Ningrum and Bakar. Scr Med. 2025 Jul-Aug;56(4):795-803. DOI:10.5937/scriptamed56-54897

META-ANALYSIS

# Caries Status and Associated Factors in Children With Intellectual Disabilities: A Systematic Review and Meta-Analysis

Valendriyani Ningrum,[1] Abu Bakar[2]

## Abstract

Children with intellectual disabilities (IDs) have incapacitated on daily life activities, chewing or swallowing problems, drooling saliva and other factors influence poor oral hygiene. The study aimed to explore scientific literatures related caries status and factor associated in children with IDs. This comparative study was a systematic review and meta-analysis regarding the caries status between children with IDs and control group. The study was conducted on five data bases: *PubMed, Web of Science, Scopus, Wiley Online* and *Cochrane Library* published from January 2004 to 15 January 2020. The reliability of the selection of the papers was very high (Kappa = 0.91). *Review Manager* (RevMan 5.3.3) was used for meta-analysis with p-value < 0.05. The initial search yielded 2337 articles. Twenty-four studies included in qualitative synthesis demonstrated several factors affected caries in IDs children consisted of parental awareness, severity of disorder, dietary intake, oral biology factor, medication use, dental professional acceptance and financial barrier. Thirteen studies included in quantitative synthesis showed the caries in children with intellectual disability was higher than normal children ($p < 0.001$). Children with IDs showed higher caries rates than general children. The findings suggest children with IDs support are necessary from their parents/caregivers, dental professional and policy maker to improve oral health promotion and prevention.

**Key words:** Dental caries; Intellectual disability; Child.

1. Department of Preventive and Public Health Dentistry, Baiturrahmah University, Padang, Indonesia.
2. Department of Oral Medicine, Baiturrahmah University, Padang, Indonesia.

**Citation:**
Ningrum V, Bakar A. Caries status and associated factors in children with intellectual disabilities: a systematic review and meta-analysis. Scr Med. 2025 Jul-Aug;56(43):795-803.

**Corresponding author:**
ABU BAKAR
E: abuba.mmed@gmail.com

Received: 21 November 2024
Revision received: 6 February 2025
Accepted: 18 February 2025

## Introduction

Dental caries remains one of the most prevalent and predominant persistent conditions affecting children worldwide, with significant implications for oral health and overall well-being. In vulnerable populations, children with intellectual disabilities face heightened challenges in maintaining oral hygiene, accessing dental care and adhering to preventive measures. These challenges are compounded by physical, cognitive and behavioural limitations, as well as systemic barriers such as lack of awareness and accessibility of healthcare services. Developmental disabilities refer to physical and/or mental disability that begins during the developmental period, typically before age of 18. Intellectual disabilities (IDs) are among the most common developmental disabilities, affecting an individual's ability to function in intellectual, social and practical domains. People with IDs suffer from a mental illness that affects their

ability to adapt in the intellectual, social and practical domains.[1] IDs often coexist with other developmental disorders, including depression, neurodevelopmental disorders such as attention-deficit disorder.[2]

Studies have shown that individuals with ID commonly experience oral health problems including dental caries,[3–9] poor oral hygiene,[10, 11] periodontal disease,[3,5–7,9,12,13] malocclusion.[5,8,14] Individuals with IDs who have mental and behavioural impairments called autistic spectrum disorders (ASD).[15] This special need care also reported have lower oral hygiene,[16–18] caries[19–22] and periodontal disease.[16, 23] However, some studies suggest that children with ASD may have lower caries[16, 24, 25] and fair oral hygiene[26, 27] compared to typically developing children. Additional IDs such as epilepsy, cerebral palsy (CP), Down syndrome (DS) have also been associated with increased dental issues.[28–30]

Despite being a crucial component of general health, oral health is frequently disregarded by people with intellectual disability (ID). Due to difficulties of maintaining good oral hygiene, dependency on caregivers and limited access to dental care, this population is at significantly higher risk of oral diseases. Children with ID are more likely to experience dental caries, periodontal problems, oral trauma and malocclusion. Many individuals with ID struggle with daily oral hygiene activities, such as toothbrushing,[8, 13, 31, 32] and may experience issues with chewing, swallowing,[33, 34] drooling saliva,[33] or medication side effects[29, 30] and all of which can contribute to poor oral health.[34, 35]

Although several studies have explored oral health in individuals with ID, in-depth research on caries status and associated factors remains limited. This study aims to systematically review the scientific literature related to caries status in children with ID and contributing factors using a high statistical power and robust estimation approach. The findings are expected to provide strong, evidence–based insight into caries status and associated factors in children with ID.

# Methods

This study follows the PRISMA guidelines to systematically review and synthesise evidence on the caries status in individuals with IDs (Figure 1). A comprehensive search and selection process was undertaken to ensure the inclusion of relevant, high-quality studies.

## Eligibility criteria

**a. Inclusion criteria**

1. Children under the age of 18 with intellectual disabilities
2. At least one quantitative metric for caries status (decayed, missing and filled teeth - DMFT or decayed, extracted, or filled primary teeth - DEFT)
3. Studies including a control group of typically developing children or siblings
4. Articles published in English
5. Clinical examination and observational study design.

**b. Exclusion criteria**

1. Abstract-only publications
2. Books
3. Conference proceedings
4. Oral/poster presentation
5. Systematic review, meta-analysis articles

## Search strategy

A systematic search was conducted across multiple databases, including *PubMed, Scopus, Web of Science Wiley Online* and the *Cochrane Library* for articles published between January 2004 and 15 January 2020. No language restrictions were applied and grey literature was included to minimise publication bias.

The search terms covered four main areas:

(a) Intellectual disabilities: (eg, intellectual disability - ID, Down syndrome - DS, autism spectrum disorder - ASD, cerebral palsy - CP, epilepsy, attention-deficit/hyperactivity disorder - ADHD)

(b) Children: (eg, preschool, child, adolescent, teenager)

(c) General health: (eg, healthy, normal, physically fit, good health)

(d) Caries status: (eg, oral health status, caries, decay, DMFT, oral hygiene)

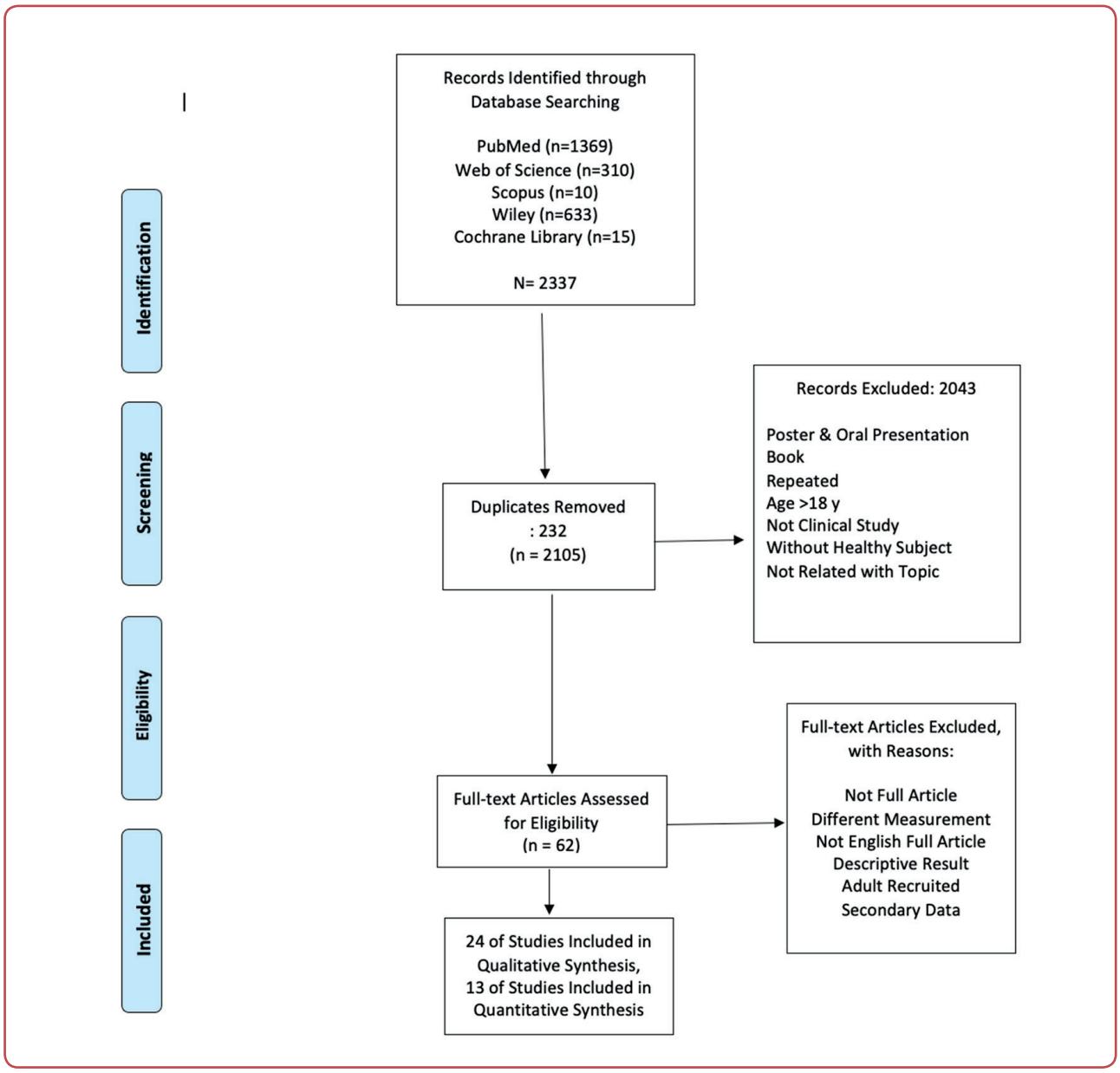


*Figure 1: PRISMA flow diagram through different phases*

## Study records

Data management: *End Note*, a reference management software, was used to organise and manage the records.

Selection process: Two independent reviewers (VN/AB) screened the identified studies and assessed their eligibility based on the inclusion criteria. Full-text examinations were conducted for abstracts that lacked sufficient detail. Disagreements were resolved through discussion. The Kappa statistic was calculated at 0.91 for study selection and 0.89 for literature analysis, indicating strong agreement (Table 1). The data gathered were subjected to analysis utilising the mean and standard deviation.

*Table 1: PICO criteria*

| Framework item | Term |
|---|---|
| Population | Children with intellectual disabilities |
| Intervention | - |
| Comparison | General children |
| Outcomes | Caries status |

## Data analysis

Data extracted included sample size, participant characteristics and study outcomes. The statistical analysis was conducted using SPSS version 23.0 and meta-analyses were performed using *Review Manager* (RevMan) Version 5.3. The significance threshold was set at $p < 0.05$.

## Results

Meta-analysis results indicated a significant disparity in caries prevalence between children with ID and typically developing children (Figure 2). Subgroup analyses showed varying results depending on the type of ID. Children with ASD exhibited significantly poorer oral health than their typically developing peers, attributed to factors such as increased salivary flow, high risk of erosion, bruxism and neglect of oral hygiene. Children with DS demonstrated significantly lower oral hygiene levels and higher caries status compared to typically developing children. However, some studies suggested lower caries rates in DS due to regular dental care. No significant difference in caries status was found between children with CP and their typically developing peers.

Continuous results were obtained by entering the mean, standard deviation (SD) and number of members in each bunch. This is how subgroup meta-analyses stratified by specifically ID were carried out. Cochrane's Q test and $I^2$ were used to survey the ponders' heterogeneity. $I^2 > 50$ % showed extensive or significant heterogeneity, which led to the use of the random effects demonstration. The threshold for factual significance was chosen at $p < 0.05$.

Several factors influencing caries prevalence in children with ID were identified, including parental awareness, severity of disability, dietary intake, oral biology, medication use, professional dental care accessibility and financial barriers.

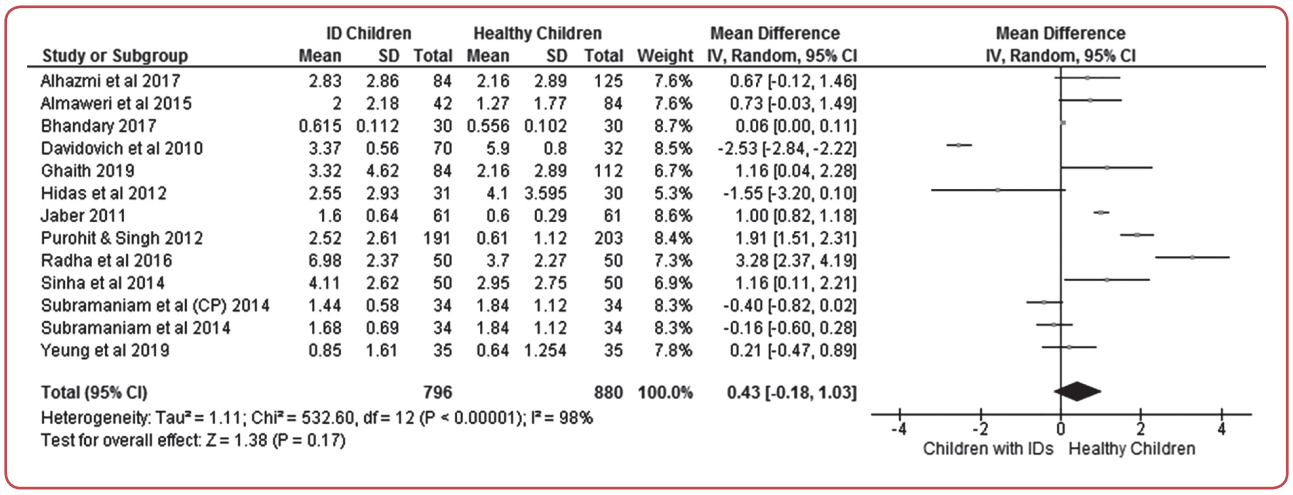


*Figure 2: Meta-analysis of caries status in children with intellectual disability compared to healthy children*

## Discussion

This systematic review and meta-analysis provide the first comprehensive evaluation of caries status in children with ID using PRISMA guidelines. The findings highlight significant differences in caries prevalence between children with ID and typically developing children. The results are consistent with previous studies demonstrating worse oral health outcomes in individuals with special needs due to limited dental care access, inadequate oral hygiene and a lack of specialised training in dental professionals.[36–39]

The subgroup analyses for children with ASD indicated significant differences caries status (SMD: -0.14, 95 % CI: -0.19- 0.09, $p < 0.00001$), Gingival Index (SMD: -0.13, 95 % CI: - 0.17, -0.08, $p < 0.00001$) between children with ASD children and normal children. This analyses equal with latest study that poorer oral health in ASD children than normal children due to increase salivary flow impact to caries, high risk erosion, high risk bruxism and oral health careless.[40–42]

The subgroup analyses for children with DS presented significant differences caries status (SMD: -1.62, 95 % CI: –1.87, -1.37, $p < 0.00001$), OHIs status (SMD: -0.55, 95 % CI: -0.88, -0.23, $p = 0.0009$) between children with DS children and normal children. This study similar with other systematic review found that lower oral health

status in DS than normal children,[14] but contrast with two studies that concluded DS have lower dental caries levels than control group[43, 44] due to DS are tend to get dental care regularly.

The subgroup analyses for children with CP showed no differences caries condition in children with CP and normal children (SMD: -0.01, 95 % CI: −0.37, 0.34, p = 0.94). In contrast with others study that presented significant differences caries level in CP children than control group due to rare regular visit to dentist and children with CP have dental developmental anomalies such as the presence of abrasions and delayed eruption.[45]

The study's findings are mixed, but those with SNs have greater oral health issues. The oral health condition of children with SNs in Asia was found to be significantly influenced by several factors. Factors influencing oral health in children with ID include: (1) Parental awareness: Parents and caregivers often lack knowledge about appropriate oral hygiene practices for children with special needs; (2) Severity of ID: Children with severe disabilities require assistance with oral hygiene, increasing the risk of caries; (3) Dietary practices: Frequent consumption of sugary foods and soft diets contributes to higher caries prevalence; (4) Medication use: Psychoactive drugs and anticonvulsants can lead to side effects such as gingival hyperplasia and dry mouth, increasing caries risk; (5) Salivary factors: Biological factors, such as salivary pH and enzyme levels, influence caries susceptibility; (6) Dental care access: Many children with ID rarely visit the dentist due to behavioural challenges, lack of professional training and financial constraints.

Several parents were unaware of the recommended toothbrushing methods for special need children.[46] Parents who are unaware of this need may inadvertently devalue instruction related to component oral hygiene skills. Additionally, previous study reported that parental/caregiver's awareness important necessary to daily oral hygiene practice of their ASD children/ ward.[26] Parents and other caregivers should understand the advantages of increased dexterity for their children's dental health in order to provide them more opportunities to learn how to be more independent.[37] Awareness leads to inventiveness, such as changing the toothbrush's handle length and size.[46] Parental/ care givers awareness for better their child's oral hygiene through visit dental professional regularly.[35, 47–49]

One important risk factor affecting caries rates is the severity of ID in individuals. Due to their limited physical capabilities for brushing, extended food retention in the oral cavity and reluctant dental procedures, children with severe disabilities exhibited noticeably higher caries rates.[50–52] Children with mild to moderate IDs clean their teeth on their own without assistance from the handle. Many people with moderately severe IDs require customised toothbrushes to do their normal brushing activities. People with CP struggle with some motor abilities, which makes it difficult for them to brush their teeth effectively.[53] In severe cases of IDs, toothbrushing requires parental or caregiver assistance.[13, 54–58] Brushing techniques should be based on the type and severity of the child's disability.[56] Some people with ID have trouble chewing, which results in food being retained in the mouth for a long time and affects their high caries status.[59] El Khatib et al study indicated children with ASD had more difficult behaviour than normal children during dental procedure.[16] Behaviour challenges in dental treatment anticipated by sedation or general anaesthesia. Sedation is more flexible and available in the dental primary care setting than general anaesthesia. Hence, general anaesthesia performs when many difficulties to handle IDs children due to lack of cooperation, communication and cognitive ability.[51, 52]

Dietary practices involving the consumption of sweets as risk factors for dental cavities in children with IDs.[56, 60] Consuming sugary liquids during main meals is significantly linked to children's high caries prevalence. Those with mild to moderate disabilities eat more sweets than those with severe or profound disabilities.[56] Restricted diet by parents in ASD children success keep oral hygiene and number caries similar with general health children.[61–63] Bakry and Alaki study reported a strong correlation between the consumption of soft foods and the rate of dental cavities (p = 0.001) in children with ID.[50]

Some individual with ID and related disorders consume drugs to control the manifestations of disorder. The presence of gingivitis in IDs children might be the side effects of psychoactive drugs or anticonvulsants.[5, 25] Since the children with epilepsy took their prescriptions in syrup form and never cleaned their mouths after taking them, prolonged use of those sugar-containing medications may raise the risk of caries in deciduous teeth[64] and gingival hyperplasia presence commonly from side-effect of phenytoin drug. The ADHD children with medicated higher

risk for decay than ADHD children without medicated due to hyposalivation as side effect from drugs use routinely.[63]

Saliva have biological factors plays an important role in the dental caries resistance, susceptibility, or both.[65] The few caries rates in children with ASD due to the presence of protective biological factors such as SIgA, salivary flow rate, lysozyme, lactoferrin and peroxidases and salivary pH.[63] Hence, Lee et al study showed DS children who have a lower caries rate might be due to the higher amounts of *Streptococcus mutans* specific IgA antibodies.[66] The pH saliva and buffering capability were less in CP children compared to the healthy group and the impact is similar caries status between both of them.[67] In contrary, Namal et al in Turkey informed that DS subjects have a more acid oral environment compared to healthy subjects cause more prevalent caries number. The individuals with ID who have both *Streptococcus mutans* and *Streptococcus sobrinus* have a significantly greater prevalent of caries than those with *S mutans* only.[68] According to the previous study, children with DS had worse oral hygiene and a lower overall antioxidant capacity due to the microbiological makeup of subgingival plaque (*Actinomyces* and *Hemophilus* strains), as well as greater amounts of salivary sialic acid.[53]

Most children with special needs never went to the dentist.[5] Most children with epilepsy reported seeing a dentist infrequently.[64] These issues are brought about by the unruly behaviour of special needs patients, the dentist's ignorance and incompetence in treating special needs patients, the strict admissions procedures, the difficulty in accessing the dental clinic and financial difficulties.[26, 30, 52, 69] Dentists should develop their unique abilities in treating children with specific problems and managing their behaviour. To properly educate and train parents and caregivers to maintain their children's oral hygiene, professional assistance is required.[11, 70]

The poor oral health status of ID group has an association with poverty.[70] Most Asia country in lower-income and middle-income country. Parents of IDs group are mostly low income and did not affordable access to dental care. They can't fill the caries because of financial reason. This condition added with low dental coverage,[71] financial barriers, particularly in low- and middle-income countries, significantly impact dental care accessibility for children with ID. Social insurance and specialised training for dental professionals may help improve oral health outcomes in this population.[72] The findings of this systematic review and meta-analysis provide a comprehensive understanding of the caries status in individuals with ID. The results demonstrate a significantly higher prevalence and severity of dental caries in this population compared to the general population, highlighting a pressing public health concern.

## Limitations

The study was limited to English-language publications, potentially excluding relevant research in other languages. The findings cannot be generalised to all individuals with special needs, as they focus primarily on those with intellectual disabilities.

# Conclusion

Overall, children with intellectual disabilities exhibit significantly worse oral health, particularly in terms of caries status. Factors such as parental awareness, severity of the disorder, diet, biological factors, medication use, professional dental care and financial constraints play a crucial role in oral health disparities.

# Ethics

This study was a secondary analysis based on the currently existing data and did not directly involve with human participants or experimental animals. Therefore, the ethics approval was not required in this paper.

# Acknowledgement

Authors are thankful to their parent institutions for the facilities.

# Conflicts of interest

The authors declare that there is no conflict of interest.

## Funding

This review received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

## Author ORCID numbers

Valendriyani Ningrum (VN):
0000-0002-5295-7651
Abu Bakar (AB):
0000-0002-3425-9825

## Author contributions

Conceptualisation: VN, AB
Methodology: VN
Formal analysis: AB
Investigation: VN
Resources: AB
Data curation: VN, AB
Writing - original draft: VN
Writing - review and editing: AB
Visualisation: AB
Project administration: AB

## References

1. Spivack E, Robinson MD, Ballesteros TJ. Oral and dental health. In: Prasher VP, Janicki MP, Eds. Physical health of adults with intellectual and developmental disabilities. Berlin: Springer 2019. doi: 10.1007/978-3-319-90083-4.
2. Einfeld SL, Piccinin AM, Mackinnon A, Hofer SM, Taffe J, Gray KM, et al. Psychopathology in young people with intellectual disability. J Am Med Assoc. 2006. doi: 10.1001/jama.296.16.1981.
3. Dheepthasri S, Taranath M, Garla BK, Karuppaiah M, Umesh, Sangeeta. Oral health status and treatment needs among intellectually disabled in Madurai. J Adv Oral Res. 2018;9(1–2):45–8. doi: 10.1177/2229411218762044.
4. Solanki J, Gupta S, Arya A. Dental caries and periodontal status of mentally handicapped institutilized children. J Clin Diagn Res. 2014 Jul;8(7):ZC25-7. doi: 10.7860/JCDR/2014/8983.4557.
5. Purohit BM, Singh A. Oral health status of 12-year-old children with disabilities and controls in Southern India. WHO South-East Asia J Public Heal. 2012;1(3):330–8. doi: 10.4103/2224-3151.207029.
6. Kumar A, Puranik MP, Sowmya KR. Relationship between untreated dental caries and dental neglect among mentally handicapped children: A cross-sectional study. J Indian Assoc Public Heal Dent. 2015;13(2):126–32. doi: 10.4103/2319-5932.159046.
7. Marks L, Wong A, Perlman S, Shellard A, Fernandez C. Global oral health status of athletes with intellectual disabilities. Clin Oral Investig. 2018;22:1681–8. doi: 10.1007/s00784-017-2258-0.
8. Oredugba FA, Akindayomi Y. Oral health status and treatment needs of children and young adults attending a day centre for individuals with special health care needs. BMC Oral Health. 2008;8:1–8. doi: 10.1186/1472-6831-8-30.
9. Fernandez Rojas C, Wichrowska-Rymarek K, Pavlic A, Vinereanu A, Fabjanska K, Kaschke I, Marks LA. Oral health needs of athletes with intellectual disability in Eastern Europe: Poland, Romania and Slovenia. Int Dent J. 2016 Apr;66(2):113-9. doi: 10.1111/idj.12205.
10. Jain M, Mathur A, Sawla L, Choudhary G, Kabra K, Duraiswamy P, et al. Oral health status of mentally disabled subjects in India. J Oral Sci. 2009;51(3):333–40. doi: 10.2334/josnusd.51.333.
11. Trihandini I, Wiradidjaja Adiwoso A, Erri Astoeti T, Marks L. Oral health condition and treatment needs among young athletes with intellectual disabilities in Indonesia. Int J Paediatr Dent. 2013 Nov;23(6):408-14. doi: 10.1111/ipd.12010.
12. Fernandez C, Declerck D, Dedecker M, Marks L. Treatment needs and impact of oral health screening of athletes with intellectual disability in Belgium. BMC Oral Health. 2015. doi: 10.1186/s12903-015-0157-9.
13. Ningrum V, Wang WC, Liao HE, Bakar A, Shih YH. A special needs dentistry study of institutionalized individuals with intellectual disability in West Sumatra Indonesia. Sci Rep. 2020;10(1):153. doi: 10.1038/s41598-019-56865-2.
14. Moreira RN, Alcântara CEP, Mota-Veloso I, Marinho SA, Ramos-Jorge ML, Oliveira-Ferreira F. Does intellectual disability affect the development of dental caries in patients with cerebral palsy? Res Dev Disabil. 2012;33(5):1503–7. doi: 10.1016/j.ridd.2012.03.026.
15. Maenner MJ. Prevalence of autism spectrum disorder among children aged 8 years—autism and developmental disabilities monitoring network, 11 sites, United States, 2016. MMWR Surveill Summ. 2020;69. doi: 10.15585/mmwr.ss6503a1.
16. El Khatib AA, El Tekeya MM, El Tantawi MA, Omar T. Oral health status and behaviours of children with Autism Spectrum Disorder: a case-control study. Int J Paediatr Dent. 2014 Jul;24(4):314-23. doi: 10.1111/ipd.12067.
17. Rai K, Hegde AM, Jose N. Salivary antioxidants and oral health in children with autism. Arch Oral Biol. 2012 Aug;57(8):1116-20. doi: 10.1016/j.archoralbio.2012.03.006.
18. Chadha GM, Kakodkar P, Chaugule V, Nimbalkar V. Dental survey of institutionalized children with autistic disorder. Int J Clin Pediatr Dent. 2012;5(1):29. doi: 10.5005/jp-journals-10005-1130.
19. Morales-Chávez MC. Oral Health Assessment of a group of children with autism disorder. J Clin Pediatr Dent. 2017;41(2):147-9. doi: 10.17796/1053-4628-41.2.147.

20. Önol S, Kırzıoğlu Z. Evaluation of oral health status and influential factors in children with autism. Niger J Clin Pract. 2018;21(4). doi: 10.4103/njcp.njcp_41_17.
21. Vishnu Rekha C, Arangannal P, Shahed H. Oral health status of children with autistic disorder in Chennai. Eur Arch Paediatr Dent. 2012 Jun;13(3):126-31. doi: 10.1007/BF03262858.
22. Suhaib F, Saeed A, Gul H, Kaleem M. Oral assessment of children with autism spectrum disorder in Rawalpindi, Pakistan. Autism. 2019 Jan;23(1):81-6. doi: 10.1177/1362361317730299.
23. Vajawat M, Deepika PC. Comparative evaluation of oral hygiene practices and oral health status in autistic and normal individuals. J Int Soc Prev Community Dent. 2012;2(2):58–63. doi: 10.4103/2231-0762.109369.
24. Subramaniam P, Gupta M. Oral health status of autistic children in India. J Clin Pediatr Dent. 2011 Fall;36(1):43-7. doi: 10.17796/jcpd.36.1.l6287842uj536x13.
25. Du RY, Yiu CCY, Wong VCN, McGrath CP. Autism developmental profiles and cooperation with oral health screening. J Autism Dev Disord. 2015;45:2758–63. doi: 10.1007/s10803-015-2416-7.
26. Bhandary S, Hari N. Salivary biomarker levels and oral health status of children with autistic spectrum disorders: a comparative study. Eur Arch Paediatr Dent. 2017 Apr;18(2):91-6. doi: 10.1007/s40368-017-0275-y.
27. Patel A, Biswas S, Shoja MH, Ramalingayya GV, Nandakumar K. Protective effects of aqueous extract of Solanum nigrum Linn. leaves in rat models of oral mucositis. Sci World J. 2014. doi: 10.1155/2014/345939.
28. Huang S-T, Hurng S-J, Liu H-Y, Chen C-C, Hu W-C, Tai Y-C, et al. The oral health status and treatment needs of institutionalized children with cerebral palsy in Taiwan. J Dent Sci. 2010;5(2):75–89. doi: 10.1016/S1991-7902(10)60012-8.
29. Morgan JP, Minihan PM, Stark PC, Finkelman MO, Yantsides KE, Park A, et al. The oral health status of 4,732 adults with intellectual and developmental disabilities. J Am Dent Assoc. 2012. doi: 10.14219/jada.archive.2012.0288.
30. Yeung PM, Wong VCN, McGrath CP, Yiu CKY, Lee GHM. Oral health status of children with epilepsy in Hong Kong. J Investig Clin Dent. 2019 Nov;10(4):e12479. doi: 10.1111/jicd.12479.
31. Diab HA, Salameh Z, Hamadeh GN, Younes G, Ayoub F. Oral Health Status of Institutionalized Individuals with Intellectual Disabilities in Lebanon. J Oral Maxillofac Res. 2017 Mar 31;8(1):e4. doi: 10.5037/jomr.2017.8104.
32. Ningrum V, Bakar A, Shieh T-M, Shih Y-H. The oral health inequities between special needs children and normal children in Asia: a systematic review and meta-analysis. Healthcare. 2021. doi: 10.3390/healthcare9040410.
33. Calis EAC, Veugelers R, Sheppard JJ, Tibboel D, Evenhuis HM, Penning C. Dysphagia in children with severe generalized cerebral palsy and intellectual disability. Dev Med Child Neurol. 2008;50(8):625–30.
34. Abanto J, Carvalho TS, Mendes FM, Wanderley MT, Bönecker M, Raggio DP. Impact of oral diseases and disorders on oral health-related quality of life of preschool children. Community Dent Oral Epidemiol. 2011 Apr;39(2):105-14. doi: 10.1111/j.1600-0528.2010.00580.x.
35. Bakar A, Ningrum V, Lee A, Hsu WK, Amalia R, Dewanto I, et al. Structural equation modelling of the complex relationship between toothache and its associated factors among Indonesian children. Sci Rep. 2020 Aug 11;10(1):13567. doi: 10.1038/s41598-020-70104-z.
36. Zhou N, Wong HM, Wen YF, Mcgrath C. Oral health status of children and adolescents with intellectual disabilities: a systematic review and meta-analysis. Dev Med Child Neurol. 2017 Oct;59(10):1019-26. doi: 10.1111/dmcn.13486.
37. Ward LM, Cooper SA, Hughes-McCormack L, Macpherson L, Kinnear D. Oral health of adults with intellectual disabilities: a systematic review. J Intellect Disabil Res. 2019. doi: 10.1111/jir.12632.
38. Wilson NJ, Lin Z, Villarosa A, Lewis P, Philip P, Sumar B, et al. Countering the poor oral health of people with intellectual and developmental disability: a scoping literature review. BMC Public Health. 2019;19(1):1530. doi: 10.1186/s12889-019-7863-1.
39. Anders PL, Davis EL. Oral health of patients with intellectual disabilities: A systematic review. Spec Care Dent. 2010. doi: 10.1111/j.1754-4505.2010.00136.x.
40. Da Silva SN, Gimenez T, Souza RC, Mello-Moura ACV, Raggio DP, Morimoto S, et al. Oral health status of children and young adults with autism spectrum disorders: systematic review and meta-analysis. Int J Paediatr Dent. 2017;27(5):388–98. doi: 10.1111/ipd.12274.
41. Lam PP, Du R, Peng S, McGrath CP, Yiu CK. Oral health status of children and adolescents with autism spectrum disorder: A systematic review of case-control studies and meta-analysis. Autism. 2020 Jul;24(5):1047-66. doi: 10.1177/1362361319877337.
42. Jeevanandam L. Perspectives of intellectual disability in Asia: epidemiology, policy, and services for children and adults. Curr Opin Psychiatry. 2009 Sep;22(5):462-8. doi: 10.1097/YCO.0b013e32832ec056.
43. Robertson MD, Schwendicke F, de Araujo MP, Radford JR, Harris JC, McGregor S, et al. Dental caries experience, care index and restorative index in children with learning disabilities and children without learning disabilities; a systematic review and meta-analysis. BMC Oral Health. 2019 Jul 15;19(1):146. doi: 10.1186/s12903-019-0795-4.
44. Deps TD, Angelo GL, Martins CC, Paiva SM, Pordeus IA, Borges-Oliveira AC. Association between dental caries and Down syndrome: a systematic review and meta-analysis. PLoS One. 2015 Jun 18;10(6):e0127484. doi: 10.1371/journal.pone.0127484.
45. Montserrat Diéguez-Pérez, de Nova-García MJ, Mourelle-Martínez MR, Bartolomé-Villar B. Oral health in children with physical (Cerebral Palsy) and intellectual (Down Syndrome) disabilities: Systematic review I. J Clin Exp Dent. 2016. doi: 10.4317/jced.52922.
46. Sinha N, Singh B, Chhabra KG, Patil S. Comparison of oral health status between children with cerebral palsy and normal children in India: A case-control study. J Indian Soc Periodontol. 2015 Jan-Feb;19(1):78-82. doi: 10.4103/0972-124X.145800.
47. De Jongh AD, Van Houtem C, Van Der Schoof M, Resida G, Broers D. Oral health status, treatment needs, and obstacles to dental care among noninstitutionalized children with severe mental disabilities in The Netherlands. Spec Care Dent. 2008;28(3):111–5. doi: 10.1111/j.1754-4505.2008.00022.x.
48. Cumella S, Ransford N, Lyons J, Burnham H. Needs for oral care among people with intellectual disability not in contact with Community Dental Services. J Intellect Disabil Res. 2000;44(1):45–52. doi: 10.1046/j.1365-2788.2000.00252.x.
49. Allison PJ, Hennequin M, Faulks D. Dental care access among individuals with Down syndrome in France. Spec Care Dentist. 2000 Jan-Feb;20(1):28-34. doi: 10.1111/j.1754-4505.2000.tb00007.x.
50. Bakry NS, Alaki SM. Risk factors associated with caries experience in children and adolescents with intellectual disabilities. J Clin Pediatr Dent. 2012 Spring;36(3):319-23. doi: 10.17796/jcpd.36.3.d716250117827056.

51. Manley MC, Skelly AM, Hamilton AG. Dental treatment for people with challenging behaviour: general anaesthesia or sedation? Br Dent J. 2000 Apr 8;188(7):358-60. doi: 10.1038/sj.bdj.4800480.
52. Prabhu NT, Nunn JH, Evans DJ, Girdler NM. Access to dental care—parents' and caregivers' views on dental treatment services for people with disabilities. Spec Care Dent. 2010 Mar;30(2):35–45. doi: 10.1111/j.1754-4505.2009.00127.x.
53. Subramaniam P, Mohan Das L, Girish Babu KL. Assessment of salivary total antioxidant levels and oral health status in children with cerebral palsy. J Clin Pediatr Dent. 2014;38(3):235–9. doi: 10.17796/jcpd.38.3.tv26g158q7343287.
54. Taleporos G, McCabe MP. The relationship between the severity and duration of physical disability and body esteem. Psychol Health. 2005;20(5):637–50. doi: 10.1080/08870440420003347 33.
55. van Vonderen A, de Swart C, Didden R. Effectiveness of instruction and video feedback on staff's use of prompts and children's adaptive responses during one-to-one training in children with severe to profound intellectual disability. Res Dev Disabil. 2010 May-Jun;31(3):829-38. doi: 10.1016/j.ridd.2010.02.008.
56. Liu H-Y, Chen C-C, Hu W-C, Tang R-C, Chen C-C, Tsai C-C, et al. The impact of dietary and tooth-brushing habits to dental caries of special school children with disability. Res Dev Disabil. 2010;31(6):1160–9. doi: 10.1016/j.ridd.2010.08.005.
57. Liu H-Y, Huang S-T, Hsuao S-Y, Chen C-C, Hu W-C, Yen Y-Y. Dental caries associated with dietary and tooth-brushing habits of 6-to 12-year-old mentally retarded children in Taiwan. J Dent Sci. 2009;4(2):61–74. doi: 10.1016/S1991-7902(09)60010-6.
58. Liu Z, Yu D, Luo W, Yang J, Lu J, Gao S, et al. Impact of oral health behaviors on dental caries in children with intellectual disabilities in Guangzhou, China. Int J Environ Res Public Health. 2014. doi: 10.3390/ijerph111011015.
59. Gabre P, Norrman C, Birkhed D. Oral sugar clearance in individuals with oral motor dysfunctions. Caries Res. 2005 Sep-Oct;39(5):357-62. doi: 10.1159/000086841.
60. Liu HY, Chen JR, Hsiao SY, Huang ST. Caregivers' oral health knowledge, attitude and behavior toward their children with disabilities. J Dent Sci. 2017 Dec;12(4):388-95. doi: 10.1016/j.jds.2017.05.003.
61. Sarnat H, Samuel E, Ashkenazi-Alfasi N, Peretz B. Oral health characteristics of preschool children with autistic syndrome disorder. J Clin Pediatr Dent. 2016 Winter;40(1):21-5. doi: 10.17796/1053-4628-40.1.21.
62. Marshall J, Sheller B, Mancl L. Caries-risk assessment and caries status of children with autism. Pediatr Dent. 2010;32(1):69–75. PMID: 20298657.
63. Hidas A, Birman N, Noy AF, Shapira J, Matot I, Steinberg D, et al. Salivary bacteria and oral health status in medicated and non-medicated children and adolescents with attention deficit hyperactivity disorder (ADHD). Clin Oral Investig. 2013 Nov;17(8):1863-7. doi: 10.1007/s00784-012-0876-0.
64. Morgan HI, Abou El Fadl RK, Kabil NS, Elagouza I. Assessment of oral health status of children with epilepsy: A retrospective cohort study. Int J Paediatr Dent. 2019 Jan;29(1):79-85. doi: 10.1111/ipd.12432.
65. Zero DT, Fontana M, Martínez-Mier EA, Ferreira-Zandoná A, Ando M, González-Cabezas C, et al. The biology, prevention, diagnosis and treatment of dental caries: scientific advances in the United States. J Am Dent Assoc. 2009;140:25S-34S.doi:10.14219/jada.archive.2009.0355.
66. Lee SR, Kwon HK, Song KB, Choi YH. Dental caries and salivary immunoglobulin A in Down syndrome children. J Paediatr Child Health. 2004 Sep-Oct;40(9-10):530-3. doi: 10.1111/j.1440-1754.2004.00457.x.
67. Al Hashmi H, Kowash M, Hassan A, Al Halabi M. Oral health status among children with cerebral palsy in Dubai, United Arab Emirates. J Int Soc Prev Community Dent. 2017 Nov;7(Suppl 3):S149-S154. doi: 10.4103/jispcd.JISPCD_295_17.
68. Okada M, Soda Y, Hayashi F, Doi T, Suzuki J, Miura K, et al. Longitudinal study of dental caries incidence associated with Streptococcus mutans and Streptococcus sobrinus in pre-school children. J Med Microbiol. 2005;54(7):661–5. doi: 10.1099/jmm.0.46069-0.
69. Scrine C, Durey A, Slack-Smith L. Providing oral care for adults with mental health disorders: Dental professionals' perceptions and experiences in Perth, Western Australia. Community Dent Oral Epidemiol. 2019;47(1):78–84. doi: 10.1111/cdoe.12427.
70. Pezzementi ML, Fisher MA. Oral health status of people with intellectual disabilities in the southeastern United States. J Am Dent Assoc. 2005. doi: 10.14219/jada.archive.2005.0291.
71. McCaul LK, Jenkins WMM, Kay EJ. The reasons for the extraction of various tooth types in Scotland: a 15-year follow up. J Dent. 2001;29(6):401–7. doi: 10.1016/S0300-5712(01)00036-7.
72. Hillebrecht A-L, Hrasky V, Anten C, Wiegand A. Changes in the oral health-related quality of life in adult patients with intellectual disabilities after dental treatment under general anesthesia. Clin Oral Investig. 2019;23(10):3895–903. doi: 10.1007/s00784-019-02820-4.