



Oral Hygiene and Periodontal Status of Children and Adolescents with Intellectual and Developmental Disabilities in India: Scoping Review



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Abstract

Background: Children and adolescents with intellectual and developmental disabilities are vulnerable to poor oral health. Global evidence suggests that there is a significant disparity in oral health when compared to those without IDD. However, there is limited evidence regarding this cohort's oral hygiene, gingival and periodontal status in India. Hence, the study aims to conduct a scoping review of published evidence regarding oral hygiene, gingival and periodontal status and associated risk factors of children and adolescents with IDD in India.

Methods: We reviewed thirty-two articles, selected using the Arksey O Malley framework from five databases. Studies were selected if they included children or adolescents with IDD, were conducted in India, measured oral hygiene and gingival or periodontal parameters, and published between 2000 and 2020. In addition, we conducted descriptive and thematic analyses of various scores and findings and measured the quality of studies using the MASTER'S framework.

Conclusion: Children and adolescents with IDD have worse oral hygiene, gingival and periodontal health compared to those without IDD. Most had 'fair' oral hygiene scores and moderate gingivitis. A significant number of studies reported moderate gingivitis and bleeding on probing. Factors affecting oral hygiene and periodontal indices were severity of disability, socioeconomic status, gender, type of disability, family structure, age and residential status. The frequency of brushing was once daily, and most children with IDD were assisted with oral care.

Clinical significance: Preventive efforts should focus on children with severe IDD and lower SES. Better awareness and training of carers could improve the frequency of brushing. Factors influencing access to dental care should be explored to improve and facilitate routine primary and preventive care. Further exploration is needed on improving oral hygiene and periodontal parameters in this cohort at a local and systems level.

Keywords: Oral hygiene; Periodontitis; Gingivitis, Intellectual and Developmental Disability, India; Oral hygiene index; Children and adolescents; Scoping review

Introduction

Individuals with intellectual and developmental disabilities (IDD) are at risk of poor oral hygiene and its consequences [1,2].

The AAIDD diagnostic criteria require individuals with IDD to have limited intellectual functioning and adaptive behaviour

before the age of 22 (“Defining Criteria for Intellectual Disability,” n.d.). These limitations affect daily oral care, making individuals with IDD vulnerable to dental diseases. The constraints include physical impairments and developmental delays that can reduce manual dexterity, making it difficult to hold a toothbrush [3]. Cognitive limitations may affect the ability to express, understand dental needs and follow instructions [4]. Severe physical and cognitive impairments affect autonomy entail dependent care, and carers may find it challenging to provide proper care if the individual is uncooperative. Hence, oral care may be ignored and given less priority as other comorbidities may take precedence [5]. Multimorbidity and comorbidities” result in polypharmacy, which can affect salivary flow, leading to dry mouth, making oral care painful and ineffective [1,6]. Antiepileptic medication, which is routine in individuals with IDD, can cause gingival hyperplasia [7]. Thus, a wide range of issues can affect oral hygiene, gingival and periodontal health in individuals with IDD.

Given that they are at risk, it is not surprising to find that studies consistently indicate poor oral hygiene and periodontal diseases among individuals with IDD. In a systematic review Ward et al. reported poor oral hygiene and gingival health in adults with IDD with the prevalence of periodontitis ranging from 22.5% to 69.2%. A cross-sectional study of 4732 individuals with IDD reported the prevalence of periodontitis to be 56% in 20 to 40-year-olds and 93% in those above 60. These findings indicated an increase with age advancement and a higher prevalence than the general population [8]. Alveolar bone loss is indicative of periodontitis, and an 8.5-year longitudinal study among adults with IDD, found 0.03 mm of average annual bone loss due to periodontitis, with worse outcomes in those with trisomy 21 [9]. Individuals with Down’s Syndrome, specific non-syndromic intellectual disabilities and developmental disabilities are genetically prone to periodontal and severe gingival issues [10]. Furthermore, Gabre et al. reported periodontitis as a major cause of tooth loss in adults with IDD. Thus, individuals with IDD not only have poor oral hygiene but suffer the consequences much more than the general population.

Evidence indicates that children and adolescents with IDD have poor oral hygiene, gingivitis, and periodontitis. Zhou et al., in a systematic review, found worse oral hygiene and a higher prevalence of gingivitis compared to those without IDD. Similarly, a systematic review exploring oral health conditions of children and adolescents in Asia found worse oral hygiene, periodontal health and plaque scores in children with special needs [11]. Reviews focussing on children with ASD reflect conflicting results, with one reporting no difference in oral hygiene and periodontal scores compared to others, while the other suggests a high prevalence of periodontal disease [12,13]. However, the authors note the poor quality of the studies; the other are findings from only three articles. The studies also point to a lack of evidence regarding periodontal health of children. The reported pooled prevalence

of periodontal health was 69% [12]. A review of children’s oral health with CP and DS found mixed results. Children with CP had poor oral hygiene but similar gingival scores to those without CP. While in children with DS, oral hygiene scores were worse or the same depending on the measuring indices used. However, gingival health and probing depth were worse in children with DS [14].

Studies from India indicate that children with IDD have worse oral hygiene and calculi scores compared to those with physical and sensory impairments [15,16]. In a survey of 225 children and adults with CP and severe disabilities, Jain et al. found the mean OHI score to be 2.81 and a mean of 4.72 bleeding sextants. Children with DS and low IQ were predictors of poor oral health [17,18]. A survey conducted in Rajasthan, India, found no participants with healthy gingiva [19]. Kadam et al [20], found that oral hygiene scores worsened with the severity of disability. Shukla et al., in a survey of 6 to 40-year-olds, estimated that 77% required professional tooth cleaning and periodontal intervention. These data indicate high unmet need among children and adolescents with IDD in India, strengthening the need for a review summarising the data and exploring risk factors.

Poor oral hygiene or plaque control increases the incidence of gingivitis and periodontitis. Periodontitis is a significant cause of tooth loss in individuals with IDD [1,6]. Despite a global decline in edentulism [21], early periodontitis-related tooth exfoliation or extractions may be the reason for the increased edentulism among older people with IDD [22]. Additionally, periodontitis can affect oral health-related quality of life, and the impact is directly proportional to the severity of periodontal health. The impact is mostly upon routine oral functions like chewing and speaking and can cause pain, disability, and psychological and social discomfort [23]. Furthermore, periodontitis affects systemic health; evidence shows periodontitis affects glycaemic control in people with diabetes [24], increases risk of cardiovascular disease, pneumonia, cognitive impairment and chronic kidney disease [25,26]. Individuals with IDD are prone to have comorbidities [27], and worsening periodontal health can affect prognosis. Thus, it is crucial to monitor and evaluate periodontal health at an early age in this cohort.

Government emphasis on caring for the dental needs of children and adolescent with IDD is lacking in India. Individuals with disabilities form the largest minority community [28]. In India, they form 2.21% of the Indian population [29], approximately 27 million, and 1 out of every 100 are presumed to have an intellectual disability [30]. Hence the burden of oral disease is presumably higher in this cohort. By right, they are obligated to equal access to health care as India became a signatory to the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) and subsequently ratified the same on October 1, 2007. In 2016, the Government of India passed the Right of People with Disability Act, guaranteeing equal access to health, education and employment. Since then, India has moved

away from medical rehabilitation to focus on social rehabilitation. Various health programs and disability rehabilitation efforts have been initiated at the central and state level. However, none cater to the dental needs of individuals with IDD [31,32]. In addition, there are no population-based surveys exploring the oral health needs of this cohort in India, and more evidence is needed to identify individuals with IDD at risk and to target activities. Thus, this study aims to explore what published evidence reflects about the oral hygiene and periodontal health of children and adolescents with IDD in India to map current evidence, identify gaps, and explore risk factors that cause poor oral hygiene and periodontal health.

Methods

The review was conducted as part of a PhD dissertation exploring the oral health of children with IDD. Only findings related to oral hygiene have been presented here. The study followed the Arksey and O'Malley framework [33]. Each step based on the framework has been described in detail below.

Research Question

1. What does published evidence report regarding oral hygiene and periodontal status of children and adolescents with IDD in India?
2. What factors or determinants affect the oral hygiene and periodontal status of children and adolescents with IDDs in India?

Searching for relevant studies

An initial preliminary search was conducted on PubMed using the terms "Oral Health", "Disability", and "India", with 'And' as the Boolean search operator. Based on the findings of the preliminary search and advice of the university librarian searches were further modified for different databases and to focus on IDD (Table 1). Databases searched include PubMed, Global Health, CINAHL, Scopus, And Psychinfo. In addition, we searched citing and cited references using Google Scholar. Indian University's thesis repositories, which were accessible online, were also searched. Authors PP, RS and WG conducted this part of the study.

Table 1: Search terms and databases used to search articles.

Database	Search Term Used
Pubmed Search Results	("Oral Health" OR "dental health" OR Dental Caries* OR "DMF Index" OR Oral Hygiene* OR "Oral Hygiene Index*" OR Gingivitis OR Gingival Index OR Periodontal Index) AND (Disabl* OR Intellectual Disability* OR Autism* OR "Cerebral Palsy" OR Differently able* OR "Special Needs" OR "Disabled Persons" OR "Learning Disabilities") AND India
CINAHL	(India OR Indian) AND((oral health or oralygiene or dental health)OR (dental caries ordental decay or dentalcavity or dental cavities ortooth decay) OR (gingivitis or gum diseaseor gum inflammation) ORperiodontitis ORmalocclusion OR traumatic dental injuries)) AND ((disability or disabilities ordisabled) OR (downsyndrome or trisomy 21)OR cerebral palsy OR (intellectual disability ormental retardation orlearning disability ordevelopmental disability orlearning disabilities)) AND ((India OR Indian))
Global Health	"
Scopus	(TITLE-ABS-KEY("Oral Health") AND TITLE-ABS-KEY(Disabl* AND Disabled)AND TITLE-ABS-KEY(India)

Selecting relevant evidence

We used three criteria to select studies: population, outcome measures, and context. The population targeted were children and adolescents with Autism Spectrum Disorder (ASD), Cerebral Palsy (CP), Down Syndrome (DS), Mental Retardation (MR), Intellectual Disabilities (ID) and other developmental disabilities. The outcomes were oral hygiene, gingival, and periodontal health indicators. The context was studies conducted in India between the years 2000 and 2020.

Study screening and selection

Articles collected were stored, deduplicated and reviewed using Zotero.

Extracting the Data: Evidence gathered was charted in Excel to reflect the following: Author(s), Year of publication, Region or

city, Population, Sample Size, Age, Study Design and Methodology of study (Table2).

Collating, summarising and reporting the result: Details of the study were summarised on an Excel sheet. The analysis was descriptive and thematic. We used the descriptive summary to describe oral hygiene, periodontal and gingival scores. Distribution of continuous scores of studies using the same indices were reported as mean with standard deviation or median with interquartile range. Nominal data were described using percentages. Factors influencing oral hygiene were thematically analysed using directed content analysis [34], against three broad categories: Genetic and Biological influences, Social and Physical environmental influences, and health-influencing behaviours [1]. Any physiological, genetic, or biological attributes, oral micro-flora, and salivary characteristics fell under genetic and

biological influences. Social and environmental factors included socioeconomic status, parental education, the composition of the family, culture, etc. Oral care practice and use of dental healthcare provisions were categorised under health-influencing behaviour. Four authors did data extraction and charting.

Three authors conducted collation, summary analysis of the results. Conflicts were resolved by consensus.

Quality appraisal: Two authors (PP1 and MV) conducted quality appraisal using the MASTER framework for bias assessment [35,36]. The framework considers 36 methodological safeguards. Since most studies were observational, a few safeguards were inapplicable, giving each study an accurate estimate of bias (Figure 1).

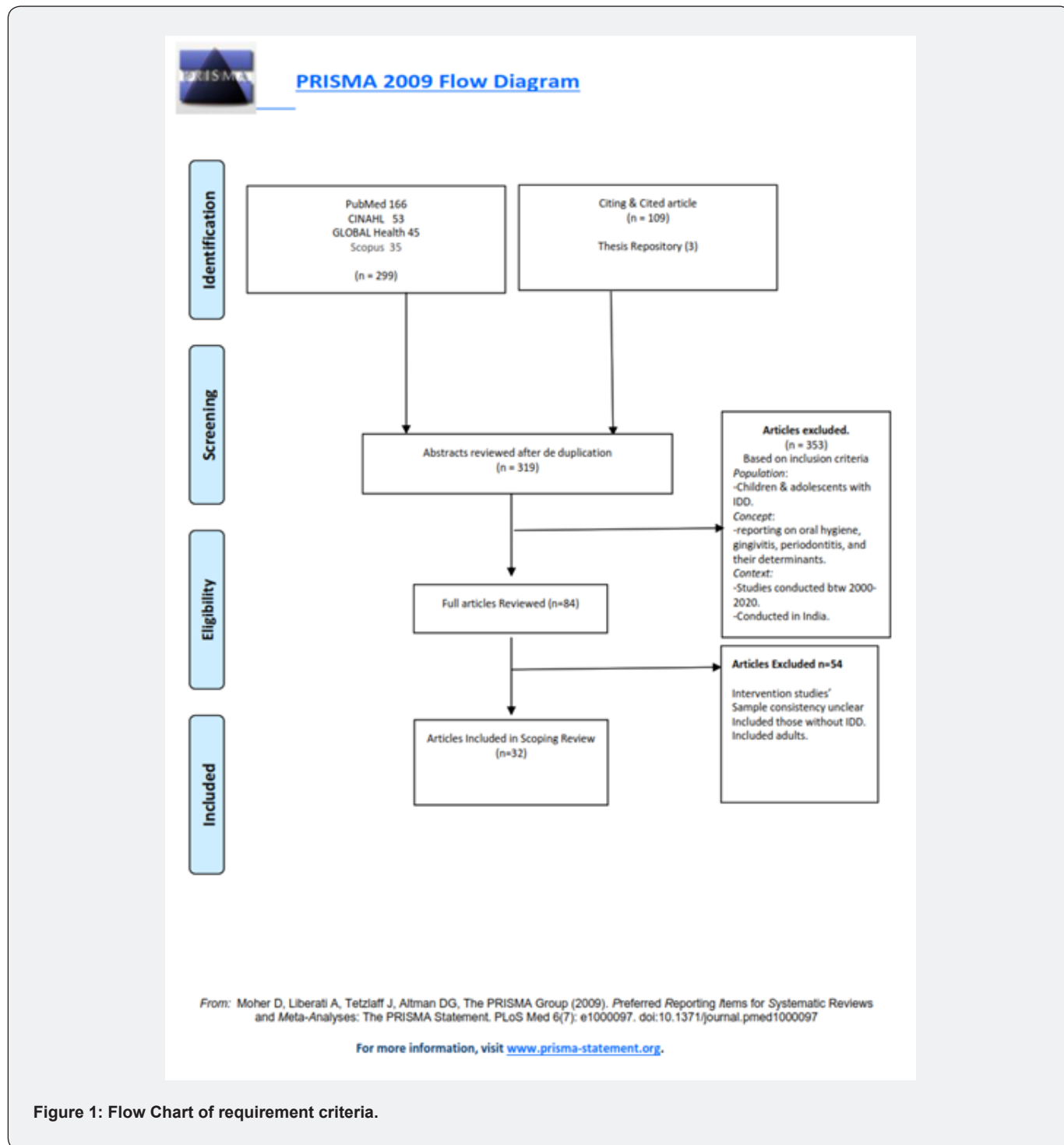


Figure 1: Flow Chart of requirement criteria.

Results

Description of Articles

A total of 411 articles were collected. After deduplication, 319 remained, screening of abstracts and headings reduced the number to 84. Three authors (PP1, PP and RR) reviewed full articles, and this exercise brought down the total number of articles included to 32 (Figure 1). Most studies were cross-sectional in design with convenience sampling. Data collection was by clinical examination and the use of questionnaires. One study retrospectively extracted details by looking at dental records [37], and another used a self-administered questionnaire [38].

Analysis was mostly descriptive, using binary, or multivariate analyses. Comparisons were made across various levels of intellectual disability, IQ scores, and other disability scores. Multivariate and logistic regression was done to explore factors affecting oral parameters. Studies also compared children with and without IDD, syndromic and non-syndromic, and siblings without a disability [39,40,41]. A few articles compared the study group based on age and gender [37,42-45]. Oral hygiene was reported using the Simplified Oral Hygiene Index [46]; OHI-S index(n 17), Plaque Index and(n1) Calculus index(n3). Gingival health was reported separately as prevalence or as the mean

number of sextants with bleeding on probing (BOP)(n 10). BOP was also recorded as part of the Community Periodontal Index (CPI) (Score1). In addition, the Gingival index was used to measure gingivitis (n2). Periodontitis was measured using modified CPI (n 9)

Description of population

There were 9004 children and adolescents with IDD in all 32 studies. While a majority of studies sample various kinds of IDD, eight were conducted exclusively on children with ASD and three on children with CP. Screening and investigations were carried out in residential or non-residential schools, residential homes, institutes, societies, disability clinics, hospitals and dental colleges. A majority of studies were from Karnataka (n=11) and Tamil Nadu (n=8) (Figure 2).

Oral Hygiene Status: (Table 2)

The median OHI-S score for the 8 studies was 2.06 (range 3.08-1). Fifty per cent reported fair OHI-s (range 29.3-60), 38% had poor (8.8-63), and 24% had good OHI-S (range 3-44.6)(n=9). The mean GI score was 1.58(n=3). Thirty-four per cent had mild gingivitis (mean, n=3), 40% had moderate, and 24.6% had severe gingivitis.

Table 2: Characteristics of studies included, key findings and risk factors assessed.

Author	Region/State	Participant	Sample Size	Age	Design & Methodology	Key findings Oral health	Determinants / risk factors evaluated			Master Score/ 35
							Genetics and Biology	Social & Physical Environment	Health-Influencing Behaviors	
Bennadi et al 2020	Mysore, Karnataka	IDD	490	6-13yrs	Cross sectional study, Clinical Examination, Questionnaire.	<ul style="list-style-type: none"> • 36.7% in IDD group had poor OHIS • 9.18% of children no IDD had poor OHIS (P < 0.000). 	<ul style="list-style-type: none"> •66.7% of profound IDD had fair OHIS •35.3% with severe IDD had poor OHIS . •13.3% of children with IDD had severe gingivitis 6.1% of those without IDD has severe gingivitis (P < 0.001) •Gingival status was better in females. 	<ul style="list-style-type: none"> • Positive correlation between oral hygiene status and parent's level of education. •Better OHI-S status was seen as socioeconomic status increases. 	<ul style="list-style-type: none"> •60% of children without disability and less than 20% of children with IDD brushed twice a day (P=0.001). •56.12% of children with IDD needed complete assistance and 32.65% needed partial assistance with brushing. 	20
		No IDD	490	6-13yrs						

Author	Region/State	Participant	Sample Size	Age	Design & Methodology	Key findings Oral health	Determinants /risk factors evaluated			Master Score/ 35
							Genetics and Biology	Social & Physical Environment	Health-Influencing Behaviors	
Fathima et al 2020	Chennai, Tamil Nadu	ASD.	16 children,	< 18yrs,	Retrospective study: data extracted from clinical records of children with ASD examined btw June 2019 to March 2020.	<ul style="list-style-type: none"> •31% of the children had OHI score of ≤ 2 •69% had a OHI score of 1 or less. 	<ul style="list-style-type: none"> •11- to 15-year-olds and males had higher OHIS scores. 			15
Sukhabogi et al 2020	Hyderabad, Telangana	IDD	328.	13.73 \pm 3.04	Cross-sectional, Clinical examination, questionnaire	<ul style="list-style-type: none"> •60% had gingivitis, •Gingivitis, was more among children with moderate IDD. 				14
Gadiyar et al. 2020	Goa, India	IDD	127	6-16	Cross-sectional study, Self-administered questionnaire, Clinical examination.	<ul style="list-style-type: none"> • Mean plaque score and gingival score were 1.16 \pm 0.58 and 0.88 \pm 0.74 respectively, • Gingival index and plaque index was higher in those with severe IDD. 			<ul style="list-style-type: none"> • 57.5% brushed once daily. • 90.6% were assisted with brushing. • 64.1% had never visited a dentist. 	6
Makkar et.al 2019	New Delhi, Delhi	IDD	269	11.63 \pm 3.64	Cross Sectional Clinical examination,	<ul style="list-style-type: none"> •Mean OHI-S score 2.05 \pm 1.07. •OHI scores were worse for severe disabled (2.66 \pm 1.07) •Oral hygiene was poor in children with DS (2.35 \pm 0.90) but those with severe disability in the NS-ID group had the worst score (3.41 \pm 0.42) 	<ul style="list-style-type: none"> •Children having severe IDD had higher OHI-S scores (P <0.05). 			18
Sinha E 2019	Bengaluru, Karnataka	IDD	250	6-14	Cross Sectional Clinical examination	<ul style="list-style-type: none"> • 47%of participants had moderate gingivitis •36% severe gingivitis. •48% had fair OHI-S •29% had poor OHI-S 	<ul style="list-style-type: none"> •51% of children with MR had fair OHI-S •48% of children with CP,59% of children with DS, and 77% with ASD had poor OHI-S. •52% with MR had moderate gingivitis. •48% with CP ,68.2% with DS, and 92.3% with ASD had severe gingivitis. 	<ul style="list-style-type: none"> •Poor oral hygiene was seen in study participants belonged to 0-10k income group. 	<ul style="list-style-type: none"> •57% brushed twice, • 43% were assisted. •57.3% belonging to 0-10K per month group severe gingivitis. •22.4% of study participants have earlier visited a dentist, •23.2 % of dental visits were for consultation and 76.8% for dental treatment. 	14

Author	Region/State	Participant	Sample Size	Age	Design & Methodology	Key findings Oral health	Determinants / risk factors evaluated			Master Score/ 35
							Genetics and Biology	Social & Physical Environment	Health-Influencing Behaviors	
Shivakumar et al. 2018	Karad, Maharashtra.	IDD.	100	5-12	Crosssectional study.	<ul style="list-style-type: none"> •35% with CPI score of 2(bleeding). •48% had a score of 3(calculus). 			<ul style="list-style-type: none"> •80% of children brushed once daily, •65% brushed under supervision 	16
Mohammed et al 2018	Chennai, Tamil Nadu	CP	30	>12	Case Control Study, Clinical Examination	<ul style="list-style-type: none"> • average probing pocket depth of 5.28mm, •CAL of 5.18 mm and most had fair OHI-S (mean 2.25). •No significant difference in OHI-S between groups. 	<ul style="list-style-type: none"> •Mean probing depth and CAL in children with CP was 5.77 &5.77 compared to 5.17 & 4.6 in healthy children. •Mean PPD and CAL in CP children with spasticity were higher compared to children with ataxia and dyskinesia. 			18
		No CP	30	>12						
Dheepthasri et al. 2018	Madurai, Tamil Nadu.	IDD	133,	12.6	Cross sectional survey, Clinical examination	<ul style="list-style-type: none"> •57.9% had fair OHI-S scores, •31.6% had periodontitis, •39.1% had poor OHI-S. 	<ul style="list-style-type: none"> •Highest OHI-S score was observed in older age group (3.26) 			16
Jaai et al. 2018	Mumbai, Maharashtra	IDD	120	6-12	Cross-sectional study, Clinical examination. Divided into three groups based on disability.	<ul style="list-style-type: none"> • PI scores was 0.93 in MC group compared to 0.83 in healthy siblings(p=0.05). • GI scores were 0.95 in MC groups compared to 0.85 in healthy siblings(p=0.05). 	<ul style="list-style-type: none"> • Gingival index scores were higher in children with DS compared to their siblings (P < 0.04). • In children with ASD, PI (P < 0.021) and GI (P < 0.05) were higher. 			19
		Siblings	120	6-12						
Bhandary et al 2017	Mangalore, Karnataka.	ASD	30	6-12	Cross sectional and Clinical Examination.	<ul style="list-style-type: none"> •56.6% of controls had good OHIS, •53.3% of the study group had fair OHIS compared to controls(p>0.05). 				21
		Siblings	30	6-12						
Chandrasekaran et al 2017	Chennai, Tamil Nadu.	MC	200	15.3 ± 2.7.	Clinical examination, four residential schools housing children with MC and fifty children were chosen randomly from each school.	<ul style="list-style-type: none"> • The mean OHI value for males was 2.41 ± 1.2 and 2.22 ± 0.96 for females. 	<ul style="list-style-type: none"> • Males had poor oral hygiene than female. 	<ul style="list-style-type: none"> •86% of children with MC brushed their teeth once daily •14% brushed twice daily. 	14	

Author	Region/State	Participant	Sample Size	Age	Design & Methodology	Key findings Oral health	Determinants /risk factors evaluated			Master Score/ 35
							Genetics and Biology	Social & Physical Environment	Health-Influencing Behaviors	
Mathur et al 2017	Ganganagar, Rajasthan.	IDD	317	3-20yrs.	Clinical examination, Interview conducted from March 2016 to May 2016. Students Group were classified based on type of ID.	•OHI-S scores were mostly 'poor' in all groups and mostly in the MR group(58.82%) (p<0.05).			•89.59% brushed once daily. •78.55% consulted dentist only in need.	17
Radha et al. 2016	Bengaluru, Karnataka	IDD	50	9-15	Cross Sectional data, Clinical examination, & saliva sample.	•CPI score of 2 was more in children with IDD (p=0.0042). • Mean CPI was 2.4±0.72 for children with IDD and 1.08±0.94 for children without IDD.				19
		No IDD	50	9-15						
Sharma et al 2016	Sri Ganganagar, Rajasthan	IDD	150	3-5	Cross sectional study, Interview & Clinical examination. Children grouped based on IQ scores from school records.	•OHI-s scores for ➤ Mild IDD: 1.1±0.73, ➤ Moderate IDD: 1.8±1.26 ➤ Severe IDD: 2.7±0.81			• 47.06 % of children with severe IDD did not brush their teeth (p<0.0001). • 70.59% of children with severe IDD and 42.22 % of children with moderate IDD were dependent on guardians for their tooth cleaning (p<0.0001). • 38.24% had never visited a dentist in the severe ID groups compared to 4.2% in the mild group(p <0.0001).	14
Rahul et al 2015	Chennai, Tamil Nadu	IDD	150	6--15	Cross Sectional Clinical examination in special schools.	•Marginal gingivitis was found in DS (92.9%) and (61.3%) of CP. •11% of DS had Periodontitis and 55.0% CP.				6
Sinha et al 2015	Jodhpur, Rajasthan	CP	50	7-17	Cross-sectional, Clinical Examination, Questionnaire,	•Children with CP had higher proportion of fair and poor OHI-S and lesser good scores(p=0.001).	•OHIS improved with age. •Those with severe CP had higher poor OHI-S.		• 84% of children with CP brushed once compared to 52% in those without CP. •27% from both groups had visited a dentist previously.	15
		No CP	50	7-17						

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Khursheed et al 2015	Mathura, Uttar Pradesh	IDD	200	3-14	Epidemiological survey, Clinical examination. The group was divided into:	<ul style="list-style-type: none"> •OHI-S in DS =1.83 ± 0.2. •OHI-S in LD =1.20±0.5. •OHI-S in MR=1.63±0.3 •OHI-S in COM=1.82±0.3 	<ul style="list-style-type: none"> •There was no significant difference between male and females. •Children with DS had the highest OHIS scores. 			9
Gardens et al 2014	Chennai, Tamil Nadu	IDD	402	6- 12	Cross sectional study, Questionnaire, medical record review and clinical examination.	<ul style="list-style-type: none"> •48% had the presence of calculus. •36.1% had bleeding on probing. •36% of children had CPI score of 1. •48% had CPI score of 2. 		<ul style="list-style-type: none"> •CPI score was comparatively better among the residents of the institutions than the non-residents (P < 0.001) 	<ul style="list-style-type: none"> •89.7% brushed their teeth once daily. •64.4% required assistance from the caregiver. •The best predictors for CPI were residential status and oral hygiene practice. •Utilisation of the dental services was minimal. 	17
Richa et al 2014	Bangalore, Karnataka	ASD	270,	4- 15	Cross sectional study, Oral Hygiene index - Simplified (Miglani's modification for deciduous teeth),	<ul style="list-style-type: none"> •Mean OHI-S, scores were significantly high among children with ASD(2.07 ± 0.83) compared to children without ASD (0.46 ± 0.58). 			<ul style="list-style-type: none"> •62.5% of ASD children and 50.7% without ASD had visited in the last 1 year. 	14
		No ASD	135	4-15						
Subramaniam et al. 2014	Bengaluru, Karnataka	CP	34	7-12	Clinical examination,	<ul style="list-style-type: none"> •Mean OHI-S was 1.58 ±0.72 for the study group & 1.35 ±0.75 in controls. 	<ul style="list-style-type: none"> •Oral hygiene of children with CP was significantly poorer than children without CP. 			7
		No CP	33	7-12						
Saravanakumar et al. 2013	Chennai, Tamil Nadu	IDD	73	children	Clinical examination.	<ul style="list-style-type: none"> •51% had fair OHI-S •66.7% children with developmental delays had gingivitis and 14 % had poor oral hygiene. • 65% of children with ASD had gingivitis and 20% had poor OHIS. 	<ul style="list-style-type: none"> •Children with developmental delays and ASD has the worst oral health scores compared to other groups. 			7
Vajawat et al. 2012.	Mysore, Karnataka.	ASD	117.	5-22	Cross Sectional, Clinical Examination.	<ul style="list-style-type: none"> •Plaque scores and gingival scores (1.3 and 1.0) were higher in study groups. (P = 0.000). •Prevalence of periodontal disease was significantly higher in children with ASD. 	<ul style="list-style-type: none"> •Oral hygiene and gingival health were poorer in ASD group •The incidence of periodontal disease increased with increase in age in both groups. 		<ul style="list-style-type: none"> •Most children in both groups brushed once daily. •Children with ASD required assistance in brushing their teeth, •Self-brushing increased with age (P = 0.001). 	16
		No ASD	126	5-22						

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							Genetics and Biology	Social & Physical Environment	Health-Influencing Behaviors	
Vishnu Rekha et al 2012	Chennai, Tamil Nadu	ASD.	483	4-16	Cross sectional, Clinical Examination.	<ul style="list-style-type: none"> •50% of children with permanent dentition and mixed dentition had bacterial plaque and gingivitis respectively. 	Difference in scores based on gender for plaque, gingivitis was statistically significant.			8
Mohinderpal Chadha et al 2012	Pune & Miraj, Maharashtra.	ASD.	35	5-10	Cross sectional, Clinical Examination & Interview regarding oral hygiene habits and daily diet.	<ul style="list-style-type: none"> •80% had a OHIs score of Fair to poor. •High amount of food debris and calculus. 			<ul style="list-style-type: none"> •65% of children brushed once daily. •Oral hygiene practice was mostly with Toothbrushes, powered toothbrushes and fingers. •Some reported rinsing the mouth using homemade mouthwashes. 	11
Rai et al , 2012	Mangalore, Karnataka	ASD	101	6-12	Clinical examination	<ul style="list-style-type: none"> •Mean OHIs score was 1.2(fair) in the study groups and 1 among controls (P < 0.001). •Low functioning group: median OHI-S=1.4 Medium functioning median OHIS = 1.2(P < 0.001). 	<ul style="list-style-type: none"> •Children with low IQ had worse oral hygiene (P < 0.001) compared to moderate IQ. 			18
		Sibling without ASD	50	6-12						
Subramaniam et al. 2011.	Bangalore, Karnataka.	ASD.	106	4 -15	Cross sectional, Clinical Examination.	<ul style="list-style-type: none"> •Mean OHI-S score: 2.19, •Mean DI-S score was 1.45. 			<ul style="list-style-type: none"> •73% brushed once daily, and 61% used fluoridated dentifrice. •56% had a negative behavior rating towards dental treatment. •64% children had their first dental examination done at the time of this study. •Out of the six special schools one had an in-house dental set-up. 	7

Author	Region/State	Participant	Sample Size	Age	Design & Methodology	Key findings Oral health	Determinants / risk factors evaluated			Master Score/ 35
							Genetics and Biology	Social & Physical Environment	Health-Influencing Behaviors	
Purohit et al 2010	Udupi district, Karnataka	IDD	256	5-15 .	Cross-sectional study, Clinical Examination, Close ended questionnaire.	<ul style="list-style-type: none"> •Poorer periodontal status was observed among children with SHCN compared to the healthy children. • Mean number of sextants affected by •BOP; <ul style="list-style-type: none"> ➤ Study group :2.8 ±0.9 ➤ No IDD: 2.1 ± 1.4 •Calculi <ul style="list-style-type: none"> ➤ Study Group:3.6 ± 1.5 ➤ No IDD : 2 ± 0.7. 		<ul style="list-style-type: none"> • Mothers education Middle school. Study Groups:42.6% No IDD: 40.6% Unemployed mothers Study Groups:69.1% No IDD :72.5% •Fathers education High school •Study group:46 .6% No IDD: 71.9% Skilled workers Study Group: 52.8% No IDD: 63.6%, 	<ul style="list-style-type: none"> • Majority of both groups brushed once a day, with tooth-brush and paste (p 0.05). • Higher number of children with SHCN (24.2%) needed help brushing compared to controls (p 0.05). •83.8% of SHCN never visited a dentist. 	20
		No IDD	310	5-15 .						
Pruthi et al 2010	Shimla, Himachal Pradesh	IDD	54	6-15-	Cross sectional study, Clinical Examination.	<ul style="list-style-type: none"> •Oral hygiene status was fair (Mean OHI-S=1.85± 0.73). 		<ul style="list-style-type: none"> •42% brushed once daily by themselves and 35% brushed once daily with assistance. 	10	

Author	Region/State	Participant	Sample Size	Age	Design & Methodology	Key findings Oral health	Determinants /risk factors evaluated			Master Score/ 35
							Genetics and Biology	Social & Physical Environment	Health-Influencing Behaviors	
Mohasin 2009	Mangalore, Karnataka	IDD	181	6-19	Cross sectional, Clinical Examination.	<ul style="list-style-type: none"> •46% had fair OHI-S •8.8% had poor OHIS. •70% had CPITN score of 2. •Calculi were higher in all groups. 	<ul style="list-style-type: none"> •62.5 % of ASD & 59.6% of DS had 'Good' OHI-S scores. •59.6 % Children with MR & 63.2% with MR with PC had higher 'fair' scores •Higher 'Poor' OHI-S scores were higher in children with CP (16.7%). •BOP were higher in ASD & MR with PC(15.8% & 18.8% respectively). •PI scores were higher in children with CP(25%). 	<ul style="list-style-type: none"> •Children with low family income had higher 'fair' OHI-S scores while children with higher family income had higher 'good' OHI-S scores(p=0.495). • There was no significant difference in annual family income and periodontal health. 	<ul style="list-style-type: none"> •91% of children were assisted with oral care. •OHIS were good in those who were assisted. •Calculus scores were higher in children who were assisted •OHIS were good in those -brush horizontal and vertical , - who brushed and rinsed after every meal, - who used medium tooth-brush. -Those who visit dentist regularly, • healthy periodontium in those who visit dentist regularly, •16% had regular dental visits every 6 months. 	14
Kumar et al 2009	Udaipur, Rajasthan	IDD	171	8 to 19.	Clinical examination,	<ul style="list-style-type: none"> •Mean DI scores was 2.20±0.64, •CI score was 1.07 ±0.82 •OHIS score was 3.80 ±1.42. •63% had poor OHIS scores. •77% had poor DI scores. • CPI score : 66% had shallow pockets. 	<ul style="list-style-type: none"> •In younger age groups 0.4 sextants were found to be healthy whereas in older age, mean number of healthy sextants was 0.1. 	<ul style="list-style-type: none"> •Education level of parents and SES affected oral hygiene and periodontal status. •Presence of a disabled sibling was a risk factor for OHIS & periodontal disease. 		18
Bhowate et al 2005	Hyderabad, Andhrapradesh.	IDD	69	10-14	Cross Sectional, clinical examination.	<ul style="list-style-type: none"> •60% had fair oral hygiene. 				13

ASD: Autism Spectrum Disorder; CP: Cerebral Palsy; DS: Down Syndrome; MR: Mental Retardation; CPI: Community Periodontal Index; CPITN: Community Periodontal Index Treatment Need; DI: Debris Index

CI: Calculus Index; BOP: Bleeding on Probing; PI: Plaque Index; HI and VI: Hearing and visual impairment.

PC: Physical Challenges; SES: Socioeconomic Status; OHI-S: Simplified oral hygiene Index

Nine studies reported on periodontal health using CPI scores: a mean of 3.6% had healthy gingiva(n6),14.0% had bleeding on probing, 22.0% had supra or subgingival calculi, 22% had pathologic pocket (n 3).

Distribution of Oral Hygiene scores

Most children with IDD had fair OHI-S scores [37,41,42,44,47-52]. However, a few articles did report a higher prevalence of "poor" scores in children with IDD [49,53-55]. The debris index was the main contributor to the OHI-S score [53]. Calculus and plaque scores were reported separately in a few articles [49,56-58]. Compared with those without disabilities, both calculi and plaque scores were higher [59,60].

Distribution of periodontal scores

The prevalence of gingivitis reported was as high as 80% and as low as 30% among children with IDD [42,61]. Compared to those without IDD, children with IDD had a higher proportion of gingival inflammation [40], and a higher proportion of severe gingivitis.

Eight studies reported periodontal health, and 6 reported a CPI score of 2 or more in most children with IDD. Less than 20% of children were found with CPI score of "4" [62]. CPI scores were higher than the comparisons. Those studies reporting periodontal health by assessing loss of attachment and clinical attachment loss found more significant loss in children with IDD than those without [63].

Risk Factors: Genetics and Biological factors

Severity of Disability: Children with severe IDD had worse oral hygiene, gingivitis and periodontal health [42,54,64]. Parameters also varied with the nature of the severity. In children with CP, oral hygiene, CAL (Clinical Attachment Loss) and PPD(periodontal probing depth) were worse in those with spasticity compared to those with ataxia and dyskinesia [63]. Increased OHI-S scores were consistently seen in children with low IQ [41,53]. Children with a combination of disabilities had worse oral hygiene and gingival scores [49].

Type of IDD: Few studies reported a higher prevalence of "poor" oral hygiene, gingival and periodontal scores based on the type of disability. One study reported worse OHI-s scores in children with DS [44], while another reported worse oral hygiene in children with ASD when compared to other disabilities [53,65]. However, children with ASD and DS also had higher good scores [49]. A higher proportion of Children with MR were found with poor oral hygiene scores [55,65], while those with developmental delays were with higher fair scores [51].

More number of children with ASD were found with severe gingivitis score compared to other [65]. Two studies reported higher BOP and calculi in children with ASD [49,65]. However, the prevalence of gingivitis was similar in children with ASD and developmental delay [51].

Age: Only a few studies reported worsening oral hygiene scores with age, [9,53]. However in a group of children with CP, oral hygiene improved with age [66]. The debris index was the main factor contributing to the higher OHIS score, while the calculus index was higher in the younger groups [53].

Gender: The effect of gender on the oral hygiene of children with IDD was mixed. Few studies reported better oral hygiene in the female child [4,9], while others observed worse oral hygiene in girls [65]. However, two studies found no difference in scores based on gender [44,48]. With regard to gingival and periodontal health, one study found better gingival status in females. The study also noted no significant difference in gingival scores based on gender [42].

Social and Physical Environments factors

Socioeconomic Status: Under this category, two factors affecting oral hygiene scores were socioeconomic status and parents' education status. Oral hygiene scores had an inverse correlation with socioeconomic status and parents' education status [42,49,53,66]. One study observed higher "fair" OHI-S scores in children with low family income and higher "good" OHI-S scores in children with a higher family income [49]. Similarly, children with less educated parents and lower SES had higher periodontal scores [53]. However, one study did report otherwise [49].

Residential Status: Gardens et al. found healthier gums in institutionalised children with IDD than in children living at their residences [56]. However, two studies reported poor oral hygiene scores among institutionalised children compared to non-institutionalised [42,57].

Family structure: The presence of a disabled sibling was a risk factor for poor OHI-S and periodontal disease [53].

Health Influencing Behaviors

Oral Hygiene practice: Major practices that affected oral hygiene and gingival scores were brushing frequency and assisted oral care. Brushing frequency in most studies was once daily [43,52,55-60,67,]. Frequency differed among various disabilities and based on severity [65], significantly impacting OHI-S and gingival scores.

A higher proportion of children with IDD required assistance with oral care and assistance involved supervision, partial or complete assistance [42,49,50,56,58,59,60,64,66,]. However, despite being assisted oral hygiene and gingival scores were not significantly better in those who were assisted [60,66]. Though one study did report better oral hygiene in the assisted group [49].

Other factors that affected oral hygiene were materials used for brushing, brushing techniques, oral hygiene aids used and who cleans the teeth of the child [65]. One study found good oral hygiene scores in those who used both horizontal and vertical brushing techniques and poor in those who used only horizontal.

Other factors that affected oral hygiene and periodontal scores were brushing after a meal, rinsing after a meal, using a medium toothbrush, and interval of changing brush [65].

Quality of studies: The median MASTER's score was 15, ranging from a minimum of 6 to a maximum of 21. Indicating a

moderate risk of bias in all studies as various safeguards were absent. This reason for moderate risk could be due to inherent limitations with descriptive and cross-sectional studies. We did not exclude studies based on the quality score (Table 3).

Table 3: Summary of gingival and periodontal scores

OHI-S (n 10)	
Median Score (Range)	2.06(3.8-1.2)
Median % with good OHI-S score (Range) [‡]	23.7 (3-44.6)
Median % with fair OHI-S score (Range) [‡]	49.7(29.3-60)
Median % with poor OHI-S score (Range) [‡]	37.9(8.8-63)
Bleeding on Probing*	
Mean Score (n 8)	21.2±18.32
Mean Sextant(n1)	1.6
Gingival Index	
Mean score(n3)	1.57±0.76
Gingivitis Prevalence(n2)	
Mean %mild gingivitis	34.5±24.7
Mean % moderate gingivitis	40.8±8.69
Mean % severe gingivitis	24.6±16.05
CPI score (n 6)	
Mean% Score 0 (healthy gingiva)	3.6±4.9
Mean% Score 2(supra/sub gingival calculi)	14.0±15.7
Mean% Score 3(4-5mm pocket)	22.0±27.06
Mean% Score 4(>6mm pocket)	22.30±38.5

*Includes score 1(BOP) in the CPI index.

n=number of studies.

Discussion

Summary of findings

Most studies reported worse oral hygiene, gingival and periodontal parameters in children with IDD than those without IDD, reflecting the existing disparities in oral health in this cohort. The chasm in oral hygiene and periodontal parameters aligns with other findings worldwide [1,10,68]. Most children had "fair" oral hygiene scores, with debris significantly contributing. Children with IDD have severe gingival inflammation, deeper pockets and loss of attachment. Oral hygiene and periodontal scores worsened with the severity of disability. Socioeconomic status and education also affected scores. An interesting finding was the influence of family structure on oral parameters. Brushing frequency was less than recommended and differed based on the severity of disability. A higher proportion of children with IDD were assisted in oral care, and this did not aid in improving oral hygiene and periodontal health. We also highlight some findings regarding

brushing techniques and oral hygiene aides on oral hygiene.

Gaps in evidence

Scoping reviews summarise research findings [33,69,]. However, they are limited in methodological rigour of studies includes as their scope is broad and do not emphasis on quality. To compensate for this shortcoming and to determine the strength of evidence we conducted quality check using MASTERS score [69,]. The checklist explores the presence of safeguards against bias in the study. Some of the safeguards were absent as all studies were observational and very few were analytical, reflecting the inherent flaws in cross-sectional study design. Studies fell short in criteria measuring temporal precedence, equal ascertainment as blinding did not occur, equal implementation as only a few studies had comparisons, and equal prognosis as very few controlled for confounder and none considered common effect of the exposure and outcome.

Most studies were from the south and west of India and hence generalisable to these areas. There were no studies from central and east of India; hence, our findings need to be more generalisable to India. There needs to be more population data regarding oral health. The last national oral health survey was published in 2004 and did not include individuals with disabilities. India is way overdue for a national oral health survey, and it needs to include persons with disabilities of all ages to identify disparities in oral health. The data would be helpful in identifying high risk groups and targeting interventions.

The measuring indices used were inconsistent and made summarising findings difficult. Studies mostly used three indices: Oral Hygiene Index, Gingival index, and the CPI index. OHI-S was primarily due to debris found on the tooth surfaces. It is well known that oral hygiene can vary throughout the day depending on oral hygiene practice and eating habits. The score is a partial recording protocol measuring only six fixed index teeth with the risk of ignoring more dirty teeth. Another issue is the risk of patients cleaning their teeth properly before the survey. When used in children, the CPI index can lead to false probing depth due to the eruption of the permanent teeth. Hence, for participants younger than 20 years of age only code 0, code 1, and 2 are recommended. One study reported code 4 in children with IDD and another on Loss of Attachment [63,66]. This finding should be treated cautiously as it may indicate false pockets [70]. Thus, we recommend calculus and gingival index to estimate oral hygiene and periodontal health in children with IDD.

Probably the most significant determinant for poor oral hygiene, gingivitis, and periodontitis was the severity of the disability and socioeconomic status, which aligns with other literature from elsewhere in the world [1,10,68]. Various reasons could cause poor oral health in those with severe IDD, ranging from difficulty providing oral care, to lack of cooperation. One study reported negligible dental visits in this subgroup [20]. In addition to being more dependent on care, the frequency of brushing was minimal in this group [64]. Though population data reports more children with mild IDD than those with moderate to severe, they tend to be overlooked in most surveys and health programs due to difficulties with clinical examination [20,43,71,72]. The type of severe impairment also affects dental health, as evidenced by the difference in oral hygiene in those with cerebral palsy with spasticity compared to other impairments [63], indicating different needs for different kinds of disability. Hence a "one fits all" model may not be apt for children with severe disabilities and requires specific and targeted approaches and may require a more coordinated multidisciplinary effort to cater to their needs.

Literature is flooded with discussion comparing oral health of individuals with IDD who are institutionalised and non-institutionalised [1,10]. We found two studies comparing institutionalised with non-institutionalised [42,73]. One study compared neurotypical noninstitutionalised children

with institutionalised and another institutionalised with non-institutionalised but was not included as the sample consistency was unclear. The significance of institutionalised care lies in the fact that care patterns is more organised than in the community, enabling better oral care and health. However due to integration of children with IDD into the community a lot of oral care is dependent on the carer/ parent's.

Carer dependent care is determined by lot of factors like economic, cultural and social factors. Our finding report that despite the child being assisted oral hygiene was not ideal. Indicating issues with quality and quantity of oral care [74]. Dental visits are also carer dependent and were inadequate. To improve oral hygiene and health it is important to discern factors that determine these variables and will need further exploration, both quantitative and qualitative to improve oral care.

Recommendations

To better understand the effect of risk factors and oral health parameters a systematic review may be required. Another recommendation is better study design and to include randomised selection of participants to help improve selection by chance and hence generalisability. Qualitative studies would help improve in depth situation analysis of both environment and behaviours with relation to oral care.

Conclusion

Oral hygiene, gingivitis and periodontitis were worse in children and adolescents with IDD than those without. Indicating a significant inequality in oral health distribution. Children with severe IDD and those with a lower socioeconomic status had the worst oral hygiene and periodontal status. Further exploration is required on how to improve oral hygiene and periodontitis status of children and adolescents with IDD as very few risk factors are modifiable. However, health is a universal right and equality demands that it be fairly distributed, factors that prevent poor oral hygiene and periodontal status at a local and systems level needs to be explored and furthered ramified.

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