1. INTRODUCTION

“Think globally - act locally”

WHO Oral Health Programme

Health promotion deals with the broader determinants of health. It aims at reducing risks through sensitive policies and actions. Health Promotion in the settings where people live, work, learn and play is a creative and cost-effective way of improving oral health and, thereby, the quality of life.

The late twentieth century saw a transformation in general and oral health unmatched in history. Yet, despite these remarkable achievements, millions of people worldwide have been excluded from the benefits of socioeconomic development and the scientific advances that have improved health care and quality of life. The past decade has been a time of significant change in international health. The understanding of the causes and consequences of ill health is changing. The social, economic, political and cultural determinants of health are significant. It may be argued that better health can be achieved by reducing poverty. Moreover, health systems, including oral health systems, have roles to play in the transformation. Systems are becoming more complex and people’s expectations of health care are rising dramatically. In many countries, the role of the state is changing rapidly, and the private sector and civil society are emerging as important players. In developing countries, a growing number of development organizations, private foundations and non-governmental organizations are becoming active in the health sector.
WHO's goals are to build healthy populations and communities and to combat ill health. Four strategic directions provide the broad framework for focusing WHO's technical work, which also have implications for the Oral Health Programme.

- Reducing oral disease burden and disability, especially in poor and marginalized populations.
- Promoting healthy lifestyles and reducing risk factors to oral health that arise from environmental, economic, social and behavioural causes.
- Developing oral health systems that equitably improve oral health outcomes, respond to people's legitimate demands, and are financially fair.
- Framing policies in oral health, based on integration of oral health into national and community health programmes, and promoting oral health as an effective dimension for development policy of society.

In accordance with WHO overall priorities, the Global Oral Health Programme has adopted the following priorities and strategic orientations. The threat of non-communicable diseases and the need to provide urgent and effective public health responses led to the formulation of a global strategy for prevention and control of these diseases, endorsed in 2000 by the Fifty-third World Health Assembly (resolution WHA 53.17). Priority is given to diseases linked by common, preventable and lifestyle related risk factors (e.g. unhealthy diet, tobacco use) including oral health.
Research in clinical and public health has shown that a number of individual, professional and community preventive measures are effective in preventing most oral diseases. However, optimal intervention in relation to oral disease is not universally available or affordable due to escalating costs and limited resources. This, along with insufficient emphasis on primary prevention of oral diseases, poses a considerable challenge for many countries, especially the developing nations and nations with economies and health systems in transition.

However, there is profound oral health disparities across regions, countries and within countries. These may relate to socioeconomic status, race or ethnicity, age, gender or general health status (WHO). Though common dental diseases are preventable, not all community members are informed of or are able to benefit from appropriate oral health-promoting measures. Under-served population groups are present in both developed and developing countries. In many countries, oral health care is not fully integrated into national or community health program (Resolution WHA 53.14).

The major challenges of the future would be to translate knowledge and experiences about disease prevention into action program. Social, economic and cultural factors and changing population demographics impact the delivery of oral health services in countries and communities and the way people care for themselves. Reducing disparities requires far-reaching wide-ranging approaches that target populations at highest risk of specific oral diseases and involves improving access to existing care. In several developing countries the most important challenge is to offer
essential oral health care within the context of primary health program. Such program should meet the basic health needs of the population, strengthen active outreach to the community, organize primary care, and ensure effective patient referral system (Resolution WHA 53.14).

Increasing urbanization, demographic and socio-environmental changes require different approaches to oral health actions. It is unlikely that improvements in oral health can be achieved by isolated interventions that target specific behaviors. The most effective, sustainable interventions combine social policy and individual action through which healthy living conditions and lifestyles are promoted (Petersen, 2004).

A thorough knowledge and understanding of the pathological conditions affecting teeth is an essential pre-requisite to plan and execute treatment logically. There are four main conditions that result in defective tooth structure – dental caries, tooth wear, trauma and developmental defects. By far, dental caries is one of the most common chronic diseases in the world (WHO 2003).

Once it occurs, its manifestations persist throughout the life though the lesion may be treated. There are practically no geographic areas in the world whose inhabitants do not exhibit some evidence of dental caries. It affects persons of both the sexes in all races, all social-economic status and every age group. It usually begins soon after the teeth erupt in the oral cavity (WHO 2003).

Dental caries plays an important role in the manifestation of tooth pain and loss, and has been associated with problems in school and absenteeism in the workplace. This leads to a decrease in quality of life. Also, oral health
presents a close association with the individual’s general health, and may be a risk factor for several diseases (WHO 2003).

1.1 Background to the research

The major advancement in genetics has enabled a greater understanding of the human genome. In the near future, the DNA blueprint could foretell the lifespan, character traits, physical attributes and the disease susceptibility of a new born. This knowledge will be a boon in propagating the philosophy of ‘prevention is better than cure’ that has always remained the impetus of the ancient Indian wisdom to the true realm. Over the past 150 years, Dermatoglyphics has been a useful tool in understanding basic questions in biology, medicine, genetics and evolution, in addition to being the best and most widely used method for personal identification. In many aspects, it has been used as an adjunct to other disciplines, serving as a vehicle to resolve broader biomedical problems. Therefore dermatoglyphics serves as a tool to describe, compare and contrast, and predict occurrences and risks for biomedical events studied by major disciplinary areas such as biology, anthropology, genetics and medicine.

Dental caries is a complex, chronic disease and one of the most common pathology in dentistry today. The etiology of dental caries has been described as a complex problem complicated by many indirect factors that obscure the direct cause or causes. There is no universally accepted theory for the etiology of dental caries. Different etiological factors responsible for dental caries are carbohydrates, microorganisms and role of acids, role of dental plaque, morphological characteristics of the tooth,
composition and position, saliva factors, diet, systemic conditions and genetic factors (Shuler et al 2001). Werneck et al in 2010 have published a critical review of the genetic influence on dental caries. The susceptibility in question is controlled by heredity and this control is undoubtedly multifactorial in nature. Though dental caries is considered as an infectious disease, there are numerous host resistance and risk factors that are determined genetically. There is substantial evidence that heredity plays an important role in this multifactorial disease process through a variety of strategies as animal experiments, twin studies with zygosity assessment, localisation of the genes responsible for saliva factors, immunoglobulins, enamel structure etc. (Hassel et al 1995).

It is therefore possible to work on an association of dermatoglyphics to susceptibility to caries that could then potentially reduce the costs associated with treatment of caries by ensuring early appropriate preventive measures.

1.2 Research problem and hypotheses

Specific finger dermatoglyphic patterns can reliably predict the susceptibility to dental caries

1.2.1 Null hypothesis

There is no significant difference in the specific finger dermatoglyphic patterns in predicting the susceptibility to dental caries

1.2.2 Alternate hypothesis

There is significant difference in the specific finger dermatoglyphic patterns in predicting the susceptibility to dental caries
1.3 Justification for the research

The recent trend in dental research has been towards the investigation of the genetic factors related to common oral diseases. The success of these efforts has helped in identification of the groups more susceptible to these diseases.

The dermal pattern remains constant throughout life since formation. Dermatoglyphics is considered as the window of congenital abnormalities and is a sensitive indicator of intrauterine anomalies. The epidermal ridges initially appear in the form of localized cell proliferations around the 10th to 11th week of gestation (Babler 1978). These proliferations form shallow corrugations which project into the superficial layer of the dermis.

The number of ridges continue to increase, and are formed either between or adjacent to existing ridges. During this period of primary ridge formation, the characteristic patterns are formed. At about 14 weeks, the primary ridge formation ceases and secondary ridges begin to form as sweat gland, and develop along the apices of the primary ridges at uniform intervals. At this time, the epidermal ridges first begin to appear on the volar surfaces. The dermal papillae develop in the valleys between the ridges on the deep surface of the epidermis around the 24th week. Till then, the morphology of primary and secondary ridges appears as a smooth ridge of tissue and later peg like structures, the dermal Papillae, characteristic of the definitive dermal ridges progressively formed (Babler 1978).

Similarly the initiation of permanent tooth and the subsequent critical bud stage formation is initiated in the 14th week and thereafter continues to
progress to various stages with little time line difference for all the permanent teeth. (Tencate 1978).

In all aspects starting from the initiation, the interaction between the epithelium and the underlying ectomesenchyme, the various mechanisms in the processes of ridge and tooth development are comparable and instigates the correlation between the 2 tissues. For example, the epidermal ridges of the fingers and palms and the tooth bud are formed during the same embryonic period from the same embryonic tissue. The genetic message in the genome whether normal or abnormal is deciphered during this period and is reflected by dermatoglyphics. Thus with genetic susceptibility with relevance to the tooth structure and thereby the proneness to dental caries may be reflected in the dermatoglyphics namely whorl and loop patterns.

This philosophy encouraged us to undertake the present descriptive study so as to investigate the association of dermatoglyphic patterns to dental caries. These patterns could indicate that susceptibility to dental caries is reflected from intrauterine life and environmental factors activate the caries process.

1.4 Need for the study

The prevalence of dental caries in developed counties has shown a decline due to a better preventive measures and oral care. An extensive and comprehensive National Health Survey conducted in 2004 throughout India had shown dental caries in 51.9% in 5 year-old children, 53.8% in 12 year-old children and 63.1% in 15 year-old teenagers. The report
concluded that a preventive dentistry program should be initiated to address this national crisis in dental caries (Bali et al 2004).

Improving oral health in a population involves collection of information, evaluation of the data to understand the need of the community, identification of the high risk group and treatment planning and preventive strategies for community. We have adopted the same strategy in our study and improved quality of oral health information systems and operational goals worldwide strengthens health systems and translate knowledge about prevention and health promotion programs for the benefit of all sections of society. Also considering the cost of relevant treatment options, the findings from this study when it becomes operational will lessen the cost burden for the patients.

1.5 Methodology and outline of research

Research should span both qualitative and quantitative methodologies, it brings the ability to describe events in greater or less depth as needed, organise information in meaningful ways and ultimately draw reasonable conclusions. In a developing country like India, it might prove to be a non-invasive, inexpensive and effective tool for screening. Moreover, this tool can be utilised in any part of the world so as to suit for the individual country's scenario. Studying this correlation in a broad spectrum of population between 5 – 45 years which are indicator age groups as per the WHO (Peterson et al 2005) – towards measuring progress in oral health promotion and disease prevention program.

Our study will therefore encompass 3 phases, first phase as case control study comprising of 800 subjects in the age group of 5-15 years,
second phase as descriptive cross sectional study among 10,250 subjects. The third phase was also done as descriptive study but comprised of 5 clusters classified according to the age groups 5-7 years, 12-14 years, 15-17 years, 25-28 years and 35 – 45 years with equal distribution of gender and 315 subjects per group. The above phases will give candid picture on carious prevalence, dermatoglyphic pattern distribution and the reliability of the patterns in predicting the susceptibility to dental caries. We restricted the age group to 45 years, as beyond 45 years the prevalence of missing teeth is more and the subject may not be aware as for the reason for extraction as the incidence of periodontitis increases with age. We have included children from 5 years as most of the subjects will be available for the follow up for future studies.

For the field work, the principal investigator selected and formed field teams consisting of three dentists to assess the dental status and 2 volunteers to record the finger prints. The study is designed as a double blinded assessment to increase the validity of results and done by forensic fingerprint experts, retired from CB-CID, Tamilnadu Police. The finger prints were subsequently studied on the basis of their shapes and presence of triradial for qualitative parameters namely whorls, loops and arches and analysis of associations was done using SPSS software.

1.6 Scope and key assumptions

The present study investigates the association and reliability of specific dermatoglyphic patterns in fingers in predicting the susceptibility of dental caries in the 5-45 years age group across four South Indian states conducted as 3 phases in a population of 800,10,250 and 1575 subjects
collected over a period of 2 years. The findings aim to propagate dermatoglyphic analysis as means of exploring the genetic basis of the susceptibility to dental caries and establish the patterns of fingers as a valid marker for caries susceptibility. The findings are relevant to all human species and hence are ultimately translated into software that can be incorporated in every dental clinic so as that it would be useful to community as whole. Though this is not a prospective study as it is unrealistic to give a time line to record future caries development, the various phases of the study and the final cluster will give a realistic picture on the association apart from the prospect of maintenance of patient records in clinics would be a practicality and ultimately be useful to the patient.

Considering the fact that dental caries is a major health and cost burden among the human population, this descriptive study focuses on the reliability of specific dermatoglyphic patterns in the fingers in predicting the susceptibility to dental caries. The recommendation from the study can be of immense help in more easier and more economical identification of high risk groups for its timely prevention especially in the developing countries having enormous population and relatively less health budgets. The findings can be eventually translated into software, the process is made simpler and made available in every dental set up.

1.7 Definitions

Dental caries is a process that brings about the progressive demineralization of the inorganic component of the tooth, accompanied by
disintegration of the organic portion. (Glossary of operative dentistry term 1983).

Dental caries is an infectious microbiologic disease of the teeth that results in localized dissolution and destruction of the calcified tissues (Loesche 1986).

It may also be defined as an irreversible microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth, often leading to cavitation (Shafer 1993).

Dental caries is a preventable disease of mineralized tissues of the teeth with a multi-factorial etiology related to the interaction over time between tooth substance and certain micro-organisms and dietary carbohydrates producing plaque acids (Ninawe 2012).

Dental caries is a microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic tissues and destruction of the organic substance of the tooth. (Shafer 1990).

G Nettleman (1998)- Dental caries is the disease produced by metabolic end products of certain microorganisms those results in dissolution of inorganic components of enamel, dentin and cementum and degradation of their organic structure.

WHO(2005)- Dental caries is defined as a localized post eruptive, pathological process of external origin, involving softening of hard tooth tissues, and proceeding into the formation of cavity. It is an infectious microbial disease of the teeth that results in localized dissolution and destruction of the calcified tissues.
Fingerprint - a print made by an impression of the ridges in the skin of a finger; often used for biometric identification in criminal investigations. (Law) An impression of the pattern of ridges on the palmar surface of the end joint of each finger and thumb.

Ridgeology: The study of the uniqueness of friction ridge structures and their use for personal identification. Volar pads are transient swellings of tissue called mesenchyme under the epidermis on the palmar surface of the hands and soles of the feet of the human fetus. Primary ridges are the first visual evidence of interaction between the dermis and epidermis and are first seen forming as continuous ridges. Secondary ridges are also cell proliferations resulting in downfolds of the basal epidermis (Ashbaugh 1999).

Minutiae arise from expansion of the volar surface during the critical stage and continues to increase in size after secondary ridge formation.

<table>
<thead>
<tr>
<th>6 -8 weeks after conception</th>
<th>Volar pads form (these are little ball like structures, eleven per hand, that make up the contour of the developing fetal hand)</th>
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<tbody>
<tr>
<td>10 -12 weeks</td>
<td>Volar pads begin to recede</td>
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<tr>
<td>13th week after conception</td>
<td>Skin ridges (fingerprints) begin to appear, taking the shape of the receding volar pad</td>
</tr>
<tr>
<td>21st week after conception</td>
<td>Fingerprint patterns are complete</td>
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There are three main fingerprint patterns: arches, loops and whorls.
The “Galton detail” system of classification divided the fingerprints in 3 main classes. (Galton 1892)

a. Whorl: These are the patterns so constructed that the characteristic ridge courses follow circuits around the core. The shape of the pattern area may be either circular or elliptical. Whorls have two triradii and may have various shapes like spiral whorl, whorl double loop, whorl symmetrical but all are designated as whorl in our study.

b. Loop: It is simple in contrast to the whorl. It possesses only one triradii. Twist site of ridges is called head of the loop. From the opposite extremity of the pattern, the ridges flow to the margin of digits. Radial loops and ulnar loops are 2 variants but all were designated as loops in our study.

c. Arches and others: The plain arch is composed of ridges which pass across the finger with slight bow distally. There is no triadic. Since the pattern has no triradii, the ridge count cannot be done. Accidental, pockets are other very minor variants.

Arches are found in about 5% of the fingerprint patterns encountered. The ridges run from one side to the other of the pattern, making no backward turn. There are four types of arch patterns: plain arches, radial arches, ulnar arches and tented arches (Henry 1900).

Loops occur in about 60-70 % of fingerprint patterns encountered. One or more of the ridges enters on either side of the impression, recures, touches or crosses the line running from the delta to the core and terminates on or in the direction of the side where the ridge or ridges entered. Each loop pattern has is one delta and one core and has a ridge
count. Radial loops are named after the radius, a bone in the forearm that joins the hand on the same side as the thumb. The flow of the pattern in radial loops runs in the direction of the radius (toward the thumb). Radial loops are not very common and most of the time radial loops will be found on the index fingers. Ulnar loops are named after the ulna, a bone in the forearm. The ulna is on the same side as the little finger and the flow of the pattern in a ulnar loop runs in the direction of the ulna (toward the little finger) (Henry 1900).

Whorls are seen in about 25-35% of fingerprint patterns encountered. In a whorl, some of the ridges make a turn through at least one circuit. Any fingerprint pattern which contains 2 or more deltas will be a whorl pattern. There are four types of whorl patterns. Plain whorls consist of one or more ridges which make or tend to make a complete circuit with two deltas, between which an imaginary line is drawn and at least one re-curving ridge within the inner pattern area is cut or touched. Central pocket loop whorls consist of at least one re-curving ridge or an obstruction at right angles to the line of flow, with two deltas, between which when an imaginary line is drawn, no re-curving ridge within the pattern area is cut or touched (Henry 1900).

Central pocket loop whorl ridges make one complete circuit which may be spiral, oval, circular or any variant of a circle. Double loop whorls consist of two separate and distinct loop formations with two separate and distinct shoulders for each core, two deltas and one or more ridges which make, a complete circuit. Between the two at least one re-curving ridge within the inner pattern area is cut or touched when an imaginary line is
drawn. Accidental whorls consist of two different types of patterns with the exception of the plain arch, have two or more deltas or a pattern which possess some of the requirements for two or more different types or a pattern which conforms to none of the definitions (Henry 1900).

Print, mark - a visible indication made on a surface.

**Latent Print:** Transferred impression of friction ridge detail not readily visible – “Hidden”. A fingerprint that is not apparent to the eye but can be made visible using light energy, chemicals or powders.

**Patent Print:** A print that is visible and may not require further development and may be deposited on an object.

**Plastic Print:** A visible impression of friction skin left on a soft pliable surface such as wetpaint, clay, wax etc… 3-D Molded or impressed.

**Etched Print:** A latent print that becomes permanently “etched” onto the substrate due to a reaction between the substrate and the acids in fingerprint residue. Most often occurs on metal.

**Dermatoglyphics in other diseases:** Considerable progress has been made in the understanding of the associations between dermatoglyphics and various medical disorders, as a result of which dermatoglyphic analysis has been established as a useful diagnostic and research tool in medicine, providing important insights into the inheritance and embryologic development of many studied clinical disorders. Congenital anomalies like trisomy 21 (Ramani et al., 2011) and 46 XY female (Bosco et al., 2001) can have multiple effects on the phenotype, including the pattern of dermatoglyphics. Study showed that dermatoglyphics may be an important feature in psychiatric illness. Schizophrenia cases showed reductions in
palmar a-b ridge counts (Bramona et al., 2005), whereas radial loops were increased in bipolar mood disorder (Chakraborty et al., 2001). Pulliam et al. (1995) proposed digital arch as a marker of the chronic intestinal pseudoobstruction. Polovina et al. (2007) found definite reflection in inderdigital area III and IV in cases of brachial plexus palsy. The dermatoglyphic patterns may be utilized effectively to study the genetic basis of breast cancer and may also serve as a screening tool in the high-risk population (Chintamani et al., 2007). Recent studies observed dermatoglyphics as diagnostic clue to various clinical conditions like acute lymphoblastic leukemia (Bukelo et al., 2011), occupational allergic bronchitis (Shemetova et al., 2000), locomotor disorder (Cvjeticanin et al., 1999), coeliac disease (Weizman et al., 1990), beta-thalassemia (Solhi et al., 2010).

1.8 Conclusion:

- Dental caries is one of the most prevalent chronic diseases of people worldwide; individuals are susceptible to this disease through their lifetime.
- Dental caries forms through a complex interaction over time between acid-producing bacteria and fermentable carbohydrate, and many host factors including teeth and saliva which dependently and independently are controlled by the individual genetic make up.
- The approach to primary prevention should focus on identifying parameters which can reliably predict the susceptibility to dental caries. Finger dermatoglyphics is one such tool which can be used and can play a pivotal role in caries prevention strategies.