, toothcleaning and going to the dentist. It is very important to know what you as a teenager think about these things.

I want to stress that this is in no way a test, and there is no right or wrong answer. We want to know what you really think and do.

So please feel free to say anything you like and what you yourself really think.

It is also important to remind you that all the answers are CONFIDENTIAL. Your identification will only be known by the interviewer.

Shall we start?
AETIOLOGY OF ORAL DISEASES

1. Tooth decay is the major disease affecting the tooth itself. One of its first signs is generally a white spot on the tooth surface. If the disease progresses, you may see a cavity on the tooth surface which, in more advanced cases, is commonly accompanied by toothache. There is much debate on the causes of tooth decay. For you what causes tooth decay?
   a. lack of brushing
   b. ingestion of sugary food
   c. microorganisms
   d. not going to the dentist
   e. other (specify)
   f. don’t know

2. What can be done in order to avoid tooth decay?
   a. brush the teeth
   b. avoid sugary food
   c. go to the dentist
   d. cannot be avoided
   e. other (specify)
   f. don’t know

3. Has anyone ever explained to you what can be done to prevent tooth decay? IF YES, who.
   a. yes, my dentist
   b. yes, my mother
   c. yes, my father
   d. yes, my parents
   e. yes, a friend of mine
   f. yes, a teacher of mine
   g. yes, other (specify)
   h. no

4. Has any of your parents ever talked to you about what can be done to prevent tooth decay? IF YES, which one of them.
   a. yes, my mother
   b. yes, my father
   c. yes, both of them
   d. no, none of them
   e. cannot remember
5. Periodontal (gum) disease affects the gum and bone supporting the teeth. The condition begins as an inflammation of the gums with redness, swelling and bleeding on brushing. This may lead, in more advanced cases, to the loosening and finally loss of the tooth. There is much debate on the causes of gum disease. What causes gum disease?

   a. lack of brushing
   b. not going to the dentist
   c. ingestion of sugary food
   d. other (specify)
   e. don’t know

6. What can be done in order to prevent gum disease?

   a. go to the dentist
   b. brush the teeth
   c. avoid sugary food
   d. other (specify)
   e. don’t know

7. Has anyone ever explained to you what can be done to prevent gum disease? IF YES, who.

   a. yes, my dentist
   b. yes, my mother
   c. yes, my father
   d. yes, my parents
   e. yes, a friend of mine
   f. yes, a teacher of mine
   g. yes, other (specify)
   h. no

8. Has any of your parents ever talked to you about what can be done to prevent gum disease? IF YES, which one of them.

   a. yes, my mother
   b. yes, my father
   c. yes, both of them
   d. no, none of them
   c. cannot remember
9. I would like to ask you a few questions on eating habits within your family now. I will start with what you ate and drank yesterday. Please tell me what you ate and drank at the main meals yesterday.

PROBE: sugary food and its form, if helped herself/himself at home, if was given or if bought herself/himself.

DAY OF THE WEEK: ______________________

BREAKFAST: ______________________________________________________

LUNCH: ____________________________________________________________

DINNER: ____________________________________________________________

10. Please tell me what you ate and drank in between the main meals yesterday.

PROBE: sugary foods and its form, if helped herself/himself at home, if was given or if bought herself/himself.

MORNING: ______________________________________________________

AFTERNOON: ______________________________________________________

NIGHT: ____________________________________________________________

11. Did you eat or drink any of the following items yesterday? IF YES, probe: when and how many, if helped herself/himself at home, if was given or if bought herself/himself.

chewing gum - ______________________________________________________

sweets/toffees - ______________________________________________________

chocolate - __________________________________________________________

crackers - __________________________________________________________

sweet biscuits - _____________________________________________________

cakes/buns - _________________________________________________________

ice cream/iced lollies - ______________________________________________

bread - ____________________________________________________________

fresh fruit - _________________________________________________________

cheese - ____________________________________________________________

milk with/without sugar - _____________________________________________

chocolate drinks - ___________________________________________________

soft drink - _________________________________________________________

fruit juice with/without sugar - _______________________________________

coffee with/without sugar - ___________________________________________

tea with/without sugar - _____________________________________________

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There is much debate on food and health. Some say you are what you eat while others believe there is no association whatsoever between what you eat and your health. I would like to discuss with you about the relationship, if there is one, between health and sugar.

12. Do you see reasons why we should avoid eating sweet-tasting food?
   a. yes (go to question 14)
   b. no
   c. don't know

IF YES,

13. Could you tell me why?
   a. blood problems (diabetes)
   b. tooth
   c. getting fat
   d. worms
   e. spots on the skin
   f. kidney problems
   g. heart disease
   h. other (specify)

14. Do you see any benefit from eating sugary food?
   a. yes (go to question 16)
   b. no
   c. don't know

IF YES,

15. Could you tell me why?
   a. taste
   b. good for the blood (energy)
   c. other (specify)
CHILD SUGAR CONSUMPTION - CONTROL BY PARENTS:

16. Some parents seem to control the amount of sweet-tasting food their children eat while others do not control it. What about your parents? Is there any control of the amount of sugary food you eat by any of your parents nowadays? IF YES, ask who.

   a. yes, the mother controls it
   b. yes, the father controls it
   c. yes, both parents control it
   d. yes, other controls it (specify)
   e. no, there is none
   f. don’t know

17. Within a family people seem to have different levels of concern about different issues. Who would you say is the person in your family who is most concerned about the amount of sugary food you eat?

   a. mother
   b. father
   c. both parents
   d. nobody
   e. other (specify)
   f. don’t know

ORAL HYGIENE

Now I would like to ask you a few questions on tooth cleansing behaviour within your family.

Toothbrushing may seem to be quite a simple procedure. However, there is much debate going on about it, for example: its frequency, techniques and methods.

18. Some people brush their teeth after each meal, others do it less often such as not every day. And you? How often do you usually clean your teeth? ____________________________

19. At what time of the day do you usually clean your teeth?

   a. before breakfast
   b. after breakfast
   c. after lunch
   d. after dinner
   e. before going to bed
   f. other (specify)
20. People seem to have different reasons for brushing their teeth. Which would be your reasons for cleaning your teeth?

a. to avoid tooth decay
b. appearance: beautiful teeth
c. cleanliness, hygiene
d. appearance: cleanliness
e. to have good breath
f. to avoid gum problems
g. to avoid going to the dentist
h. other (specify)
j. don’t know

21. Some people use dental floss while others don’t. What about you? Do you floss your teeth?

a. yes, every day/almost every day
b. yes, seldom
c. no

22. IF YES, why do you use dental floss?

a. to clean in between the teeth
b. to remove food stuck in between the teeth
c. habit
d. other (specify)
e. don’t know

22. IF NO, why don’t you use dental floss?

a. not used to it
b. do not have time
c. do not like it
d. does not know it
e. see no reason why should do it
f. do not have at home
g. other (specify)
h. don’t know

23. What brand of toothpaste do you use?

a. with fluoride
b. without fluoride
c. don’t use
d. don’t know/cannot remember
24. Why do you use this one?

a. price
b. habit
c. taste
d. avoids tooth decay because of fluoride
e. cleans teeth better
f. better known
g. mother buys it
h. father buys it
i. parents buy it
j. no reasons
k. other (specify)

**ORAL HYGIENE - CONTROL BY PARENT:**

25. Some adults tend to remind younger people to brush their teeth while others do not. What about you? Does anyone remind you to brush the teeth? IF YES, ask who.

   a. yes, mother does
   b. yes, father does
c. yes, both parents do
d. yes, other does (specify)
e. no, no one does
f. don’t know

26. Within a family people tend to have different levels of concern about children cleaning their teeth. Who in your family would be more concerned about you cleaning your teeth?

   a. mother
   b. father
c. both parents
d. other (specify)
   e. don’t know
PATTERN OF DENTAL ATTENDANCE

Finally I would like to ask you some questions about going to the dentist now.

27. Have you ever been to the dentist?
   a. yes
   b. no (go to question 33)

   IF YES,

28. What kind of service do you usually use? (e.g. private, public) _____________________________________________________

29. When did you last go to the dentist?
   a. under treatment at present
   b. within 6 months
   c. within 7-12 months
   d. within 13-24 months
   e. over 24 months
   f. can't remember

30. This last course of treatment, why did you initially go to the dentist?
   a. pain
   b. tooth extraction
   c. for treatment
   d. for check up
   e. for preventive procedures: polishing, fluoride, etc)
   f. dentist sent a reminder
   g. other (specify)

31. People have different patterns of going to the dentist: Some go mainly for check ups while others mainly when in trouble. What about you? What is your usual pattern of going to the dentist?
   a. check ups mainly
   b. in trouble mainly (go to question 33)
   c. don't know
32. IF CHECK UPS, how often do you usually go?
   a. every 6 months
   b. once a year
   c. once every 2 years
   d. less often
   e. don’t go

33. People give different reasons for going to the dentist regularly. Are there any reasons you can think of why you should go to the dentist regularly?
   a. check ups
   b. keep teeth healthy
   c. treat early tooth decay
   d. more economic
   e. for preventive procedures: polishing, fluoride, check brushing, etc
   f. have beautiful teeth
   g. extract tooth
   h. avoid tooth decay
   i. avoid gum disease
   j. avoid pain
   k. see no reason in doing that
   l. other (specify)
m. don’t know

DENTAL ATTENDANCE - CONTROL BY PARENTS

34. Deciding when a child should go to the dentist varies between families. While in some the child may ask to go, in others the dentist may send a reminder. And in your family? Who decides when you should go to the dentist?
   a. she herself/ he himself
   b. mother
   c. father
   d. both parents
   e. other (specify)
f. don’t know
35. Within a family people may have different levels of concern if the children are going to the dentist. Who would be more concerned if you are not going to the dentist?

a. mother
b. father
c. both parents
d. other (specify)
e. don't know

THANK YOU VERY MUCH FOR YOUR COLLABORATION!
As perguntas que eu gostaria de te fazer agora estão mais relacionadas com a saúde da sua boca, por exemplo: escovar os seus dentes, ir ao seu dentista e o que você gosta de comer.

Eu gostaria de te lembrar que NÃO se trata de um teste e, portanto, NÃO existe uma resposta certa ou errada. Eu simplesmente gostaria que você respondesse a TODAS as perguntas dizendo o que você realmente faz e pensa.
ALIMENTAÇÃO

1. Eu gostaria de fazer algumas perguntas a respeito dos hábitos alimentares na sua família: Eu gostaria de te fazer algumas perguntas sobre o que você comeu e bebeu ontem.

PROBE: alimentos que contenham açúcar, forma dos alimentos, se pegou em casa, comprou com próprio dinheiro ou se ganhou de alguém.

DIA DA SEMANA: ______________________

CAFE DA MANHA: ___________________________________________________________
___________________________________________________________

ALMOÇO: ______________________________________________________________
___________________________________________________________

JANTAR: ______________________________________________________________
___________________________________________________________

2. Você comeu ou bebeu algum alimento ENTRE AS REFEIÇÕES?

PROBE: horário (manhã, tarde e noite), alimentos acucarados, quantos e quantas vezes, forma dos alimentos, se pegou em casa, se comprou com o próprio dinheiro ou se ganhou de alguém.

MANHA: ______________________________________________________________
___________________________________________________________

TARDE: ______________________________________________________________
___________________________________________________________

NOITE: ______________________________________________________________
___________________________________________________________
3. Você comeu ou bebeu algum desses itens ontem entre as refeições? NOS CASOS AFIRMATIVOS, PROBE: quando, quantos e quantas vezes, se pegou em casa, se comprou com o próprio dinheiro ou se ganhou de alguém.

chicletes - ______________________________________
balas/drops - _______________________________________
chocolate/ bombom - _________________________________
biscoito doce/salgado _________________________________
bolo/torta/doce - __________________________________
sorvete/picole/chup-chup - _________________________
pão doce/sal - _____________________________________
fruta - ____________________________________________
queijo - ___________________________________________
leite com/sem açúcar - ______________________________
chocolate (Nescau, Toddy, etc) - _______________________
refrigerante - _________________________________
suco de fruta com/sem açúcar - _______________________
café com/sem açúcar - ______________________________
cha com/sem açúcar - _______________________________
Finalmente, eu gostaria de te fazer algumas perguntas a respeito de ir ao dentista.

6. Você já foi ao dentista?
   a. sim
   b. não

/CASO AFIRMATIVO,

7. Qual o tipo de dentista que você normalmente vai?

8. Quando foi a última vez que você foi ao dentista?
   a. em tratamento no momento
   b. há menos de 6 meses
   c. há 7-12 meses
   d. há 12-24 meses
   e. há mais de 24 meses
   f. não me lembro

9. As pessoas vão ao dentista por diversos motivos. Enquanto que alguns vão somente quando tem dor, outros vão regularmente para uma revisão. Qual seria o motivo mais frequente pelo qual você vai ao dentista?
   a. na maioria, para revisões
   b. na maioria, para tratamento
   c. não sei

/10. SE REVISOES, qual a frequencia com que voce vai?
   a. a cada 6 meses
   b. uma vez por ano
   c. uma vez a cada dois anos
   d. com menor frequencia
   e. não sei

MUITO OBRIGADA PELA SUA COLABORAÇÃO!
The questions I am going to ask you are about your oral health habits, for example: eating, toothcleaning and going to the dentist.

I want to stress that this is in no way a test, and there is no right or wrong answer. We want to know what you really think and do.

Shall we start?
FOOD HABITS

1. I would like to ask you a few questions on eating habits within your family now. I will start with what you ate and drank yesterday. Please tell me what you ate and drank at the main meals yesterday.

PROBE: sugary food and its form, if helped herself/himself at home, if was given or if bought herself/himself.

DAY OF THE WEEK: ___________________

BREAKFAST: ______________________________________________________

LUNCH: _________________________________________________________

DINNER: _________________________________________________________

2. Please tell me what you ate and drank in between the main meals yesterday.

PROBE: sugary foods and its form, if helped herself/himself at home, if was given or if bought herself/himself.

MORNING: _________________________________________________________

AFTERNOON: _____________________________________________________

NIGHT: ____________________________________________________________

3. Did you eat or drink any of the following items yesterday? IF YES, probe: when and how many, if helped herself/himself at home, if was given or if bought herself/himself.

chewing gum - ______________________________________________________
sweets/toffees - ____________________________________________________
chocolate - _________________________________________________________

crackers - _________________________________________________________
sweet biscuits - ____________________________________________________
cakes/buns - _______________________________________________________

ice cream/iced lollies - ____________________________________________

bread - ____________________________________________________________

fresh fruit - _________________________________________________________

cheese - ____________________________________________________________
milk with/without sugar - ___________________________________________

chocolate drinks - _________________________________________________

soft drink - _________________________________________________________

fruit juice with/without sugar - _______________________________________

coffee with/without sugar - _________________________________________

tea with/without sugar - _____________________________________________
ORAL HYGIENE

Now I would like to ask you a few questions on tooth cleansing behaviour within your family.

Toothbrushing may seem to be quite a simple procedure. However, there is much debate going on about it, for example: its frequency, techniques and methods.

4. Some people brush their teeth after each meal, others do it less often such as not every day. And you? How often do you usually clean your teeth? _________________________________________

5. At what time of the day do you usually clean your teeth?
   a. before breakfast
   b. after breakfast
   c. after lunch
   d. after dinner
   e. before going to bed
   f. other (specify)

PATTERN OF DENTAL ATTENDANCE

Finally I would like to ask you some questions about going to the dentist now.

6. Have you ever been to the dentist?
   a. yes
   b. no

   IF YES,

   7. What kind of service do you usually use? __________

   8. When did you last go to the dentist?
      a. under treatment at present
      b. within 6 months
      c. within 7-12 months
      d. within 13-24 months
      e. over 24 months
      f. can't remember
9. People have different patterns of going to the dentist. Some go mainly for check ups while others mainly when in trouble. What about you? What is your usual pattern of going to the dentist?
   a. check ups mainly
   b. in trouble mainly
   c. don't know

10. IF CHECK UPS, how often do you usually go?
   a. every 6 months
   b. once a year
   c. once every 2 years
   d. less often
   e. don't go

THANK YOU VERY MUCH FOR YOUR COLLABORATION!
Data on prosthetic, oral hygiene, periodontal and caries status, and treatment needs were collected in this present investigation.

Examinations were carried out at the participants' home, taking an average of 10 minutes each. Examinations were all carried out with the examiner positioned in front of the subject, who was seated in a chair. Standard illumination was obtained with the use of a head-lamp. The instruments used for the clinical examinations were: no. 4 plain mouth mirror, sickle-shaped explorer and CPITN-E probe (which was colour-coded with a black band starting at 3.5 mm and ending at 5.5 mm from the ball ended tip). The explorer was used only to remove debris, to check for interproximal caries and to check occlusal cavitation where doubt existed on visual inspection. All the instruments were sterilised in dry-heat oven at 160° C for 90 minutes.

The criteria for examination used in this present study were adapted from WHO (1987), and are now presented in detail.
1. PROSTHETIC STATUS:

Denture wearing and prosthetic treatment needs were assessed separately for both upper and lower jaws, following the criteria established by WHO (1987). Therefore, wearing a prosthesis was coded as follows: not wearing a denture, wearing a partial denture and wearing a full denture. Prosthetic treatment needs were coded as: no denture needed, need for denture repair, need for partial denture, need for full denture.

2. ORAL HYGIENE STATUS:

Two indicators were used to assess the oral hygiene status: the tooth area covered by debris, and the presence or absence of supra- or sub-gingival calculus.

2.1. Debris:

Six surfaces were examined for debris, four posterior and two anterior. In posterior region, the first fully erupted tooth distal to the second premolar, usually the first molar, but sometimes the second or the third molar, was examined on each side of each arch. The buccal surface of the selected upper molars and the lingual surfaces of the selected lower molars were inspected. In the anterior region, the labial surfaces of the upper right and lower left central incisors
were examined. In the absence of either of these anterior teeth, the central incisor on the opposite side of the midline was examined instead.

Only fully erupted teeth were examined. A tooth was considered to be fully erupted when the occlusal or incisal surface had reached the occlusal plane. Natural teeth with full crown restorations and surfaces reduced in height by caries or trauma were not recorded. Instead, an alternative tooth was examined (Greene and Vermillion, 1964).

Oral debris was considered as the soft foreign matter loosely attached to the tooth. The surface area covered by debris was estimated by running the side of a sickle-shaped explorer along the tooth surface being examined. The extent of the debris was noted as it was being removed. The scoring system, developed by Greene and Vermillion (1964), was used:

0. no debris or stain present,

1. soft debris covering not more than one-third of the tooth surface being examined or the presence of extrinsic stains without debris regardless of the surface area covered,

2. soft debris covering more than one-third, but not more than two-thirds of the tooth surface,

3. soft debris covering more than two-thirds of the tooth surface.
2.2. Calculus:

All teeth were examined for calculus. A plain mirror was used to assess supra-gingival calculus. If calculus was not obvious in any part of the tooth surface, the sub-gingival tooth surface was probed for calculus. Following the anatomic configuration of the root surface, the probe was gently inserted between the tooth and the gingiva until the resistance of the supra-alveolar fibres was felt. The total extent of the surface of the tooth was examined. Calculus, if supra- or sub-gingival, was scored as present or absent.

3. PERIODONTAL STATUS:

Gingival bleeding after probing and periodontal pockets were used in the assessment of the periodontal status. All the teeth were assessed.

3.1. Pocketing:

The presence or absence of pockets were recorded at the same time as the assessment of the calculus deposits for each tooth. The following criteria were used:

1. no pocketing: clinical gingival sulcus of 3.5 mm or less,
2. shallow pockets: pockets greater than 3.5 mm, but less than or equal to 5.5 mm,

3. deep pockets: pockets greater than 5.5 mm.

All pocket depths were measured from the gingival margins, and the deepest pocket of each tooth was recorded.

3.2. Bleeding:

The absence or presence of bleeding was also recorded at the same time as calculus and pocketing. When all teeth in one sextant had been probed for calculus and pockets, these same teeth were re-examined in the same sequence to ascertain whether the probing had resulted in obvious bleeding.

4. DENTAL STATUS:

Dental status was assessed using a plain mouth mirror and a sickle-shaped explorer. All surfaces of the teeth were examined and recorded. A tooth was considered present in the mouth when any of its part was visible or could be touched with the tip of the explorer without unduly displacing soft tissues. If a permanent and a primary tooth occupied the same space, the status of the permanent tooth only was taken into account.
4.1. Sound Surface:

A tooth surface was recorded as sound if it showed no evidence of treated or untreated clinical caries. The stages of caries that precede cavitation, as well as other conditions similar to the early stages of caries, were recorded as sound. Thus the tooth surfaces showing the following characteristics, in the absence of any other positive clinical criteria, were recorded as sound:

1. white or chalky spots,
2. discoloured or rough spots,
3. stained pits or fissures in the enamel that catch the explorer but do not have a detectable softened floor, undermined enamel, or softening of the walls,
4. dark, shiny, hard, pitted areas of the enamel in a tooth showing signs of moderate to severe fluorosis, and
5. a traumatised broken tooth surface.

All questionable lesions were recorded as sound.

4.2. Decayed Surfaces:

A surface was recorded as decayed when a lesion in a pit or fissure, or on a smooth tooth surface, had a detectable softened floor, undermined enamel, or a softened wall. On approximal surfaces, caries was recorded as present when the explorer tip entered a lesion with certainty.
All surfaces with temporary fillings were recorded as decayed.

Where any doubt existed, caries was not recorded as present.

4.3. Filled Surface with Decay:

A tooth surface was recorded as filled with decay when it contained one or more permanent restorations and one or more areas that were decayed.

4.4. Filled Surface with No Decay:

A surface was considered filled without decay when one or more permanent restorations were present and there was no secondary caries or other area with primary caries. Crowns and bridge abutments were not recorded in this category.

4.5. Tooth Missing due to Caries:

A missing tooth due to caries was recorded when a permanent or primary tooth had been extracted because of caries. For primary teeth, missing was recorded only if the subject was at an age when normal exfoliation would not have been a sufficient explanation for absence.
4.6. Tooth Missing for Any Other Reason:

A permanent tooth was recorded as missing for any other reason when it was judged to be absent congenitally, or extracted for orthodontic reasons or lost due to trauma. This information was obtained by asking the subject.

Deciduous teeth were not recorded in this category.

4.7. Sealant:

A sealant was recorded when a fissure sealant had been placed on the occlusal surface. Teeth recorded in this category were included in the DMFS and DMFT calculations as sound because the number of surfaces recorded as sealed was not meaningful, only 0.5% of the surfaces examined.

If a sealed surface had caries, it was recorded as decayed.

4.8. Bridge Abutment or Special Crown:

A permanent or deciduous tooth was recorded as crowned when a crown had been placed on a tooth due to previous caries or as a replacement of a filling. All crowned teeth which were bridge abutment and were previously decayed or filled were recorded in this category.
The teeth recorded in this category were included in the calculation of both DMFS and DMFT indices since the prevalence of dental caries is very high in Brasil and crowns are a common procedure in the Brazilian dental practice.

A sound tooth which had been crowned for any other reason, for example, trauma or bridge abutment, was excluded. The reason for crowning as well as the previous tooth condition was obtained through questioning the subject.

A missing tooth replaced by a bridge was recorded as missing due to caries or missing for any other reason, according to the subject's account.

4.9. Unerupted Tooth:

This criterion was restricted to permanent teeth, and was used only for a tooth space with an unerupted permanent tooth, but without a primary tooth.

4.10. Excluded Tooth:

A tooth was excluded when:

. it could not be examined, and

. a sound tooth had been crowned for reasons other than decay or filling replacement.

All third molars were included in this category.
5. DENTAL TREATMENT REQUIREMENTS OF INDIVIDUAL TEETH:

Assessment of the type of treatment required, if any, was recorded based on the examiner's clinical judgement. The criteria established by WHO (1987) for treatment requirements of individual teeth was used as the basis of judgement.

5.1. No Treatment Required:

No treatment required was recorded if a permanent or deciduous tooth was sound, or if it was decided that a tooth could not or should not be extracted or receive any other treatment.

5.2. Caries Arresting and Sealant Care:

Caries arresting was rare and fissure sealants were not indicated due to the high caries rates. This item was therefore excluded.

5.3. Filling:

Restorations were coded according to how many surfaces would have to be involved: one surface filling, and two or more surface filling. Fillings were indicated when one or more of the following conditions existed:
. presence of primary or secondary caries,
. need to repair damage due to trauma, and
. need to replace unsatisfactory fillings.

A filling was considered unsatisfactory if it presented a fracture or deficient margin that either caused it to be loose or permitted leakage into dentine. Overhanging margins causing obvious local irritation to the gingiva and which could not be removed by recontouring of the restoration were also considered unsatisfactory. A lenient criteria were used when considering a restoration satisfactory.

5.4. Crown and Bridge Abutment:

Teeth with enough root support but with a destroyed tooth crown would be indicated for a crown treatment. Bridge abutments were also included in this category.

5.5. Bridge Element:

Bridge pontic was recorded to indicate the portion of the bridge replacing the missing tooth/teeth.

5.6. Pulp Care:

Pulp care was recorded to indicate that a tooth probably needed pulp care prior to restoration with a filling or crown
because of deep or extensive caries or because of tooth mutilation or trauma.

5.7. Extraction:

A tooth indicated for extraction when the following conditions prevailed:

- caries had destroyed the crown to such an extent that the tooth could not be restored,
- advanced periodontal disease which caused the tooth to be loose or functionless or when the tooth could not be restored to a firm and functional state by periodontal therapy,
- space for a prosthesis was required,
- for orthodontic or cosmetic reasons, and
- in the presence of impactions.

6. SELECTION OF DENTAL HEALTH INDICATORS:

The decision by which a measure of oral health status is chosen depends on the purpose to which the measure will be applied. In the present study, the dental health status measures were used to evaluate a possible association between behavioural factors and dental health status as well as to assess the pattern of dental health status among family members.
In spite of the fact that the data collected provided information on dental as well as periodontal status, in the present investigation only measures to assess the dental health status were used: DMFS and ODI-S indices. The main reason for that was the fact that the children in this present study showed very low levels of periodontal involvement, which invalidated the use of this measurement in the assessment of periodontal disease amongst family members.

A description of the construction of these two measures now follows.

6.1. DMFS Index:

The DMFS index was calculated by summing up the number of decayed (DS), missing (MS) and filled surfaces (FS). The surfaces recorded as decayed and as filled with decay composed the DS component of the DMFS index. The surfaces recorded as missing due to caries composed the MS component, and the surfaces recorded as filled without decay and as crowned composed the FS component of the DMFS index.

All surfaces recorded as excluded, unerupted, and missing due to any other reason than decay, were not included in the calculation of DMFS and DMFT indices.

The DMFS calculation was based on 128 surfaces since the third molars were excluded.

DMFS index reflects mainly primary prevention or the lack of it. It is important to remember that for adults, DMFS index
expresses a life-time experience, which may reflect the impact of present dental health behaviour and socio-economic status.

6.2. ODI-S Index:

The calculation of the Simplified Oral Debris Index (ODI-S) followed Greene and Vermillion (1964). The scores assigned to the surfaces examined were added, and the arithmetic mean was calculated. This score was considered as missing when the subject did not present at least two of the surfaces required for the calculation of the index.

The original form used to record the clinical examination is presented next.
ORAL HEALTH ASSESSMENT FORM

IDENTIFICATION:

NAMES: ....................................................... 

DATE:  (6)  DAY  MONTH  YEAR  (6)  

I.D. NUMBER:  (9)  FAMILY MEMBER  (6)  

ORIGINAL / DUPLICATE:  0  (1)  

EXAMINER:  0  (1)  PLACE OF EXAM:  0  (3)  

SCHOOL:  0  (4)  

DENTURE:

DENTURE WEARING:  

UPPER  LOWER  (6)  (11)  

0: no denture  
1: partial denture  
2: full denture  

NEED FOR DENTURES:  

UPPER  LOWER  (6)  (11)  

0: no denture needed  
1: need to repair denture  
2: need for partial denture  
3: need for full denture  

ORAL HYGIENE:  

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0: no debris  
1: debris up to 1/3  
2: debris 1/3 to 2/3  
3: debris more than 2/3  
5: missing  
8: unerupted
CARIES STATUS AND TREATMENT NEEDS:

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<td>caries arresting or sealant care</td>
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<td>two or more surface filling</td>
<td>crown or bridge abutment</td>
<td>bridge element</td>
<td>pulp care</td>
<td>extraction</td>
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8. need for other care
9. specify
PERIODONTAL STATUS:

**Calculus:**

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1: no  
2: yes  
5: missing  
8: unerupted

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</table>

1: no  
2: yes, 4.5 mm  
3: yes, 6 mm or more  
5: missing  
8: unerupted

**Bleeding:**

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<td>(234)</td>
<td>(235)</td>
<td>(236)</td>
</tr>
</tbody>
</table>

1: no  
2: yes  
5: missing  
8: unerupted
The ABA-ABIPEME (1978) criteria of socio-economic classification are based on a group of specific socio-economic indicators. These indicators can be divided into two categories: resources (Table AP4.1) and educational level of the head of the family (Table AP4.2). For resources, points are assigned according to the number of each of the 7 resources available at home. For educational level, points are assigned according to the number of years of formal education the head of the family has had. The point obtained in each of the categories are then added and a final score, which defines the social class, is given.

Tables AP4.1 and AP4.2 show the indicators used and the number of points assigned to each of them. Social class definition and the score to each of the five social classes are described in Table AP4.3. The distribution of the five social classes in the two largest Brazilian cities, São Paulo and Rio de Janeiro, is given in Table AP4.4.
Table AP4.1. - Indicators used by ABA-ABIPEME criteria of socio-economic classification and the number of points assigned to each indicator: Resources.

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>NUMBER OF POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.V.</td>
<td>0 2 4 6 8 10 12</td>
</tr>
<tr>
<td>RADIO</td>
<td>0 1 2 3 4 5 6</td>
</tr>
<tr>
<td>BATHROOM</td>
<td>0 2 4 6 8 10 12</td>
</tr>
<tr>
<td>MOTORCAR</td>
<td>0 4 8 12 16 16 16</td>
</tr>
<tr>
<td>MAID</td>
<td>0 6 12 18 24 24 24</td>
</tr>
<tr>
<td>VACUUM CLEANER</td>
<td>0 5 5 5 5 5 5</td>
</tr>
<tr>
<td>WASHING MACHINE</td>
<td>0 2 2 2 2 2 2</td>
</tr>
</tbody>
</table>

Table AP4.2. - Indicators used by ABA-ABIPEME criteria of socio-economic classification and the number of points assigned to each indicator: Educational level of the head of the family.

<table>
<thead>
<tr>
<th>LEVEL OF EDUCATION</th>
<th>NUMBER OF POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>0</td>
</tr>
<tr>
<td>PRIMARY SCHOOL (4 years)</td>
<td>1</td>
</tr>
<tr>
<td>PRIMARY SCHOOL (8 years)</td>
<td>3</td>
</tr>
<tr>
<td>SECONDARY SCHOOL (12 years)</td>
<td>5</td>
</tr>
<tr>
<td>UNIVERSITY</td>
<td>10</td>
</tr>
</tbody>
</table>
Table AP4.3. - Social class definition and the final score assigned to each of them.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>FINAL SCORE (in points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>more than 34</td>
</tr>
<tr>
<td>B</td>
<td>21 - 34</td>
</tr>
<tr>
<td>C</td>
<td>10 - 20</td>
</tr>
<tr>
<td>D</td>
<td>5 - 9</td>
</tr>
<tr>
<td>E</td>
<td>0 - 4</td>
</tr>
</tbody>
</table>

Table AP4.4. - Social class distribution in the cities of São Paulo and Rio de Janeiro, Brasil*

<table>
<thead>
<tr>
<th>CITY</th>
<th>SOCIAL CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Sao Paulo</td>
<td>8%</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>5%</td>
</tr>
</tbody>
</table>

*Data based on 900 interviews.
SCHOOLS PARTICIPATING IN THE STUDY

The following schools were randomly selected to take part in the study. The total number of students as well as the number of 13-year-old students (CEDINE, 1985) are also given.

1. Schools located in the 'more privileged' area (central area)

   . Colegio Loyola (private):
     total number of students: 1,694
     number of 13-year-old students: 252

   . Escola Santo Tomas de Aquino (private):
     total number of students: 1,064
     number of 13-year-old students: 105

   . Colegio Logosofico Gonzales Pecotche (private):
     total number of students: 405
     number of 13-year-old students: 37

   . Escola Albert Einstein (private):
     total number of students: 176
     number of 13-year-old students: 16

   . Colegio Pitagoras -Cidade Jardim (private):
     total number of students: 2,219
     number of 13-year-old students: 271

   . Instituto de Educacao de Minas Gerais (state):
     total number of students: 2,368
     number of 13-year-old students: 254

   . Colegio Dom Cabral (private):
     total number of students: 346
     number of 13-year-old students: 23
Colegio Coracao de Jesus (private):
  total number of students: 956
  number of 13-year-old students: 107

2. Schools located in the 'less privileged' areas (suburban area)

  - Escola Estadual Celso Machado (state):
    total number of students: 1,349
    number of 13-year-old students: 197

  - Escola Estadual Professora Maria Luiza (state):
    total number of students: 963
    number of 13-year-old students: 189

  - Escola Estadual Silviano Brandao (state):
    total number of students: 1,800
    number of 13-year-old students: 164

  - Escola Estadual Cecilia Meireles (state):
    total number of students: 1,108
    number of 13-year-old students: 84

  - Escola Estadual Diogo Vasconcelos (state):
    total number of students: 851
    number of 13-year-old students: 54

  - Escola Estadual Mendes Pimentel (state):
    total number of students: 1,619
    number of 13-year-old students: 255

  - Escola Estadual Princesa Isabel (state):
    total number of students: 1,341
    number of 13-year-old students: 130

  - Colegio Municipal Salgado Filho (state):
    total number of students: 889
    number of 13-year-old students: 181

The schools were approached following the order determined by the random selection. When a sufficient number of families to compose the sample was obtained, the remaining schools were
not contacted. Therefore, the following schools were actually contacted. The actual number of 13-year-old students is also given. This figure is based upon information gathered at each the school registrar's office.

1. Schools located in the 'more privileged' area (central area)

   - Colegio Loyola (private):
     number of 13-year-old students: 51
   - Escola Santo Tomas de Aquino (private):
     number of 13-year-old students: 100
   - Colegio Logosofico Gonzales Pecotche (private):
     number of 13-year-old students: 33
   - Escola Albert Einstein (private):
     number of 13-year-old students: 28
   - Colegio Pitagoras -Cidade Jardim (private):
     number of 13-year-old students: 120
   - Instituto de Educacao de Minas Gerais (state):
     number of 13-year-old students: 133

2. Schools located in the 'less privileged' areas (suburban area)

   - Escola Estadual Celso Machado (state):
     number of 13-year-old students: 197
   - Escola Estadual Professora Maria Luiza (state):
     number of 13-year-old students: 280
   - Escola Estadual Silviano Brandao (state):
     number of 13-year-old students: 126
Most of the social characteristics differed by social class of the families.

1. AREA OF RESIDENCE:

According to PLAMBEL (1984), Belo Horizonte can be divided into five major areas: 'nucleo central', 'area pericentral', 'pampulha', 'eixo industrial', and 'periferias'.

The families participating in this study were unevenly distributed throughout these five areas (Table AP6.1). 'Nucleo central' contained the largest number of families (34.8%) followed, in a descending order, by 'pampulha' (24.4%), 'eixo industrial' (22.6%), 'area pericentral' (15.9%), and 'periferias' (2.4%).

Overall a specific social class tended to cluster in each area (Table AP6.1). 'Area central' had only families from the two wealthier social classes. However, the families from social class A greatly outnumbered those from social class B.

In contrast 'eixo industrial' was only inhabited by families coming from the two 'less privileged' social classes.
The majority of families living in this area were from social class D.

'Pampulha' was composed of three social classes: B, C, and D. More families from social class C were living in this area when compared to families from social classes B and D.

'Area pericentral' held households from each of the four social classes. More families from social classes B and D were found in this area than families from social classes C (23.1%) and A (7.7%).

'Periferias' had the smallest number of families (4), 2 of them being from social class B and 2 from social class C.

Table AP6.1. - Social class characteristics: Family distribution according to social class and area of residence.

<table>
<thead>
<tr>
<th>AREA OF RESIDENCE</th>
<th>SOCIAL CLASS</th>
<th></th>
<th></th>
<th></th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Nucleo Central</td>
<td>39</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>57</td>
</tr>
<tr>
<td>Area Pericentral</td>
<td>2</td>
<td>9</td>
<td>6</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>Pampulha</td>
<td>0</td>
<td>12</td>
<td>17</td>
<td>11</td>
<td>40</td>
</tr>
<tr>
<td>Eixo Industrial</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>21</td>
<td>37</td>
</tr>
<tr>
<td>Periferias</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>164</td>
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</tbody>
</table>
2. LEVEL OF EDUCATION OF PARENTS:

The level of education of the father of a family was one of the indicators used in the ABA-ABIPEME criteria of socio-economic classification of the families participating in the study (Appendix 4). Therefore, as it would be expected, social class showed a close relationship to the educational level of parents. The 'more privileged' the social class, the more years of formal education the parents would have (Table AP6.2).

In social class A all the parents had at least twelve years of formal education. Four out of five parents attended university, and 6% of them had taken a post-graduate course.

Parents from social class B showed a similar pattern of formal education. Most the parents had experienced at least twelve years of schooling. In relation to higher education parents from this social class tended to be half as likely to have extended their studies to university levels as those from social class A.

While parents from class C tended to be in all educational levels, the predominant pattern was for parents to have attended up to four years of education.

In social class D the parents had the lowest levels of education. None of them had attended university and only one had secondary education (12 years of formal education). The majority of parents (50%) had up to four years of schooling, while nearly two-in-five could only read and write.

Within the families, especially those from the 'more privileged' social classes, the educational level of parents
was strongly influenced by gender (Table AP6.2). Overall, men had higher levels of formal education than women.

In social class A, in spite of the educational level of both parents being high, the fathers had proportionally more years of formal education than did the mothers. Nine out of ten fathers had attended university, while 75% of the mothers had done so. All those parents who had attended a post-graduate course were males.

In social class B the fathers were twice as likely as the mothers to have gone to university and fewer men stopped studying after completing secondary education (12 years). The mothers, on the other hand, were more likely to leave school after the completion of twelve years of formal education and comparatively more of them attended only four years of schooling.

Hardly any difference could be found between the educational level of mothers and fathers from social classes C and D. Fathers, however, showed a slightly higher level of education than mothers.
Table AP6.2. - Social characteristics: Level of education of parents by social class and gender.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>GENDER</th>
<th>EDUCATIONAL LEVEL</th>
<th>FATHERS</th>
<th>MOTHERS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fathers</td>
<td>ILLIT.</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R&amp;W.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4Y.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8Y.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12Y.</td>
<td>2</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNIV.</td>
<td>34</td>
<td>27</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P.G.</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Mothers</td>
<td>ILLIT.</td>
<td>0</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R&amp;W.</td>
<td>0</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4Y.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8Y.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12Y.</td>
<td>16</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNIV.</td>
<td>34</td>
<td>27</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P.G.</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>ILLIT.</td>
<td>0</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R&amp;W.</td>
<td>0</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4Y.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8Y.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12Y.</td>
<td>16</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNIV.</td>
<td>34</td>
<td>27</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P.G.</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

* ILLIT. = illiterate
R&W. = read and write
4Y. = 4 years of education
8Y. = 8 years of education
12Y. = 12 years of education
UNIV. = university education
P.G. = post-graduate education

-377-
3. INCOME:

The household income was defined as the monthly income salary earned by the father and expressed in terms of the equivalent number of minimum wages. The minimum wage (M.W.), in turn, may be described as the lowest salary a worker may receive at the end of one month's work. It is adjusted monthly to the rising cost of living by the Government and, on the first of November 1988, was equivalent to US$ 64.74 (Veja, 1988).

There are three main reasons for the adoption of the number of minimum wages (M.W.) instead of the Brazilian currency - the 'cruzado'. Firstly, to gather comparative information on income in a study conducted in a specific year (1988) in a country where inflation rates are very high (in 1988, it was 934% (Veja, 1989)), the use of a standardised measure is of utmost importance. Secondly, the minimum wage is a measure used in all governmental publications, such as those published by IBGE, a governmental institution dealing with all the Brazilian statistical data. Thirdly, the use of the Brazilian currency would prove meaningless when read in different countries and even in Brasil at different times.

Following the criteria established by IBGE (1986), the income for each household was divided into six groups: >1-2 M.W., >2-3 M.W., >3-5 M.W., >5-10 M.W., >10-20 M.W., and >20 M.W.. The families interviewed in the present study were unevenly distributed in these six groups (Table AP6.3). Half of the families participating in this study were allocated to two of these categories: 30% of the households were in the groups...
earning more than twenty minimum wages/month (>20 M.W.) and almost 20% of the households were in the category earning more than three but up to five minimum wages (>3-5 M.W.). The other families were fairly distributed in the other four remaining income groups.

Income was strongly related with social class. The 'more privileged' the social class the higher the income would be (Table AP6.3). The families from social class A were, overall, the wealthiest ones. Almost nine out of ten of these families lived on a monthly income of more than twenty minimum wages (>20 M.W.), whilst the remaining families from social class A earned more than ten but up to twenty minimum wages (>10-20 M.W.).

In social class B, in spite of the family income being fairly high, it was lower than those families from social class A. Approximately one-half of the families earned more than ten but up to twenty minimum wages (>10-20 M.W.), and nearly one-third of them were included in the group with a monthly income of more than twenty minimum wages (>20 M.W.). Twenty percent of families from social class B earned more than five but up to ten minimum wages (>5-10 M.W.).

The households from social class C had an income varying from one to ten minimum wages/month. However, the income group of more than three but up to five minimum wages (>3-5 M.W.) comprised the largest number of families (46.3%), followed by the group with a salary of more than five but up to ten minimum wages (>5-10 M.W.), which contained slightly over 25% of the families from social class C.
The majority of the families from social class D lived on an income lower than five minimum wages/month. Two-in-five families earned up to two minimum wages/month (>1-2 M.W.), while almost one-third earned more than three but up to five minimum wages (>3-5 M.W.).

Table AP6.3. - Social characteristics: family distribution by income and social class.

<table>
<thead>
<tr>
<th>INCOME (IN M.W.)*</th>
<th>SOCIAL CLASS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A  B  C  D</td>
<td></td>
</tr>
<tr>
<td>&gt;1-2 M.W.</td>
<td>0  0  3  18</td>
<td>21</td>
</tr>
<tr>
<td>&gt;2-3 M.W.</td>
<td>0  0  8  10</td>
<td>18</td>
</tr>
<tr>
<td>&gt;3-5 M.W.</td>
<td>0  0  19 12</td>
<td>31</td>
</tr>
<tr>
<td>&gt;5-10 M.W.</td>
<td>0  7 11  1</td>
<td>19</td>
</tr>
<tr>
<td>&gt;10-20 M.W.</td>
<td>5 19 0  0</td>
<td>24</td>
</tr>
<tr>
<td>&gt;20 M.W.</td>
<td>36 15 0  0</td>
<td>51</td>
</tr>
<tr>
<td>TOTAL</td>
<td>41 41 41 41</td>
<td>164</td>
</tr>
</tbody>
</table>

*M.W. = minimum wages
While all the fathers participating in the study were in a paid job (this was one of criteria for sampling selection), the majority of the mothers were not in a paid job. However, social class showed a strong relation with the distribution of working mothers. On the whole, the women from the 'more privileged' social classes (A and B) were twice as likely as those women from social classes C and D to be in paid employment (Table AP6.4)

In both social classes A and B, three in five women had a paid job, while only one-third of the mothers from social classes C and D had formal employment.

Table AP6.4. - Social characteristics: distribution of working mothers by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>WORKING MOTHERS</th>
<th>NON-WORKING MOTHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>B</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>C</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>D</td>
<td>13</td>
<td>28</td>
</tr>
</tbody>
</table>

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5. FAMILY SIZE, AGE AND GENDER OF CHILDREN:

The mean number of children per family was 3.25. The families from social classes A and B had the lowest mean number of children/family, 2.8. Although the children of families from social class C outnumbered those from the 'more privileged' social classes, the families from social class D emerged as having markedly more children than all the other three social classes (Table AP6.5).

The age of the children ranged from 2 to 21 years, but the majority of them were between the ages of 8 to 16 years (Table AP6.6). Gender distribution of the 533 children participating in the study was fairly evenly distributed: 279 girls and 254 boys (Table AP6.7). For the 13-year-old child, however, more girls were randomly selected than boys. When only siblings were taken into account, the number of girls and boys was virtually equivalent.

Table AP6.5. - Social characteristics: number of children per family by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>TOTAL No. CHILDREN</th>
<th>MEAN No.CHILDREN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>114</td>
<td>2.8</td>
</tr>
<tr>
<td>B</td>
<td>116</td>
<td>2.8</td>
</tr>
<tr>
<td>C</td>
<td>137</td>
<td>3.3</td>
</tr>
<tr>
<td>D</td>
<td>166</td>
<td>4.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>533</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Table AP6.6. - Social characteristics: age distribution of siblings*

<table>
<thead>
<tr>
<th>AGE (in years)</th>
<th>FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6</td>
<td>40</td>
<td>10.8</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>5.4</td>
</tr>
<tr>
<td>7</td>
<td>17</td>
<td>4.6</td>
</tr>
<tr>
<td>8</td>
<td>29</td>
<td>7.9</td>
</tr>
<tr>
<td>9</td>
<td>38</td>
<td>10.3</td>
</tr>
<tr>
<td>10</td>
<td>42</td>
<td>11.4</td>
</tr>
<tr>
<td>11</td>
<td>39</td>
<td>10.6</td>
</tr>
<tr>
<td>12</td>
<td>21</td>
<td>5.7</td>
</tr>
<tr>
<td>13*</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>14</td>
<td>20</td>
<td>5.4</td>
</tr>
<tr>
<td>15</td>
<td>34</td>
<td>9.2</td>
</tr>
<tr>
<td>16</td>
<td>30</td>
<td>8.2</td>
</tr>
<tr>
<td>&gt;16</td>
<td>38</td>
<td>10.4</td>
</tr>
</tbody>
</table>

*The 13-year-old child, the index child, has not been included.

Table AP6.7. - Social characteristics: distribution of children by gender

<table>
<thead>
<tr>
<th></th>
<th>GIRLS</th>
<th>BOYS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-Y.O. CHILD</td>
<td>96</td>
<td>68</td>
<td>164</td>
</tr>
<tr>
<td>SIBLINGS</td>
<td>183</td>
<td>186</td>
<td>369</td>
</tr>
<tr>
<td>TOTAL</td>
<td>279</td>
<td>254</td>
<td>533</td>
</tr>
</tbody>
</table>
6. SUMMARY:

Social class differences were found in most of the characteristics analysed. A summary of the social characteristics is now given.

For social class A the majority of families were living in 'nucleo central' and all the parents had gone through at least twelve years of formal education (80% of them had gone through higher education). The family monthly income was always above ten minimum wages, the majority of families having an income equivalent to more than twenty minimum wages (>20 M.W.). Most of the mothers had a paid job, and the family size was 2.8 children/family.

The families from social class B were distributed in the five areas of Belo Horizonte, the majority of them though were concentrated in 'nucleo central'. In spite of the level of education of parents being high - the majority had at least twelve years of formal education - 60% of them had gone to higher education. Income level for this group was quite high, since all the families lived on a monthly income above five minimum wages, with the majority of them concentrated in the income group of more than ten but up to twenty minimum wages (>10-20 M.W.). Most of the mothers were in a paid job, and the mean number of children per family was 2.8.

In social class C the greatest number of families was concentrated in 'pampulha' and 'eixo industrial'. The educational level of parents was scattered in all groups, the predominant patterns was of four years of schooling. The family
income ranged from one to ten minimum wages/month, but the majority of these families lived on a monthly income of more than three but up to five minimum wages (>3-5 M.W.). Few mothers were in a paid job, and the mean number of children per family was 3.3.

The families from social class D were living in 'pampulha' and 'eixo industrial', the latter concentrated the largest number of them. The parental level of education was low since most of the parents had attended four years of schooling at most. The income level was also low, varying from one to ten minimum wages/month. The greatest concentration of these families earned more than one but up to two minimum wages (>1-2 M.W.). Few mothers had a paid job, and the mean family size was the largest, 4.1 children/family.
1. INTRODUCTION:

The assessment of intra-family patterns in dental health status, through path analysis, comprised data from both parents and all of their children aged 10 years and above. In Chapter 3, a detailed description of the oral health status and related behaviours was given for the parents and the index children (13-year-old children).

In this appendix, the children (aged 10 years and above) are analysed together, and the results are followed by a summary. It was decided to present the description (with the data analysis) of these children separately for one main reason. When analysing children from the same family, the assumption of independence, which should be respected in all the statistical procedures employed in the data analyses, is violated. Hence the statistical results obtained from these analyses are compromised and should be treated with caution. However, it would be important to present a detailed description of these children, since the results obtained from path analysis are highly dependent of the sample they were derived from. Therefore, it was thought acceptable to present a detailed description of the children, aged 10 years and above,
separately, stressing the fact that the statistical inferences should be treated with care.

In this appendix, an analysis by social class of the oral health status and the oral health related behaviours is presented. The first section covers a brief presentation of the statistical procedures applied to the data. The second section covers the results obtained, and the final section provides a summary of the results.

2. STATISTICAL PROCEDURES:

The statistical procedures used in the analyses of the data from the children, aged 10 years and above, are very similar to what has been described in Chapter 3. In this section, only the most relevant points concerning these procedures will be briefly reviewed.

2.1. CLINICAL DATA:

2.1.1. Dental Status:

The dental status was evaluated with the use of DMFS and its components (DS, MS, and FS) (Appendix 3). The analysis of these data comprised the one-way analysis of variance (Anova) and an 'a posteriori' multiple comparison test, Tukey-Kramer.

There are three assumptions underlying the use of one-way analysis of variance: independence, normality, and
homoscedasticity (homogeneity of variance). These assumptions were fully discussed in Chapter 3. In this appendix, however, it becomes important to bring to light once more the assumption of independence.

Anova assumes that the subjects in each of the independent sample groups are randomly and independently drawn so that an observed value in any one group has no effect or influence on any other observed value in that group or any of the other groups. The assumption is, therefore, violated in the analyses of the data from the children (aged 10 years and above) since some of them come from the same family, and are related.

In order to overcome this problem, it would be advisable to use the random effect or hierarchical model. For such an analysis, due to the large sample size (164 families), the capacity of a computer should be large. Since the computer facilities available were not adequate, such a procedure could not be undertaken. Therefore, the statistical inferences from Anova should be seen with caution.

When using one-way Anova, it is assumed that the variances of each of the groups under comparison are homogeneous (homoscedasticity). For balanced samples, Anova is quite robust to violations of this assumption. For unbalanced samples, Anova was shown to be robust provided the sample size is positively correlated with the size of the variance (Box, 1954).

The several tests for homogeneity of variance available are oversensitive to small departures of normality, and their results are questionable. In the present analysis, Cochran's test was applied (Winer, 1971). When the homogeneity test was
rejected at the 0.1% level \((p = .001)\) (Anderson and McLean, 1974), a non-parametric test statistic (Kruskal-Wallis) was applied to the data, and the results of both analyses are given.

In order to detect which sample means differed, a pairwise multiple comparison test was used: Tukey-Kramer test. This test is based on the harmonic mean of the two groups under comparison, being indicated, therefore, for unbalanced cases (unequal sample sizes) (Winer, 1971; Stoline, 1981). This test also assumes that variance is homogeneous (homoscedasticity). It is important to state that, according to the literature reviewed (Winer, 1971; O'Neill and Wetherill, 1971; Carmer and Swanson, 1973; Ury, 1976; Stoline, 1981) it does not seem to exist an adequate 'a posteriori' pair-wise multiple comparison test that overcomes the problem of heteroscedasticity (heterogeneity of variance). Therefore, Tukey-Kramer test, in spite of not being 'ideal' for such cases, was used in the present analysis. In an attempt to overcome this shortcoming, a non-parametric multiple comparison test was calculated and its results are also presented.

All the calculations of Anova and related tests were performed using SPSS/PC+ Version 2.0 (Norušis, 1988).

2.1.2. Oral Hygiene Index:

Oral hygiene was assessed using the simplified oral debris index (ODI-S) (Greene and Vermillion, 1964) (Appendix 3). Since ODI-S falls into a \textit{ordinal} scale, a non-parametric test was
applied to the data (Siegel and Castellan, 1988; Worthington, 1989).

Kruskal-Wallis is a highly efficient non-parametric test. Despite the assumptions of normality, homoscedasticity or additiveness not being relevant when using this test, the assumption of independence should be respected. For this reason, the results drawn from the analyses here presented should be considered with caution.

The variance of the sampling distribution of Kruskal-Wallis is influenced by ties (Siegel and Castellan, 1988). Since there are methods for adjusting for ties, all the results from Kruskal-Wallis given are corrected for ties.

In order to determine which group/s differ, a multiple comparisons test was performed (Siegel and Castellan, 1988).

Kruskal-Wallis one-way analysis of variance was performed using SPSS/PC+ Version 2.0 (Norušis, 1988). The multiple comparison test was performed by this author by hand, following the description in Siegel and Castellan (1988 p.213-214). All the hand calculations were performed at least twice. When identical results were obtained for the first and second calculations, that value was considered correct. If results differed, the calculation was repeated as many times as necessary for the obtention of two identical results.
2.2. BEHAVIOURAL DATA:

The analysis of the behavioural data followed what has been described so far for the clinical data. For this reason, only differences in data analysis will be described.

2.2.1. Dietary Habits:

Dietary habits were assessed by means of the 24-hour recall method (Appendices 1 and 2). All food intakes during the previous 24 hours were recorded, but in the present discussion only sugar consumption intake is presented. As described in Chapter 3, the intake frequency was estimated by counting the number of sugary items consumed during the previous 24 hours (Varveri and Bellagamba, 1986). The total sugar intake frequency was then sub-divided into intake at meals and intake in-between meals. In addition sugar intake frequency was analysed according to the source of origin of the sugary item, that is, if it was available at home, if it was given to the child or if it was purchased by the child (Croucher and Rodgers, 1985).

The analysis of these data comprised the one-way analysis of variance (Anova) and Anova-related tests. If the assumption of homoscedasticity did not hold true, Kruskal-Wallis test was performed, and the results from both analyses are given.
2.2.2. Oral Hygiene Habits:

The assessment of oral hygiene habits comprised reported tooth-brushing frequency (Appendices 1 and 2), collected during the interviews. For the data analysis the reported tooth-brushing frequency was recoded into three categories: less than once/day, once/day, and more than once/day.

Kruskal-Wallis one-way analysis of variance and related tests were then performed on the data.

2.2.3. Pattern of Dental Attendance:

Data on the pattern of dental attendance consisted of the frequency of dental attenders and non-attenders among interviewees. For dental attenders, further analyses were carried out: the usual type of dentist, the time interval since last visit to the dentist, and the usual reason for dental attendance.

Since most of the variables follow a nominal scale, the chi-square test was used during data analyses. Proper application of this procedure requires that the expected frequencies in each cell are not too small. As a rule of thumb, it is recommended that in chi-square tests for which the degrees of freedom are greater than 1, no more than 20% of the cells should have an expected frequency of less than 5, and no cell should have an expected frequency of less than 1 (Bland, 1987; Siegel and Castellan, 1988).
In addition, for the proper application of the chi-square test, it is assumed that the cells and the units in each cell are randomly and independently drawn. Therefore, this assumption of independence is violated, making the statistical inferences from the data analyses questionable.

The chi-square test statistic was calculated using SPSS/PC+ Version 2.0 (Norusis, 1988).

All the p values given in the data analyses of any of the variables here described are two-tailed values.

3. RESULTS:

The analyses of the oral health status and related behaviours comprised all the index children (13-year-old children) and the siblings at the age of ten and above. A total of 389 children were analysed: 164 13-year-old children and 255 siblings (aged 10 and above). These 389 children were unevenly distributed among the four social classes: social class A with 80 children, social class B with 88 children, social class C with 100 children and social class D with 121 children.
3.1. CLINICAL DATA:

3.1.1. Dental Health Status:

The mean DMFS score of children from all social classes was 10.2 (s.d. 12.2). Children from social class A had the lowest DMFS score, 6.4 (s.d. 5.3). Children from social classes B and D had virtually the same DMFS scores, 10.6 (s.d. 10.3) and 11.1 (s.d. 15.2). Children from social class C had the highest DMFS scores, 12.0 (s.d. 13.0) (Table AP7.1.).

Age and gender are known to affect dental caries experience among children. Prior to the analysis of DMFS scores, adjustment for age and sex was performed. DMFS scores were regressed on a cubic polynomial on age and sex (age, age^2, age^3, sex, sex x age, sex x age^2, sex x age^3) in a stepwise manner. The higher-order age and sex terms were retained in the regression equation only if they were significant at the 5% level (p < .05). Therefore, the regression equation for children's DMFS scores was

\[ \text{DMFS} = -2.51 + 4.89 (\text{age}^3) \]

This equation explained 34% of the variance (\( r^2 = .339 \)). While age showed a non-linear relationship with dental health status, gender did not seem to influence DMFS scores in this group of children.
Scores predicted from this equation were subtracted from original scores to derive residual scores, which were then used for further analysis. The residual scores obtained from the regression equation were first assessed for normality and homoscedasticity.

A histogram of the residuals was obtained, and it was observed that the residuals were normally distributed. The scatterplot of residuals against predicted values showed that the residuals were randomly distributed, indicating homogeneity of variance. Hence the multiple regression equation was accepted.

One-way analysis of variance was performed on the residuals. No differences in dental health status was detected ($F = 1.55; p = .201$) (Table AP7.1.). Cochran's C test for homogeneity of variance rejected the hypothesis of homoscedasticity ($C = .49, p = .000$). Therefore, Kruskal-Wallis one-way analysis of variance was also performed on the data.

The results of Kruskal-Wallis showed a statistically significant difference in dental health status among the four social classes ($KW = 9.84; p = .012$). The multiple comparison test pinpointed a difference between children from social class B and D, with children from social class B having a higher mean ranking than those from social class D ($A = 182.9; B = 224.5; C = 199.6; and D = 178.1$).
Table AP7.1. - Children's* DMFS, DS, MS, FS, (mean and standard deviation) by social class#.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>DMFS</th>
<th>DS</th>
<th>MS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (n = 80)</td>
<td>6.4 (5.3)**</td>
<td>0.4 (1.1)</td>
<td>0.0 (0.0)</td>
<td>6.0 (5.2)</td>
</tr>
<tr>
<td>B (n = 88)</td>
<td>10.6 (10.3)</td>
<td>1.0 (2.3)</td>
<td>0.5 (2.1)</td>
<td>9.1 (8.5)</td>
</tr>
<tr>
<td>C (n = 100)</td>
<td>12.0 (13.0)</td>
<td>2.8 (7.7)</td>
<td>1.9 (4.2)</td>
<td>7.2 (7.8)</td>
</tr>
<tr>
<td>D (n = 121)</td>
<td>11.1 (15.2)</td>
<td>3.4 (7.1)</td>
<td>2.6 (7.5)</td>
<td>5.0 (6.2)</td>
</tr>
<tr>
<td>TOTAL (n = 389)</td>
<td>10.2 (12.2)</td>
<td>2.1 (5.8)</td>
<td>1.4 (4.9)</td>
<td>6.7 (7.2)</td>
</tr>
</tbody>
</table>

*Age group: 10 to 21 years.

**Figures in parentheses are standard deviations

#Anova was performed on the residuals of a stepwise multiple regression of DMFS, DS, MS and FS on a cubic polynomial in age and sex. The values of Anova here presented are age-sex-adjusted.

- DMFS - F = 1.55  p = .201
- DS - F = 3.39  p = .018  (Tukey-K = A vs D)
- MS - F = 2.73  p = .044  (Tukey-K = no differences)
- FS - F = 11.90  p = .000  (Tukey-K = A vs B,D; B vs C,D; C vs D)

The total mean number of decayed surfaces was 2.1 (s.d. 5.8). Children from social class A had 0.4 (s.d. 1.1) decayed surfaces; social class B 1.0 (2.3); social class C 2.8 (s.d. 7.7); and social class D 3.4 (s.d. 7.1) (Table AP7.1.).

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Anova was performed on the residuals of the stepwise multiple regression equation of decayed surfaces on a cubic polynomial on age and sex. The residuals were calculated from the subtraction from the original scores of the predicted scores, which in turn were derived from the following equation

\[ DS = 5.86 - 0.11 \text{ (age}^2\text{)} + 0.01 \text{ (age}^3\text{)} \]

This equation explained 15% of the variance \((r^2 = .146)\). The regression equation showed that while gender did not show a relationship with DS scores, age had a non-linear relationship with the number of decayed surfaces of these children.

Assessment of normality and homogeneity assumptions, using scatterplot and histogram, showed that the residuals were normally distributed and had homogeneous variance.

Anova was then performed on the age-sex-adjusted DS scores. A statistically significant difference among the four groups emerged. Children from social class A had a lower mean number of decayed surfaces (adjusted for sex and age) than children from social class D (Tukey-K = A vs D) (Table AP7.1.).

Since the hypothesis of homoscedasticity was rejected \((C = .53; \ p = .000)\), Kruskal-Wallis one-way analysis of variance was carried out. The results obtained confirmed Anova \((KW = 8.18; \ p = .04)\). Multiple comparison test showed that the difference in mean ranking score was between children from social classes A and D \((A = 178.8; \ B = 181.7; \ C = 192.1; \ D = 217.8)\).
The mean number of **missing surfaces** when all the children were grouped together was 1.4 (s.d. 4.9). While the children from social class A had no extracted teeth, the children from social class D had a mean number of missing surfaces of 2.6 (s.d. 7.5). Children from social class B had a mean MS of 0.5 (s.d. 2.1) and from social class D 1.9 (s.d. 4.2) (Table AP7.1.).

Sex-age adjustment of MS scores used a stepwise multiple regression of MS on a cubic polynomial on age and sex. High-order terms, significant at the 5% level were retained, and the following equation was obtained

\[
MS = 0.85 - 0.03 (\text{sex} \times \text{age}^2) + 0.002 (\text{sex} \times \text{age}^3)
\]

This equation explained 20% of the variance \(r^2 = .203\). Both gender and age emerged as having a non-linear relationship with the number of missing surfaces of the children in the present study. The assumptions of normality and homoscedasticity, assessed through histogram and scatterplot of the residual, were accepted. The residuals were then used in the Anova.

In spite of the Anova showing a statistically significant difference among the four groups \(F = 2.73; p = .044\), Tukey-Kramer's multiple comparison test did not detect any difference (Table AP7.1.). One possible explanation for that is the conservative nature of multiple comparison tests in general.

Since the hypothesis of homogeneity of variance was rejected \((C = .68; p = .000)\), Kruskal-Wallis was performed \((KW = .71; p = .871)\). The results did not reveal any difference
among the four groups, confirming the findings of Tukey-Kramer's multiple comparison test.

The mean number of filled surfaces for all the children was 6.7 (s.d. 7.2). Children from social class A had a mean FS score of 6.0 (s.d. 5.2), from social class B 9.1 (s.d. 8.5), from social class C 7.2 (s.d. 7.8), and from social class D 5.0 (s.d. 6.2) (Table AP7.1.).

Age-sex-adjusted FS were obtained through a stepwise multiple regression of DS scores on a cubic polynomial on age and sex. The higher-order terms retained in the equation were

\[ FS = -17.75 + 2.02 \text{(age)} - 0.001 \text{(sex x age}^3) \]

This equation explained 22% of the variance \((r^2 = .217)\) and showed a non-linear relationship of both sex and gender with the FS scores of the children participating in the present study. Histogram of the residuals showed that residuals were fairly normally distributed. Scatterplot of the residual against predicted values showed that these residuals were randomly distributed, confirming the hypothesis of homoscedasticity. These residuals were then used in the Anova.

One-way Anova revealed statistically significant differences in the sex-age-adjusted FS scores among the four groups \((F = 11.90; \ p = .000)\). This finding was due to the differences among children from social class A when compared with social classes B and D; of children from social class B when compared with social classes C and D; and from children
from social class C when compared with social class D (Tukey-K = A vs B,D; B vs C,D; C vs D) (Table AP7.1).

Cochran's C test for homogeneity of variance accepted the assumption of homoscedasticity (C = .33; p = .036).

3.1.2. Oral Hygiene Index:

The mean ODI-S score for all the children, aged 10 years and above, when grouped together was .59 (s.d. .46). Lowest scores were found amongst children from the 'more privileged' social classes. Children from social class A had a mean ODI-S score of .35 (s.d. .37), and those from social class B .56 (s.d. .39). Mean ODI-S score for children from social class C was .64 (s.d. .45), and for children from social class D .72 (s.d. 50) (Table AP7.2.).

Mean ODI-S scores in all social classes were clinically low. Statistically significant differences among the four social classes were observed, however (KW = 39.74; p = .000). Children from social class A had a lower mean ODI-S score than children from the other three social classes: B, C, and D.
Table AP7.2. - ODI-S (mean and standard deviation) by social class

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.35 (.37)*</td>
<td>.56 (.39)</td>
<td>.64 (.45)</td>
<td>.72 (.50)</td>
<td>.59 (.46)</td>
</tr>
<tr>
<td>(n = 80)</td>
<td>(n = 88)</td>
<td>(n =100)</td>
<td>(n =121)</td>
<td>(n =389)</td>
<td></td>
</tr>
</tbody>
</table>

*Figures in parentheses are standard deviations.

Children - KW = 39.74  p = .000  (A vs B,C,D)

3.2. BEHAVIOURAL DATA:

3.2.1. Dietary Habits:

On the whole the total amount of sugary items intake was very high: the mean intake for all the children was 7.9 items (s.d. 4.6). Children from social class A and D consumed a lowest mean number of sugary items : 6.9 (s.d. 3.1) and 7.1 (s.d. 4.4), respectively. Children from social class B and D showed very similar mean number of sugary items intake, both extremely high, 8.7 (s.d. 5.4) and 9.1 (s.d. 4.8), respectively (Table AP7.3).
Statistically significant differences emerged among the four groups ($F = 6.05; p = .001$). Tukey-Kramer's multiple comparison test pinpointed differences between children from social classes A and D when compared with children from social class B and C (Table AP7.3.). Homoscedasticity was accepted ($C = .35; p = .003$)

Table AP7.3. - Frequency of sugary items intake/day (mean and standard deviation) of children* by social class.

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>TOTAL NUMBER OF SUGARY ITEMS</th>
<th>SUGARY ITEMS AT MEALS</th>
<th>SUGARY ITEMS IN-BETWEEN MEALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (n = 80)</td>
<td>6.9 (3.1)**</td>
<td>2.9 (1.6)</td>
<td>4.0 (2.6)</td>
</tr>
<tr>
<td>B (n = 88)</td>
<td>8.7 (5.4)</td>
<td>2.5 (1.3)</td>
<td>6.2 (4.9)</td>
</tr>
<tr>
<td>C (n =100)</td>
<td>9.1 (4.8)</td>
<td>2.5 (1.3)</td>
<td>6.6 (4.7)</td>
</tr>
<tr>
<td>D (n =121)</td>
<td>7.1 (4.4)</td>
<td>2.1 (1.1)</td>
<td>4.9 (4.1)</td>
</tr>
<tr>
<td>TOTAL (n=389)</td>
<td>7.9 (4.6)</td>
<td>2.5 (1.3)</td>
<td>5.4 (4.3)</td>
</tr>
</tbody>
</table>

*Children aged 10 and above  
**Figures in parentheses are standard deviations

TOTAL NUMBER - $F = 6.05 \ p = .001$ (Tukey-K = A,D and B,C)  
AT MEALS - $F = 5.09 \ p = .002$ (Tukey-K = A vs D)  
IN-BETWEEN MEALS - $F = 7.27 \ p = .001$ (Tukey-K = A vs B,C; C vs D)
At meals sugary items intake on the previous 24 hours was 2.5 (s.d. 1.3) for all children. Children from the different social classes showed a very similar pattern of intake: children from social class A consumed 2.9 items (s.d. 1.6), from social class B 2.5 (s.d. 1.3), from social class C 2.5 (s.d. 1.3), and from social class D 2.1 (s.d. 1.1). Social class differences emerged, however (F = 5.09; p = .002). These differences were due to the higher intake of children from social class A when compared with social class D (Tukey-K = A vs D) (Table AP7.3.). Homogeneity of variance among the four groups was accepted (C = .35; p = .006).

The mean number of sugary items consumed in-between meals was 5.4 (s.d. 4.3). The mean in-between meals intake of children form social class A was 4.0 (s.d. 2.6), followed by children of social class D, with a mean intake of 4.9 (s.d. 4.1). Children from social class B consumed 6.2 items (s.d. 4.9) and from social class C 6.6 (s.d. 3.7). Social class differences were detected (F = 7.27; p = .001) among children from social class A when compared with those from social class B and C, and among children from social class C when compared with those from social class D (Tukey-K = A vs B,C; and C vs D) (Table AP7.3.). Homogeneity of variance was accepted (C = .34; p = .017).

The source of sugary items of the children was also investigated. To this end, children were asked the origin of the sugary items: if got at home, if given to the child or if bought by the child.

The main source of sugary items was home. The mean value of sugary items got at home was 4.8 (s.d. 3.1) for all
Children. Children from social class D had 4.0 sugary items (s.d. 2.2) got from home. Children from social classes A, B and C had 4.9 (s.d. 3.1), 5.2 (s.d. 3.4), and 5.5 (s.d. 3.4) sugary items got from home, respectively. Social class differences emerged \( F = 5.48; p = .001 \), when children from social class D were compared with children from social classes B and C (Tukey-K = D vs B,C) (Table AP7.4.). Homoscedasticity was confirmed \( (C = .31 p = .105) \).

<table>
<thead>
<tr>
<th>SOCIAL CLASS</th>
<th>SUGARY ITEMS GOT AT HOME</th>
<th>SUGARY ITEMS BOUGHT BY CHILD</th>
<th>SUGARY ITEMS GIVEN TO CHILD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (n = 80)</td>
<td>4.9 (3.1)**</td>
<td>1.5 (2.0)</td>
<td>0.4 (0.9)</td>
</tr>
<tr>
<td>B (n = 88)</td>
<td>5.2 (3.4)</td>
<td>2.3 (3.4)</td>
<td>1.2 (3.4)</td>
</tr>
<tr>
<td>C (n = 100)</td>
<td>5.5 (3.4)</td>
<td>2.8 (4.0)</td>
<td>0.7 (2.2)</td>
</tr>
<tr>
<td>D (n = 121)</td>
<td>4.0 (2.2)</td>
<td>2.3 (4.2)</td>
<td>0.8 (1.7)</td>
</tr>
<tr>
<td>TOTAL (n = 389)</td>
<td>4.8 (4.5)</td>
<td>2.7 (3.6)</td>
<td>0.8 (2.2)</td>
</tr>
</tbody>
</table>

*Children aged 10 and above
**Figures in parentheses are standard deviations

GOT AT HOME - \( F = 5.48 \ p = .001 \) (Tukey-K = D vs C,B)

BOUGHT BY CHILD - \( F = 1.91 \ p = .128 \)

GIVEN TO CHILD - \( F = 1.74 \ p = .158 \)
The mean number of sugary items bought by the child was 2.7 (s.d. 3.6). Social class differences were not detected at the 5% level (F = 1.91; p = .128). The mean number of sugary items bought by children from social class A was 1.5 (s.d. 2.0), from social class B 2.3 (s.d. 3.4), from social class C 2.8 (s.d. 4.0), and from social class D 2.3 (s.d. 4.2) (Table AP7.4). Homogeneity of variance was confirmed (C = .35; p = .005).

Overall a small number of sugary items was given to the children in this present study: 0.8 items (s.d. 2.2). Social class differences were not detected at the 5% significance level (F = 1.74; n.s. at 5% level). Children from social class A bought a mean number of 0.4 (s.d. 0.9) of the sugary items they consumed; from social class B 1.2 (s.d. 3.4); from social class C 0.7 (s.d. 2.2); and from social class D 0.8 (s.d. 2.2) (Table AP7.4.).

Since heteroscedasticity was observed (C = .57; p = .000), Kruskal-Wallis one-way analysis of variance was carried out. As with Anova, no statistically significant difference at the 5% level emerged among the four groups (KW = 2.09; n.s. at 5% level). This finding confirms the robustness of one-way Anova for heteroscedasticity when the variance of a cell is correlated to the cell sample size it was derived from.
3.2.2. Oral Hygiene Habits:

The majority of the children (83.8%) in this study reported a tooth-brushing frequency of more than once a day. Only 4.4% of them stated brushing their teeth less often than once a day. Social class differences emerged among the children from social class A when compared with those from social class D (KW = 19.41; p = .000) (Table AP7.5.).

Table AP7.5. - Children's frequency and relative frequency of distribution of reported brushing frequency by social class

<table>
<thead>
<tr>
<th>RESPONDENT BRUSHING FREQUENCY</th>
<th>SOCIAL CLASS</th>
<th></th>
<th></th>
<th></th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>&lt;1/DAY</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>(3.4)*</td>
<td>(3.0)</td>
<td>(9.1)</td>
<td>(4.4)</td>
<td></td>
</tr>
<tr>
<td>1/DAY</td>
<td>5</td>
<td>7</td>
<td>11</td>
<td>23</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>(6.3)</td>
<td>(8.0)</td>
<td>(11.0)</td>
<td>(19.0)</td>
<td>(11.8)</td>
</tr>
<tr>
<td>&gt;1/DAY</td>
<td>75</td>
<td>78</td>
<td>86</td>
<td>87</td>
<td>326</td>
</tr>
<tr>
<td></td>
<td>(93.8)</td>
<td>(88.6)</td>
<td>(86.0)</td>
<td>(71.9)</td>
<td>(83.8)</td>
</tr>
</tbody>
</table>

*Figures in parentheses are relative frequencies, expressed in percentages
**Age group = 10 to 21 years

Children - KW = 19.41  p = .000 (A vs D)
3.2.3. Pattern of Dental Attendance:

The majority of the children (aged 10 and above) had been to a dentist. Social class differences seemed to be present in the frequency of attenders and non-attenders ($X^2_3 = 24.55; p = .000$). This difference, however, should be treated with caution since 25% of the cells showed an expected frequency of less than 5.

All the children from social class A had been to a dentist (80 children). Nearly all the children (99%) from social class B had visited a dentist (87 children). Ninety-seven children from social class C reported having been to a dentist (97%), and from social class D 86% of them stated having attended a dentist (104 children).

Most of the children (54%) had a private dentist, 26% went to a NHS dentist, and 20% were on a 3rd-party co-payment. Statistically significant differences emerged among the four groups ($X^2_6 = 104.91; p = .000$). More children from social class A visited a private dentist (90%), while the majority of children from social class D had a NHS dentist (54%) (Table AP7.6.).
Table AP7.6. - Children’s* frequency distribution of type of dentist by social class

<table>
<thead>
<tr>
<th>RESPONDENT TYPE OF DENTIST</th>
<th>SOCIAL CLASS A</th>
<th>SOCIAL CLASS B</th>
<th>SOCIAL CLASS C</th>
<th>SOCIAL CLASS D</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRIVATE</td>
<td>72 (90.0)**</td>
<td>55 (63.2)</td>
<td>44 (45.4)</td>
<td>29 (27.9)</td>
<td>200</td>
</tr>
<tr>
<td>NHS</td>
<td>0 (9.2)</td>
<td>8 (27.6)</td>
<td>31 (32.0)</td>
<td>56 (53.8)</td>
<td>95</td>
</tr>
<tr>
<td>3rd-PARTY CO-PAYMENT</td>
<td>8 (10.0)</td>
<td>24 (22.7)</td>
<td>22 (22.7)</td>
<td>19 (18.3)</td>
<td>73</td>
</tr>
</tbody>
</table>

*Age group: 10 to 21 years
**Figures in parentheses are relative frequencies, expressed in percentages

Children - $X^2_{6} = 104.91$ p = .000 (no cells with E.F. <5)

The majority of the children reported visiting a dentist for check-ups (62%). Statistically significant differences were observed among the four social classes ($X^2_{3} = 135.24$; p = .000). While the majority of the children from social classes A (100%) and B (82%) reported visiting a dentist for check-ups, 78% of the children from social class D stated having symptom-related reason as their usual reason for dental attendance (Table AP7.7.).
### Table AP7.7. - Children's* frequency distribution of usual reason for dental attendance by social class.

<table>
<thead>
<tr>
<th>RESPONDENT USUAL REASON</th>
<th>SOCIAL CLASS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>SYMPTOM-RELATED</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td><strong>(18.4)</strong></td>
<td><strong>(45.4)</strong></td>
<td><strong>(77.9)</strong></td>
</tr>
</tbody>
</table>

**CHILDREN**

<table>
<thead>
<tr>
<th>CHECK-UPS</th>
<th>80</th>
<th>71</th>
<th>53</th>
<th>87</th>
<th>141</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(100.0)</strong></td>
<td><strong>(81.6)</strong></td>
<td><strong>(54.6)</strong></td>
<td><strong>(22.1)</strong></td>
<td><strong>(61.7)</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Age group: 10 to 21 years

**Figures in parentheses are relative frequencies, expressed in percentages

Children - $X_3^2 = 135.24$  $p = .000$ (no cells with E.F. < 5)

Forty-two percent of the children stated having been to a dentist within the last 6 months. One-third of them reported having visited a dentist within the previous 6 to 24 months, and one-quarter of them had not been to a dentist for more than 24 months. Statistically significant differences were detected ($X_6^2 = 93.45; p = .000$). While more children from the two 'more privileged' social classes reported having paid a visit to a dentist in the previous 6 months, children from the two 'less privileged' social classes were more likely to state having not been to the dentist for more than 24 months. One-
third of children from each of the four social classes, however, stated having been to the dentist within the previous 6 to 24 months (Table AP7.8.).

Table AP7.8. - Children's* frequency distribution of time interval since last visit to dentist, by social class.

<table>
<thead>
<tr>
<th>RESPONDENT TIME INTERVAL</th>
<th>SOCIAL CLASS A</th>
<th>SOCIAL CLASS B</th>
<th>SOCIAL CLASS C</th>
<th>SOCIAL CLASS D</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 MONTHS</td>
<td>51</td>
<td>56</td>
<td>31</td>
<td>18</td>
<td>156</td>
</tr>
<tr>
<td></td>
<td>(63.8)**</td>
<td>(64.4)</td>
<td>(32.0)</td>
<td>(17.3)</td>
<td>(42.4)</td>
</tr>
<tr>
<td>6-24 MONTHS</td>
<td>24</td>
<td>27</td>
<td>38</td>
<td>33</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td>(30.0)</td>
<td>(31.0)</td>
<td>(39.2)</td>
<td>(31.7)</td>
<td>(33.2)</td>
</tr>
<tr>
<td>&gt;24 MONTHS</td>
<td>5</td>
<td>4</td>
<td>28</td>
<td>53</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>(6.3)</td>
<td>(4.6)</td>
<td>(28.9)</td>
<td>(51.0)</td>
<td>(24.5)</td>
</tr>
</tbody>
</table>

*Age group: 10 to 21 years
**Figures in parentheses are relative frequencies, expressed in percentages

Children - $X^2 = 93.45$  $p = .000$  (no cells with E.F. < 5)

4. SUMMARY:

Dental caries experience was very high for this group of Brazilian children. While one-way [Anova] could not detect a statistically significance difference in sex-age-adjusted DMFS
scores among the children from the different social classes, Kruskal-Wallis one-way analysis of variance pinpointed a difference between the children from social class B and D. The former had a higher mean ranking order. When the sex-age-adjusted DMFS components were analysed, however, social class differences emerged. The children from the 'more privileged' social classes had a larger mean number of filled surfaces (FS), while those from the 'less privileged' social classes presented more untreated disease (DS). No statistically significance was detected for the mean number of missing surfaces (MS) among the children from the different social classes.

Oral hygiene status was very good among these children. Statistically significant differences were observed, however, when Kruskal-Wallis one-way analysis of variance was applied to the data. Children from the 'more privileged' social classes had a lower ODI-S score than those from the 'less privileged' social classes. The clinical significance of these statistically significant differences are questionable due to the overall low mean ODI-S scores observed for all social classes.

Overall the sugar consumption within the previous 24 hours was very high. All the children reported a mean sugar intake of 7 items, which puts them all into the high risk group (Varveri and Bellagamba, 1986). Statistically significant differences were found among the children from the different social classes. The children from social classes A and D reported a lower sugar consumption than those from social class C.
Most of the sugary items consumed within the previous 24 hours were obtained from home. Statistically significant differences emerged among the children from the four social classes: children from social class D obtained a lower mean number of sugary items from home than those from social classes B and C. However, since sugar was so widely available at home for all social classes, the clinical significance of this statistical difference may be questioned.

The majority of the children (83.8%) reported a tooth-brushing frequency of more than once/day. Very few children reported brushing their teeth less often than once/day (4.4%). While statistically significant differences were detected (children from social class A reported a higher frequency than those from social class D), the clinical significance of this finding is questionable.

Most of the children reported having been to a dentist at least once. Children from the 'more privileged' social classes were more likely to state having seen a private dentist within the previous 6 months and being check-ups their usual reason for seeking dental care. On the other hand the children of the 'less privileged' social classes were more likely to report seeing a school-dentist, visiting a dentist for symptom-related reasons, and not attending for dental care within the previous 6 months.
I would like to gratefully acknowledge Professor Aubrey Sheiham, who as thesis adviser made many useful comments, criticisms and suggestions over the years.

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