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SYSTEMATIC REVIEW

Implant-supported prostheses in patients with special needs: A systematic literature review of protocols and outcomes

Marie-Sophie Bogner, BDS, MSc,^a Vivien Chambas, BDS,^b Emmanuel Nicolas, BDS, MSc, PhD, HDR,^c Denise Faulks, BDS, MSc, PhD, HDR,^d and Martine Hennequin, BDS, MSc, PhD, HDR^e

Patients with special needs are at higher risk of missing teeth when compared with the general population because genetic disorders can be associated with agenesis and aggressive periodontal disease.^{1,2} Early tooth loss may also be associated with poor access to care, leading to more advanced oral disease when services are first contacted. In addition, these patients are more likely to undergo extractions than periodontal, endodontic, or restorative treatment compared with the general population.³ Missing teeth that are not replaced may lead to social and functional impairments and disability, and functional oral rehabilitation is challenging to provide for patients with special needs.⁴⁻⁶ In particular, removable dentures are often declined or abandoned after a short period of use.⁷⁻⁹ Handling and

cleaning removable dentures can be challenging for patients with physical or cognitive impairments. In addition, drug-associated xerostomia can lead to unfavorable outcomes.¹⁰ The benefits of implant-supported or

ABSTRACT

Statement of problem. Implant-supported prostheses for individuals with special needs have been considered high-risk because of the prevalence of poor oral hygiene and parafunction in this population; however, systematic evidence on protocols and outcomes is scarce.

Purpose. The purpose of this systematic review was to summarize implant procedures and outcomes for the special needs population.

Material and methods. A systematic literature review was conducted using PubMed, Embase, and Scopus databases in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodological framework. Data collected included patient information, location and number of implants, surgical and prosthetic procedures, behavior support techniques, postoperative follow-up, complications, and criteria for outcome assessment. Survival rates were pooled for quantitative analysis, and a separate analysis pooling data from groups of special needs patients that present similar risks was undertaken.

Results. The qualitative analysis included 79 studies involving 759 patients and 2269 implants. The quantitative analysis included 65 studies concerning 666 patients with special needs and 1886 implants. The overall weighted implant survival rate was 95.4%, with a mean follow-up duration of 40.7 ±29.5 months.

Conclusions. In individuals with special needs considered suitable for implant-supported prostheses by their clinician, implant survival rates were similar to those reported in the general population. (J Prosthet Dent xxx;xxx:xxx-xxx)

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Clinical Implications

Complex medical conditions, cognitive and physical disabilities, and genetic disorders should not necessarily be contraindications to providing implant-supported prostheses.

implant-retained prostheses with improved oral health-related quality of life compared with removable dentures have been established in the general population, elderly patients with edentulism, and patients with tumors.^{11–19}

The high prevalence of poor oral hygiene, lack of cooperation, and the presence of parafunction have been commonly voiced against implant placement in patients with special needs.^{20–25} However, international evidence-based recommendations or guidelines for this population are lacking. This systematic review aimed to summarize implant procedures and outcomes for patients with special needs. Considering the diversity and multiplicity of risk factors for poor oral hygiene and parafunction in patients with special needs, the research hypothesis was that implant survival rates would be lower in patients with special needs than in the general population.

MATERIAL AND METHODS

A systematic literature review was conducted using the PubMed, Embase, and Scopus databases in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodological framework in October 2021.²⁶ A follow-up search was conducted in November 2022 to identify any additional studies or clinical reports published after the initial search.

Two reviewers conducted the study selection independently (M-S.B., V.C.). A consensus on any uncertainties was obtained after discussion with a third researcher (M.H.). The electronic search in the databases had the following key words: (dental implant) AND ((disabled) OR (disability) OR (disabilities) OR (handicapped) OR (special need/s) OR (specific need/s) OR (medical compromised) OR (cerebral palsy) OR (phobia) OR (Down syndrome) OR (autism) OR (osteogenesis imperfecta) OR (cleidocranial dysplasia) OR (polyarthritis). A hand search was also undertaken in the *Journal of Disability and Oral Health*, which was not indexed in PubMed. Title and abstract were screened to identify studies with the following criteria: publications in English or French; clinical studies, case reports, and case series; patients with special needs undergoing dental implant placement; detailed information about the number of implants placed and loaded; rehabilitation finished, including prosthetic loading. Exclusion criteria were articles

not in English or French; in vitro or animal studies; use of implants other than dental endosseous titanium implants; no prosthetic loading; and systematic reviews of implant survival rates within specific subgroups of special care patients. The full text of the articles was assessed for eligibility. The references cited within each article were also assessed to avoid missing studies. Critical appraisal was assessed according to the JBI Critical Appraisal Checklists for case control studies, case reports, and case series.^{27,28}

Two investigators (M-S.B., V.C.) screened each included study independently. The following information was recorded: patient data: sociodemographic data and description of special needs; implant data: number per participant and location in the mouth; clinical procedures: surgical and prosthetic procedures, number and details of surgical and prosthetic complications that arose during the postoperative period; behavioral support procedures: general anesthesia (GA), conscious sedation, premedication, local anesthesia; study indicators: criteria used for outcome assessment.

Descriptive statistics were performed by measuring the weighted survival rate of the implants. Articles were eligible if they reported a follow-up duration (at least 1 follow-up appointment after prosthetic loading). For studies including patients with and without special needs, only those with special needs were included. For cohort studies, only the most recent data were included. The survival rate was calculated for each cohort or patient with a simple analysis of the number of implants lost weighted by the number of implants placed. The data were pooled with a separate analysis by pooling data from groups of patients with special needs that presented similar risks: patients able to perform oral hygiene and with no immune or metabolic/bone problems mentioned or deducted; patients needing support for oral hygiene because of dexterity or cognitive impairment and with no immune or metabolic/bone problems mentioned or deducted; and patients with impaired immunity and/or with a syndrome and/or medication affecting bone quality.

RESULTS

Fifty-four of the 124 articles assessed for eligibility were excluded, 15 of which reported systematic reviews of implant survival rates within specific subgroups of patients with special needs (geriatric patients²⁹; people taking antiresorptive drugs³⁰; those with Down syndrome,^{31,32} systemic conditions,^{33–36} oral manifestations of autoimmune diseases,^{37–42} and osteogenesis imperfecta).⁴³ Seventy-nine studies were included in the qualitative synthesis: 16 observational studies (2 case control studies and 14 case series),^{20,25,31,44–56} 59 case reports,^{57–115} and 4 articles presenting more than 1 clinical report.^{116–119} The quality of the included studies varied. Overall, studies described practices from 24

Table 1. Description of patients

Author	Country	No. of Patients	Age (Years)	Sex (M/W)	Special Needs as Described by Authors
Observational studies					
Cune et al, 2009 ⁴⁰	The Netherlands	61	43.2	NR	Severe epilepsy and multiple disabilities.
Corcuera-Flores et al, 2017 ⁴⁴	Spain	19	up to 40	36 implants/66 implants	Thirteen patients with cerebral palsy (71 implants), 6 with Down syndrome (31 implants).
De Bruyn et al, 2019 ⁴⁵	Belgium	8	45	6/2	Down syndrome.
Ekfeldt, 2005 ⁴⁶	Sweden	14	44.1	5/9	Neurologic disabilities.
Ekfeldt, 2013 ⁴⁷	Sweden	27	46	14/13	Neurologic disabilities.
Enkling et al, 2013 ⁴⁸	Switzerland	30	50.5	17/13	Fifteen patients with dental phobia versus 15 non-fearful patients.
Feijoo et al, 2012 ⁴⁹	Spain	8	36.7	5/3	Non-syndromic intellectual disability.
Jagadeesh et al, 2020 ⁵⁰	India	342	NR	NR	Patients with various medical conditions, diabetes mellitus, hypertension, mental disability, oral cancer, osteomyelitis.
Kim et al, 2017 ⁵¹	South Korea	19	32.9	8/11	Eleven patients with mental retardation, 3 with autism, 2 with cerebral palsy, 2 with schizophrenia, and 1 with brain disorder.
Krennmair et al, 2010 ⁵²	Austria	34	58.1	0/34	Rheumatoid arthritis.
Limeres Posse et al, 2016 ⁵³	Spain	25	34	13/12	Down syndrome.
López-Jiménez et al, 2003 ²¹	Spain	18	34.7	7/11	Six patients with cerebral palsy, 3 with head injuries, 4 with Down syndrome, 3 with dementia, 1 with pyknodysostosis, 1 with Rieger's syndrome.
Öczakir et al, 2005 ⁵⁴	Switzerland	25	55.6	8/17	Cleft lip/palate (n=8), Down syndrome (n=3), Sjogren syndrome and scleroderma (n=2), ectodermal dysplasia (n=4), developmental retardation (n=2), chronic leukemia (n=2), lichen planus (n=1), cerebral palsy (n=1), deaf-muteness (n=1), amyotrophic lateral sclerosis (n=1).
Packer et al, 2009 ²⁵	UK	9	63	NR	Parkinson's disease.
Van de Velde et al, 2007 ⁵⁵	Belgium	18	39–77	8/10	Among patients, 1 with Down syndrome.
Weinländer et al, 2010 ²⁶	Austria	22	55.6	0/22	Rheumatoid arthritis and connective tissue diseases.
Case reports					
Apaydin et al, 2014 ⁵⁷	Turkey	1	17	W	Amelogenesis imperfecta.
Barker et al, 2008 ⁵⁸	UK	1	NR	NR	Ankylosing spondylitis.
Rogers, 1995 ⁵⁹	UK	1	64	NR	Athetoid cerebral palsy.
Hong et al, 2017 ⁶⁰	Republic of Korea	1	33	W	Cerebral palsy and mental retardation.
Eder and Watzek, 1999 ⁵¹	Austria	1	81	W	Chronic polyarthritis.
Ambard et al, 2019 ⁶²	USA	1	21	M	Cleidocranial dysostosis.
Angle and Rebellato, 2005 ⁶³	USA	1	17	W	Cleidocranial dysostosis.
Ahmad et al, 2019 ⁶⁴	Sudan	1	24	W	Cleidocranial dysplasia.
Atil et al, 2018 ⁶⁵	Turkey	1	48	W	Cleidocranial dysplasia.
Calvo-Guirado et al, 2013 ⁶⁶	Spain	1	31	W	Cleidocranial dysplasia.
Daskalogiannakis et al, 2006 ⁶⁷	Canada	1	39	W	Cleidocranial dysplasia.
Lee et al, 2015 ⁶⁸	Republic of Korea	1	29	M	Cleidocranial dysplasia.
Lombardas and Toothaker, 1997 ⁶⁹	USA	1	15	M	Cleidocranial dysplasia.
Noh et al, 2014 ⁷⁰	South Korea	1	27	W	Cleidocranial dysplasia.
Petropoulos et al, 2004 ⁷¹	USA	1	42	W	Cleidocranial dysplasia.
Petropoulos et al, 2011 ⁷²	USA	1	45	W	Cleidocranial dysplasia.
Schnutenhaus et al, 2015 ⁷³	Germany	1	43	M	Cleidocranial dysplasia.
Schnutenhaus et al, 2021 ⁷⁴	Germany	1	26	M	Cleidocranial dysplasia.
Tan et al, 2020 ⁷⁵	Singapore	1	24	M	Cleidocranial dysplasia.
Balshi and Wolfinger, 2002 ⁷⁶	USA	1	30	W	Dental phobia.
Alqahtani et al, 2018 ⁷⁷	Saudi Arabia	1	44	M	Down syndrome.
Altintas et al, 2019 ⁷⁸	Turkey	1	37	W	Down syndrome.
Comparin et al, 2022 ⁷⁹	Brazil	1	50	M	Down syndrome.
Lustig et al, 2002 ⁸⁰	Israel	1	16	M	Down syndrome.
Reiche et al, 2015 ⁸¹	Hungary	1	18	M	Down syndrome.
Ribeiro et al, 2011 ⁸²	Brazil	1	36	W	Down syndrome.
Saponaro et al, 2016 ⁸³	USA	1	27	W	Down syndrome.
Schmidt et al, 2020 ⁸⁴	Germany	1	52	M	Down syndrome.
Soares et al, 2010 ⁸⁵	Brazil	1	22	M	Down syndrome.
Thomas and Simons, 2011 ⁸⁶	UK	1	49	M	Down syndrome.
Brahim et al, 1992 ⁸⁷	USA	1	38	M	Erdheim-Chester disease.
Engel et al, 1992 ⁸⁸	USA	1	30	W	Fanconi's anemia.
Gallotini et al, 2018 ⁸⁹	Brazil	1	16	W	Fraser syndrome.
Güven et al, 2010 ⁹⁰	Turkey	1	26	M	Freeman-Sheldon syndrome.
Merlini et al, 2016 ⁹¹	Italy	1	32	M	Gnathodiaphyseal dysplasia.
Deniz E et al, 2011 ⁹²	Turkey	1	67	W	Huntington's disease.
Jackowski et al, 2001 ⁹³	Germany	1	56	M	Huntington's disease.
Peñarocha et al, 2001 ⁹⁴	Spain	1	52	W	Idiopathic torsion dystonia.
Károlyházy et al, 2014 ⁹⁵	Hungary	1	NR	NR	Intellectual disability with epilepsy.
Shek et al, 2014 ⁹⁶	USA	1	79	W	Involuntary mandibular movements.
Oelgiesser et al, 2006 ⁹⁷	Israel	1	19	W	Maple syrup urine disease.
Poluha et al, 2019 ⁹⁸	Brazil	1	40	W	Microstomia.
Peñarocha et al, 2001 ⁹⁹	Spain	1	67	W	Oromandibular dystonia with blepharospasm.
Ullbro et al, 2000 ¹⁰⁰	Sweden	1	25	W	Papillon-Lefèvre syndrome.
Woo et al, 2003 ¹⁰¹	USA	1	13	M	Papillon-Lefèvre syndrome.
Applebaum et al, 1997 ¹⁰²	USA	1	72	W	Parkinson's disease.
Chu et al, 2004 ¹⁰³	China	1	84	W	Parkinson's disease.
Fiberg, 1994 ¹⁰⁴	Sweden	1	57	W	Polyarthritis

Table 1 (Continued)

Author	Country	No. of Patients	Age† (Years)	Sex (M/W)	Special Needs as Described by Authors
Bencharit et al, 2010 ¹⁰⁵	USA	1	74	W	Polymyalgia rheumatica.
Abdel-Kader et al 2019 ¹⁰⁶	Egypt	1	22	W	Regional odontodysplasia.
Gaur et al, 2021 ¹⁰⁷	India	1	60	W	Rheumatoid arthritis
Ella et al, 2011 ¹⁰⁸	France	1	56	W	Rheumatoid polyarthritis
Choi et al, 2019 ¹⁰⁹	South Korea	1	62	M	Schizophrenia.
Tizzoni et al, 2014 ¹¹⁰	Italy	1	54	M	Severe physical disability caused by neoplastic disease.
Thor et al, 2005 ¹¹¹	Sweden	1	60	W	Systemic mastocytosis.
Kelleher et al, 1998 ¹¹²	UK	1	69	W	Tardive dyskinesia.
Misch et al, 1998 ¹¹³	USA	1	64	W	Thalassemia.
Flanagan, 2011 ¹¹⁴	USA	1	24	W	Traumatic brain injury
Takeuchi et al, 2019 ¹¹⁵	USA	1	53	M	Traumatic brain injury
Durham et al, 2006 ¹¹⁶	USA	6	68	NR	Various cognitive disabilities.
Friberg, 2013 ¹¹⁷	Sweden	6	42.7	NR	Three patients with X-linked hypophosphatemia, 2 patients with Langerhans cell histiocytosis, 1 patient with osteogenesis/dentinogenesis imperfecta.
Heckmann et al, 2000 ¹¹⁸	USA	3	75.7	2/1	Parkinson's disease.
Owens et al, 2009 ¹¹⁹	Ireland	6	38.8	3/3	One patient with cerebral palsy and epilepsy, 1 patient with Morquio's syndrome, 2 with moderate learning disability, 1 with a factor VIII deficiency hemophilia associated to HIV and Hepatitis C, 1 with diabetes, kidney and pancreas transplant.

M, Man; No, Number; NR, Not reported; UK, the United Kingdom; USA, the United States of America; W, Woman.

† Mean age given if more than one patient included.

countries with different health systems (Table 1). Sixty-five articles were included in the quantitative synthesis.

The articles included 759 patients with a mean \pm standard deviation age of 42.4 \pm 18.8 years. Sex was given for 313 patients, with a majority of women (n=196). The description of the special needs of the patients included in the studies varied (Table 1). Descriptions included physical disabilities and individuals with movement disorders, neurodegenerative diseases, learning disabilities, genetic disorders, and dental anxiety. Oral hygiene status was specified in 30 articles.^{20,25,44,45,48,49,51–54,56,58,60–62,67,77,79–83,86,90,109,110,114,117–119}

It was considered good or satisfactory for 121, and poor or inadequate for 80 patients. Support for oral hygiene was explicitly described for 32 patients. Good plaque control was a criterion for preselection of patients receiving implants in 2 studies.^{44,48} Inability to perform oral self-care was an inclusion criterion for 1 observational study.⁵¹ Parafunctional status (such as bruxism or thumb-sucking) was detailed for 18 patients, 14 of whom had parafunction.^{46,83,85} Atypical swallowing was not mentioned. Smoking status was specified for 422 patients, 11 of whom were smokers.^{52,73,76,111,115} Cooperation during dental treatment was described for 131 patients, 57 of whom were uncooperative.^{20,51,59,60,77,84,110} For patients with cognitive impairment, information about their ability to communicate was available for 37 patients and was described as difficult for 4 of them.^{59,60,79,84}

Overall, 2269 implants were placed, all endosseous titanium implants of different brands and models. The implants were equally distributed between the maxillary (n=712) and mandibular arches (n=718), although this information was not available in 4 articles^{20,21,45,50} and

the location was not specified for 2 of the 105 implants placed in 1 study.⁵⁴

Protocols for surgery, type of prosthodontic rehabilitation, and sedation are shown in Supplemental Table 1 (available online). The surgical procedures consisted of 2-stage surgery, 1-stage surgery, or implant placement with immediate loading. If immediate loading was not used, healing times until abutment connection and prosthetic rehabilitation were reported in 45 articles^{21,25,45–47,51,53,60,61,63,65,66,68–70,74,77–80,82–84,87–90,92–94,97–103,106,108–110,112–114,117} and ranged from 1 month^{53,92} to 13 months,¹¹⁷ with a mean \pm standard deviation time of 5.2 \pm 2.4 months.

Implant-supported prostheses included single crowns (SCs), fixed partial dentures (FPDs), fixed complete arch complete dentures (FCD), and overdentures (IOD).

Surgical complications were reported in 6 articles.^{46,47,57,93,105,116} Flap dehiscence with infection and implant exposure was specified,^{46,47} as were lack of primary stability,¹⁰⁵ sublingual hematoma,⁹³ temporary paraesthesia,⁵⁷ fracture of the mandible during the healing phase associated with trauma during an alteration, and upper airway obstruction.¹¹⁶

Prosthetic complications were reported in 29 articles, specifying one or more biological implant-related complications or failures (Supplemental Table 2). When the exact number of implants was specified, complications occurred in 308 implants. Implant fixture complications were marginal bone loss (194 implants), implant loss (90 implants), perimucositis (14 implants), peri-implantitis (5 implants), pain (4 implants), and soft tissue alterations (1 implant). Complications were identified at different stages: in the healing phase, by stage-2 surgery,

when changing the prosthesis a second time, or during an evaluation appointment. Report of complications was not always directly associated with failure, and the implants were not systematically removed.^{47,82,105} Twenty-two articles specified one or more lost implants in patients with special needs. In the 19 articles for which the information was available, 56 implants were lost before they had been loaded, and 31 implants were lost after osseointegration.

Behavioral management and anesthesia were described in 44 articles (Supplemental Table 1). Protocols differed depending on the treatment phase. For the implant surgery, GA was most frequently reported, followed by management under local anesthesia (LA), and then under conscious sedation (CS). Lack of cooperation during dental treatment was not the only reason to proceed with GA.^{57,64,71,109} When detailed, sedation was described as 'light'⁴⁹ or 'deep'^{53,60} without precision; as inhalation sedation with nitrous oxide;¹¹⁰ and as intravenous sedation^{20,21,25,51,80,92,103,110,113,119} with midazolam only^{20,25,92,103,110,119} or in association with pethidine⁹⁰ or nitrous oxide.¹⁰⁸ Propofol sedation was provided for a cone beam computer tomography scan and for periodontal surgery undertaken separately from the implant surgery phases.⁶⁰ When 2-stage surgery was provided, 8 articles^{45,46,65,77,79,80,84,119} specifically described that pharmacological behavioral support with GA^{45,84} or intravenous sedation^{79,80,119} was necessary to uncover the implants. Four articles described that wax occlusal registrations and impressions were made during the implant surgery with sedation.^{20,45,46,76}

Nine articles reported that pharmacological behavioral support was also required for the prosthetic phases of treatment (impression making or prosthesis placement) when GA or CS had been previously necessary for implant placement.^{21,45,46,49,51,80,84,109,119} Depending on the patient, the techniques used were GA,^{45,46,49,51,80,84,109} intravenous sedation,^{21,119} light sedation,⁴⁹ or oral premedication.²¹

Nine clinical reports did not specify follow-up, but all the implants were successfully loaded. Dental examinations were timed on an individual basis (Supplementary Table 2). The time between 2 appointments was generally decided by the clinician according to the patient's oral condition and was reduced if the patient had difficulty maintaining oral hygiene at home. The patients were closely monitored during the first year. Thereafter, the appointments became less frequent. They took place, or were expected to take place, every 3 months, 6 months, or annually.

The evaluation criteria of the success or failure of an implant were not always explicitly stated. The definitions and the clinical and radiological criteria were not standardized, although they were often similar (Supplemental Table 3). Reported survival rates^{44,45,48,49,52,54} ranged from 84.4%⁴⁵ to 100%.^{48,52,56} An estimation of the cumulative

survival rate was specified in 5 articles,^{20,47,51,52,54} ranging from 85.5%⁴⁷ to 100%⁵² at respectively 5 to 15 years⁴⁷ and 1 to 7 years⁵² after implant placement and loading. Only 2 articles^{52,56} made a clear distinction between survival rate and success rate. Whereas the authors of both articles reported a survival rate of 100%, the 3-year success rates were 93.8%⁵² and 96.1%.⁵⁶

One article specified the mastication ability and improved quality of life as reported by the patient's relatives.⁷⁹ Two articles evaluated the subjective experience of the patients using satisfaction questionnaires.^{52,118} One article investigated the oral health-related quality of life of a patient with the Oral Health Impact Profile-14.¹¹⁵ Another evaluated improvement in mastication through a quantifiable criterion of gastrointestinal deficiency.^{118,120}

The single treatment of a patient with special needs in a cohort of patients from the general population was included with those of the clinical reports.⁵⁵ Fourteen of the 79 articles included in the qualitative synthesis were excluded from the quantitative analysis, 12 of which did not report follow-up duration. Two articles were cohort studies.

Overall, 65 studies involving 666 patients with special needs and 1886 implants were included. Eighty-six implants were lost or removed. The weighted survival rate was 95.4% with a mean \pm standard deviation follow-up duration of 40.7 \pm 29.5 months.

The survival rate among patients who were able to perform oral hygiene and with no immune or metabolic bone disease (18 patients, 75 implants) was 100% for a mean \pm standard deviation follow-up time of 21.7 \pm 18.6 months.^{48,76,111,113} A 96.1% survival rate was found for the 196 patients (715 implants) needing oral hygiene support because of dexterity or cognitive impairment, but with no immune or metabolic bone disease.^{20,21,25,44,47,49,51,54,59,60,92-99,103,109,112,114,116,118,119}

Their mean \pm standard deviation follow-up time was 39.5 \pm 29.8 months. A 93.9% survival rate was reported for the 425 patients (1096 implants) whose immune system was impaired and/or with a syndrome and/or medication affecting bone quality for a mean \pm standard deviation follow-up time of 43.4 \pm 29.6 months.^{44,45,50,52,53,55,58,61,64,67-70,72,74,75,78-89,91,100,101,104,105,107,108,110,117,119}

DISCUSSION

The study hypothesis that implant survival rates would be lower in patients with special needs than in the general population was rejected. The results show an encouraging implant survival rate in a population that includes individuals with dental anxiety, genetic disorders, and cognitive and/or physical impairment. This review is possibly the most exhaustive yet of the use of dental implants in

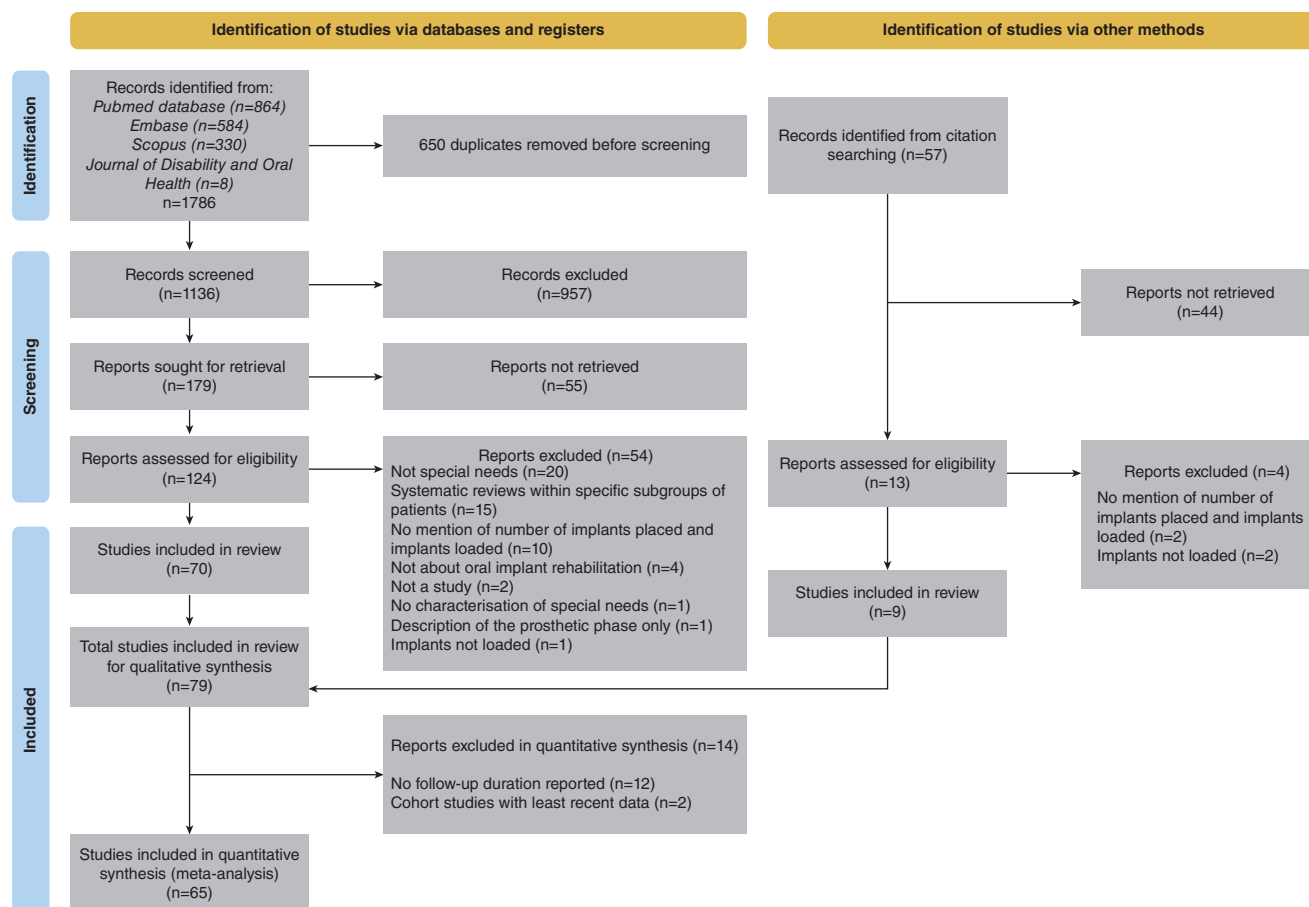


Figure 1. Preferred reporting items for systematic reviews and meta-analyses 2020 flow diagram.

patients with special needs. The population of patients with special needs is varied and difficult to classify. Patients tend to share common characteristics, including poor cooperation and barriers to oral self-care. The fact that 79 articles could be included in the qualitative synthesis is a testimony to a real and worldwide clinical interest in implant rehabilitation in special care dentistry that has steadily increased over the past decade. Nevertheless, the low number of randomized controlled clinical trials compared with the high number of case reports illustrates the challenges of undertaking clinical research into oral rehabilitation for populations with special needs. Case reports advance knowledge when little evidence exists, but they tend to lean strongly toward positive outcomes and therefore this systematic review was subject to risk of publication bias.¹²¹ Further studies with higher quality evidence are needed.

This literature review reported that, as with the general population, patients with special needs are prone to both biological and technical complications.^{122,123} The wide heterogeneity of the population included implied differences in risk factor exposure. Patients with bone pathology have additional risks for the biological complications of dental implants.¹²⁴

Previous systematic reviews and meta-analyses have focused on subgroups of patients with special needs. The reported survival rate ranged from 65% to 100% in these groups.^{29,31,35–37,39,40,43,125–133} Systematic reviews of the survival rates of dental implants in the general population show the following results: 95.6%¹³⁴ or 91.27% to 96.36% depending on the implant-supported prosthesis after 5 years.¹³⁵ The value ranges from 93.1%¹³⁴ to 94.6%¹³⁶ after 10 years. The present results showed survival rates consistent with those for patients with systemic conditions and within the range of survival rates for healthy patients. The findings suggested that complex medical conditions, cognitive and physical disabilities, and genetic disorders should not be considered immediate contraindications to oral implant rehabilitation and that implants are stable once osseointegrated.^{45,47}

Poor oral hygiene, poor cooperation, and parafunction are arguments commonly heard against implant placement in patients with special needs. However, few authors mentioned these factors, and the evident lack of available data hinders an evidence-based conclusion. All patients with dental implants should be followed up at regular intervals to monitor peri-implant status, the

condition of the implant-supported prosthesis, and plaque control.¹³⁷ Patients with special needs may have reduced capacity to express pain.¹³⁸ The awareness of their need for care may rely on the assessment of care givers.¹³⁹ Follow-up appointments therefore need to be more frequent and information needs to be provided to help carers understand, be involved, and perform oral hygiene when necessary.

The evaluation criteria for treatment outcomes differ widely in the included articles. All focused on biological instead of physiological criteria despite the fact that improving function is a primary aim when treating patients. The success and survival rates reported were related to the implant only and not to the implant-supported prosthesis. Several alternatives exist for the evaluation of oral implant rehabilitation. For individuals without cognitive impairments, psychometric evaluations can be used, and validated questionnaires of oral health-related quality of life have been used.¹⁴⁰ A tool based upon the International Classification of Functioning, Disability and Health describing the functional impact of oral health is currently being developed and could be used in further studies.^{141–144} For individuals with cognitive and/or learning disabilities, objective evaluation is needed. Mastication can be judged objectively with several validated methods,^{145,146} some of which have already been used in implant dentistry.^{147–151}

A multidisciplinary approach is necessary to assess the benefit-risk ratio of any oral rehabilitation for patients with special needs, to choose the most suitable option between implant-supported fixed prostheses, implant-supported overdentures, fixed partial dentures, removable dentures, or no rehabilitation. It has been well documented that patients with missing posterior teeth and an unstable occlusion are at higher risk of dysphagia, choking, food aspiration, and severe bronchopulmonary disease.^{152–155} These factors can only be magnified in patients with preexisting neuromotor conditions. The consequences of not providing oral rehabilitation must therefore be weighed against mental health, quality of life, and the risk of implant failure when making clinical decisions regarding patients with special needs.^{92,93,112} This assessment may be one path to ensuring more equitable oral health outcomes for patients with special healthcare needs (Fig. 1).

CONCLUSIONS

Based on the findings of this systematic literature review of protocols and outcomes, the following conclusion was drawn:

This review should enrich the discussion between professionals and patients for whom daily oral hygiene and parafunction are difficult to control

when making informed decisions between the different treatment options for oral rehabilitation.

DATA AVAILABILITY STATEMENT

The review was not registered. Protocol, critical appraisal review and data presented in this study are available on request from the corresponding author.

APPENDIX A. SUPPORTING INFORMATION

Supplemental data associated with this article can be found in the online version at [doi:10.1016/j.prosdent.2023.09.013](https://doi.org/10.1016/j.prosdent.2023.09.013).

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CRediT authorship contribution statement

All listed authors made considerable and valuable contributions to the development of the manuscript. **Martine Hennequin** conceived the design and idea. **Marie-Sophie Bogner** and **Vivien Chambas** performed the literature search and carried out data collection. **Marie-Sophie Bogner**, **Vivien Chambas**, **Martine Hennequin** and **Denise Faulks** were involved in drafting the manuscript. **Marie-Sophie Bogner** and **Emmanuel Nicolas** participated in meta-analysis. **Marie-Sophie Bogner**, **Martine Hennequin** and **Denise Faulks** performed a critical revision of the article for important intellectual content. All authors read the final manuscript and approved it.

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