"ASSESSING POTENTIAL MALOCCLUSIONS AMONG PRE-SCHOOL CHILDREN OF BELAGAVI CITY, KARNATAKA, USING BABY RISK OF MALOCCLUSION ASSESSMENT (BABY ROMA) INDEX - A CROSS-SECTIONAL STUDY"

By

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Dissertation

Submitted to
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MASTER OF DENTAL SURGERY
IN
ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

(BRANCH – V)

Under the Guidance of

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Dedicated
To
My Family

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Dr. Susmita Bala Shenoi

ABSTRACT

BACKGROUND:

It is a common notion that Orthodontic treatment is only aimed at the correction of alignment of teeth once all the permanent teeth have erupted, that is when the child is about 12-13 years of age. Most often, when people think of "Orthodontic therapy", what is commonly thought of is "braces". However, orthodontic treatment is not only aimed at the correction of malocclusion but also aids in the physiological development of the orofacial region if carried out/ intercepted at the right time.

The presence of risk factors or the malocclusion already present in the deciduous dentition would affect permanent dentition. It is therefore more important to identify the influencing or causing factors of malocclusion in this period, so preventive or interceptive strategies can be implemented.

MATERIALS AND METHODS:

550 students (4-6 years) who fit the inclusion criteria from different zones of Belagavi City, Karnataka were selected by random sampling method, and included in the study. They were screened and using the Baby ROMA Index, the prevalence of risk of malocclusion present was determined. Descriptive and inferential statistics were used and the Chi-Square test was used to compare the prevalence of potential malocclusion problems and risk category of malocclusion problems based on age and gender.

RESULTS:

The study concluded that the prevalence was found to be 40.7%. The most prevalent form of a problem encountered, using the Baby ROMA Index, was caries along with missing teeth and poor oral hygiene, followed by the presence of a deep bite. There was also a positive correlation between the age of the child and the presence of a condition that needed to be monitored.

CONCLUSION:

The study thus helped create an increased awareness regarding the need for interceptive or preventive treatment among the population.

Apart from this, this study also serves as a baseline for further longitudinal studies about the association of malocclusion in primary dentition with permanent dentition as well as for validating the Baby ROMA Index since there is very little literature available on the same.

LIST OF ABBREVIATIONS

Baby ROMA	:	Baby Risk Of Malocclusion Assessment
ECC	:	Early Childhood Caries
mm	:	millimetre
NAM	:	Naso Alveolar Moulding
OSAS	:	Oral Sleep Apnoea Syndrome
OVB	:	Overbite
OVJ	:	Overjet
TMJ	:	Temporomandibular Joint

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INTRODUCTION

Malocclusion is a universal dental problem that affects individuals to different degrees. According to the Dental Practice Board, the term 'malocclusion' is defined as "an abnormal occlusion in which teeth are not in normal position in relation to adjacent teeth in the same jaw and/or the in the opposite arch when the mouth is closed". Orthodontists describe it as "an appreciable deviation from ideal occlusion".[1] It is one of the most common problems affecting the oral cavity along with caries, gingivitis, and dental fluorosis.[2]

It leads to problems such as difficulty in chewing, speech articulation, and possible undesirable development of the jaw bones.[3]

Some studies in the past, have already concluded that malocclusion in primary dentition could be a possible determinant of malocclusion in succeeding permanent dentition[4,5,6.]

Moreover, it is also stated that the presence of malocclusion in the primary dentition could predict the need for orthodontic treatment in the future.[7]

Besides, the presence of malocclusion may lead to low self-esteem in later years of a child's life, as this is the age where they establish self-identity and their initial personality. [8]

Preventive orthodontics are those procedures undertaken before the development of malocclusion when the development is anticipated. Thus, these procedures aid in the physiological development of normal occlusion. Interceptive therapies are those undertaken at an early stage of malocclusion (already developed malocclusion) to re-establish a normal occlusion. Several malocclusions can be

prevented and intercepted at an early age. This early intervention helps establish normal occlusion and facial harmony.

Early orthodontic treatments can be carried out at the stage of primary and/or early mixed dentition to reduce the length, decrease the severity, and hence the length of orthodontic treatment later.[9]

Early orthodontic treatment, is particularly effective and desirable when the correction of skeletal malocclusions in young children is needed. The advantage of early treatment includes "stable results, fewer extractions of permanent teeth and reduction of treatment duration".[10,11,12]

The prevalence of malocclusion in primary dentition is more than 50 % worldwide. [13,14]

Though the concept of early treatment is debatable [7,15], many studies confirm that the severity of malocclusion in the deciduous dentition would affect permanent dentition. Thus, rather than early management or permanent treatment, it is more important to identify the causal factors of malocclusion in this period, so preventive strategies can be implemented. This will thus decrease the severity and incidence of malocclusion in the future.[16,17]

The ROMA index[18] is one of the few indices, that can be used to assess both skeletal and functional aspects of malocclusion in the mixed and permanent dentitions, that other indices do not account for such as skeletal and functional problems.

C. Grippaudo et al who came up with The ROMA index in 1998, modified it to the Baby ROMA index[19] in 2014 to target the primary dentition. The Baby-ROMA

Index is used for the early diagnosis and treatment of malocclusion in the early stages of development. This is the age (4-6 years) at which several skeletal, dental, and functional factors if neglected could negatively affect the development of normal occlusion and craniofacial growth.

Apart from only occlusal parameters, even skeletal and functional factors that pose as risk factors for malocclusions are measured by the index.

This will further indicate the need for preventive or interceptive orthodontic treatment according to given scores.

It is a common notion that Orthodontic treatment is only aimed at the correction of alignment of teeth once all the permanent teeth have erupted, that is when the child is about 12-13 years of age. Most often, when people think of "Orthodontic therapy", what is commonly thought of is "braces". However, orthodontic treatment is not only aimed at the correction of malocclusion but also aids in the physiological development of the orofacial region if carried out/ intercepted at the right time.

Thus, the current study aimed at determining the prevalence of risk factors for developing malocclusions in pre-school children of Belagavi city, Karnataka, requiring the need for preventive or interceptive orthodontic treatment.

This in turn will help assess the most prevalent forms of risk factors for malocclusions present in the primary dentition period and help differentiate those conditions that need emergency interception as compared to those that require routine follow-ups.

It will help us better understand those problems that pose higher risks for developing malocclusions at a later stage. Apart from these objectives, this study will also help create an increased awareness regarding the need for interceptive or preventive treatment among the population.

AIM AND OBJECTIVES

AIM OF THE STUDY:

To determine the prevalence of risk factors for potential malocclusions in pre-school children of Belagavi city, which require the need for preventive or interceptive orthodontic treatment.

OBJECTIVES:

- To determine the prevalence of potential malocclusions present in children (4-6 years) in Belagavi city, Karnataka using the Baby ROMA index.
- To determine the most prevalent form of risk factors of a potential malocclusion seen in this age group (Primary dentition period)
- To identify cases which pose a high risk of a developing malocclusion that requires early interception or preventive measures as compared to those that require regular monitoring

REVIEW OF LITERATURE

- A "population-based birth cohort study" by **Karen Glazer Peres et al (2015)**[20] concluded that malocclusion in the deciduous teeth poses as a risk factor for orthodontic treatment need in the permanent dentition. This shows the importance of intercepting conditions in the primary dentition phase. The combination of a crossbite found along with an open bite was said to be the hight risk factor present.
- **Ricketts(1979)** [21,21,23] in his articles supports the theory that early treatment is simpler and has the advantage of guiding physiological dental development. He also is in favor of early functional therapy in the primary dentition phase. He stated that treatment in the deciduous phase reduced the need for extraction later. Also, apart from early treatment reducing the incidence of trauma to proclined upper anteriors, there is the added benefit of reducing severe skeletal malocclusion hence the need for a surgical correction after growth completion.
- According to **Jacobson (1979)**[24], having an ideal or acceptable set of deciduous teeth results in a more harmonious and beneficial facial growth that is well balanced. It also improves a child's low self-esteem. He also states that maximum skeletal change can be seen as compared to only dentoalveolar corrections at a later age.
- A "5 years follow up longitudinal" study by **Góis et al (2012)**[25] revealed a positive correlation between a particular malocclusion present in the primary dentition and its presence in the mixed-phase. Thus, children with anterior open bite, large overjet, and posterior crossbite had a higher risk of presenting with the same malocclusion in the mixed dentition.

- A study conducted by **Bhayya et al (2012)**[26] showed a high prevalence of malocclusion among preschoolers. It was also stated that there is a lack of literature about malocclusion and it's risk factors in India and emphasized the need for the same to increase awareness in the community to prophylactically prevent problems.
- In a study to assess the long term effects of interceptive therapy provided to children with sagittal discrepancies below 6 years of age, **Olga Grosfeld et al (1978)**[27] concluded, early treatment was advantageous concerning duration and number of needed extractions. It was stated that the earlier the treatment, the benefit of increased adaptability of "somatic and psychic systems" were present which led to a more physiological development of the child.
- **Carvalho AC (2011)**[28]et al found the "prevalence of malocclusion" in preschoolers to be 46.2%, which was termed high and important to note. They found an increased prevalence especially in the transverse and vertical planes of space.
- Another study carried out by **Correa et al (2014)**[29] in Brazil concluded that the prevalence among preschool children was 32.5% with the open bite being the most common type of malocclusion. There was also a significant correlation of open bite with the presence of a habit. Bottle feeding and persistent habits were identified as risks for the development of malocclusion in children.
- **Alonso Chevitarese et al (2003)** [30] recorded the "prevalence of malocclusion" and the relationship with oral habits in Brazilian preschoolers to be 75.8%. The presence of oral habits was related in 34.8% of the sample. Here too, habits were associated with the presence of open bites.

- In a questionnaire study by **Patidar Deepika et al (2018)**[31] to assess "the parental knowledge and awareness about malocclusion in their children", results revealed that most parents were unaware of their child's occlusal condition including the presence of a habit. The only importance of primary teeth known to them was space maintenance. A very small fraction (11.8%) took their children for annual dental check-ups throwing light on the lack of awareness.
- **Flavia Robson et al (2009)**[32] emphasized the need to assess malocclusion such as increased overjet to provide treatment for the same to reduce the risk of traumatic injuries seen with proclined teeth with lip incompetency (39.1%). These children were said to have a risk of injury 3.75 times higher than those with competent lips.
- **Facciolli Hebling et al (2008)**[33] stated there was a positive correlation between social class and the presence of habits. Oral habits were found in 83.1% of the sample of preschoolers. Thus, there is a need for an increase in knowledge among the population regarding the association if habits and malocclusion.
- The prevalence of caries and the need for treatment among 3-5-year-old children was estimated in Dharwad city by **R. Mahejabeen et al (2006)**[34]. The prevalence of caries was 54.1%. The study concluded that there was a scarcity of awareness among mothers. Imparting knowledge to mothers regarding the need for prevention of caries would reduce the future prevalence of the same.
- A "cross-sectional study" by **Prashanth Prakash et al (2012)**[35] recorded the prevalence of " Early Childhood Caries (ECC)" to be 27.5% among preschoolers in Bangalore city. The children of those women who were

uneducated and from lower social statuses have increased risk profiles. He emphasized the need to target mothers and caretakers of children along with general dentists and school nurses for "oral health care programs".

- In a similar study conducted by **H.R. Priyadarshini et al (2011)**[36], the prevalence of ECC was found to be 37.3% thus suggesting a need for preventive and interceptive care with increased oral health care awareness.
- **C. T. Dülgergil et al (2012)**[37] stated that the presence of carious incisors in the early primary dentition revealed the increased caries profile in the permanent dentition. He emphasized the importance of detection, prevention, and interception of caries in the deciduous period.
- **M. S. Skeie et al (2006)**[38] in a longitudinal study revealed that there was a positive correlation with caries in deciduous and permanent dentition. In those children with caries present on more than 2 surfaces on primary second molars, there was a greater risk of the development of caries in the permanent dentition.
- **Doron Harari et al (2010)**[39] concluded that mouth breathers exhibited a clockwise mandibular rotation, turning towards a vertical growth pattern with an increased palatal plane and constriction of both maxillary and mandibular arches when compared with a nasal breather group. This shows that naso-respiratory obstruction with mouth breathing during critical growth periods poses a potential threat for developing potential malocclusions.
- **Heidi Kerosuo et al (2002)**[40] mentioned that early interceptive treatment reduced the complexity of malocclusions, eliminates deleterious habits that can pose a risk for a potential malocclusion, and directs the child towards having a more favorable growth pattern.

- In a long term follow up study by **Al Nimri K et al (2000)**[41], to test the "applicability and effectiveness of interceptive orthodontic treatment", the result showed that 33% of children needed interceptive therapy, wherein 94% of those receiving interceptive treatment was judged to be successful if accompanied by patient compliance.
- It is stated in an article by **Arvystas et al (1998)**[42], that premolar extractions can be omitted in cases where "arch length discrepancies" are treated early. If prolonged, once growth is complete, treatment options are limited. Hence, precise early diagnosis and intervention is essential.
- Several studies conducted by **Al Nimri K et al (2000)**[41], **Pietilä T et al(1998)**[43] and **Pietilä T et al** (1998)[44] showed that treating a developing malocclusion reduces the complexity and cost of treatment later. They also stated that the treatment could be rendered by a general dentist and did not need a specialized orthodontist if detected at the right time.
- **Dincer M et al (1996)**[45] in his study stated that the increase in intercanine width was prevented with the use of "removable space maintainers" during the transition from deciduous to permanent dentition in those cases where there was premature exfoliation of mandibular deciduous molars.
- In studies conducted by **Larsson et al (1986, 1987)**[46,47], it is mentioned that in those children who have digit sucking habits, there are occlusal interferences created on the primary canines due to constricted on the maxillary arch and expansion of the mandibular arch. This ultimately results in a forced unilateral crossbite leading to future TMJ problems besides occlusal and arch developmental defects.

- A questionnaire study was conducted among parents of preschoolers of Belagavi City to assess the "knowledge, attitude, and practices of oral health care" concerning the prevention of "Early Childhood Caries" by **H. P. Suma Sogi et al (2016)**[48].
- It was found that despite good awareness among the parents, their attitude, and practices were deficient to keep up with the needed standards to improve the oral health status of their child.
- In a similar study by **Hugar SM et al (2016)**[49] among parents of preschoolers in Belagavi city, "the knowledge and attitude regarding oral care" was evaluated. It was observed that those children with parents who understood the importance of deciduous dentition had better oral hygiene than those who didn't. This thus emphasizes the need for awareness among caretakers.
- The "prevalence of malocclusion" and the necessity for "preventive and interceptive treatment" were both large in a study conducted by **Nicholas Karaiskos et al (2005)**[50]. It was observed that most of the malocclusion found prevalent in the study were those that could be intercepted with therapy such as space maintainers, crossbite correction appliances, and arch expansion devices.
- **Lillemor Dimberg et al (2015)**[51], conducted a longitudinal study to check the "prevalence and change in malocclusion" present between primary and early permanent dentition. It was seen that 22% of the total sample of 227 has severe immediate treatment need in the permanent dentition, borderline treatment need was seen in 23.5% of cases, and 54.5% needed no treatment. Also, it was observed that in those children with lip incompetency along with an increased overjet of above 4 mm, the risk for trauma increased by three-

folds. This thus sheds light on the need for the interception of those cases with increased incisor proclination or increased overjet.

- **C. Grippaudo et al (2014)**[19] modified the ROMA index[18] after validating it in 2007 and targeted primary dentition (Baby-ROMA Index). The Baby-ROMA Index is used for the early diagnosis and treatment of malocclusion in the early stages of development. This study was designed to determine the risk factors of malocclusions needing interception in a sample of Italian children between 4 and 6 years of age. Their study shed light on the importance of interceptive treatment and classified the need for emergency treatment into those requiring immediate attention and those which needed only routine follow-ups and re-assessment at a later stage in life.
- In a study by **Grippaudo et al (2019)**[52], to assess the presence of malocclusion related problems and risk factors in Italian pre-schoolers,
- The conclusion stated there was an increased requirement of early orthodontic visits. In addition, the families of children needed to be trained for proper oral health care and also be made aware of existing breathing and speech problems if present. To promote normal harmonious growth of the face, eliminating potential risks that can interfere with physiological development should be sought for.

MATERIALS AND METHODS

The present study was conducted to determine the prevalence of risk factors for potential malocclusions in pre-school children of Belagavi city, using the Baby ROMA index. The study was conducted from November 2019 to January 2020.

Study Design: The study was a cross-sectional descriptive study.

Source of Data: The study was conducted in 4-6-year-old preschool children attending various pre-schools, play homes, Anganwadis, etc. of Belagavi city, Karnataka.

Method of data collection: Belagavi city was divided into 4 zones, Belagavi North, South, East and West, and pre-school children from four zones of Belagavi city were screened for the following criteria:

INCLUSION CRITERIA:

- Children aged between 4-6 years of age
- Both male and female children were included
- Children with complete primary dentition
- No previous history of any form of Orthodontic treatment/ Appliance therapy
- The children whose parents/guardian gave consent for the study

EXCLUSION CRITERIA:

- Those children who had received any form of previous Orthodontic therapy
- Children with mixed dentition

Permissions: Before the start of the study, ethical approval was obtained from the Institutional Ethics Committee of KLE Academy of Higher Education and Research, KLE University's VK Institute of Dental Sciences, Belagavi (ANNEXURE- I).

Permission to conduct the study was obtained from the school and written informed consent was obtained from parents and the head teacher/ caretakers in the respective schools/ play homes. (ANNEXURE- II, ANNEXURE- III, ANNEXURE- IV).

Training and calibration of the investigator: Before conducting the study, the investigator was trained to record the Baby ROMA index[19] under the supervision of the guide in the Department of Orthodontics, KLE VK Institute of Dental Sciences, Belagavi.

The investigator recorded the score on five subjects. The same 5 subjects were recalled after 15 days, and the investigator re-recorded the scores. The intra examiner reliability was found to be 0.86.

Pilot Study: A pilot study was conducted on 20 students to know the reliability and ease of carrying out the study. Some problems were faced during the recording of "Inheritance of malocclusion". In cases where the parent/ guardian was present, a detailed history was taken regarding the inheritance of malocclusion. In other cases, a modification was done and pictures of most common types of malocclusion such as crowding, deep bite, open bite, severe class II div 1 or class III cases, etc. were shown to both the subject as well as the caretaker or teacher to provide a parental history of the subject if possible.

Sample Size calculation and Sampling Technique

The sample size was estimated based on the prevalence of malocclusion found in the pilot study which was 29%.

The following formula was used:

$$n = \frac{Z^2 pq}{d^2}$$

Where p= prevalence= 29%

q= 100-p= 71%

Z= 2.58 at 99% confidence

d= Precision= 5%

n= 548

Thus, the final sample sixe was 548 preschool children.

SAMPLING TECHNIQUE: Random sampling was used to select preschools. A list of all pre-schools and anganwadis were obtained from the Women and child development officer of Belagavi city.

From each school, subjects were selected according to the inclusion criteria of the study.

Data Collection:

- Instruments and Material Used in the Study:
  1. Kidney Tray
  2. Plain mouth mirror
  3. Probe

4. Tweezer
5. Sterile cotton rolls
6. Disposable Head Cap
7. Disposable Gloves
8. Disposable Mouth mask
9. Flashlight
10. Korsolex solution (Composition- Glutaraldehyde- 7gm, 1.6 Dihydroxy, 2,5 Dioxahexane (Chemically bound formaldehyde); 8.2 gm Polymethylol urea derivatives- 17.6 gm, rust inhibitors)
11. Wooden tongue depressors
12. Study Proforma

Infection control protocol: Instruments were sterilized in the department in the autoclave before every visit to the schools. Spot sterilization was done using chemical disinfecting solution – Korsolex- 2% when required. Utmost care was taken to maintain asepsis during the entire course of the study.

DATA COLLECTION PROCEDURE: The investigator went to the preschools, explained the study procedure to the school authorities, and obtained the permission. On a pre-determined date, the investigator went to the selected preschools and performed the following procedure.

1. Investigator- Selected schools, anganwadis, etc, obtained permission, did the primary screening, and recorded malocclusion
2. Recording clerks- Assisted the examiner in entering scores
3. Statistician- Performed the data analysis

Details of the Examination: Oral examination was carried out by the investigator himself. The child was made to sit on a chair or stand, while the investigator sat comfortably for adequate visualization of the oral cavity of the participant.

Type III examination was performed using a mouth mirror, under natural daylighting conditions.

A recording clerk who was trained to assist in the recording procedure helped the investigator in recording the findings. The recording clerk was made to sit as close to the investigator as possible so that the investigator could cross-check the entries made by the recording clerk.

DETAILS OF THE PROFORMA ((ANNEXURE- V)

The study proforma consisted of two parts. The first part included the details of the patient and the second part contained the Baby ROMA Index.

Index used: "The Baby Risk of Malocclusion Assessment Index (Baby ROMA Index)"[19] was used to assess the requirement of early orthodontic therapy.

Index description: The ROMA index is used to assess skeletal and functional aspects of malocclusion in the mixed and permanent dentitions in growing patients has been modified to the Baby ROMA index to target the primary dentition.

The **Baby ROMA index**[19] is an index that helps assess the risk of malocclusion and the need for early treatment. It is a modification of the ROMA index[18], which is used for subjects in mixed and permanent dentition to assess the skeletal and functional aspects of malocclusion.

The Baby ROMA index is modified to assess the status of malocclusion in primary or deciduous dentition. Such an index, apart from Summer's Occlusal Index, does not exist for primary dentition. Moreover, the Summer's index does not take into consideration the skeletal and dental problems like the Baby ROMA Index, does, along with functional and systemic factors.

Details of the Index:

The index is divided into 4 main categories of problems:

- Systemic
- Craniofacial
- Dental
- Functional

Each category is given a number that corresponds to the severity of the risk, and an alphabet for every type of malocclusion.

- "Scores of 4 and 5 require immediate orthodontic treatment."
- "A score of 3 indicates the presence of a malocclusion that can persist or worsen, therefore patients will be assessed again before the growth spurt."
- "Scores of 1 and 2 need only routine check-ups to monitor the occlusion, score 2 is more exposed to the action of risk factors."

The index is as follows:

SYSTEMIC PROBLEMS	Maxillo-facial Trauma	with condylar fracture	5a
		without condylar fracture	2a
	Congenital Syndromes/ Malformations		5b
	Postural/ Orthopaedic Problems		2c
	Medical or Auxological Conditions		2d
	Inheritance of malocclusion		2e
CRANIOFACIAL PROBLEMS	Facial or Mandibular Asymmetries		4f
	TMJ dysfunctions		4g
	Outcomes of trauma or surgery of the craniofacial district		5j
	Maxillary Hypoplasia / Mandibular Hyperplasia	OVJ<0	4k
		OVJ>0	2k
DENTAL PROBLEMS	Maxillary Hyperplasia / Mandibular Hypoplasia	OVJ>6mm	3h
		3mm<OVJ<6mm	2h
	Caries and Early Loss of Deciduous Teeth		4l
	Scissor bite		4m
	Crossbite	>2mm or lateral shift	4n
		<2mm or no lateral shift	2n

	Displacement	>2mm displacement	3o
		>1mm - absence of diastema	2o
	Open bite	>4mm	3p
		>2mm	2p
	Hypodontia	up to 2 teeth	3q
		more than 2 teeth	4q
	Supernumerary teeth		4q
	OVB>5mm		2r
	Poor oral hygiene		2t
FUNCTIONAL PROBLEMS	Parafunctions (bruxism, jaw clenching)		2v
	Thumb/ Finger Sucking Habit		2w
	Oral breathing / OSAS		2x
NONE OF THE PROBLEMS LISTED ABOVE			N

Oral Health Education

After the examination, the parents or caretakers of those children who needed emergency treatment were informed about the immediate need for treatment. A free referral card was distributed to all the study participants.

Like a moral obligation, an oral health talk was given to the students as well as teachers of the selected preschools, regarding maintenance of good oral hygiene and the importance of healthy teeth.

STATISTICAL ANALYSIS

The data obtained were entered in Microsoft Excel and subjected to statistical analysis. Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released in 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

Descriptive Statistics: It included expression of the study variables in terms of frequency and proportions.

Inferential Statistics: Chi-Square test was used to compare the prevalence of risk factors of potential malocclusion problems and risk category of malocclusion problems based on age and gender.

The level of significance [P-Value] was set at $P<0.05$

SCHEMATIC REPRESENTATION OF METHODOLOGY

List of all preschools, Anganwadis, etc. in Belagavi city were obtained

↓

Belagavi city was divided into 4 zones: North, South, East, and West

↓

Approximately 3-4 schools in each zone were randomly selected and approval to conduct the study was taken from the school authority

↓

All the children (whose parents gave consent) from selected schools were examined

The sample comprised of 550 children fulfilling the inclusion criteria from schools in Belagavi city, Karnataka

↓

Baby ROMA index[19] was used to assess the state and risk of malocclusion

↓

The examination of the children was carried out using visible light, mouth mirror, probe, and scale (for linear measurements)- Type 3 method of examination- by the principal investigator after obtaining consent

Spot disinfection/ sterilization was done before the examination

↓

Data obtained was be subjected to statistical analysis

PHOTOGRAPH 1: Armamentarium used for Type III examination in the study

PHOTOGRAPH 2: Examination of study participants by investigator along with recording clerk

RESULTS

The purpose of the study was to determine the prevalence of risk factors for potential malocclusions present in children (4-6 years) in Belagavi city, Karnataka using the Baby ROMA Index.

In addition, the objectives were also to determine the most prevalent form of potential malocclusion seen in this age group (Primary dentition period) and to identify cases which pose a high risk of a developing malocclusion that requires early interception or preventive measures as compared to those that require regular monitoring.

The findings of the study were statistically analysed using descriptive statistics, and inferential statistics using Chi Square test to compare the prevalence of potential malocclusion problems and risk category of malocclusion problems based on age and gender.

The results were regarded as statistically significant at $p < 0.05$.

INTERPRETATION OF RESULTS:

- **Age wise distribution of the study participants**

Table 1 and **Figure 1** show the age wise distribution of the study participants. Out of the total sample of 550 children, 211 (38.40%) were 4 years of age, 221 (40.20%) were 5 years of age, and 118 (21.50%) were 6 years of age.

- **Gender wise distribution of the study participants**

Table 2 and **Figure 2** show the gender wise distribution of the study participants. Out of the total sample of 550 children, 348 (63.30%) were females and 202 (36.70%) were males.

- **Distribution of prevalence of risk factors for potential malocclusion among the study participants according to the Baby ROMA index**

Table 3 and **Figure 3** show the distribution of prevalence of risk factors for potential malocclusion among the study participants according to the Baby ROMA index. Out of the total sample of 550 children, 224 (40.7%) children had some form of potential malocclusion problem that was recorded.

326 (59.3%) children had no form of potential malocclusion poblem recorded.

- **Prevalence of risk factors for potential malocclusion based on the age of the study participants using Chi Square Test**

Table 4 and **Graph 1** show the prevalence of risk factors for potential malocclusion based on the age of the study participants using Chi Square Test.

- In the 4 year age group, 82 children (38.9%) had some form of potential malocclusion problem present, and 129 children (61.1%) did not.
- In the 5 year age group, 81 children (36.7%) had some form of potential malocclusion problem present, and 140 children (63.3%) did not.
- In the 6 year age group, 61 children (51.7%) had some form of potential malocclusion problem present, and 57 children (48.3%) did not.

When Chi Square test was applied, a statistically significant association was observed between age of the child and presence or absence of risk factors for potential malocclusion. (p value: 0.02)

- **Prevalence of risk factors for potential malocclusion based on the gender of the study participants using Chi Square Test**

Table 5 and **Graph 2** show the prevalence of risk factors for potential malocclusion based on the gender of the study participants using Chi Square Test.

- Out of the 348 female children, 149 (42.8%) had some form of potential malocclusion problem present, and 199 children (67.2%) did not.
- Out of the 202 male children, 75 (37.1%) had some form of potential malocclusion problem present, and 127 children (62.9%) did not.

The association between gender of the child and presence and absence of a potential malocclusion problem was not statistically significant.

- **Distribution of risk factors for potential malocclusion among study participants based on Baby ROMA index**

Table 6 and **Graph 3** show the distribution of risk factors for potential malocclusion among study participants based on Baby ROMA index.

Among all the parameters checked for, it was seen that the prevalence of poor oral hygiene (2t, 21.8%, n=120)was the highest, followed by Caries and Early loss of deciduous teeth (4l, 20.4%, n=112).

Following poor oral hygiene and Caries and Early loss of deciduous teeth, the other prevalent potential malocclusion problems were OVB >5mm (2r, 4.5%, n=25); Oral

breathing (2x, 4.2%, 23); Displacement >1mm - Absence of Diastema (2o, 3.6%, n=20) and Maxillary Hypoplasia / Mandibular Hyperplasia :OVJ<3 (2h, 3.1%, n=17).

- **Frequency distribution of different grades of Baby ROMA index among study participants**

Table 7 and **Graph 4** show the Frequency distribution of different grades of Baby ROMA index among study participants.

The prevalence of potential malocclusion problems that fell Grade 5 was 0.9% (n=5), Grade 4 was 20.9% (n=115), Grade 3 was 2.9 % (n=16), and Grade 2 was 33.6% (n=185) with a total prevalence of 40.7% (n=224).

Since a single child could fall into more than one risk category or grade, the total frequency of different grades exceeded the prevalence of potential malocclusion (n=224), as shown in the table.

- **Distribution of different risk groups for potential malocclusion based on Baby ROMA index among study participants**

Table 8 and **Graph 5** show the distribution of different risk groups for potential malocclusion based on Baby ROMA index among study participants.

Out of the total sample of 224 subjects with th presence of a potential malocclusion problem, 118 (21.5%) fell into the high risk group, 8 (1.5%) fell into the moderate risk group and 98 (17.8%) fell into the low risk group. 326 of the participants (59.3%) had no prpblem.

- **Comparison of different risk category for potential malocclusion based on different age groups using Chi Square Test**

Table 9 and **Graph 6** show the comparison of different risk category for potential malocclusion based on different age groups using Chi Square Test.

- In the 4 year age group, 62.2% (n=51) fell into the high risk category, 2.4% (n=2) fell into the moderate risk category and 35.4% (n=29) fell into the low risk category.
- In the 5 year age group, 44.4% (n=36) fell into the high risk category, 4.9% (n=4) fell into the moderate risk category and 50.6% (n=41) fell into the low risk category.
- In the 6 year age group, 50.8% (n=31) fell into the high risk category, 3.3% (n=2) fell into the moderate risk category and 45.9% (n=28) fell into the low risk category.

The association between age of the child and distribution of risk category for potential malocclusion using Chi Square Test was not statistically significant.

- **Comparison of different risk category for potential malocclusion based on different genders using Chi Square Test**

Table 10 and **Graph 7** show comparison of different risk category for potential malocclusion based on different genders using Chi Square Test

- Among the female study participants, 53.0% (n=79) fell into the high risk category, 4% (n=6) fell into the moderate risk category and 43.0% (n=64) fell into the low risk category.

- Among the male study participants, 52.0% (n=39) fell into the high risk category, 2.7% (n=2) fell into the moderate risk category and 45.3% (n=34) fell into the low risk category.

The association between gender of the child and distribution of risk category for potential malocclusion using Chi Square Test was not statistically significant.

RESULT TABLES

Table 1 shows the age wise distribution of the study participants.

Table 1: Age wise distribution of study participants			
Variable	Categories	n	%
Age	4 Years	211	38.40%
	5 Years	221	40.20%
	6 Years	118	21.50%
	Total:	550	

Table 2 shows the gender wise distribution of the study participants.

Table 2: Gender wise distribution of study participants			
Variable	Categories	n	%
Gender	Females	348	63.30%
	Males	202	36.70%
	Total:	550	

Table 3 shows the distribution of prevalence of risk factors for potential malocclusion among the study participants according to the Baby ROMA index.

Table 3: Distribution of prevalence of risk factors for potential malocclusion among the study subjects

Variable		n	%
Prevalence of risk factors for Potential Malocclusion	Present	224	40.7%
	Absent	326	59.3%
	Total:	550	

Table 4 shows the prevalence of risk factors for potential malocclusion based on the age of the study participants using Chi Square Test.

Table 4: Comparison of prevalence of risk factors for potential malocclusion based on the age of the study participantsusing Chi Square Test

Variable	Category	Present		Absent		χ^2 Value	P-Value
		n	%	n	%		
Age	4 Years	82	38.9%	129	61.1%	7.705	0.02*
	5 Years	81	36.7%	140	63.3%		
	6 Years	61	51.7%	57	48.3%		

**** - Statistically Significant***

Table 5 shows the prevalence of risk factors for potential malocclusion based on the gender of the study participants using Chi Square Test.

Table 5: Comparison of prevalence of risk factors for potential malocclusion based on the gender of the study participants using Chi Square Test

Variable	Category	Present		Absent		χ^2 Value	P-Value
		n	%	n	%		
Gender	Females	149	42.8%	199	57.2%	1.716	0.19
	Males	75	37.1%	127	62.9%		

Table 6 shows the distribution of risk factors for Potential Malocclusion among study participants based on Baby ROMA index.

Table 6: Distribution of risk factors for Potential Malocclusion problems among study subjects based on Baby ROMA index			
Risk Factors	Codes	n	%
High Risk [Grade 5 & 4]			
Maxillofacial Trauma with Condylar Fracture	5a	0	0.0%
Congenital syndromes / Malformations	5b	4	0.7%
Outcomes of Trauma / surgery of craniofacial defect	5j	1	0.2%
Facial or Mandibular asymmetries	4f	1	0.2%
TMJ Dysfunctions	4g	0	0.0%
Maxillary Hypoplasia / Mandibular Hyperplasia [OVJ<0]	4k	0	0.0%
Caries and Early loss of deciduous teeth	4l	112	20.4%
Scissor bite	4m	0	0.0%
Cross bite >2mm or lateral shift	4n	2	0.4%
Hypodontia of > 2 teeth/Supernumerary teeth	4q	1	0.2%
Moderate Risk [Grade 3]			
Maxillary Hyperplasia / Mandibular Hypoplasia [OVJ>6]	3h	5	0.9%
Displacement >2mm	3o	8	1.5%
Open Bite >4mm	3p	1	0.2%
Hypodontia of up to 2 teeth	3q	2	0.4%
Low Risk [Grade 2]			
Maxillofacial Trauma without Condylar Fracture	2a	2	0.4%
Postural/Orthopaedic problems	2c	0	0.0%
Medical or Axiological Conditions	2d	2	0.4%
Inheritance of malocclusion	2e	3	0.5%
Maxillary Hypoplasia / Mandibular Hyperplasia [OVJ>0]	2k	3	0.5%
Maxillary Hyperplasia / Mandibular Hypoplasia [3mm<OVJ<6mm]	2h	17	3.1%
Cross bite <2mm or lateral shift	2n	11	2.0%
Displacement >1mm - Absence of Diastema	2o	20	3.6%
Open Bite >2 mm	2p	13	2.4%
OVB >5mm	2r	25	4.5%
Poor Oral Hygiene	2t	120	21.8%
Parafunctions [Bruxism, Jaw clenching]	2v	6	1.1%
Thumb or Finger sucking habit	2w	7	1.3%
Oral breathing	2x	23	4.2%
None of the problems listed above [Grade 1]	N	326	59.3%

Table 7 shows the Frequency distribution of different grades of Baby ROMA index among study participants.

Table 7: Frequency distribution of different grades of Baby ROMA index among study participants			
Variable	Category	n	%
Grades of Baby ROMA index	Grade 5 (High Risk)	5	0.9%
	Grade 4 (High Risk)	115	20.9%
	Grade 3 (Moderate Risk)	16	2.9%
	Grade 2 (Low Risk)	185	33.6%
	Total Prevalence	224	40.7%

Note: a. The total frequency of different grades exceeds the prevalence of potential malocclusion (n=224), since the same subject has reported with > 1 malocclusion problem.

b. The individual grade projects lesser frequency as compared to the sum total of the problems in the same grade, since the same subject has >1 potential malocclusion problems with same grade.

Table 8 shows the distribution of different risk groups for potential malocclusion based on Baby ROMA index among study participants.

Table 8: Distribution of different risk groups for potential malocclusion based on Baby ROMA index among study participants			
Variable	Risk Group	n	%
Risk for Potential Malocclusion	High (Grade 5 and Grade 4)	118	21.5%
	Moderate (Grade 3)	8	1.5%
	Low (Grade 2)	98	17.8%
	No Problem (Grade 1)	326	59.3%

Table 9 shows the comparison of different risk category for potential malocclusion based on different age groups using Chi Square Test.

Table 9: Comparison of different risk category for potential malocclusion based on different age groups using Chi Square Test								
Risk Group	High (Grade 5 and Grade 4)		Moderate (Grade 3)		Low (Grade 2)		χ^2 Value	p-Value
	n	%	n	%	n	%		
4 years	51	62.2%	2	2.4%	29	35.4%	5.480	0.240
5 years	36	44.4%	4	4.9%	41	50.6%		
6 years	31	50.8%	2	3.3%	28	45.9%		
Total	118	52.7%	8	3.6%	98	43.3%		

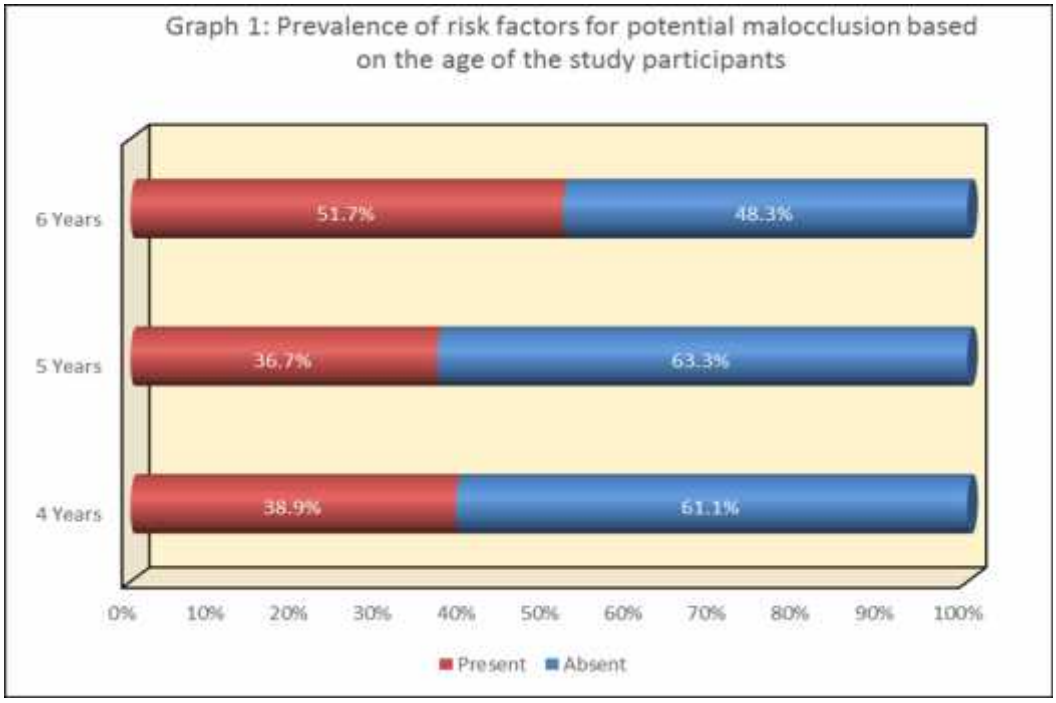
Table 10 shows comparison of different risk category for potential malocclusion based on different genders using Chi Square Test.

Table 10: Comparison of different risk category for potential malocclusion based on different genders using Chi Square Test

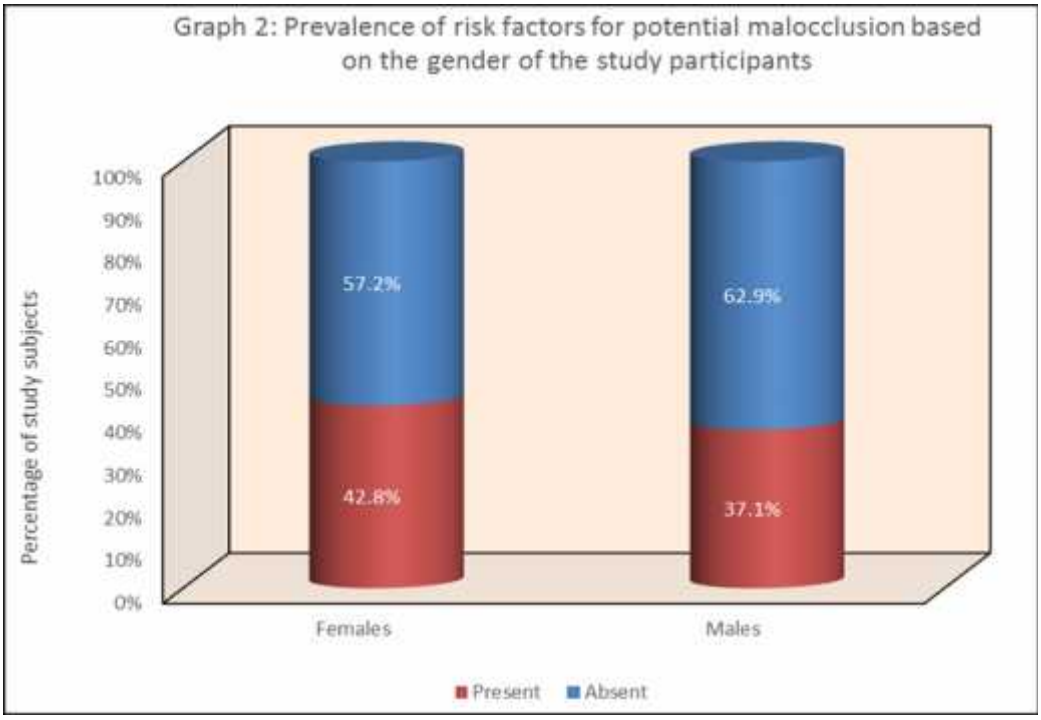
Risk Group	High (Grade 5 and Grade 4)		Moderate (Grade 3)		Low (Grade 2)		χ^2 Value	p-Value
	n	%	n	%	n	%		
Females	79	53.0%	6	4%	64	43.0%	0.333	0.850
Males	39	52.0%	2	2.7%	34	45.3%		
Total	118	52.7%	8	3.6%	98	43.3%		

RESULT GRAPHS

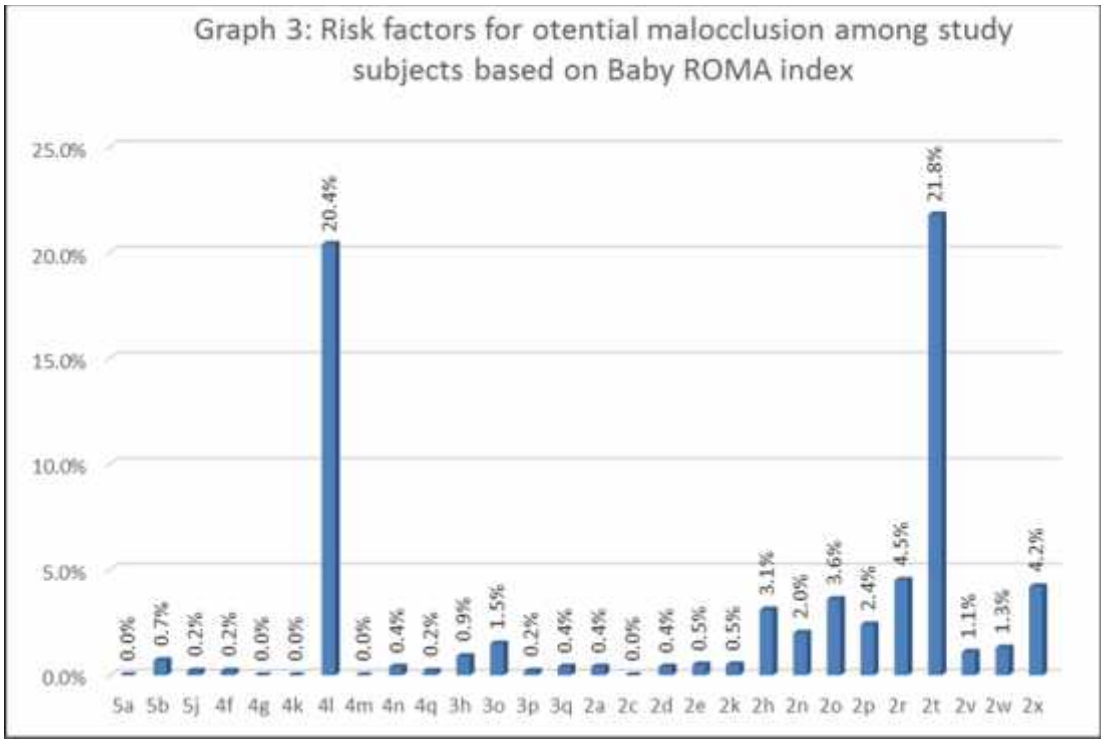
Graph 1 shows the prevalence of risk factors for potential malocclusion based on the age of the study participants using Chi Square Test.



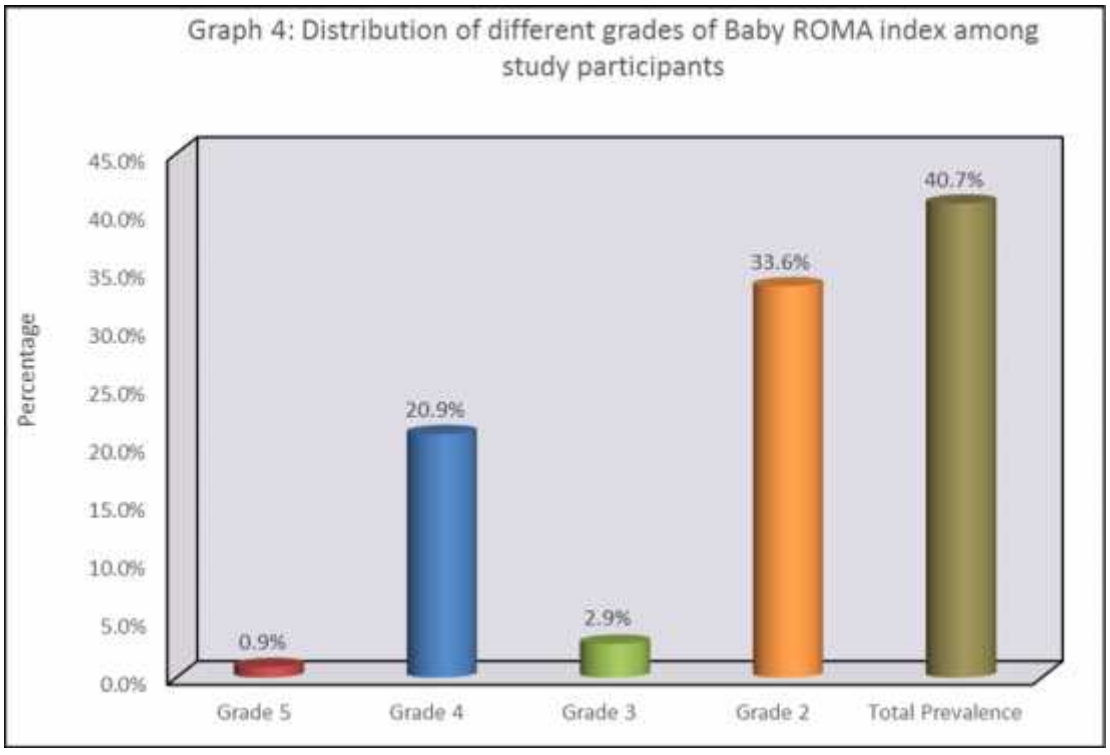
Graph 2 shows the prevalence of risk factors for potential malocclusion based on the gender of the study participants using Chi Square Test.



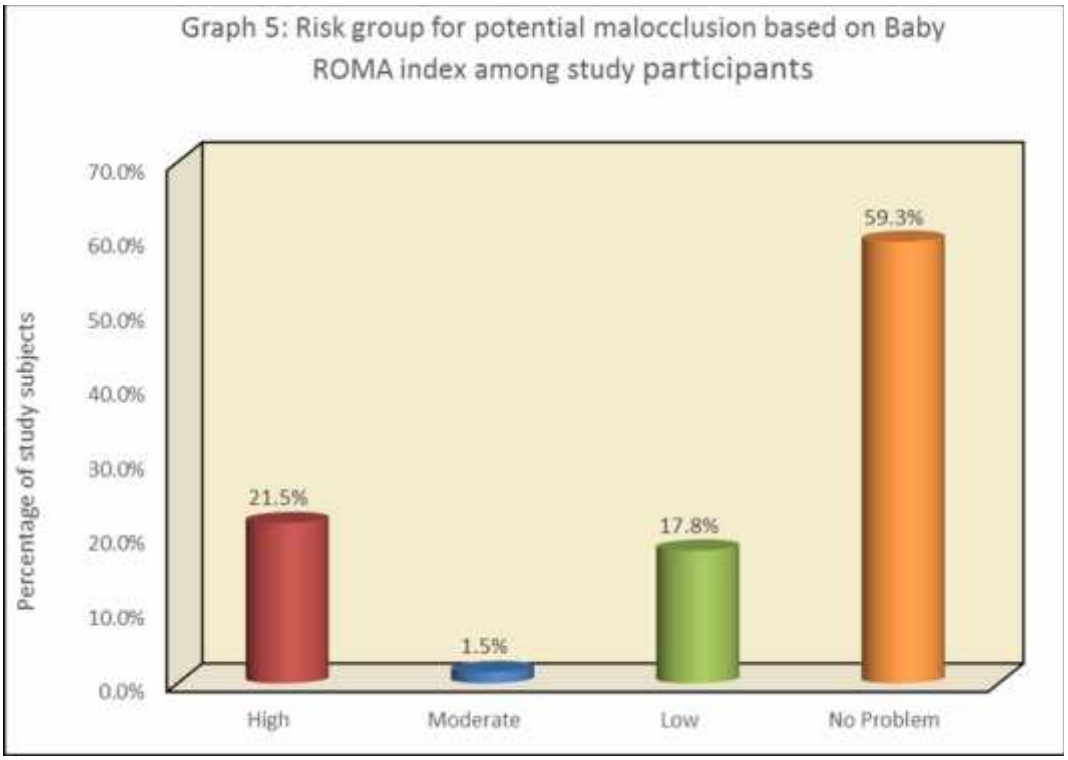
Graph 3 shows the distribution of risk factors for Potential Malocclusion among study participants based on Baby ROMA index.



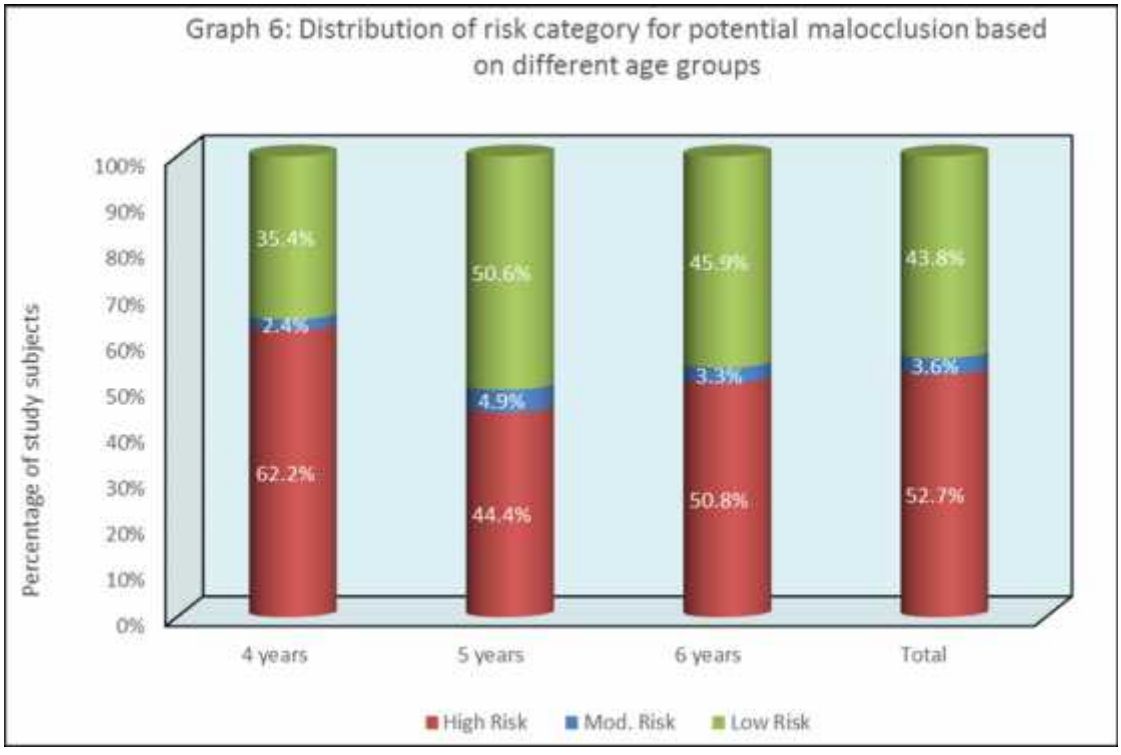
Graph 4 shows the Frequency distribution of different grades of Baby ROMA index among study participants.



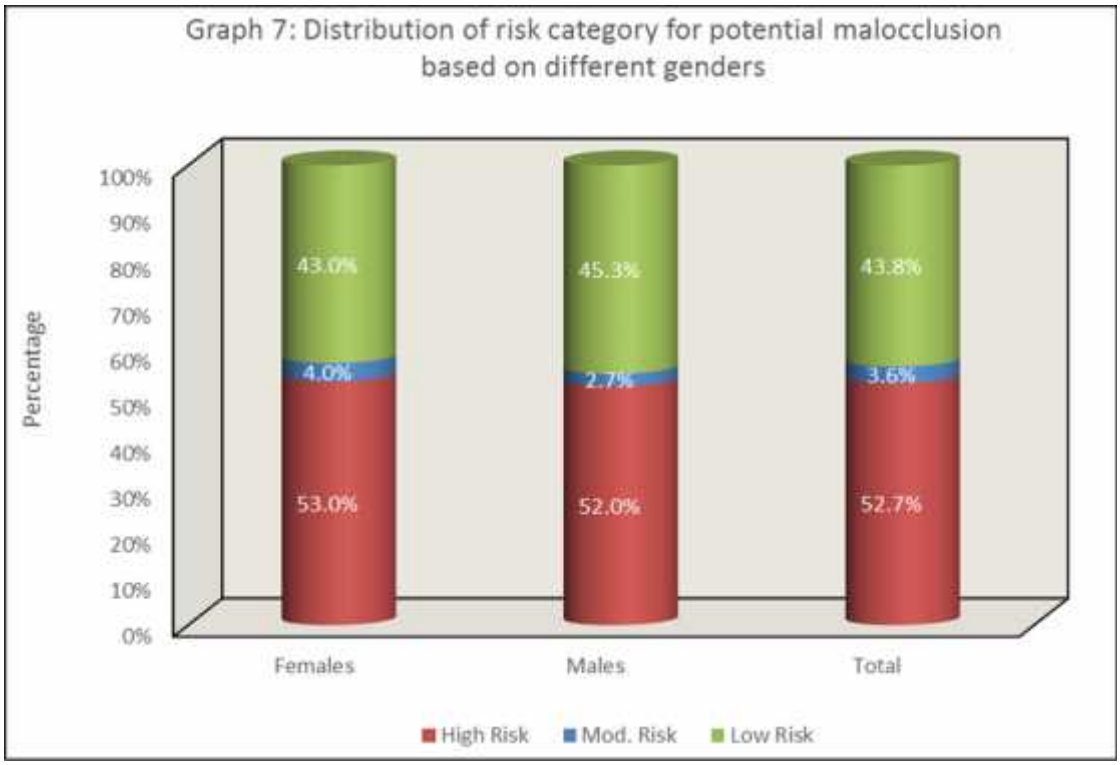
Graph 5 shows the distribution of different risk groups for potential malocclusion based on Baby ROMA index among study participants.



Graph 6 shows the comparison of different risk category for potential malocclusion based on different age groups using Chi Square Test.



Graph 7 shows comparison of different risk category for potential malocclusion based on different genders using Chi Square Test.



RESULT FIGURES

Figure 1 shows the age wise distribution of the study participants.

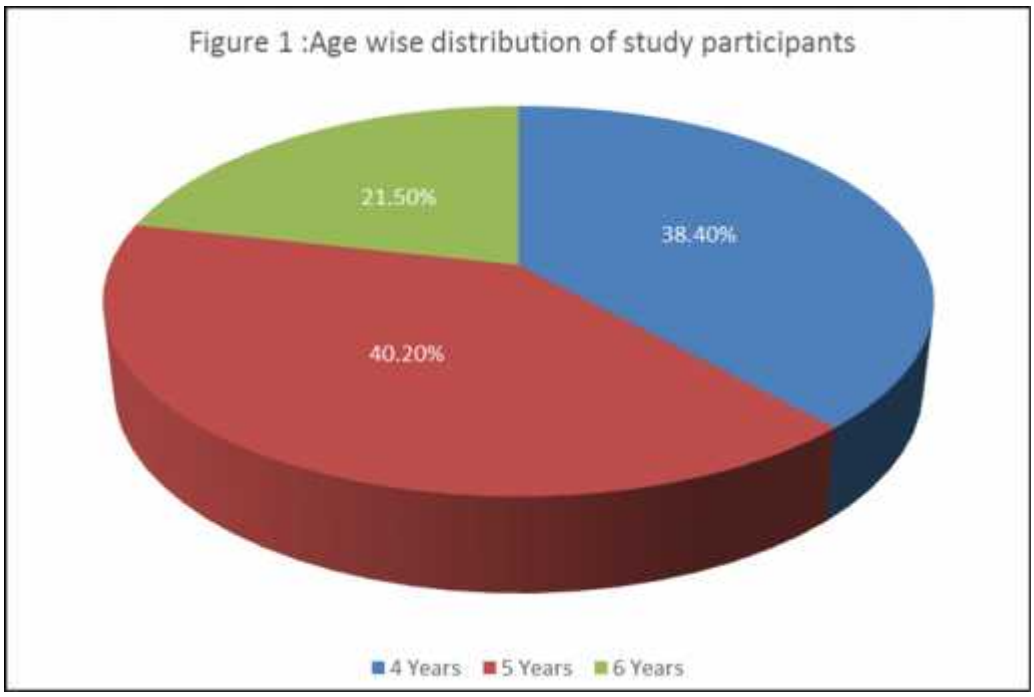


Figure 2 shows the gender-wise distribution of the study participants.

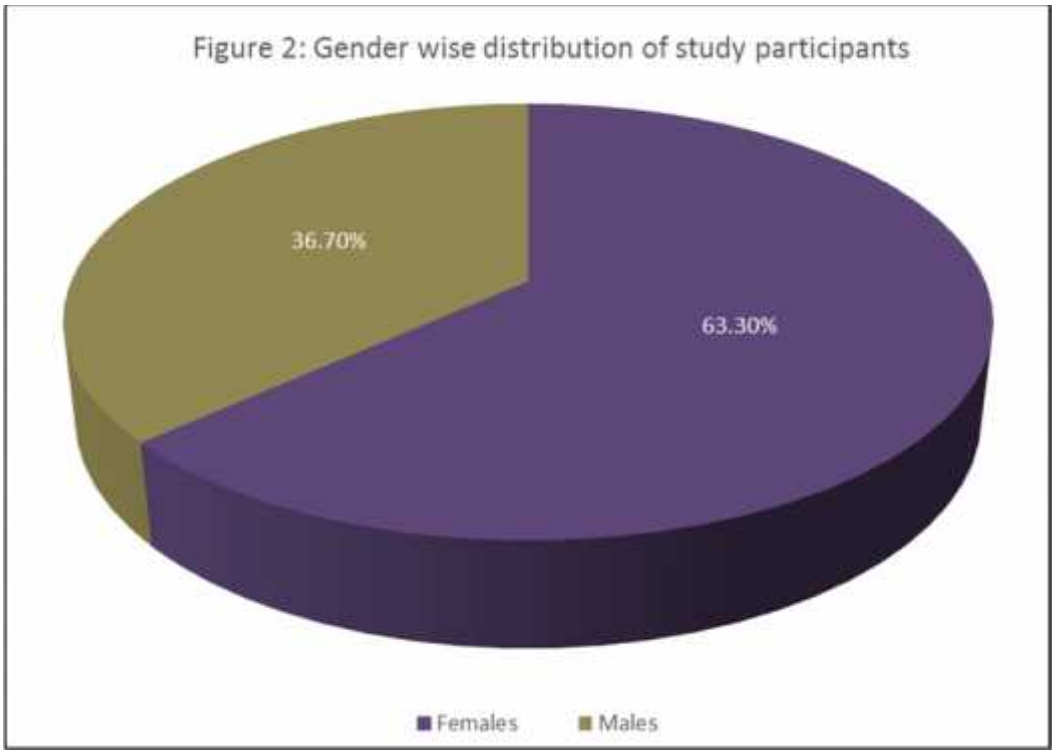
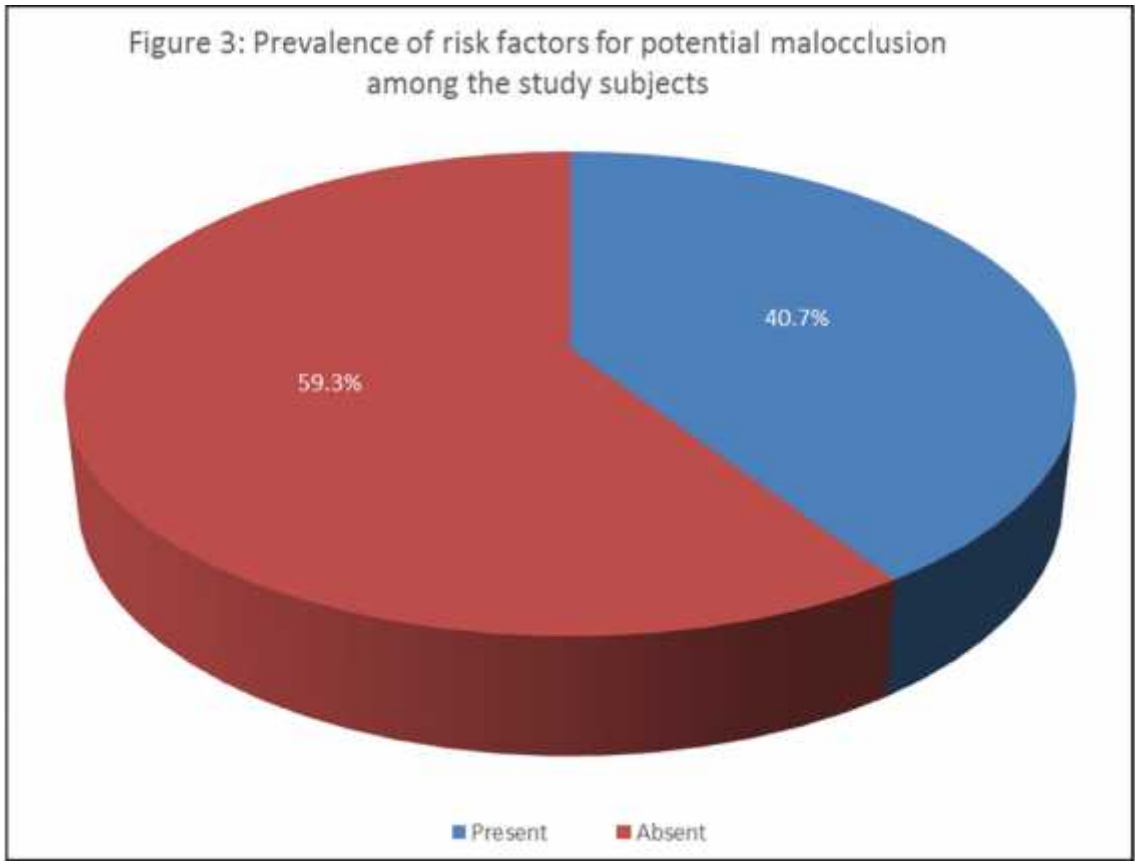


Figure 3 shows the distribution of prevalence of risk factors for potential malocclusion among the study participants according to the Baby ROMA index.



PHOTOGRAPH 3:

Photograph of caries and early loss of deciduous teeth (4l)

PHOTOGRAPH 4:

Photograph of deep bite malocclusion (2r)

PHOTOGRAPH 5:

Photograph of anterior open bite (3p) with poster cross bite (2n) malocclusion

PHOTOGRAPH 6:

Photograph of tongue thrust habit causing anterior openbite (3p,2w)

PHOTOGRAPH 7:

Photograph of crowding in primary dentition with absence of physiologic spacing (3o)

PHOTOGRAPH 8:

Photograph of child with bruxism habit (2v)

PHOTOGRAPH 9:

Photograph of child with missing teeth due to trauma (2a)

PHOTOGRAPH 10:

Photograph of child with caries and poor oral hygiene (4l,2t)

PHOTOGRAPH 11:

Photograph of malformed teeth showing fusion/gemination (4q)

PHOTOGRAPH 12:

Photograph of crossbite with lateral shift (4n)

DISCUSSION

"Prevention is the first strategy of contemporary medicine that must be applied to reduce the prevalence of diseases and reduce the biological costs and expense of health treatments."[53]

According to WebMD, a risk factor is defined as "anything that increases the chance of a person developing a disease or condition."

Malocclusions should be viewed primarily as a developmental condition or problem, where each developmental stage has its method for prevention. Prevention in childhood refers to the introduction of a healthy diet, interception or prevention of deleterious habits and functions as well as their standing for the future relationship between teeth and jaws.[54,55,56]

Identifying risk factors for a potential malocclusion at an early age and providing interceptive treatment when necessary is thus very essential for the treatment to be most effective in the future, for the reduction in treatment time, as well as lowering treatment costs.[41,43,44]

Malocclusion present in primary dentition can predict the malocclusion that can develop in the mixed and/or permanent dentition.[57]

Even in orthodontics, it would be desirable to consider this aspect as early interceptive treatment of bad habits and developing malocclusions are simpler to correct early, than at a later date.

It is thus important to first find out the prevalence rate of potentially developing malocclusions of a region in this age group and then stress on the need for treatment respective to the type of pertaining malocclusion.

Therefore, the study was oriented on the assessment of the preschoolers' type of malocclusion and its risk factors, as well as treatment needs, in and around Belagavi City, along with calculating the prevalence rate using the Baby ROMA Index[19].

Though many indices are available to assess the severity of malocclusion and the need for treatment, most of them target the mixed and permanent dentition.

Also, malocclusion is a multifactorial condition, that is linked to various functional, genetic, and systemic conditions, apart from taking into consideration only the dentition.

The Occlusal Index by Summers[58] is used to assess malocclusion in deciduous dentition, however, it does not account for skeletal or functional problems. It is also difficult in terms of data collection.

The ROMA index[18] Is one of the few indices, that can be used to assess both skeletal and functional aspects of malocclusion in the mixed and permanent dentitions, that other indices do not account for.

C. Grippaudo et al who came up with The ROMA index in 1998[18] modified it to the Baby ROMA index in 2014[19] to target the primary dentition. The Baby-ROMA Index is used for the early diagnosis and treatment of malocclusion in the early stages of development. It differs from the ROMA Index in the scores given to the presence of risk factors. For example, Displacement is scored 2 and 3, and not 4 like in the

ROMA Index, because the presence of crowding in the deciduous dentition should not be treated, can be looked at as one of the risk factors of malocclusion. Also, certain conditions like disturbances in exfoliation are not accounted for as the Baby ROMA index targets only a full set of primary dentition.

This is the age (4-6 years) at which several skeletal, dental, and functional factors if neglected could negatively affect the development of normal occlusion and craniofacial growth.

Apart from only occlusal parameters, even skeletal and functional factors that pose as risk factors for malocclusions are measured by the index.

This will further indicate the need for preventive or interceptive orthodontic treatment according to given scores.

Existing problems are divided into four main categories by the Baby ROMA Index which are: “Systemic problems, Craniofacial problems, Dental problems, and Functional problems”.

As already discussed above, knowing the prevalence of risk factors, we can establish a proper treatment path by providing interceptive treatment as well as aim at improving the awareness to the parents, or caretakers, emphasizing the need for early treatment.

It is also important to note that when a literature search was done, only one study[52] was conducted on preschoolers using the Baby ROMA Index. Due to a lack of similar studies, we were unable to compare our study results regarding prevalence with similar studies using the same index.

The discussion of the study will be explained in the following order of risk factors, in accordance with the results obtained that is:

- Caries, early loss of teeth (20.9%, 4l), and poor oral hygiene (21.8%, 2t)
- Deep bite (4.5%, 2r)
- Habits and associated malocclusion (Oral breathing 2x: 2.4%, Other habits 2v, 2w: 2.4%)
- Displacements/crowding (Greater than 1 mm ,2o =3.6%, Greater than 2 mm ,3o =1.5%)
- Class II and class III malocclusion (Refer to table 6)
- Open bite [Open Bite >4mm (0.2%, 3p), Open Bite >2 mm (2.4%, 2p)]
- Congenital syndromes and malformations (0.7%, 5b)
- TMJ/ Condylar problems

❖ CARIES, EARLY LOSS OF TEETH AND POOR ORAL HYGIENE

Most of the occlusal problems found in our study were grade 4 (20.9%) attributed mainly to the presence of rampant caries and early loss of deciduous teeth (i.e, 4l). This was found accompanied by the subjects having poor oral hygiene (2t).

Understanding the importance of primary teeth is very essential for every individual as a caretaker, parent, or teacher. The very thought of putting a child through the entire process of dental treatment, for teeth that are considered temporary, is what sets off the need for treatment.

The question “Why should I put my child through this torturous process when the teeth are anyway going to fall and get replaced by permanent teeth?” is most often what runs through the minds of many parents.

The oral health of pre-schoolers is a disregarded aspect of childhood health and well-being. Most of the time, these young children constitute a sect of the population vulnerable to caries because of their dependence and inability to communicate with their parents. It thus becomes the parents' duty to ensure proper care.

Various studies have shown that there is an increased incidence of caries in the permanent dentition of those individuals who had carious deciduous teeth.[37,38,59]

Thus, it becomes obvious that prevention or treating the problem at an early age reduces the risk of caries as well as other treatment required in the future.

The prevalence of caries and early loss of deciduous dentition can result in various complications in the future, even for orthodontic treatment practices.

In a study by Pedersen et al[60], It was found that the premature or early loss of deciduous teeth would result in an increased possibility of developing a sagittal, vertical as well as transversal malocclusion.

For example, the early loss of a tooth due to caries can lead to crowding in the future due to dentoalveolar collapse. Identifying such a problem at an early age, and intercepting it by providing a space maintainer to maintain the available space would make further treatment less complicated.

Failure to maintain oral hygiene at a young age will result in increased chances of caries development in the permanent dentition. This would further complicate orthodontic treatment by causing increased chances in the development of white spot lesions, need to recement bands/ rebond brackets due to frequent

restoration requirement, loss of arch space in the case of proximal caries, and also the possible supra eruption of teeth opposing edentulous spaces.

In a study that was conducted to compare the prevalence and pattern of caries in 4-5½-year-old children of urban and non- urban parts of Karnataka state, India, the results showed caries prevalence of 66.3% in the urban population, and 58.4% in the rural sample. [61], which is much higher than a rate of 20.4% in the current study.

This is also lower as compared to another study conducted[35], Where the prevalence of Early Childhood Caries (ECC) in urban Bangalore within Karnataka state was 27.5%.

A possible reason for this could be due to the rapid growth and development of Bangalore city, not only concerning the land area but also in terms of employment opportunities and education status. Literacy rates amongst females in metro cities like Bangalore (84.01) versus small cities like Belagavi (64.58)[62], could be a reason for the increased number of working mothers. This could probably increase the chances of a child developing caries due to poor hygiene practices as mothers might not get enough time with a child who is mostly left under the supervision of caretakers.

Those who are more educated and literate tend to be more aware of risks associated with poor oral hygiene practices than the rural population, however, this knowledge isn't usually put into practice probably due to lack of time. Also, in today's world with women being more conscious of their body image, the practice of bottle feeding is on the rise.

Also, all these have chances of affecting the psychological aspect of a growing child.

Thus, an increased awareness, along with the practical application, among the public, especially mothers, as well as primary caretakers of children is of utmost importance.

In a study conducted by Suma Sogi et at [48] to assess the "knowledge, attitude, and practices of oral health care in the prevention of early childhood caries (ECCs) among parents of children in Belagavi city", it was found that despite good knowledge among the parents, their attitude, and practices were deficient to keep up with the needed standards to improve the oral health of their children. Parents should thus be the targets for delivering oral health care awareness for their children, especially those below the ages of 6 years.

A study by Hugar et al [49] revealed that the children of those parents who understood the standing of milk teeth had better oral health (fewer caries). Besides, the importance of visiting the dentist before the child turns one should be emphasized.

Additional professional preventive practices such as pit and fissure sealants, or topical fluoride application should be administered at primary health centers, along with timely vaccinations (after the complete eruption of all deciduous teeth).

To improve the Oral health of these pre-schoolers, more dental camps should thus be carried out, or else nurses in schools should be trained in carrying out these preventive therapies.

Like vaccine protocols, the government should also make dental health check-ups and ophthalmology check-ups a mandatory protocol from infancy, to instill the sense of importance among the population.

The presence of caries could be attributed to various factors apart from oral hygiene practices, such as feeding techniques (bottle feeding), mother's education, salivary consistency, etc. Since there was a high prevalence of our study participants with poor oral hygiene, it further emphasizes the importance of maintaining good oral hygiene from the primary dentition period itself.

DEEP BITE

The present results revealed that the next most common malocclusion found was the presence of a deep bite (Overbite >5 mm). The prevalence of deep bite in our study was 4.5%.

The increased prevalence of deep bite in primary dentition in this study is supported by various other studies where results showed that deep bites were very commonly found in pre-schoolers.[51]

In a study conducted by Shen et al[63], the most common trait of malocclusion present was revealed to be a deep overbite (33.66%), higher than the prevalence obtained in the present study.

However, the presence of a deep bite in the deciduous period is considered transient. It is said that spontaneous correction occurs owing to the growth of the ramus vertically along with the eruption of permanent molars.[64,65]

Only if the lower anterior teeth impinge onto the palatal mucosa in the maxillary arch, leading to symptoms such as pain or impairment of function, treatment is needed during the primary period.[66]

Thus, this kind of malocclusion falls under the category of those problems that require routine check-ups to monitor the occlusion. However, no immediate attention or interceptive treatment would be required at this stage of childhood.

HABITS AND ASSOCIATED MALOCCLUSION

In the present study, 4.2% of the sample showed mouth breathing and 2.4% reported other deleterious habits such as digit sucking and parafunctional habits. The results of the current study were much lower in comparison to a study conducted by Abreu et al in assessing the prevalence of mouth breathing in preschoolers.[67]

Oral habits are "repetitive behavior in the oral cavity resulting in loss of tooth structure and include digit sucking, pacifier sucking, lip sucking and biting, nail-biting, bruxism, self-injurious habits, and tongue thrusting".

Studies have shown that the presence of bad habits, such as thumb sucking, can cause alterations of the occlusion. [68,69] Oral breathing or mouth breathing associated with respiratory or nasal obstructions may cause alterations to the physiological patterns of the craniofacial growth.[70]

Children who are chronic oral breathers are more prone to developing speech disorders, facial deformities, abnormal body posture, and displaced teeth.[71,72]

The relationship between insufficient nasal breathing and dentofacial morphology has been studied extensively previously, and a lot of authors believe that the pattern and direction of craniofacial growth can be affected drastically by unbalanced muscle function typical of mouth breathing. [39,73,74,74,76]

Also, there is increased chances of caries development due to the accompanied dry mouth and increased salivary viscosity.

Children who are mouth breathers are more prone to develop a Class II malocclusion and a skeletal Class II profile with an increased overjet. The depressor muscles of the jaw exert a backward pressure thus displacing the mandible distally, retarding its growth.

The presence of persistent non-nutritive sucking habits may lead to long-term problems also affecting the stomatognathic system. This exerts a constricting force on the maxillary bicuspids and molars, which do not receive balancing support from the tongue. Thus, the upper arch becomes constricted as the neutral zone gets obliterated. Besides, lip function is also almost always abnormal. The lower lip is often large and bulbous with the upper lip being short and without any function. In some cases, a lip trap may also be present.

The risk of a child having a posterior crossbite in the primary as well as permanent dentition was doubled in those children with a non-nutritive sucking habit with bottle feeding as stayed by Vigianno et al.[77]

A study conducted by Warren to know about the extent to which nonnutritive sucking habits contribute to malocclusion in the mixed dentition stated that anterior open bite and posterior crossbite were associated with habits of 36 months or more.

Digit habits were associated with an anterior open bite when continued for 60 months or longer .[78]

Nonnutritive sucking habits are usually associated with an atypical swallowing pattern, and with tongue thrusting. This leads to the development of a posterior crossbite. [79,80]

The early cessation or interception of bad habits naturally leads to structural and functional normalization.[81]

Apart from its' effect on malocclusion, identifying the etiology for sucking habits is essential. It is said that prolonged sucking habits are indicative of emotional problems where the child feels a lack of affection.[82]

Thus, this possible cause should be explained to the parents of the child, as with the increasing rates of literacy and working mothers, the children are many a time left with caretakers.

It is thus clear that the negative influence of bad habits on occlusion originates in childhood.

This emphasizes the importance of intercepting such habits at a young age with habit breaking appliances such as oral screens, tongue cribs, bluegrass appliances, or psychological methods such as the Dunlop's Beta Hypothesis.[83]

DISPLACEMENTS/CROWDING

The presence of spaces between anterior teeth in the deciduous dentition is a common phenomenon. The spaces are called "physiologic interdental spaces".[84]

These spaces play a very important and crucial role in the alignment of permanent teeth, at a later stage.[85] The absence of these physiological spaces in the primary dentition indicates a discrepancy between the jaw and tooth size.[86]

The present study revealed that the prevalence of crowding/ displacements > 1mm was 3.6%, and >2 mm was 1.5%.

In the cases of crowding present in the primary dentition period, there are increased chances of food impaction and plaque accumulation. [87]

Hence, this deteriorates the oral health status of the child, leading to the development of caries and early tooth loss. This was proved in a study that concluded crowding of primary teeth is associated with the incidence of proximal caries.[88]

The relationship or association between crowding in the primary and permanent dentition cannot be entirely established due to mixed opinions present in the literature. [89]

Baume[90](1950) stated that "greater the spaces which exist in the primary arch, lesser crowding will exist in the permanent arch, but since individuals were found whose spaced primary arch led to a crowded permanent dentition and almost every variation of succession was found, it is not possible to make more than general statements of prediction of crowding".

Though the index classifies displacements as those malocclusions that need routine check-ups and no immediate intervention, a thorough knowledge about the significance of crowding and the possible complications are essential. It is thus very important for dentists and caretakers to pay attention to anterior spacing or crowding in primary teeth, despite this controversial opinion on the need for immediate treatment.

Also, in the mixed dentition phase, assessment for the need for serial extraction procedures to accommodate the erupting permanent dentition is very essential. In a 20 year follow up of a series of cases treated with serial extraction [91], it was seen that "undertaking a serial extraction protocol determined relevant esthetic

changes that afforded an improvement of the patient's self-esteem, resulting in a positive social impact." It is however important to note that following this protocol does not assure future stability, but this reason solely cannot annul its benefit.

CLASS II AND CLASS III MALOCCLUSION

Though the prevalence rates of maxillary hyperplasia/hypoplasia, and mandibular hypoplasia/hyperplasia, along with an overjet that isn't ideal, were less in our study the importance and benefits of early treatment for the same will be discussed.

The prevalence in the current study found was Maxillary Hypoplasia / Mandibular Hyperplasia [OVJ>0] 2k 0.5%; Maxillary Hyperplasia / Mandibular Hypoplasia [3mm<OVJ<6mm] 3.1%,2h and Maxillary Hyperplasia / Mandibular Hypoplasia [OVJ>6], 0.9%,3h

In a survey conducted on the insights of early treatment by the "Diplomats of the American Board of Orthodontics", the benefits stated were; "the increased possibility of modifying growth, the self-concept of the child being improved with parental satisfaction, increases stability, simpler treatment in the future; and reduced possibility of tooth damage."[92]

It has been stated that treating Class II malocclusions in the early mixed dentition reduces the incidence of "premolar extractions, root resorptions, ectopic cuspid eruptions, with better patient cooperation, and reduced need for surgical orthodontics." [93]

A study conducted by the University of Pacific indicated that almost 50% of the subjects who received early treatment did not need a second phase of treatment.

Early treatment resulted in eduction in expenses as well as a limited number of visits. It is also stated that treating a child early increases compliance as the treatment duration is reduced. Besides, later treatment has a greater requirement for retention. [93]

However some studies state that when dental and skeletal changes are compared, there are almost no advantages of early treatment as most of the effects finally seen are dentoalveolar, with very little skeletal benefits, and the acceleration in growth that takes place is only temporal.[94,95,96]

In addition, two very important factors to be considered in the early treatment of these discrepancies are the concept of self-image and the psychology of patients, as well as the reduced risk of incisal trauma.

A multicenter, randomized controlled trial conducted revealed that early functional appliance treatment in Class II division 1 patients resulted in more positive childhoods and higher self-concepts than untreated controls.[94]

Also, it is very well documented in the literature that the early treatment of cases with increased overjets and incisor proclination, greatly reduced the risk of anterior teeth trauma. This thus reduces the requirement of esthetic or prosthetic rehabilitation in the permanent dentition phase. [97,98]

Interception of a developing class 3 malocclusion at the right time can yield beneficial results.[99,100]

Early treatment of Class III malocclusions have been encouraged to avoid future potential complications like gingival recession concerning lower incisors [101], compromised dental and facial esthetics[102], elimination of an anterior functional shift of the mandible[103], and reducing the need for future orthognathic surgeries. [104]

A developing Class III malocclusion is known to worsen with time, and this thus stresses the benefits of interception.[105,106] There are "prolonged periods of active late mandibular growth", accompanied by a "failure or absence of maxillary catch up growth that is associated with the discrepancy". [107]

Although the ideal timing to intercept Class 3 malocclusions remains controversial, evidence states that if a pseudo Class III type of malocclusion exists, it should be treated at the earliest.[100,106,108,109,110]

Since pseudo Class III is characterized by dental problems, the early treatment aims at improving or making ideal the angulation of the upper anteriors. This will lead to the elimination of the mechanical interference, that happens due to the mandible over closing because of the anterior teeth in crossbite. Overall, this increases or maximizes the growth potential of the "naso-maxillary complex".[99,109]

Other reasons for early treatment of a persistent anterior crossbite is to reduce the chances of future temporomandibular joint (TMJ) dysfunctions, unesthetic outcomes, and related negative psychosocial effects.[110]

It is essential to remember since the treated Class III patients will grow similar to the untreated patients, they need to be kept under observation until their growth is entirely complete. [105,111]

In summary, although a lot of controversies exist regarding treatment timing for developing Class II and Class III malocclusions, and the Baby ROMA index does not consider these malocclusions as those that require immediate attention (Except for anterior crossbites, 4k), knowledge about the risks associated and need for interception is a must.

Growth modification is considered most successful when carried out synchronously with the adolescent growth spurt and ends around when rapid growth subsides. If not, then the original growth pattern will result in the loss of whatever correction was done. “Growth modification started too late is ineffective, and that started too soon, results in increased time for completion”.[112]

In Class II cases, mainly for reduced risk of occlusal trauma and for the improvised self-image, and in Class III mainly in the case of anterior crossbites, early treatment can be sought for.

Orthopedic treatment can thus be carried out in children with remaining active growth, to obtain maximum skeletal and minimum dental changes.

Treatment at an early age has the advantage of utilizing growth to aid in the process of correction. Besides, the hard tissues during this period are highly responsive to forces that are applied, and the soft tissues show greater degrees of being adaptable and changing thus improving stability.

OPEN BITE

The prevalence of anterior open bite greater than 2mm was 2.4% and greater than 4 mm was 0.2%. These results were much lesser than the prevalence seen in a study by Silvestrini et al which was 18%. This was associated with bottle feeding habits.[113]

The increased use of bottle feeding in the west could be a possible reason for the same, however, no assessment of feeding habits was done in the present study.

Early treatment of an open bite in the primary dentition period, is controversial, probably because of its multifactorial causes.

Identifying if the open bite is skeletal or dental is thus essential to provide appropriate treatment. The open bite that can be treated successfully during growth is that in children with average growth patterns. Open bites present in children with increased vertical patterns have a poorer prognosis. [114]

Most often, only habits are spoken about for the cause of an open bite. However, possible other aetiologies such as premature loss of teeth, mouth breathing, the presence of macroglossia, supernumerary teeth, enlarged and hypertrophied adenoids as well as temporomandibular disorders should be made aware of. [115]

CONGENITAL SYNDROMES AND MALFORMATIONS

Most congenital syndromes that affect the orofacial region, such as Treacher Collins Syndrome, Pierre Robin Syndrome, etc are most often associated with one or more of the above-mentioned malocclusions and thus require more of an interdisciplinary approach to treatment.

They are often associated with discrepancies requiring an immediate attention, such as crossbites, hypodontia, hyperdontia, poor oral hygiene, etc, and thus interceptive treatment is of utmost importance in such cases.

The parents or caretakers need to be made aware of the need for treatment at the early stages to reduce the severity of developing malocclusions.

Also, with a high prevalence of CLP patients,[116] patients' caretakers can be made aware of pre-surgical infant orthopedic procedures such as NAM, or passive plates, and expansion appliances.

TMJ/ CONDYLAR PROBLEMS

Though in the present study, no subjects were found with Temporomandibular joint problems, diagnosis if present in children is very essential.

The children were asked questions about common complaints such as pain on opening, chewing, frequent headaches. Palpation and examination were also done for common signs such as tenderness, joint sounds, and limited range of mandibular movement as described by Okeson in his article titled Temporomandibular disorders in children.[117]

The condyle is considered an area in the mandible that is frequently injured. Moreover, it is also considered to be a primary growth center of a child's jaw.

It at all there is any blow or direct trauma to the mandible, there is a proximal transmission of forces that can lead to the condylar process getting injured.[118]

Temporomandibular joint injuries at a young age can result in growth disturbances, facial asymmetries, malocclusions, restricted mouth opening, and bony ankylosis.[119]

TMJ associated problems in childhood are associated with disabling conditions which include speech impairment, masticatory difficulty, rampant caries, poor oral hygiene, drastic disturbances in craniofacial growth, airway compromise, thus invariably leading to psychological and physical difficulties at a later date. [120-123]

These possible complications make the diagnosis, accurate treatment, and "long-term follow-up" of condylar problems in the child's developing mandible essential.

Any problems at a young age thus need to be diagnosed and intercepted at the right time to avoid enhanced disturbances as the individual grows.

A very important point to note, apart from all the above-discussed problems associated with risk factors for malocclusion explained, till now, it was seen in the study that there was a statistically significant relationship between the age of the child and the prevalence of malocclusion.

At 4 years of age, the prevalence was 38.9% (n=82), while at 6 years of age it was 51.7% (n=61).

This sheds light on the importance of intercepting developing malocclusions at earlier ages and proves that the lack of interceptive treatment of conditions at an early age will lead to increased prevalence at a later age.

It was also observed that the parents of many of the children who had been examined reverted regarding their occlusal condition or habit of their child, thus making evident that this study increased awareness of the importance of oral health care in pre-schoolers. This in turn will reduce the severity of a developing malocclusion, or completely obliterate the need for future orthodontic treatment, therefore benefiting the child.

LIMITATIONS OF THE STUDY

A limitation of our study was the inability to accurately record the prevalence of those malocclusions that are inherited, due to the difficulty in contacting parents of all the individuals included in the study.

However, the Baby Roma Index classifies inherited malocclusions into the group that does not require immediate attention and only routine normal dental health check ups. The instruction of routine check ups were given to all the individuals taking part in the study. Thus, the parameter of inherent malocclusions does not significantly alter the study results.

SCOPE OF THE STUDY

Follow up studies can be carried out to assess the validity of the Baby ROMA index.

A follow up of the same students can be carried out at a later date, and a prevalence study can be conducted using the ROMA Index.

Hence, this study serves as a baseline for further longitudinal studies about the association of malocclusion in primary dentition with permanent dentition.

It can reveal how the risk factors present in the primary dentition period affects the development or persistence of malocclusion in the permanent dentition.

CONCLUSION

The study concluded that the most prevalent risk factor for a potential malocclusion encountered, using the Baby ROMA Index, was caries along with missing teeth and poor oral hygiene, followed by the presence of a deep bite and oral breathing. The prevalence was found to be 40.7%. There was a positive correlation between the age of the child and the presence of a risk factor for potential malocclusion that needed to be monitored.

These results show the importance of early orthodontic screening procedures and clinic visits in childhood. It explains the possible problems that can be encountered if certain types of malocclusions or etiological factors of malocclusions are not intercepted at the right time.

Intervening at an early age, not only prevents and helps in early diagnoses of malocclusions but also tackles conditions such as breathing and speech problems.

Parent education, paediatrician or nurse training and counselling further is required for the stressing on the importance of the same.

The measures to prevent the development of a malocclusion should be based on all the inter disciplinary interventions, aiming to promote normal growth and development of the face, eliminating all the potential interferences that may harm this natural process.

Appropriate communication between the orthodontist, pedodontist, paediatrician and other therapists, along with care takers and parents is essential for state-of-the-art oral health care in children. This also helps create a system of reference to specialized figures.

The development of a formal protocol or system aiming to direct parents from a paediatrician to the orthodontist to a pedodontist should be carried out in order to establish a specialized diagnostic and therapeutic approach.

SUMMARY

It is known that the presence of risk factors or the malocclusion already present in the deciduous dentition would affect permanent dentition. It is therefore more important to identify the influencing or causing factors of malocclusion in this period, so preventive or interceptive strategies can be implemented. This will decrease the severity and incidence of malocclusion in the future.

Hence, the current study aimed at determining the prevalence of risk factors for potential malocclusions in pre-school children (4-6 years) of Belagavi city, Karnataka, requiring the need for preventive or interceptive orthodontic treatment.

550 students (4-6 years) who fit the inclusion criteria from different zones of Belagavi City, Karnataka were selected by random sampling method, and included in the study.

They were screened using Type 3 examination using the Baby ROMA Index, with the objective to find out the prevalence of risk of malocclusion present, and the most prevalent form of potential malocclusion present.

The study concluded that the total prevalence was found to be 40.7%.

The most prevalent form of problem encountered, using the Baby ROMA Index, was caries along with missing teeth and poor oral hygiene, followed by the presence of a deep bite and oral breathing. There was also a positive correlation between the age of the child and the presence of a condition that needed to be monitored. That is, as the age increased, the prevalence of risk factors increased.

The parents or caretakers of those children who needed emergency treatment were informed, and oral hygiene instructions were delivered to all the participants of the study. Free referral cards were distributed to all the children.

The study thus helped create an increased awareness regarding the need for interceptive or preventive treatment among the population.

Apart from this, this study also serves as a baseline for further longitudinal studies pertaining to the association of malocclusion in primary dentition with permanent dentition as well as for validating the Baby ROMA Index since there is very less literature available on the same.

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ANNEXURE - I - ETHICAL CLEARANCE

Research and Ethics Committee
KLE V K INSTITUTE OF DENTAL SCIENCES
KLE University
Accredited 'A' Grade by NAAC Placed in Category 'A' by MHRD (GoI)
Nehru Nagar, Belagavi - 590 010, Karnataka State
☎: 0831-2470362 Web: http://www.kledental-bgm.edu.in
FAX: 0831-2470640 E-mail:principal@kledental-bgm.edu.in

Sl. No. : 1231

CERTIFICATE

This is to Certify that the synopsis titled

Assessing potential malocclusions among pre-school children of Belagavi city, Karnataka, using Baby Risk of Malocclusion Assessment (Baby ROMA) index - A cross sectional study *Submitted by*

Dr. Susmita Bala Shenoi *P. G. Student /*

Staff, Guided by Dr Roopa Jatti *from Department of* Orthodontics & dentofacial orthopedics *has been critically evaluated by committee members and granted ethical clearance to conduct the above mentioned study*

Date : 24/06/2019

Member Secretary
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

ANNEXURE – II - PERMISSION LETTER

From: Dr. Susmita Shenoi
Post Graduate Student
Department of Orthodontics
KLE Vishwananth Katti Institute of Dental Sciences

Through: Dr. Roopa Jatti
Professor and Head
Department of Orthodontics
KLE Vishwananth Katti Institute of Dental Sciences

To: Whom it may concern

Respected Ma'am/Sir,

SUB:- Permission to carry out oral examination

I, Dr. Susmita Bala Shenoi, a post graduate student in the Department of Orthodontics, am conducting a study on the **status of malocclusion** of preschool children where I will be examining the oral status/ teeth arrangement of children to see if they require immediate treatment or not.

It is purely and **observational study**, and will thus there is no intervention that will be done, and I will require to only screen the children of your institution between the **ages of 4-6 years**.

I kindly request you to grant me the permission to do so as I require a sample of 600 students in total from preschools around Belagavi City for my study.

Thanking you,

Dr. Susmita Shenoi

Dr. Roopa Jatti
Professor and Head
KLE VK Institute of Dental Sciences

ANNEXURE – III - CONSENT FORM

K. L. E V.K. INSTITUTE OF DENTAL SCIENCES, K.A.H.E.R, Belagavi- 590010

DEPARTMENT OF ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

CONSENT FORM

"Assessing potential malocclusions among pre-school children of Belagavi City, Karnataka, using Baby Risk of Malocclusion Assessment (Baby ROMA) Index - A Cross Sectional Study"

The aim of the study is to determine the prevalence of potential malocclusions in pre-school children of Belagavi city, which require the need for preventive or interceptive orthodontic treatment (early treatment to correct alignment of teeth).

The current study is a cross sectional observational study and there are **no risks** associated with this study since all that will be done is an **oral examination (teeth check-up)** with no intervention.

The data obtained from this study will be used to assess cases which pose a high risk of a developing malocclusion in the future, and thus require early treatment.

I, _____aged _____ have been informed about the involvement of my child _____aged _____, Male/Female, in the study.

1. I approve of giving my child's personal details like name, age, sex, address and the details required for the study to the best of my knowledge

2. I permit the dentist to conduct an oral examination (teeth check-up) of my child, and utilize the results from this study for presentation and publication purpose
3. I will not claim any returns for mine and my child's cooperation in the study, even if it is being sponsored by any agency. I am participating with my own will and wish
4. I will ensure I inform my child that an oral examination will be conducted on him/her

In my full consciousness and presence of mind, and after understanding all the procedures in my vernacular language, I am willing and give my consent to participate in this study.

DATE:

PLACE:

Dr. SUSMITA BALA SHENOI

SIGNATURE OF PARENT/GUARDIAN NAME & SIGNATURE OF INVESTIGATOR

ANNEXURE – IV - PATIENT INFORMATION SHEET

K. L. E V.K. INSTITUTE OF DENTAL SCIENCES, K.A.H.E.R, Belagavi- 590010

DEPARTMENT OF ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

PATIENT INFORMATION SHEET

Study Title:

"Assessing potential malocclusions among pre-school children of Belagavi City, Karnataka, using Baby Risk of Malocclusion Assessment (Baby ROMA) Index - A Cross Sectional Study"

Name of Investigator/ Dentist: Dr. Susmita Bala Shenoi

- The current study is a cross sectional observational study and there are **no risks** associated with this study since all that will be done is an **oral examination (teeth check-up)** with no intervention, no procedure.
- ***Baby ROMA index*** (A list with certain teeth problems) will be used to assess the state and risk of malocclusion – current state of dentition to check if there are any problems and if treatment is required to correct alignment of teeth.

  That is, the dentist will have a list of certain teeth problems, and will check if the child has any of the problems listed.
- The examination of the children will be carried out using light, mouth mirror, etc., by the dentist after obtaining permission from the child's parent
- Data obtained will be subjected to statistical analysis to assess the prevalence of malocclusion in the sample and the most common malocclusions requiring treatment at this age group

ANNEXURE – V - STUDY PROFORMA

STUDY PROFORMA

K. L. E V.K. INSTITUTE OF DENTAL SCIENCES, K.A.H.E.R, Belagavi- 590010

DEPARTMENT OF ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

Assessing potential malocclusions among pre-school children of Belagavi City, Karnataka, using Baby Risk of Malocclusion Assessment (Baby ROMA) Index - A Cross Sectional Study

Study ID No:

Name: **Age:** **Sex:**

Date of Birth:

SYSTEMIC PROBLEMS	Maxillo-facial Trauma	with condylar fracture	5a
		without condylar fracture	2a
	Congenital Syndromes/ Malformations		5b
	Postural/ Orthopaedic Problems		2c
	Medical or Auxological Conditions		2d
	Inheritance of malocclusion		2e
CRANIOFACIAL PROBLEMS	Facial or Mandibular Asymmetries		4f
	TMJ dysfunctions		4g
	Outcomes of trauma or Surgery of the cranio-facial district		5j
	Maxillary Hypoplasia / Mandibular Hyperplasia	OVJ<0	4k
		OVJ>0	2k

DENTAL PROBLEMS	Maxillary Hyperplasia / Mandibular Hypoplasia	OVJ>6mm	3h
		3mm<OVJ<6mm	2h
	Caries and Early Loss of Deciduous Teeth		4l
	Scissor bite		4m
	Crossbite	>2mm or lateral shift	4n
		<2mm or no lateral shift	2n
	Displacement	>2mm displacement	3o
		>1mm - absence of diastema	2o
	Open bite	>4mm	3p
		>2mm	2p
	Hypodontia	up to 2 teeth	3q
		more than 2 teeth	4q
	Supernumerary teeth		4q
	OVB>5mm		2r
	Poor oral hygiene		2t
FUNCTIONAL PROBLEMS	Parafunctions (bruxism, jaw clenching)		2v
	Thumb/finger Sucking Habit		2w
	Oral breathing / OSAS		2x
NONE OF THE PROBLEMS LISTED ABOVE			N

Score:

ANNEXURE – VI - DATA ENTRY SHEET																														
ID NO.	**AGE**	**SEX**	**5a**	**5b**	**5j**	**4f**	**4g**	**4k**	**4l**	**4m**	**4n**	**4q**	**3h**	**3o**	**3p**	**3q**	**2a**	**2c**	**2d**	**2e**	**2k**	**2h**	**2n**	**2o**	**2p**	**2r**	**2t**	**2v**	**2w**	**2x**	**N**
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ID NO.	AGE	SEX	5a	5b	5j	4f	4g	4k	4l	4m	4n	4q	3h	3o	3p	3q	2a	2c	2d	2e	2k	2h	2n	2o	2p	2r	2t	2v	2w	2x	N
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