Effectiveness of psychological techniques in dental management for children with autism spectrum disorder: a systematic literature review

Ismail Nabil AlBhaisi1, Marisa Shanthini Thomas Santha Kumar2, Anissha Engapuram2, Zaleha Shafiei2, Ahmad Shuhud Irfani Zakaria3, Shahida Mohd-Said1* and Colman McGrath4

Abstract
Background: A rise in the reported numbers of children with Autism Spectrum Disorder (ASD) highlights the need for dental practitioners to be more familiar with the treatment approaches for these special needs children to ensure comfortable, well-accepted and efficient management while in dental office.

Aim: This paper aimed to acquire a deeper understanding of some of the innovative and best approaches to managing children with ASD in dental settings.

Design: A systematic literature search was performed in PubMed, Scopus, Web of Science, Cochrane databases, and grey literature based on the PRISMA 2020 statement, using main keywords such as: ‘management’, ‘dental’, ‘children’, and ‘Autism Spectrum Disorder’. Original full-text papers including randomised controlled trials (RCT) and all other designs of non-randomised controlled studies (NRS) reporting relevant intervention studies in English were included without any publication time limit. The quality of the evidence found eligible for the review were then assessed using the ROB-2 and ROBINS-I tools. Subsequently, the details of management interventions and impact of treatment approaches were compared and discussed.

Results: Out of the 204 articles found, 109 unrelated articles were excluded during the initial screening. The full papers of remaining 28 were retrieved and only 15 (7%) articles were eligible to be reviewed; eight RCTs with ‘some concerns’ and ‘high risk’ categories particularly concerning their randomisation design, and seven NSRs with ‘serious’ to ‘critical’ bias largely due to confounding factors.

Conclusion: Our review found inconclusive evidence on the strength of recent psychological and non-pharmacological approaches used to manage children with ASD in dental settings. Small sample size and lack of a control group in certain studies affected the strength of evidence and credibility of the findings. Nevertheless, this review shared informative details on some innovative approaches for better understanding of the management of children with ASD for dental professionals.
Introduction
Children with autism spectrum disorders (ASD) commonly face anxiety and fear when undergoing dental treatment, as manifested via difficult behaviours and uncooperative reactions [1, 2]. The special congestive profile of autistic children and the specific process related to the response and adaptability to the surrounding environment exhibit a wide spectrum of behaviour alterations [3, 4]. Children with ASD often show prominent characteristics of aggressiveness, unresponsiveness, lack of attention, and the presence of other medical signs that may compromise the dental treatment plan [1]. In addition to ASD, the term autism spectrum condition (ASC) has also been used to emphasise on the biomedical diagnosis of the learning and thinking differences in affected individuals [5]. This issue further complicates the fact that several studies have found that the oral health of children with ASD is worse than that of typical children due to lack of awareness among the dental community in how to increase a caregivers’ oral hygiene practices for their children, difficulty in accessing dental care facilities, and the knowledge and attitude of dental professionals towards the children [6, 7].

Communication between the child and dental team in clinic can be very difficult or restricted [8] if there is no standard protocol to manage these children especially while being treated. Thus, the dental team must attempt different ways of communications, behavioural management, and pharmacological management to control the child [9, 10]. Altered behaviours among autistic children and their tendencies of self-injury further increase the risk of unresponsiveness or even trauma during dental treatment and prevent the clinicians from performing comprehensive dental treatment. In such scenarios, more aggressive techniques such as Protective Stabilization Board (papoose) or general anaesthesia may be required [6], and these may not be well-received by patients and caregivers. Alternatively, some studies have focused on the effectiveness of specific behavioural or psychological approaches either on oral care or as a communication-aided intervention [11, 12], general strategies of ASD management in a dental office [13] and visual aid approaches (visual pedagogy) using either printed or electronic materials [14, 15].

So far, the effectiveness of more recent pharmacological and psychological (non-pharmacological) strategies to improve the dental management of children with ASD has not been reported systematically and are not well known to most dental professionals. Therefore, this systematic literature review aimed to evaluate the effectiveness of available reported behaviour management and modification strategies for children with ASD to overcome the anxiety and discomfort associated with the treatment in dental clinics. This review may provide the necessary evidence for clinical guidelines on the management of dental anxiety, the acceptance, success rates, and impact of each approach with the aim of improving the oral health status and wellness of the children.

Materials and methods
This systematic literature review was conducted in compliance with the “Preferred Reporting Items for Systematic Reviews and Meta-Analysis” (PRISMA 2020 statement). It is registered under the “International Prospective Register of Systematic Reviews” (CRD42021273415), and received approval for conduct by the research ethics committee (UKM PPI/111/8/JEP-2020-757).

Search strategy and definitions
The PICO strategy was utilised in answering the research questions: What is the impact of special techniques in dental management for children with autism spectrum disorder on their cooperation while undergoing treatment in dental clinic? The study population (P) of interest was children with ASD within the range

---

**Keywords:** Dental management, Autism spectrum disorders, Dental care, Dental setting, Behaviour modification, Thinking differences, Learning differences

**Highlights**
- Explores deeper knowledge and understanding of psychological approach for managing children with ASD in a clinical dental setting.
- Highlight the impact of such intervention on dental anxiety, the level of children's cooperation, and the success of the implementation of dental procedures, which will help the dentists to meet and treat children with ASD according to their individual needs.
- Discuss the evidence in favour of the use of behaviour management in reducing anxiety and enhancement of cooperation in children with ASD at the dental setting.
of 2–18 years old who were receiving interventions (I) including special dental management techniques in the dental setting as well as other intervention aimed at improving the success and cooperation of children while receiving dental treatment. The results from this survey were compared (C) with healthy children, children with any other disabilities, or another ASD group receiving other intervention(s). The expected outcome (O) from the intervention was the improvement in cooperation during dental procedures as rated by dental professionals or caregivers, improvement in the behaviour scale, and a decreased level of anxiety.

**Selection criteria**

The search strategy was carried out in the following database: Scopus, Web of Science, PubMed, and Cochrane, as well as grey literature searches included Google Scholar and hand-search the reference lists of all included articles and relevant literature reviews. The core keywords included (management) AND (child*) AND ("Autism Spectrum Disorder" OR ASD OR autism OR "Asperger syndrome") AND (dental). The Medical Subject Headings, MeSH (https://meshb.nlm.nih.gov/search) was also used to identify words and phrases from articles of interest (Table 1). No time limit was set in this search.

The inclusion criteria were: original full-text papers for studies involving children of 2–18 years old, randomised controlled trials (RCT) or all designs of non-randomised controlled study (NRS), i.e. non-RCT, interventional study, studies with comparative groups, interrupted time series study, cohort study, controlled before-and-after study, and case series (uncontrolled longitudinal study). Furthermore, the full-text article must be written in the English language and report the impact of the intervention in the form of behaviour scales or cooperation rate. Studies that focused only on the perceptions and concerns of the caregivers or those with insufficient information on the outcome were excluded from the review.

**Study selection**

The articles obtained from the search were exported into Microsoft Excel. The list of articles was screened for replicates and their relevance to the study title. Any duplicates or non-ASD-related articles were rejected. Two researchers (MS and SE) screened the titles and abstracts of all the retrieved full-text articles to filter out those that were not relevant to the research question. If there was some disagreement on the relevance of the articles between the two researchers, it would be resolved through discussion with the other three reviewers (S.M-S., Z.S, and I.N.B.).

**Data extraction**

For each of the included articles, the following information was obtained: general characteristics (authors, year of publication, title, and study design), the sample size of subjects, comparative groups, assessment tools used in the study, dental procedures done in each study, type of management or techniques as intervention, outcome measures (e.g. improvement in the anxiety and behaviour scores, changes before and after intervention related to improvement in achievement in planned dental procedure to be implemented), and lastly key findings.

**Risk of bias assessment**

The reviewers assessed the risk of bias of the included studies independently. Studies with NRS designs were evaluated using the ROBINS-I “Risk Of Bias In Non-randomised Studies-of Interventions” and the studies were rated with the same coding of the data extraction process. The seven domains of ROBINS-I assessed are risk of bias arising from (confounding, selection of participants,

---

**Table 1** Search strategy for literature

| Database   | Search string                                                                 | Limits/Inclusion                          |
|------------|-------------------------------------------------------------------------------|-------------------------------------------|
| SCOPUS     | (TITLE-ABS-KEY ("Autism Spectrum Disorder") OR TITLE-ABS-KEY (ASD) OR TITLE-ABS-KEY (autism) OR TITLE-ABS-KEY ("Autistic Disorder") OR TITLE-ABS-KEY (child*) AND TITLE-ABS-KEY (dental) AND TITLE-ABS-KEY (management) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English"))) | Language: English Document: Articles Stage: Final |
| Web of Science | [TS = (child*) AND TS = ("Autism Spectrum Disorder" OR ASD OR autism OR "Asperger syndrome") AND TS = (management) AND TS = (dental)] | Language: English Timespan: All years Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCISH, ESCI |
| PubMed     | (management) AND (child*) AND ("Autism Spectrum Disorder" OR ASD OR autism OR "Asperger syndrome") AND (dental) | Language: English Full text |
| Cochrane   | (management) AND (child*) AND ("Autism Spectrum Disorder" OR ASD OR autism OR "Asperger syndrome") AND (dental) | Language: English |
classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, selection of the reported result) respectively. In addition, the bias of the RCT studies was evaluated using version 2 of the Cochrane Risk-of-bias tool for randomised trials (ROB-2) and the data in the table were generated using the Excel tool provided by the same team. The five domains of ROB-2 assessed are risk of bias arising from (randomization process, deviation from the intended interventions, missing outcome data, measurement of outcomes, and selection of the reported results) respectively. Criteria for reaching the overall judgements for studies included in both (ROB-2 or ROBINS-I) tools were performed in compliance with the guidelines for each tool [16, 17]. Meanwhile, the inter-evaluator reliability was calculated using Kappa statistics.

Results
Study selection
Final search date was 1st January 2022. The initial search retrieved 202 papers from four databases; 65 were found to be duplicates. One hundred and nine papers were excluded due to the irrelevance of titles and/or abstracts (Agreement between reviewers was high, K = 0.92). Fifteen were excluded based on full-text ratings (Agreement between reviewers was high, K = 0.86). Additionally, two papers were added scanning the references lists of eligible papers. The step-by-step search and selection strategy is shown in Fig. 1 using the PRISMA template for systematic literature review [18].

Characteristics of the studies
Of the 15 articles selected, 8 were RCT [19–26] and 7 were NRS; of which three were interrupted time series study (ITSSs) [27–29]. All the included studies were organised according to the year of publication and intervention approach. The total number of children involved were 904, of which 862 were children with ASD. The age of the children ranged from 2–18 years with a predominance of male children across the studies. The range of the time interval was two months in between of analysis (Table 2).

In most studies, the cooperation of children during dental assessment was the most frequent tool used to assess the impact of the approach used [20, 22, 25, 27, 29, 30], followed by the success of oral examination [26, 31, 32], caregivers’ preference [21, 33], number of dental appointments to perform the planned procedure [19], customised engagement checklist [28], and lastly,
Table 2 Description of reviewed studies

| Studies                     | Design and assessment tool | Children involved                                      | Comparative groups | Dental procedures received                                      |
|-----------------------------|----------------------------|-------------------------------------------------------|--------------------|-----------------------------------------------------------------|
| Lefer et al. 2019 [27]      | Interrupted time-series study | 52 ASD children and adolescents: 3–19 years old        | No control group   | Clinical oral assessment                                       |
|                             | Cooperation of children in dental assessment | 7 females, 45 males                               |                    |                                                                 |
| Zink et al. 2018 [19]       | Randomised clinical trial | 40 children with ASD: 9–15 years old                   | Two groups: Application group: | Dental prophylaxis using low-speed handpiece |
|                             | Number of dental appointments needed to perform the procedure | 2 females, and 38 males | (2 females, 18 males) PECS: (20 males) | Topical fluoride application |
| Hidayatullah et al. 2018 [28] | Interrupted time-series study | 13 children with ASD: 5–18 years old                   | One ASD group      | Dental examination                                             |
|                             | Customised engagement checklist on 10 stages of the procedure | 2 females, 11 males                               |                    |                                                                 |
| Nilchian et al. 2017 [20]   | Randomised clinical trial | 40 children with ASD: 6–12 years old                   | 20 children in each group | Fluoride therapy                                               |
|                             | Cooperation of children in clinical examinations | 3 females, 37 males                               |                    |                                                                 |
| Tounsi et al. 2017 [31]     | Retrospective cohort study | 168 children with ASD: 4–18 years old                  | No control group   | Dental examination only                                        |
|                             | The success of dental examination | 28 females, 140 males                                |                    |                                                                 |
| Murshid et al. 2017 [33]    | Cross-sectional non-randomised controlled trial study | 40 children with ASD: 5–9 years old                   | No control group   | Oral examinations, prophylaxis, and topical fluoride applications |
|                             | Parents’ evaluation and procedures performed | 10 females, 30 males                               |                    |                                                                 |
| Nelson et al. 2017 [30]     | Retrospective cohort study | 168 children with ASD: 4–18 years old                  | No control group   | Dental examination                                             |
|                             | Successful dental examination | 29 females, 139 males                                |                    |                                                                 |
| AlHumaid et al. 2016 [32]   | Retrospective cohort study | 44 children with ASD: 5–18 years old                   | 22 in each group   | 70% received dental treatment: Cleanings (50%) Restorative treatment (18%) Extractions (2%) |
|                             | Frankl behaviour rating scale and dental procedures completed | 14 females, 30 males                               |                    |                                                                 |
| Marion et al. 2016 [21]     | Randomised controlled trial study | 40 children with ASD and their caregivers: 18 years old | No control group   | No treatment given                                             |
|                             | Caregivers’ preference via questionnaire | 6 females, 34 males                                 |                    |                                                                 |
| Mah & Tsang 2016 [22]       | Randomised control trial | 14 children with ASD: 3–8 years old                   | Two ASD group      | Dental examination                                             |
|                             | Cooperation of children in dental assessment | 14 males                                           |                    |                                                                 |
|                             | Tell-show-do with visual pedagogy | 7 Tell-show-do only, N = 7                           |                    |                                                                 |
| Cagetti et al. 2015 [29]    | Interrupted time-series study | 83 children with ASD: 6–12 years old                   | Three groups undergoing same intervention: | Children underwent four stages: An oral examination (stage 1) A professional oral hygiene session (stage 2) Sealants (stage 3) If necessary, a restorative treatment (stage 4) |
|                             | Acceptance rate of the treatment | 18 females, 65 males                                | 6–7 years 8–9 years 10–12 years |                                                                 |
| Cermak et al. 2015 [23]     | Crossover randomised trial | 44 children: 6–12 years old                           | 22 ASD children    | Oral examination                                               |
|                             | Physiological stress and anxiety, measured by electrodermal activity (EDA) | 16 females, 28 males                               | 22 non-ASD children | Prophylaxis (dental cleanings)                                 |
|                             |                                                                 |                                                     |                    | Fluoride application                                           |
Outcomes of the intervention approach

In this systematic review, the main outcome was determined by the improvement in the child’s cooperation during dental procedures as rated by dental professionals or caregivers. Another main outcome was the improvement in the behaviour and decrease in the anxiety level of the children in the dental setting. Accordingly, the measures of effect for the outcomes reported in the studies were the increase in the success rate or completion of dental procedure, i.e., the increase in the number of components achieved in a dental visit, and/or improvement on the behaviour rating scales.

All the approaches were evaluated according to the planned procedure. Most of the studies focused on the clinical oral assessment and examination as main dental procedures to be assessed [22–31, 33]. Some other studies focused on more advanced procedures such as dental prophylaxis and topical fluoride application [19, 20, 23, 24, 29, 33]. Only two studies focused on dental treatment such as restorative treatment and extractions [29, 32] (Table 3).

A variety of approaches have been proposed to improve the management of children with ASD. So far, visual pedagogy appeared as the most common approach [28]. It can be in the form of printed materials that demonstrate the dental settings and procedures in a colourful way to the parents and/or children [28, 33]. Digital-based visual pedagogy on mobile devices or iPad applications was found to confer a more superior impact on the outcome compared to the printed materials [19, 21, 29]. One study in this review focused on the use of digital visual pedagogy as the main approach [27]. Also, the standard clinical dental examinations without any visual pedagogy approach were compared with examinations with use of printed materials [20], and use of video materials (DVD, video goggles, and video modelling) [24]. Meanwhile, the desensitisation programme led to an improvement of the children as seen on the Frankl behaviour scale [30, 31], especially when compared to the standard behaviour guidance approaches that included tell-show-do (TSD), voice control (VC), passive restraint, active restraint (AR), and pharmacological options such as nitrous oxide (NO) [32]. The positive reinforcements supported with TSD showed superiority when compared with negative reinforcements [26]. Finally, another impressive approach was the “Treatment and Education of Autistic and related Communications Handicapped Children” (TEACCH) that included all the communication strategies such as TSD and visual pedagogy to educate and manage the children with ASD [25] (Table 3).

Risk of bias assessment

The characteristics of the studies were assessed individually to evaluate the outcomes and effects of the interventions using the specific tools based on the study design (Table 2).
Table 3  Intervention techniques for managing children with ASD

| Studies                  | Description of method of intervention                        | Outcomes of intervention                                                                 |
|--------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Lefer et al. 2019 [27]   | No control groups çATED app showing pictures of dental examination using iPad | 65.4% percentage individuals showed improved compliance during oral assessment          |
|                          | Eight months (evaluation at two-, four-, six-, and eight-month) |                                                                                        |
| Zink et al. 2018 [19]    | Picture exchange communication system by flash-cards with pictures of routine at dental office | Decrease in number of dental visits and attempts to acquire each skill between two groups (3/5) respectively |
|                          | Time interval: Not applicable                                |                                                                                        |
| Hidayatullah et al. 2018 [28] | No control group (Applied Behaviour Analysis) ABA based management methods using image cards | Improvement in behavioural stages for 11 children                                           |
|                          | One child was able to complete all stages                    |                                                                                        |
|                          | Time interval: Treatment was conducted four times at one-week intervals for a month |                                                                                        |
| Nilchian et al. 2017 [20] | Standard examination without any intervention Visual pedagogy (set of colouring pictures illustrated dental examination steps) | Cooperation during fluoride therapy increased in the case group (5/1) respectively        |
|                          | Cooperation in the control group did not increase in most stages |                                                                                        |
|                          | Both groups presented the same findings in opening of mouth and showing the teeth, or entering the office, and sitting in the chair or examination with mirror |                                                                                        |
|                          | Time interval: Practices for 8 weeks                         |                                                                                        |
| Tounsi et al. 2017 [31]  | No control group Dental desensitisation                      | 77% of ASD children were successfully examined within 1 to 2 visits in compared to 88% by the fifth visit |
|                          | 12.5% could not receive dental examination                    |                                                                                        |
|                          | Time interval: Two visits only                               |                                                                                        |
| Murshid et al. 2017 [33] | No control group A children’s book preparing children and their parents for the first dental visit | 47.5% of ASD children acted positively during the dental procedure                        |
|                          | 37.5% showed positive effect on the behaviour of children according to their parents’ evaluation |                                                                                        |
|                          | Time interval: 6 months (evaluation at week-1 and 4 months) |                                                                                        |
| Nelson et al. 2017 [30]  | No control group Progressive desensitisation with individualised reinforcements (The child is gradually exposed to glimpses from the dental setting that cause anxiety, and rewards as positive reinforcement.) | Minimal threshold examination (MTE) was achieved for 77.4% of all children within 1 to 2 visits and 87.5% in 5 visits or less |
|                          | Desensitisation was effective in achieving an MTE for most children |                                                                                        |
|                          | Time interval: 5 dental visits                               |                                                                                        |
Table 3 (continued)

| Studies                      | Description of method of intervention                                                                 | Outcomes of intervention                                                                                                                                 |
|------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| AlHumaid et al. 2016 [32]    | Standard Behavioural Guidance Techniques (SBGTs) including tell-show-do (TSD), voice control (VC), nitrous oxide (NO), passive restraint, and active restraint (AR) | D-TERMINED Programme used the familiarisation process through the philosophy of repetitive tasking. D-TERMINED programme group had significantly lower referral rate compared to the SBGTs group. Frankl scale showed significant improvement in the behaviour of test group in compared to SBGTs group. 52% of participants showed improvement in behaviour. |
| Marion et al. 2016 [21]      | No control group                                                                                        | Dental stories available via different media (paper, tablet computer, and computer). Nine (64%) caregivers found the dental story useful. Two (14%) caregivers found the aid was only helpful for themselves. |
| Mah & Tsang, 2016 [22]       | TSD (tell-show-do) only                                                                                 | Visual pedagogy with TSD method. Cooperation level during dental treatment increased. Completed more steps in final appointment. Decreased time required to achieve child cooperation. Lower level of behavioural distress. |
| Cagetti et al. 2015 [29]     | No control group                                                                                        | Visual aid. Sketch of the steps of the four planned dental procedures: (Oral examination, dental hygiene appointment, fissure sealants, and restorative procedure). 77 subjects (92.8%) overcame both stage 1 and 2. 6 subjects (7.2%) refused stage 3. 3 subjects (7.2%) refused stage 4. |
| Cermak et al. 2015 [23]      | Regular dental environment (RDE) – existing practise and setting                                         | Sensory adapted environment (SADE) applied in the dental environment in three aspects, i.e. visual, auditory, and tactile: Visual: Shading the windows with curtains and turning off the dental chair. Auditory: playing rhythmic music lamp. Tactile (deep pressure): papoose board looks like a butterfly with its wings. Significant decrease in electrodermal activity (EDA) in SADE compared to RDE. Effect size of the SADE vs RDE (0.23ASD/0.29 non-ASD). |
| Isong et al. 2014 [24]       | Usual care (Group A)                                                                                   | Group B: A DVD video of a typically developed child having a dental appointment was used for video peer modelling. Group C: Sunglass-style eyewear was used for children to view a favourite movie during a dentist visit. Group D: Video of peer modelling plus video goggles. Between visits 1 and 2, the mean anxiety and behaviour scores decreased significantly among subjects within groups C and D compared to others. |
| Orellana et al. 2014 [25]    | No control group                                                                                        | TEACCH-Based Approach (Treatment and Education of Autistic and related Communication-handicapped Children). The mean number of steps achieved significantly increased in children between pre- and post-intervention. |

Time interval:

- Mean number of dental visits: 2–6
- 6-month until follow-up survey was completed
- 3 weeks
- 1.5 months
- 3–4 months
- 6 months (evaluated baseline and at the end of the study)
| Studies | Description of method of intervention | Outcomes of intervention |
|---------|--------------------------------------|--------------------------|
| Lowe & Lindemann, 1985 [26] | Negative reinforcements (e.g. “you won’t get lunch”), if positive reinforcements (e.g. rewards) failed | Positive reinforcements, with tell-show-do (TSD) was successfully examined on first visit Negative reinforcement was used among 8 ASD and 2 Non-ASD children ASD/Non-ASD (10/18) patients underwent bitewing radiographs Time interval: NA |
The reviewers assessed the quality of the eight RCTs using Version 2 of ROB-2 [19–26] (Fig. 2). Six studies were judged as having a high risk of bias [21–26] and two with a moderate risk of bias [19, 20].

The seven NRS studies were assessed using the ROB-INS-I tool. Five studies were judged as having a serious risk of bias [27–30, 32] and two with critical risk of bias [31, 33] (Fig. 3).

Discussion
In this review, we took into consideration the substantial difference between behavioural management and behavioural modification in line with the proper definition of dental management for children with ASD. Behavioural management is a central component of paediatric dentistry while behavioural modification focused on dealing with the problem, challenges, or avoidance behaviours to ease dental treatment and perform the planned procedures [34].

In the included studies, various approaches were used to improve the management of children with ASD. The significance of behavioural modification in the dental setting was also highlighted. Many behavioural scales have been developed and validated to measure the level of behaviour and its association to anxiety and fear among children. Frankl behavioural rating scale is one of the most widely used. It categorises the children’s behaviour...
into four groups based on their attitude and cooperation during dental treatment [35]. Additionally, the Venham scale was developed to rate the level of anxiety and uncooperativeness of the child towards dental stress [36].

In this review, most of the studies focused on visual pedagogy since it was one of the conventional approaches to manage children in the dental setting. Visual pedagogy in the form of printed material such as dental stories or coloured books about dental treatment can help the parents and/or children to adapt faster to the dental environment [28, 33]. Additionally, digital visual pedagogy materials including mobile devices/ iPad applications such as cATED app and Picture Exchange communication system (PECS) were more impactful than the printed materials [19, 21, 27, 29]. The standard examination showed a clear improvement with the introduction of printed materials, especially during fluoride therapy [20]. Meanwhile, video materials such as DVDs, video goggles, and video modelling also improved the mean anxiety and behavioural scores [24].

Furthermore, the desensitisation programme was associated with an improvement in the Minimal Threshold Examination (MTE) and behavioural level of the children, as manifested by an improvement in children's cooperation during the dental examination [30, 31], especially among children with moderate ASD. Desensitisation programmes, such as D-TERMINED are built on familiarisation and repetitive tasking of specific procedures, also known as the Sensory Adapted Environment (SAE) that was developed from the Applied Behaviour Analysis theory (ABA). The desensitisation programme was found to be superior to the standard behavioural guidance approach that included communication strategies, restraint, and even the pharmacological options as nitrous oxide (NO) [32].

Next, the positive reinforcements supported by TSD also showed an improvement in cooperation during dental examination compared to negative reinforcements [26]. Finally, one of the most impressive approaches, “TEACCH” that incorporated all the communication strategies such as TSD, visual pedagogy approaches was beneficial in the management of children with ASD in the dental setting [25] (Table 3).

For the NRSI, it was rare for the overall judgement of bias to be low due to confounding. For this review, we accepted the outcomes at all levels from all the included papers, unless the paper did not show sufficient ability to produce a valid conclusion.
There are several limitations to this study. Most of the included studies had a small sample size hence may not be able to fully demonstrate the optimal benefit of specific behavioural strategies on the children from compared groups. Furthermore, some studies lacked control groups. Qualitative assessment could also benefit from the studies in addition to quantitative parameters measured to provide in-depth response on behavioural modification effects [37–39].

Conclusion
This systematic review provided current available approaches yet inconclusive evidence on the effectiveness of the psychological approach for managing children with ASD at dental setting. Although the impact of the approach on the management of dental anxiety, the level of children's cooperation, and the success of the implementation of dental procedures was reported, the study design of these behavioural modification techniques requires better randomisation and bias control to suggest effectiveness of intervention.

Acknowledgements
The authors would like to thank the Deans of both the Faculty of Dentistry, Universiti Kebangsaan Malaysia (UKM) and Hong Kong University (HKU) for their continuous support to our collaborative research and publication efforts.

Author contributions
INB – Design, content, data collection, data analysis, initial draft, final review. MST – Content, data collection, data analysis, initial draft, AE – Content, data collection, data analysis, initial draft, ZS – Content, data collection, final review. ASIZ – Final review, funding. SM-S – Design, content, data collection, data analysis, initial draft, final review. CM – Final review. All authors read and approved the final manuscript.

Funding
This study was funded by the Ministry of Higher Education Malaysia Translation Research Grant [Translational-2019-001/2].

Availability of data and materials
All data generated or analysed during this study are included in this published article. Additional data is available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not required.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
1 Department of Restorative Dentistry, Faculty of Dentistry, Universiti Kebangsaan Malaysia (The National University of Malaysia), Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia. 2 Department of Craniofacial Diagnostics and Biosciences, Faculty of Dentistry, Universiti Kebangsaan Malaysia (The National University of Malaysia), Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia. 3 Department of Family Oral Health, Faculty of Dentistry, Universiti Kebangsaan Malaysia (The National University of Malaysia), Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia. 4 Applied Oral Sciences and Community Dental Care, Faculty of Dentistry, The University of Hong Kong, Prince Philip Dental Hospital, 34 Hospital Road, Sai Ying Pun, Hong Kong.

Received: 10 March 2022 Accepted: 25 April 2022 Published online: 06 May 2022

References
1. Limeres-Posse J, Castaño-Novoa P, Abeleira-Pazos M, Ramos-Barbosha I. Behavioural aspects of patients with Autism Spectrum Disorders (ASD) that affect their dental management. Medicina oral, patología oral y cirugía bucal. 2014;19(5):e467.
2. Suhaimi AH, Mohamed S, Satari NA, Bakar KA, Yunus F. The challenge of managing children with autism from fathers’ perspectives. Hum Soc Sci. 2020;2020(83):367–79.
3. Karalunas SL, Hawkley E, Gustafsson H, Miller M, Langhorst M, Cordova M, et al. Overlapping and distinct cognitive impairments in attention-deficit/hyperactivity and autism spectrum disorder without intellectual disability. J Abnorm Child Psychol. 2018;46(8):1705–16.
4. Mohd Nordin A, Ismail J, Jamal NJ. Motor development in children with autism spectrum disorder. Front Pediatr. 2021;9:598276.
5. Lai MC, Lombardo MV, Baron-Cohen S. Autism. The Lancet. 2014;383(9920):896–910.
6. Lewis C, Vigo L, Novak L, Klein EJ. Listening to parents: a qualitative look at the dental and oral care experiences of children with autism spectrum disorder. Pediatr Dent. 2015;37(7):98E–104E.
7. Ferrazzano GF, Salerno C, Bravaccio C, Inginato A, Sangianantoni G, Cantile T. Autism spectrum disorders and oral health status: review of the literature. Eur J Paediatr Dent. 2020;21(1):9–12.
8. Faras H, Al Ateeqi N, Tidmarsh L. Autism spectrum disorders. Ann Saudi Med. 2010;30(4):295–300.
9. Davila JM, Jensen OE. Behavioral and pharmacological dental management of a patient with autism. Spec Care Dentist. 1988;8(2):58–60.
10. Aznor NS, Singh SJ. The use of facilitative interaction strategies by parents of autism spectrum disorder children. Buletin Sains Kesihatan. 2021;5(2):27–33.
11. Aljubour A, AbDElBaki MA, El Meligy O, Al Jabri B, Saggagh H. Effectiveness of dental visual aids in behavior management of children with autism spectrum disorder: a systematic review. Child Health Care. 2021;50(1):83–107.
12. Balian A, Cinco S, Salerno C, Wolf TG, Campus G, Cagetti MG. Is visual pedagogy effective in improving cooperation towards oral hygiene and dental care in children with autism spectrum disorder? A systematic review and meta-analysis. Int J Environ Res Public Health. 2021;18(2):789.
13. Shetty AA, Fernandes DY, Hegde AM. Autism spectrum disorder in a dental office—a Review. J Evol Med Dent Sci. 2021;10(26):1931–40.
14. Hakim INA, Mohamad UH, Ahmad A. A framework for designing an augmented reality application focusing on object function for children with autism. J Inf Syst Technol Manag. 2011;6(2):367–79.
15. Cisneros JL, Limeres-Posse J, Sanhueza GM, Santacruz M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;353:i7084.
16. Sterne JAC, Savović J, Page MJ, Elbers RG, Vang G, leaning N, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2019;366:i4870.
17. Sterne JAC, Hernández RA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;355:i5483.
18. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev. 2021;10(1):189.
20. Nilchian F, Shakibaei F, Jarah ZT. Evaluation of visual pedagogy in dental check-ups and preventive practices among 6–12-year-old children with autism. J Autism Dev Disord. 2017;47(3):858–64.
21. Marion IW, Nelson TM, Sheller B, McKinney CM, Scott JM. Dental stories for children with autism. Spec Care Dentist. 2016;36(4):181–6.
22. Mah JWT, Tsang P. Visual schedule system in dental care for patients with autism: a pilot study. J Clin Pediatr Dent. 2016;40(5):393–9.
23. Cermak SA, Duker LIS, Williams ME, Dawson ME, Lane CJ, Polido JC. Sensory adapted dental environments to enhance oral care for children with autism spectrum disorders: a randomized controlled pilot study. J Autism Dev Disord. 2015;45(9):2876–88.
24. Isong IA, Rao SR, Holifield C, Iannuzzi D, Hanson E, Ware J, et al. Addressing dental fear in children with autism spectrum disorders: a randomized controlled pilot study using electronic screen media. Clin Pediatr (Phil). 2014;53(3):230–7.
25. Orellana LM, Martinez-Sanchis S, Silvestre FJ. Training adults and children with an autism spectrum disorder to be compliant with a clinical dental assessment using a TEACCH-based approach. J Autism Dev Disord. 2014;44(4):776–85.
26. Lowe O, Lindemann R. Assessment of the autistic patient’s dental needs and ability to undergo dental examination. ASDC J Dent Child. 1985;52(1):29–35.
27. Lefer G, Rouches A, Bourdon P, Lopez CS. Training children with autism spectrum disorder to undergo oral assessment using a digital iPAD® application. Eur Arch Paediatr Dent. 2019;20(2):113–21.
28. Hidayatullah T, Agustiani H, Setiawan AS. Behavior management-based applied behaviour analysis within dental examination of children with autism spectrum disorder. Dent J (Majalah Kedokteran Gigi). 2018;5(2):71–5.
29. Cagetti MG, Mastroberardino S, Campus G, Olivari B, Faggioli R, Lenti C, et al. Dental care protocol based on visual supports for children with autism spectrum disorders. Medicina oral, patologia oral y cirugia bucal. 2015;20(5):e598.
30. Nelson T, Chim A, Sheller BL, McKinney CM, Scott JM. Predicting successful dental examinations for children with autism spectrum disorder in the context of a dental desensitization program. J Am Dent Assoc. 2017;148(7):485–92.
31. Tounsi A. Children with autism spectrum disorders can be successfully examined using dental desensitization. J Evid Based Dent Pract. 2017;17(4):414–5.
32. AHHumaid J, Tesini D, Finkelman M, Loo CY. Effectiveness of the D-TER-MINED program of repetitive tasking for children with autism spectrum disorder. J Dent Child. 2016;83(1):16–21.
33. Murshid EZ. Effectiveness of a preparatory aid in facilitating oral assessment in a group of Saudi children with autism spectrum disorders in Central Saudi Arabia. Saudi Med J. 2017;38(5):533.
34. Kohlenberg R, Greenberg D, Reymore L, Hass G. Behavior modification and the management of mentally retarded dental patients. ASDC J Dent Child. 1972;39(1):61–7.
35. Shao AG, Khababuka FK, Mbawalla HS. Children's behaviour in the dental setting according to Frankl behaviour rating and their influencing factors. J Dent Sci. 2016;1(1):103.
36. Venham LL, Gaulin-Kremer E, Munster E, Bengston-Audia D, Cohan J. Interval rating scales for children’s dental anxiety and uncooperative behavior. Pediatr Dent. 1980;2(3):195–202.
37. Neville P, Zahra J, Pilch K, Jayawardena D, Waylen A. The behavioural and social sciences as hidden curriculum in UK dental education: a qualitative study. Eur J Dent Educ. 2019;23(4):461–70.
38. Livingston LA, Shah P, Happé F. Compensatory strategies below the behavioural surface in autism: a qualitative study. The Lancet Psychiatry. 2019;6(9):766–77.
39. Smith PA, Theemens-Huber M, Akbar T, Richards D, Freeman R. What motivates dentists to work in prisons? A qualitative exploration. Br Dent J. 2011;211(4):E7–E7.

Publisher's Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.