Reducing challenging behaviours among children and adolescents with intellectual disabilities in community settings: a systematic review of interventions

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Background: Challenging behaviours are common among children and adolescents with intellectual disabilities. Such behaviours often result in poor quality of life outcomes such as physical injury, difficulties with relationships and community integration.

Aim: This systematic review aimed to synthesise evidence from studies that assessed the effect of interventions used to reduce/manage challenging behaviour among children with intellectual disabilities in community settings.

Methods: Studies published between January 2015 and January 2021 were sought from five electronic databases. The quality of studies was assessed, and a narrative synthesis was conducted.

Results: A total of 11 studies were included which utilised various non-pharmacological interventions including multi-model interventions, microswitch technology, cognitive behavioural therapy, art, music and illustrated stories. Microswitch cluster technology was the most used intervention. Studies using pharmacological interventions were not retrieved. Results indicated that a person-centred planning approach was key to offering individualised treatment.

Conclusions: The superiority of one intervention or a combination of interventions could not be determined from this review given the heterogeneity of studies. Future research is required to explore the use and effects of pharmacological interventions to compare outcomes and improve quality of care of children with intellectual disabilities.

Abbreviations: ABA: applied behaviour analysis; ABC: aberrant behaviour checklist; BSP: behaviour support plan; CB: challenging behaviours/ behaviours that challenge; CBCL: child behaviour checklist /4-18; CBT: cognitive behavioural therapy; CDSPB: criteria for determining severe problem behaviour; ID: intellectual disability; NR: not reported; O: objective; PBS: positive behaviour support; SEL: socioemotional learning.

Keywords: adolescents, challenging behaviour, children, intellectual disability, systematic review

1. Introduction

Intellectual disability (ID) is defined by the World Health Organisation (2019) as having 'a significantly reduced ability to understand new or complex information and to learn and apply new skills (impaired intelligence)'. Individuals diagnosed with an ID often present with challenging behaviours (CB) which include aggression, stereotypy, self-injury and destruction of property (Lloyd and Kennedy 2014). CB has been defined by Emerson (2001) as 'culturally abnormal behaviour(s) of such intensity, frequency or duration that the physical safety of the person or others is likely to be placed in serious jeopardy, or behaviour which is likely to seriously limit the use of, or the person being denied access to, ordinary community facilities' (p.7). According to Emerson (2001), the prevalence of CB among the overall ID population is 10 to 15%, however among children with IDs, the prevalence increases to 60% worldwide. This is consistent with recent findings from a systematic review on the prevalence of CB which found that the overall prevalence rates of CB among children with ID ranged from 48% to 60% (Simo-Pinatella *et al.* 2019).

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Autism spectrum disorders (ASD) have been reported as common comorbidities associated with IDs (Tonnsen *et al.* 2016). The prevalence of CB among children with ASD is even higher than children with IDs and has been reported to affect up to 73.5% of children with ASD (Brereton *et al.* 2006). This is of great concern as these behaviours can lead to physical injury (Poppes *et al.* 2016), significant implications in terms of the child's ability to integrate into their community, develop and maintain relationships (Gonzalez *et al.* 2009) and their overall quality of life. Such behaviours are also known to have a major impact on family members, peers and healthcare staff leading to increased stress and burnout (Absoud *et al.* 2019). Pharmacological interventions are frequently prescribed for children with IDs who display CB, many of which include psychotropic medications (Menon *et al.* 2012), despite a lack of evidence for their efficacy (McQuire *et al.* 2015). Furthermore, those who have a dual diagnosis of both ID and ASD are often the most pharmacologically treated population (Sappok *et al.* 2013). Since the airing of the Winterbourne View scandal (Department of Health 2012), there has been a greater focus internationally on individualised care and positive behavioural support to reduce CB and the risk of abuse among this population (Absoud *et al.* 2019, Brady *et al.* 2019). In recent years, a variety of non-pharmacological interventions have been used to reduce and manage CB including behavioural and environmental strategies/ therapies, parent training programmes such as Stepping Stones Triple P (Tellegen and Sanders 2013), and physical restraint which involves non-restrictive and restrictive interventions (Menon *et al.* 2012).

On review of the literature, recent studies have focused on specific behaviours such as self-injurious behaviours, children with Autism (Chezan *et al.* 2017), specific levels of IDs such as children with mild to borderline IDs (Schuiringa *et al.* 2017) or focused on single pharmacological interventions (McQuire *et al.* 2015). Despite the evidence to support the use of some of those strategies, there seems to be a lack of comparisons within studies evaluating various interventions and their effects. Timely access to interventions which are evidence-based and effective is crucial for this population and their families (Benson *et al.* 2018). Several systematic reviews have been conducted in the area of CB for children with IDs in recent years, one of which included a recent review of non-pharmacological interventions for children up to 12 years with IDs who display self-injurious behaviours conducted by Erturk *et al.* (2018). The authors of this review outlined the need for future research to consider the effects of pharmacological interventions in conjunction with behavioural interventions.

To date, to the best of our knowledge, there is no systematic review that comprehensively evaluated the broad range of interventions used among this population without focusing on specific behaviours, subgroups, or limited ages as outlined above. Therefore, the aim of this systematic review was to synthesise evidence from studies that assessed the effect of any interventions used to reduce and/or manage CB among children and adolescents with IDs in community settings. Using the Population, Intervention, Comparison, Outcome (PICO) framework (Richardson *et al.* 1995), this systematic review aimed to answer the following questions:

i. What pharmacological and non-pharmacological interventions compared with baseline and/or control conditions were used for children and adolescents with IDs who present with CB in community care settings?
ii. What is the effect of pharmacological and non-pharmacological interventions used to reduce/manage CB compared with baseline and/or control conditions for children and adolescents with IDs in community care settings?

2. Methods

This systematic review was conducted in conjunction with the Cochrane Handbook for Systematic Reviews of Interventions (Higgins *et al.* 2019) and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Page *et al.* 2021).

2.1. Eligibility criteria

The eligibility criteria for this review were guided by the modified PICO framework, namely the PICOSS framework to include 'S' for Setting and 'S' for Study design. The following were the inclusion criteria: Population: Children aged up to 19 years, with a diagnosis of ID and a history of CB. IDs were defined as intelligence quotient (IQ) test score of ≤70, onset before 18 years of age and a significant impairment of social or adaptive functioning (American Psychiatric Association 2013). Throughout this review children and adolescents are referred to as children ≤19 years of age (World Health Organisation 2013). Children diagnosed with Autism/ASD were included only if they had an IQ ≤ 70. Intervention: Pharmacological and/or non-pharmacological interventions aimed at reducing/managing CBs. Comparison: Studies with between or within group comparisons. Outcome: The effect of interventions on reducing and/or managing CBs. Setting: Community-based settings. Study design: Any experimental study design.

Studies with participants over the age of 19 years, without an ID (IQ > 70), and without a history of CB were not eligible for inclusion. Participants with a diagnosis of autism who do not have a diagnosis of ID (i.e. IQ > 70) were not eligible for inclusion as the primary

Table 1. Study inclusion and exclusion criteria.

PICOSS framework	Inclusion criteria	Exclusion criteria
Population	1. Children and adolescents < 19 years of age 2. Children and adolescents with intellectual disabilities (IQ <70) 3. Children and adolescents who present or have presented with CB. 4. Studies reporting on interventions for parents, guardians, teachers, or healthcare professionals caring for children which indirectly impact children and reduces/manages CB.	1. Adults > 19 years 2. Children and adolescents without intellectual disabilities (IQ > 70) 3. Children and adolescents who have never/do not currently present with CB. 4. Children and adolescents diagnosed with Autism only. 5. Studies where findings from children with intellectual disability could not be isolated.
Intervention	Studies involving pharmacological and/or non-pharmacological interventions aimed to reduce/manage CB.	Studies without any intervention.
Comparison	All types of comparisons including between or within pharmacological and/or non-pharmacological interventions.	Studies with no comparison.
Outcome	Studies that include the reduction or management of CB.	Studies that do not include, are not relevant to, or do not result in the reduction and/or management of CB.
Setting	Community-based settings such as day services, residential services, home settings, school settings and outpatient clinics.	Acute care settings.
Study design	Experimental studies including randomised controlled trials, non-randomised controlled trials, quasi-experimental studies, case control studies, case series and cohort studies.	Any non-experimental studies, grey literature records, dissertations, policy documents, editorials, opinion pieces, abstract only articles, conference papers, literature reviews, pilot studies, single case studies and study protocols.

focus of this review is on children and adolescents with confirmed ID. Studies without interventions, comparisons and/or conducted in acute care settings were also excluded. Review papers, abstract only articles, pilot studies, and conference and editorial papers were not included. Single case studies were also excluded due to limited generalisability of findings to the target population (Stark and Torrance 2005). See Table 1 for full review eligibility criteria.

2.2. Search strategy

A scoping search of the grey literature was completed in the National Institute for Health and Care Excellence (NICE) (2021), Health Information and Quality Authority (2021), Health Service Executive (2021), World Health Organisation (2021), Google (2021), and Google Scholar (2021), to identify common keywords and synonyms. A comprehensive search was then conducted in five electronic databases namely: MEDLINE, CINAHL, APA PsychArticles, Psychology and Behavioural Sciences Collection and APA PsycInfo. The search was conducted based on title or abstract using truncation, the explode feature and phrase searching. Concepts were combined using Boolean operators 'OR' and 'AND' as follows: ('intellectual disabilit*' OR 'learning disabilit*' OR 'developmental disabilit*' OR 'mental retard*' OR 'mental handicap*') AND ('challeng* behav*' OR behav* OR 'problem* behav*' OR 'aggress* behav*' OR aggress* OR 'physical* aggress*' OR 'verbal* aggress*' OR 'difficult* behav*' OR self-injur* OR 'self injur*' OR self-harm* OR 'self harm*') AND (medicat* OR interven* OR treat* OR pharma* OR non-pharma* OR 'non pharma*' OR

therap* OR manag* OR reduc* OR strateg*) AND (child* OR paediatric* OR pediatric* OR infant* OR toddler* OR adolesc* OR youth* OR teen*).

The search was conducted in February 2021 and was limited to peer-reviewed studies published in English within a six-year timeframe (between January 2015 and January 2021). Of note, a similar systematic review with studies published between 2009 and 2016 was conducted by Erturk et al. (2018). Therefore, the present review provides recent interventions to manage and reduce CBs among children and adolescents with confirmed ID. Moreover, the year limit in the current review coincides with the publication of the National Institute of Care and Excellence (National Institute for Health and Care Excellence (NICE) 2015) seminal guidelines: 'Challenging behaviour and learning disabilities: prevention and interventions for people with learning disabilities whose behaviour challenges.'

2.3. Study selection

Records identified through database searching were uploaded to Endnote X9, a citation management tool and transferred to Rayyan QCRI ®, a systematic review software system to be screened (Ouzzani et al. 2016). Duplicates were removed then aims, objectives and inclusion and exclusion criteria were shared with a second reviewer. Records were screened based on title and abstract independently by the two reviewers. All records deemed potentially eligible were then reviewed on full text by both reviewers and conflicts were resolved through discussions and consensus. A third reviewer was consulted to resolve screening conflicts
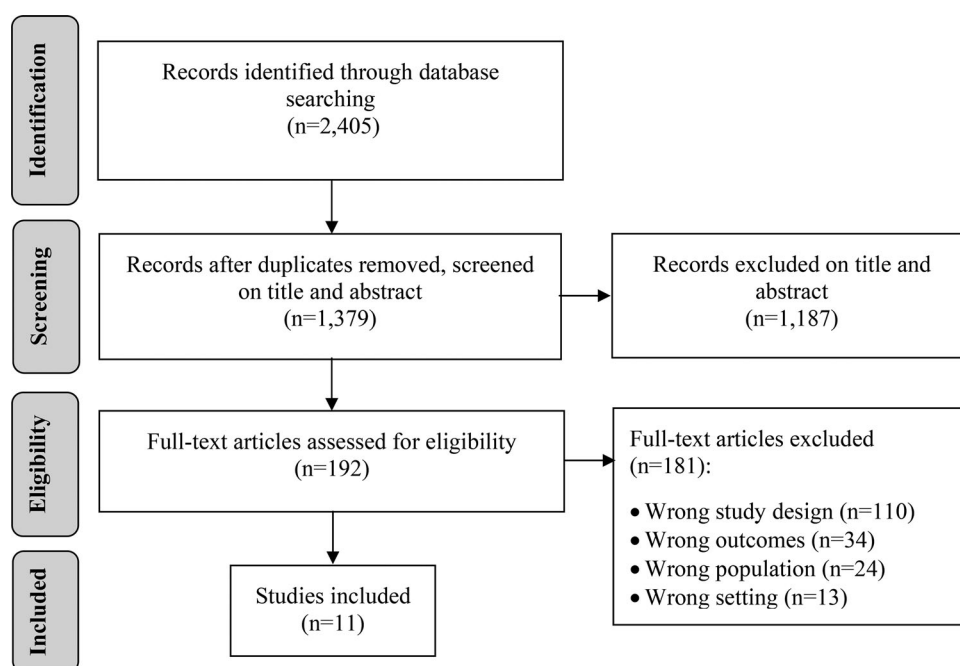
Figure 1. Flow diagram for study identification, screening and selection.

when needed. The reference lists of the included studies were hand searched for potentially eligible papers.

2.4. Data extraction

Data were extracted using two standardised tables. The first table was based on study characteristics and included the following headings: Author/year and country, aims and objectives, research design, sample and setting, relevant outcome(s), intervention(s) and data collection and instruments (Fineout-Overholt *et al.* 2010). The second table was based on the summary of key study findings for each study. Data were extracted by one author and cross-checked for accuracy by a second author.

2.5. Data synthesis

Given the methodological (i.e. measurement tools and study designs) and clinical (i.e. intervention type and delivery) heterogeneity of studies, a meta-analysis was not plausible. Moreover, it was not plausible to conduct a statistical comparison between the studies using the mean differences and standard deviations. Therefore, a textual narrative approach guided by Popay *et al.*'s (2006) guidance on narrative synthesis was utilised to report results and draw conclusions from the reviewed studies. Narrative synthesis offers a transparent and systematic means of combining studies together in accordance with the review aim and questions (Soundy *et al.* 2014). This type of synthesis also helps explore gaps in the literature and discuss the strengths of studies using a descriptive approach. In the present review, data were synthesised according to the type of interventions used to reduce and/or manage CB.

2.6. Quality appraisal

The methodological quality of the included studies was assessed using the following four Joanna Briggs Institute (2017) tools: Checklist for Randomised Controlled Trials (Tufanaru *et al.* 2017a), Checklist for Case Series (Moola *et al.* 2017a), Checklist for Quasi-Experimental Studies (Tufanaru *et al.* 2017b), and the checklist for Cohort Studies (Moola *et al.* 2017b). The key elements of these tools included sample representativeness, randomisation, blinding, validity and reliability of outcome measures, and appropriateness of analysis. Each question was answered as 'yes', 'no', 'unclear', or 'not applicable'. Quality appraisal was conducted by the first author and cross-checked by the last author. Conflicts in quality appraisal were discussed until consensus was reached.

3. Results
3.1. Study selection
The search identified a total of 2,405 records. Duplicates were removed, and 1,379 records were screened based on title and abstract. In conjunction with the review eligibility criteria, 1,187 records were excluded and judged as irrelevant. Full text screening was completed for 192 records. Of those, 181 records were excluded primarily due to wrong study design ($n = 110$). A total of 11 studies were included. No additional records were identified from the hand search. See Figure 1 flow diagram of the study selection process.

3.2. Study characteristics
A total of 11 studies were included. Most studies used a case series design ($n = 5$) and quasi-experimental

design ($n = 4$). The sample size ranged from 3 (Moskowitz *et al.* 2017) to 60 participants (Beh-Pajooh *et al.* 2018). The ages of children ranged from 6 (Kalgotra and Warwal 2017, Moskowitz *et al.* 2017) to 18 (Perilli *et al.* 2019) years across the studies. Nine countries were represented, with Italy as the majority country ($n = 3$). Most studies were conducted in school and home settings, while one study was conducted in a rehabilitative medical centre (Stasolla *et al.* 2018) and another conducted in a residential care facility (Grey *et al.* 2018). CBs discussed in the reviewed studies include stereotypic behaviour such as hand/objects mouthing and body rocking ($n = 4$), aggression including verbal, physical and self-injurious ($n = 9$) and absconding, avoidance, and tantrum behaviours ($n = 5$). Microswitch cluster technology was the most used intervention (Stasolla *et al.* 2017; Stasolla *et al.* 2018; Perilli *et al.* 2019). This is an educational and rehabilitative program which supports individuals with a dual simultaneous goal of promoting an adaptive response and reducing a challenging behaviour (Stasolla *et al.* 2017). The technology utilised was dependant on the primary purpose of the intervention and the experimental sequence varied in each study: ABCAC (Stasolla *et al.* 2017), ABB1AB1 (Perilli *et al.* 2019), and ABABCBCB (Stasolla *et al.* 2018). Other interventions included positive behavioural support (Grey *et al.* 2018), music (Kalgotra and Warwal. 2017, Ekins *et al.* 2019), painting therapy (Beh-Pajooh *et al.* 2018), cognitive behavioural therapy (Moskowitz *et al.* 2017, Agbaria 2020), functional assessment-based consultations (Inoue and Oda 2020) and a socioemotional learning programme (Faria, Esgalhado and Pereira 2019). Applied behaviour analysis was utilised as a strategy to implement an intervention in one study (Kalgotra and Warwal 2017), while Moskowitz *et al.* (2017), also utilised aspects of applied behaviour analysis combined with aspects of positive behavioural support in their study. See Appendices A1 for full study characteristics.

3.3. Quality appraisal

For all quasi-experimental studies ($n = 4$), it was clear what the cause and effect were, the participants were included in similar comparisons and there were multiple measurements of the outcome pre- and post-test. Methodological issues, however, related to lack of clarity in statistical analysis (Grey *et al.* 2018), completion of follow up and differentiating between groups (Kalgotra and Warwal 2017), and reliability of outcome measurements (Faria *et al.* 2019). Furthermore, none of the participants in the studies ($n = 4$) were included in any comparisons receiving similar care other than the intervention of interest and one study did not have a control group (Grey *et al.* 2018).

All case series studies ($n = 5$) reported measuring the condition in a standard and reliable way, utilised valid measures and clearly reported the outcomes and results of cases. Clinical information relating to participants were reported and appropriate statistical analysis was utilised in four studies (Inoue and Oda 2020, Perilli *et al.* 2019, Stasolla *et al.* 2017, Stasolla *et al.* 2018). However, three studies were unclear in relation to having complete inclusion of the participants (Inoue and Oda 2020, Moskowitz *et al.* 2017, Perilli *et al.* 2019) and only one study (Stasolla *et al.* 2017) clearly reported consecutive inclusion of participants.

The quality of the only randomised controlled trial (Beh-Pajooh *et al.* 2018) was assessed and resulted in several items rated as unclear. For instance, it was not clear if true randomisation took place and if the allocation to treatment groups was concealed. The reliability of outcome measurements and blinding of participants was not clear for those delivering the intervention and outcome assessors. However, analysis was clear, both groups were similar at baseline, the trial was appropriate, and outcomes were measured in the same way for both groups.

The remaining cohort study (Agbaria 2020) met most of the quality appraisal criteria. Groups were similar and recruited from the same population, exposures were measured similarly for assignment, and appropriate statistical analysis was used. Furthermore, follow up time was reported and deemed sufficient for outcomes to occur, and exposures and outcomes were measured in a valid and reliable way. However, confounding factors were not identified it was not clear if participants were free of the outcome at the beginning of the study and the completion of follow-up was unclear. See Appendices A2 for the full quality appraisal checklists. Of note, studies were not ranked based on quality since the use of scales for assessing quality in systematic reviews is discouraged (Higgins and Green 2019).

3.4. Synthesis of results

Non-pharmacological interventions were used to reduce and/or manage CBs in all the reviewed studies ($n = 11$). None of the reviewed studies included pharmacological interventions as the primary intervention and none included combined (i.e. pharmacological and non-pharmacological) interventions.

Results from this systematic review were synthesised and grouped by intervention type as follows: (i) multi-modal interventions; (ii) microswitch technology; (iii) cognitive behavioural therapy; and (iv) art, music and illustrated stories. The summary of key study findings is presented in supplemental materials in Appendix A3.

3.4.1. Multi-modal interventions

Grey *et al.* (2018) reported that six of the seven participants in their study reduced their frequency of CBs from baseline and maintained this in the months following implementation of unique behavioural support

plans.Further to this Grey *et al.* (2018) reported an overall reduction in the use of pharmacological interventions as a secondary outcome. Of the seven participants, five were receiving psychotropic medications at the start of the study including 'anti-depressants, anxiolytics, ADHD medication, anti-psychotics and mood stabilizers' (Grey *et al.* 2018, p.402). On completion of this study, however, one participant's psychotropic medication was no longer required, another participant's medication dose was significantly reduced, and the remaining three participants had their medication doses stabilized. Although this study had a small sample size ($n = 7$), it provided evidence that the use of positive behavioural support as a non-pharmacological intervention is effective in discontinuing, reducing, and stabilizing psychotropic medications for this population (Grey *et al.* 2018).

Similarly, the study by Inoue and Oda (2020) used functional assessment and developed individual interventions for each participant. Among the 10 behaviours identified, the interventions resulted in slightly high to high rates of reduction of 6/10, low reduction rate of 2/10 and no records for the remaining 2 behaviours (teachers reported difficulty recording due to high frequency) among participants. Although not all behaviours reported reductions in this study, in contrast to the study conducted by Grey *et al.* (2018), Inoue and Oda (2020) reported statistically significant results for overall and average scores. A statistically significant improvement was seen in the total scores of the Criteria for Determining Severe Problem Behaviour (CDSPB), Aberrant Behaviour Checklist (ABC), and externalising behaviours factor of the Child Behaviour Checklist (CBCL). The pre-average score of the CDSPB was 17.38 (Standard Deviation [SD] = 8.40) with the post average score decreasing to 9 points, a statistically significant improvement ($p = 0.05$). Statistically significant improvements in the total scores of the ABC ($p = 0.02$), and total ($p = 0.02$) and externalising ($p = 0.02$) scores of the CBCL were also reported (Inoue and Oda 2020).

3.4.2. Microswitch technology
Microswitch technology was the most commonly used intervention ($n = 3$) to reduce CBs (Perilli *et al.* 2019, Stasolla *et al.* 2017, Stasolla *et al.* 2018). Overall, studies reported positive outcomes relating to the reduction of CBs including hand/object mouthing (Stasolla *et al.* 2017), hand biting (Perilli *et al.* 2019), body rocking and hand clapping (Stasolla *et al.* 2018), as well as increase in participants' quality of life. For instance, Stasolla *et al.* (2017) reported that participants ($n = 6$) commenced their baseline with a mean frequency free of CB (hand/objects mouthing) of 0/30. This increased from 11.7/30 to 14.4/30 during the intervention phase and although it fluctuated during other phases, participants' time free of CB increased significantly from

16.4/30 to 21.6/30 during follow-up ($p < 0.01$). This indicates a positive result as a higher score reflects an increase in the amount of time participants did not display CBs. These results are comparable to another study by Perilli *et al.* (2019), whereby one participant had a mean value of CB (hand biting) significantly decrease from 9.17/60 at the first baseline to 4.67/60 at the second cluster phase and finally to 4.3/60 at the end of the one-year follow-up phase ($p < 0.01$). This indicated a positive result as a lower score reflected an increase in the amount of time CBs were not displayed by participants. Stasolla *et al.* (2018) also reported a substantial result for one participant whose CB (body rocking) decreased from 94/100 at the first baseline to 10.33/100 at the fourth contingent intervention, where a lower score indicated a decrease in the amount of time CB was displayed. In accordance with the other two studies which used microswitch technology (Perilli *et al.* 2019, Stasolla et al. 2017), a difference of statistical significance of $p < 0.01$ was reported for all participants for the reduction of stereotypic behaviours (body rocking and hand clapping) during the contingent intervention phases.

3.4.3. Cognitive behavioural therapy
Cognitive behavioural therapy was used as an intervention in two studies (Agbaria 2020, Moskowitz *et al.* 2017), with both studies noting a positive impact of cognitive behavioural therapy on children's behaviours. Agbaria (2020) included parents as participants ($n = 50$). The experimental group ($n = 25$) received fifteen 2.5-hour cognitive behavioural therapy group sessions and the control group participated in an art and painting intervention. It was found that cognitive behavioural therapy significantly improved children's ability to manage anger and obedience to rules. The mean overall score for the intervention group was 2.56 (SD = 0.26) at pre-test which increased significantly to 3.21 (SD = 0.34) at post-test ($t = 3.68; p < 0.01$). As for the control group, no statistically significant improvements were observed. Similarly, Moskowitz *et al.* (2017) indicated significant reductions of CBs (absconding, verbal and physical aggression and tantrum behaviour) post cognitive behavioural therapy as compared to baseline for all three participants: participant 1: 81% CB pre-test (SD = 7%) versus 2% post-test (SD = 4%); participant 2: 77% CB pre-test (SD = 27%) versus 3% (SD = 5%) post-test; and participant 3: 54% CB pre-test (SD = 16%) versus 0% post-test which is a 100% mean baseline reduction.

3.4.4. Art, music, and illustrated stories
Art therapy was utilised in a randomised controlled trial conducted by Beh-Pajooh *et al.* (2018). The programme delivered to children in the intervention group ($n = 30$, painting therapy) resulted in a statistically significant

difference in externalising behaviours from pre-test ($M = 52$, SD $= 0.73$) to post-test ($M = 45$, SD $= 0.80$; $p < 0.01$), while no statistically significant difference was reported in externalising behaviours for the control group ($n = 30$, usual care) from pre-test ($M = 51.56$, SD $= 0.70$) to post-test ($M = 51.90$, SD $= 0.67$; $p < 0.01$).

Two studies focused on music (drums) as an intervention to reduce CB (Ekins *et al.* 2019, Kalgotra and Warwal 2017). Ekins *et al.* (2019) found that drums alive sessions for the intervention group (two drums alive sessions and two physical exercise classes per week) demonstrated a non-statistically significant improvement among individual behaviour patterns from week one ($M = 1.08/2$, SD $= 0.64$) to week seven ($M = 0.52/2$, SD $= 0.25$; $p = 0.344$) and the control group (exercise intervention alone) showed a slight decrease over time: week one ($M = 1.42/2$, SD $= 0.36$) to week seven ($M = 1.66/2$, SD $= 0.47$; $p = 0.062$). However, at the end of the intervention (week 7), the overall difference from results of the developmental behaviour checklist pre- and post-intervention were statistically significant ($p = 0.007$), indicating the significantly better effect of the drums alive sessions on observed behaviour patterns in comparison to the conventional exercise programme. Kalgotra and Warwal (2017) also found that songs, rhymes, soft music, and drum beating positively reduced CBs (destructive and violent behaviour), using strategies from applied behavioural analysis: verbal instructions, skill modelling, prompting, task analysis, shaping and the use of positive feedback. The mean differences (for mild F1 [contrast] F2 [error], for moderate F1 [contrast] F13 [error]), were significant for children with mild ID (F $[1,2] = 36.937$, $p = 0.26$) and moderate ID (F $[1,13] = 71.686$, $p = 0.000$) where measures of significance were $p < 0.05$ and $p < 0.01$ respectively). In contrast, no statistically significant differences were seen in the control group. Of note, the authors reported that no statistically significant changes were noted within the domains of 'temper tantrums, odd behaviours and fears' (p.173).

Faria *et al.* (2019) focused on a 'smile, cry, scream and blush' programme which utilised simple illustrated stories for children with IDs in conjunction with socioemotional learning to improve socioemotional competencies related to behaviour, positive relationships and decision making. It was found that the programme had a positive effect on the experimental group's ($n = 21$) behaviours by enabling children to learn, understand and manage their emotions pre-test $M = 0.54$ (SD $= 0.19$) versus post-test $M = 0.96$ (SD $= 0.07$; $p < 0.05$) in comparison to the control group ($n = 29$), where no statistically significant differences were noted. The authors did note, however, that although a statistical difference was reported overall for the experimental group, this was not the case for the item 'recognition of emotions based on facial expressions.'

4. Discussion

This systematic review aimed to synthesise evidence from 11 studies that assessed the effect of interventions used to reduce/manage challenging behaviour among children with intellectual disabilities in community settings. A variety of CBs were included in the identified studies including aggression, stereotypical, self-injurious, destructive, and anxiolytic behaviours. Non-pharmacological interventions were used in all included studies with microswitch technology being the most common ($n = 3$). Positive outcomes relating to indices of happiness and statistically significant reductions of CBs including hand/object mouthing, hand biting, body rocking, and hand clapping were reported (Perilli *et al.* 2019, Stasolla *et al.* 2017, Stasolla *et al.* 2018). These results are consistent with earlier research conducted by Stasolla *et al.* (2014), which reported a reduction of stereotypical behaviours among two high functioning children with ASD through assistive technology. Microswitch-aided technology has also been used in other populations including those in a minimally conscious state to increase functional responding (Lancioni *et al.* 2018). To the best of the authors' knowledge, this is the first systematic review to synthesise evidence from studies which used microswitch technology to reduce and manage CB, specifically among children and adolescents who have a clear/formal diagnosis of ID (IQ ≤ 70).

Other non-pharmacological interventions associated with reductions in CBs included: music (Ekins *et al.* 2019, Kalgotra and Warwal 2017), painting therapy (Beh-Pajooh *et al.* 2018), cognitive behavioural therapy (Agbaria 2020, Moskowitz *et al.* 2017), functional assessment-based consultations (Inoue and Oda 2020), positive behavioural support (Grey *et al.* 2018) and a socioemotional learning programme involving illustrated stories (Faria *et al.* 2019). Indeed, in recent years, therapies have been highlighted as high-quality interventions for CBs. Results from the cognitive behavioural therapy intervention in this review are comparable to previous research among adult ID populations. In a study conducted by Willner *et al.* (2013), cognitive behavioural therapy was found to be effective in improving anger control and decreasing physical aggression among adults with IDs, while Cooney *et al.* (2017), reported a decrease in anxiety symptoms among adults with mild to moderate IDs using computerised cognitive behavioural therapy in a randomised controlled trial.

Each of the included studies utilised different methodologies and focused on various behaviours and populations, however, all studies centred on the functions of CBs (although preliminary functional analysis was not

always conducted). This is reflected through the collection and analysis of data such as: informal interviews and questionnaires and monitoring for improvements following implementation of interventions, which is an interesting finding. The analysis and assessments of the function of behaviours is one of the main components of functional analysis which is a growing area of interest and is recommended as a means of determining appropriate interventions based on the functions of behaviours (Ali *et al.* 2014).

Studies utilising pharmacological interventions were not retrieved in this review. This may indicate that more studies are being conducted internationally on the use of non-pharmacological rather than pharmacological interventions for the management of CB in children and adolescents with ID across community settings. The rationale for this, perhaps, is the increased focus on non-pharmacological interventions as first treatment options, in line with NICE (2015) recommendations. One of the included studies (Grey *et al.* 2018) reported on the reduction, stabilisation, and discontinuation of psychotropic medications as a secondary outcome following implementation of their non-pharmacological intervention of behaviour support plans. This contrasts with a systematic review conducted by Deb *et al.* (2014) on the use of pharmacological interventions for CB among the overall ID and ASD population where improvements were reported for participants receiving aripiprazole (anti-psychotic medication). However, Deb *et al* (2014) noted that due to the low quantity and quality of studies included, further research on pharmacological interventions was required.

Overall, results from this systematic review indicate that non-pharmacological interventions such as multi-model interventions, microswitch technology, cognitive behavioural therapy, art, music and illustrated stories are effective in reducing and managing a broad range of CBs displayed by children and adolescents with mild to moderate and severe to profound IDs including aggression, stereotypical, self-injurious, destructive, and anxiolytic behaviours. The broad range of non-pharmacological interventions available to this population is promising in terms of possible movement away from historic strategies of punishment, restrictions and negativity which came to light in the Winterbourne View exposure (Department of Health 2012), towards more evidence based proactive strategies which are person-centred.

5. Limitations and future directions
Current review findings suggest several avenues for future research. Given this review did not retrieve any studies which utilise pharmacological interventions, an exploration of the impact of pharmacological interventions on CB is warranted. It is also evident that there is a lack of high-quality evidence available within the

systematic review timeframe (i.e. January 2015 to January 2021), to evaluate the effect of non-pharmacological interventions among this population. In addition, only one randomised controlled trial (Beh-Pajooh *et al.* 2018) was retrieved in comparison to recent studies conducted amongst adult ID populations (Hassiotis *et al.* 2018, McGill *et al.* 2018, Singh *et al.* 2020). This highlights a need for randomised controlled trials on both, pharmacological and non-pharmacological interventions, and trials to compare the impact of such interventions, to allow opportunity to compare outcomes. Studies incorporating larger sample sizes with longitudinal design should be a priority for research in this area in order to measure more long-term outcomes.

The results of this review will help build on previous research and offer up to date evidence for policy development and healthcare professionals and families supporting this population. For clinical practice, a continued need exists to support the appropriate assessment and causes/functions of CB among children with IDs to identify individuals in need of intervention. Findings suggest a need for appropriately trained staff to support the implementation and evaluation of evidenced based interventions in community settings and support parents who care for their children at home. Results can also be integrated into curricula for nurses and healthcare professionals working with this population to increase knowledge on the range of non-pharmacological interventions available and ensure the delivery of evidenced based care. Educating students, nurses, and healthcare professionals on the effects of non-pharmacological interventions for CB reduction and management is essential given the potentially serious adverse effects of commonly used pharmacological interventions (Matson and Mahan 2010). Furthermore, children with ID have the right to evidenced based services which strive to achieve positive outcomes and improve quality of life (Townsend-White *et al.* 2012).

Despite the encouraging outcomes relating to the reduction and management of CBs for children and adolescents with IDs, this systematic review has some limitations. Firstly, only one randomised controlled trial was retrieved through the database search (Beh-Pajooh *et al.* 2018). Randomised controlled trials are considered as level 1 evidence and gold standard when evaluating the effectiveness of interventions therefore the significant lack of this study design may impact on the overall findings from this review. The significant lack of randomised controlled trials is a known issue within ID research and has been acknowledged as a priority for this population (Hastings 2013). However, previous research has noted that ethical issues may be posed to those wishing to conduct randomised controlled trials on therapeutic interventions for CBs (Oliver *et al.* 2002). The authors excluded single case studies due to limited generalizability of findings. Studies represented

small sample sizes with the maximum sample involving 60 participants (Beh-Pajooh *et al.* 2018) and the review was limited by year of publication (January 2015 to January 2021). While this could have led to the exclusion of relevant studies published before 2015, the decision to limit the search by year of publication helped source the most up to date interventions used to manage and reduce CBs among children and adolescents with ID. There are a number of different tools used to collect data and measure outcomes, which made it impossible to conduct a meta-analysis as findings could not be grouped statistically (Higgins and Green 2019). Finally, many studies involved parents who completed questionnaires and other pre- and post-tests to measure CBs which may have resulted in biased results due to subjective opinions.

6. Conclusion

While this review provides areas for improvement and further research is warranted, evidence to support the use and increasing value of several non-pharmacological interventions to reduce CB among children with IDs is provided. Children with a broad range of ID severity and who present with various forms of CB were included in this review in which results are applicable to many families, healthcare professionals and services supporting this population. From a practical standpoint, all interventions evaluated in this review can be considered for implementation in community settings with many having the potential to add fun and play to routines and/or school curricula. These results have both, social and clinical significance as well as the potential to build on previous evidence, and positively impact on the treatment and reduction of CBs among this population with several important implications for practice, research, and education.

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Appendix A1.
Study characteristics (n = 11)

Author (year) and Country	Aim and Objectives	Design	Sample and Setting	Relevant outcome	Intervention	Data collection and Instruments
Agbaria (2020) Israel	To examine the efficacy of a cognitive-behavioural intervention on acquiring social and cognitive skills for parents.	Cohort study (Randomised)	N = 50 Arab parents with a child aged 8-12 years and diagnosed a minor ID were randomly selected from five special education schools in the district.	Obedience to rules and ability to manage anger.	Participants were randomised to the experimental group (n = 25) and the control group (n = 25). The control group participated in an art and painting intervention. The experimental group received X15 2.5h cognitive behavioural therapy group sessions.	Questionnaires were completed by parent's pre and post intervention. These consisted of 10 domains (involving 100 items) each rated on the Likert scale from 1-5. Independent sample t-tests for the overall and each of the sub scores were conducted to examine pre-intervention followed by paired sample t-tests to assess changes within both groups, retrospectively.
Ben-Pajooh et al. (2018) Iran	To identify the effectiveness of a painting therapy program in alleviating the externalising behaviours of male children with ID.	Randomised Clinical Trial	N = 60 male children with ID recruited from 20 special schools (4 schools from each zone).	externalising behaviours	Participants were divided into 2 separate groups. The intervention group received a painting therapy program over 12 weeks (2 sessions per week). The control group did not receive any program.	Questionnaires were completed by parents at the beginning and at the end of the program. These consisted of 22 items relating to externalised behaviours which were rated on a 4-point Likert scale.
Ekins et al. (2019) Germany	To examine the effects of a multi-modular Drums Alive Kids Beats intervention on physical performance, behaviour, cognitive, social, and practical competencies.	Quasi-Experimental	N = 15 children with a mean age of 13.9 years diagnosed with IDs participated in the study in a special school setting.	Behaviour.	Participants were assigned by schoolteachers to the intervention group or comparison group. The intervention group conducted two Drums Alive sessions and two physical exercise classed per week over the duration of 7 weeks. The comparison group performed 3 physical education classes a week.	Trained assessors, parents and schoolteachers assessed the participants within 2 days before and after the intervention and during the intervention phase. The German Motor Skill Test (DMT) was utilised to measure performance before and after the assessments were conducted. Behaviour and competencies were assessed by means of two questionnaires, the Heidelberg Competency Inventory (HKI) and the VFE as well as the Developmental Behaviour Checklist (DBC) which monitors daily behavioural patterns.
Faria et al. (2019) Portugal	To analyse the impact of the Socioemotional learning (SEL) programme by comparing the scores obtained in the Test of Emotion Comprehension (TEC).	Quasi-Experimental	N = 50 children aged 8 to 15 years diagnosed with mild IDs (IQ 50-69), participated in a school setting.	Socioeconomic competencies (SEC)	Participants were divided into 2 groups; 1 experimental (N = 21) and 1 control (N = 29). TEC was applied to both groups as a pre-test. The SEL programme: 'Smile, Cry, Scream and Blush' was implemented in the experimental group divided into 3 subgroups of 7 children	The instruments included a data questionnaire, the TEC (which stored the answers that were analyses in the Statistical Package for Social Data collection) and the SEL programme.

(Continued)

Author (year) and Country	Aim and Objectives	Design	Sample and Setting	Relevant outcome	Intervention	Data collection and Instruments
Grey et al. (2018) Abu Dhabi, United Arab Emirates.	To monitor the effects of positive behavioural support (PBS) on CBs, psychiatric symptomology, the rates of psychotropic medication and Quality of Life (QoL).	Quasi-Experimental Design	N = 7 children between the ages of 8 and 17 years diagnosed with an ID, referred for PBS services (due to the presence of substantial CBs) and live in full time residential community settings participated in the study.	Frequency of CBs, psychiatric symptomology and psychotropic medications.	each. Each session lasted between 40 and 45mins in a total of 8sessions. TEC was then re applied to both the control and experimental groups as a post-test. A formal functional assessment was conducted, and hypothesis developed regarding the function of the CB, a behaviour support plan (BSP) was then implemented. Each BSP identified interventions relating to the environmental accommodations, direct interventions, functional skills teaching and reactive strategies. The study was conducted over 24 months for each participant.	Dependant measures collated during baseline and throughout intervention stages included: the frequency of target behaviours, use of psychotropic medications, Periodic Service Review (PSR) system (a self-reported measure), and the Behaviour Support Plan Quality Evaluation (BSP-QE) (to rate the quality of a BSP scoring several categories from 0-12). The Child and Adolescent Psychiatric Assessment Scale (ChA-PAS) was administered by a trained member of the research team. The assessment consisted of a semi-structured interview and assessed symptoms in 7 domains. The Quality of Life (QoL) questionnaire for individuals with intellectual and developmental disabilities was utilised which comprised of 4 sections and each category was measured out of 9. The Health of the Nation Outcome Scale (HonNos) for learning disabilities was utilised (an 18-item measure scored from 0-4). The ChA-PAS, QoL questionnaire and the HonNos, were all completed during baseline (TI), after 12 months (T2) and after 24 months (T3).
Inoue and Oda (2020) Japan	To examine the effects of a functional assessment consultation for teachers of students with severe behaviours.	Case Series	N = 8 students with severe IDs and behavioural disorders participated in the study at 2 special schools in western Japan.	The effects of consultations based on functional assessments for each behavioural scale.	Functional assessment-based consultations were conducted by an external consultant team in conjunction with student's teachers in both schools. The specific consultation (intervention) recommended was dependant on the analysis of behaviours and when the function of the behaviour was determined.	The Criteria for Determining Severe Problem Behaviour (CDSPB), a rating scale comprising 11 domains was distributed to all teachers for all students in each school and students selected as candidates (N = 8) were evaluated again using the CDSPB before commencing consultation. The profile of each student was collected which included the student's gender, school grade, diagnosis and IQ or developmental quotient (DQ). The Aberrant Behaviour Checklist (ABC), an assessment comprising of 58 items

(Continued)

Author (year) and Country	Aim and Objectives	Design	Sample and Setting	Relevant outcome	Intervention	Data collection and Instruments
						classified into 5 subscales and the Child Behaviour Checklist/4-18 (CBCL), a questionnaire comprising of 118 items and 8 subscales and 2 factors (internalising and externalising behaviours) was utilised to collect data. Behaviour recording sheets were developed for each child which were completed by the homeroom teachers each day. These records were analysed by the consultant team, a consultation sheet was prepared, and advice was given at consultations. The number of consultations ranged between 3 and 6 sessions over a 6-month period with each session lasting 15 to 20min. In some cases, video footage was requested to observe CBs. The effects of the consultations were examined by improvements in the effect size (on single subject data) and scores of the behaviour measures through a mean baseline reduction (MBR) method. 'The data of pre-post-test on each measurement was using Wilcoxon signed-rank test with the IBM SPSS Statistics version 25. Differences were considered significant if the p value was < 0.5', p110.
Kalgotra and Warwal (2017) India	To study the effect of music on behavioural disorders using strategies from Applied Behaviour Analysis.	Non-Randomised Quasi Experimental	$N = 21$ children aged 6 to 17 years with mild ($n = 5$) to moderate ($n = 16$) IDs and behavioural disorders participated in the study at 5 school settings.	Changes in the domains of various behaviours.	Participants were assigned to the experimental and control group by matching groups based on their chronological age and intelligence. The music Intervention was introduced sequentially to the experimental group. The control group did not receive the intervention and were not involved in an additional activity.	The Seguin Form Board Intelligence test was used to measure IQ and test-retest was completed after 20 days to check reliability. Behaviour Assessment Scale for Indian Children-MR (Part-B) was used to assess level of problem behaviours pre-test and post-test. It consists of 75 items under 10 domains. Each item was scored on a 3-point scale. Data were collected on socio-economic data scale from participant's parents/guardians at a parent teacher meeting. BASIC-MR (part B) was administered to both groups as pre-test. Statistical analysis was performed using the Statistical Package for Social Sciences (version 16.0 for windows). Descriptive and inferential statistics were used to analyse and describe data relating to behaviours. Correlation coefficient was

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Author (year) and Country	Aim and Objectives	Design	Sample and Setting	Relevant outcome	Intervention	Data collection and Instruments
Moskowitz et al. (2017) USA.	To combine aspects of cognitive behavioural therapy (CBT) with aspects of applied behavioural analysis (ABA) and positive behavioural support (PBS) to treat anxiety behaviours.	A multiple baseline design. Case Series	N = 3 children aged between 6 and 9 years old diagnosed with ASD and ID who displayed anxiety and problem behaviour within the children's home/ community setting.	Anxiety ratings and problem behaviours.	Between 4 and 7 baseline sessions were conducted with each participant. On completion of the final baseline session, the first author met with parents to discuss results and propose various intervention strategies. Parents selected options they felt represented the best fit for their family and were trained to implement the intervention strategies. Treatment included strategies used both during and prior the intervention sessions which included CBT treatment components and ABA/PBS antecedent-Based strategies.	used to determine the relationships between pre-test and post-test scores. During all session's participants wore the Alive Heart and Activity Monitor and were videotaped. Data were collected on the frequency of anxious and problem behaviour across 10 s intervals by 2 independent observers. Parent report and subjective ratings of anxiety using the Functional Assessment Interview (FAI) were used. Blind observers rated the appearance of anxiety from videos using a 4-point scale. HR and RSA were measured using QRSTool and CmetX. The frequency of anxious and problem behaviours were coded for Interobserver Agreement (IOA) by the first and second author across sessions. 2 blind research assistants coded videotapes for appearance of anxiety using a 4-point rating scale. 2 observers (with no prior knowledge of the study) completed intervention integrity checks on all baseline and intervention sessions for each child.
Perilli et al. (2019) Italy	To enhance adaptive responses, reduce hand biting behaviours and evaluate effects on indices of positive participation as an outcome measure of participants quality of life.	Single subject experimental design Case series	N = 6 adolescents aged between 13 and 17 years diagnosed with Fragile X syndrome within the severe and profound ranges of ID who presented with hand biting stereotypic behaviours, participated in their homes.	Hand biting behaviours, indices of positive participation and quality of life.	Microswitch technology. The adaptive response consisted of inserting three different objects into three containers within 4 s. Three 10min sessions were video recorded 4 days per week. An ABB1AB1 experimental sequence was applied and 1 year follow up was conducted with an AB1AB1 experimental sequence. The study was completed within 15 months (including 1 year follow up). 130 sessions were carried out for each participant. The adaptive response included 4 s and the contingent positive reinforcement lasted 6s.	Formal screening of preferences and informal interviews with parents/ caregivers was completed to select positive stimulations as reinforcements. The technology consisted of 3 square containers equipped with a sensitive pressure microswitch, an optic sensor (on the participants lip), a laptop and an interface connecting the microswitches to the laptop. 2 blind research assistants recorded indices of positive participation and computed the fidelity of the dependant variables. Videos were systematically and randomly validated through a Likert-type scale with a 1-5 points by 3 groups of external raters (22 per group). Data were summarised over blocks of sessions and plotted in graphs and tables.
Stasolla et al. (2017) Italy	To evaluate the effectiveness and suitability of a rehabilitative	Single subject experimental design Case Series	N = 5 adolescents aged between 14 and 17 years old diagnosed with Rett syndrome, severe to	Indices of happiness and stereotypic behaviours.	A microswitch program where 4 forward steps were to be performed within a 3 s interval (adaptive response).	Informal interviews with parents and caregivers and formal screening preference assessments were completed. The technology consisted of

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Author (year) and Country	Aim and Objectives	Design	Sample and Setting	Relevant outcome	Intervention	Data collection and Instruments
	intervention (microswitch programme) on participants indices of happiness and on the reduction of stereotypic behaviours.		profound developmental disabilities and who presented with stereotypic behaviours (hand clapping or body rocking) within a rehabilitative medical centre.		The optic microswitch (photocell) was fixed in the front left side of each walker while the reflector panel was in the front right side. Sessions lasted 5 mins and were video recorded. 4 sessions collected per day with a 15-20 min of rest period, 5 days per week. An ABABCBCB experimental sequence was applied.	a photocell, rectangular reflector panel, battery-powered system control unit, CD players, coloured lights, tactile vibrations, and a four-wheel walker device. CD players were fixed behind the photocell and the reflector panel along both sides of walkers. Coloured lights and tactile vibrations were placed on the walkers in front of participants. Data collection concerned independent adaptive responses, indices of happiness and the display of behaviours. Social validation scores were recorded by a 15 s partial interval coding system. 2 blind research assistants watched sessions while 16 external raters (randomly divided into 5 groups) assessed videos through a 6-item questionnaire based on a 5-point Likert scale. Data were plotted in graphs and tables.
Stasolla et al. (2017) Italy	To improve adaptive behaviour and decrease hand/ objects mouthing using microswitch technology and to assess the effects of the intervention on indices of happiness.	Single-subject experimental design Case series	N = 6 children with a mean age of 8.2, diagnosed with ASD and estimated to be within the severe to profound range of ID. The study and sessions were carried out individually in each participant's home.	Adaptive response, performance, and CB.	Microswitches were utilised as a basic form of assistive technology to enable participants with independent access to positive stimulation by learning to perform a new adaptive response and reduce CBs. An ABCAC experimental sequence was adopted. A first intervention phase was implemented for increasing the adaptive responding irrespective of the CB, followed by a cluster phase where positive stimulation was provided on an adaptive response if the CB was absent. 5-minute sessions per day across 5 days per week were recorded.	Informal interviews with parents were completed and a formal preference screening procedure for stimulus presentations was recorded. The microswitches were optic sensors fixed within containers for recording the adaptive behaviour. A frame fixed on participants chin recorded CB. Indices of happiness were recorded manually and scored by the research assistant. 2 research assistants watched 50% of the video-recorded sessions. Groups of external raters watched a 6- minute videoclip and completed a 6-item questionnaire assessed on a 5-point interval scale. Statistical comparisons were performed between baseline, intervention, and cluster phases. Data was summarised over blocks of sessions and plotted in graphs.

Appendix A2. Quality appraisal checklists from joanna briggs institute

A2.1. Quality appraisal of the included quasi experimental studies ($n = 4$)

JBI Items	Ekins et al. (2019)	Faria et al. (2019)	Grey et al. (2018)	Kalgotra and Warwal (2017)
Is it clear in the study what the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Yes	Yes	Yes	Yes
Were the participants included in any comparisons similar?	Yes	Yes	Yes	Yes
Were the particpants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	No	No	No	No
Was there a control group?	Yes	Yes	No	Yes
Were there multiple measurements of the outcome both pre and post the intervention/exposure?	Yes	Yes	Yes	Yes
Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Yes	Yes	Yes	Unclear
Were the outcomes of participants included in any comparisons measured in the same way?	Yes	Yes	Yes	Yes
Were outcomes measured in a reliable way?	Yes	Unclear	Yes	Yes
Was appropriate statistical analysis used?	Yes	Yes	Unclear	Yes

A2.2. Quality appraisal of the included case series studies ($n = 5$)

JBI Items	Inoue and Oda (2020)	Stasolla et al (2018)	Stasolla et al (2017)	Moskowitz et al (2017)	Perilli et al (2019)
Were there clear criteria for inclusion in the case series?	Yes	Yes	Unclear	Yes	Yes
Was the condition measured in a standard, reliable way for all participants included in the case series?	Yes	Yes	Yes	Yes	Yes
Were valid methods used for identification of the condition for all participants included in the case series?	Yes	Yes	Yes	Yes	Yes
Did the case series have consecutive inclusion of participants?	No	Unclear	Yes	No	Unclear
Did the case series have complete inclusion of participants?	Unclear	Yes	Yes	Unclear	Unclear
Was there clear reporting of the demographics of the participants in the study?	Yes	Unclear	Unclear	Unclear	No
Was there clear reporting of clinical information of the participants?	Yes	Yes	Yes	Unclear	Yes
Were the outcomes or follow up results of cases clearly reported?	Yes	Yes	Yes	Yes	Yes
Was there clear reporting of the presenting site(s)/clinic(s) demographic information?	Yes	Yes	Yes	Yes	Yes
Was statistical analysis appropriate?	Yes	Yes	Yes	Unclear	Yes

A2.3. Quality appraisal of the included randomised controlled trials (*n* = 1)

JBI items	Beh-Pajooh et al. (2018)
Was true randomization used for assignment of participants to treatment groups?	Unclear
Was allocation to treatment groups concealed?	Unclear
Were treatment groups similar at the baseline?	Yes
Were participants blind to treatment assignment?	Unclear
Were those delivering treatment blind to treatment assignment?	Unclear
Were outcomes assessors blind to treatment assignment?	Unclear
Were treatment groups treated identically other than the intervention of interest?	Yes
Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?	Yes
Were participants analysed in the groups to which they were randomized?	Yes
Were outcomes measured in the same way for treatment groups?	Yes
Were outcomes measured in a reliable way?	Unclear
Was appropriate statistical analysis used?	Yes
Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	Yes

A2.4. Quality appraisal of the included cohort studies (*n* = 1)

JBI Items	Agbaria (2020)
Were the two groups similar and recruited from the same population?	Yes
Were the exposures measured similarly to assign people to both the exposed and unexposed groups?	Yes
Was the exposure measured in a valid and reliable way?	Yes
Were confounding factors identified?	No
Were strategies to deal with confounding factors stated?	Not applicable
Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Unclear
Were the outcomes measure in a valid and reliable way?	Yes
Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Yes
Was the follow up complete, and if not, were the reasons to loss to follow up described and explored?	Unclear
Were strategies to address incomplete follow up utilized?	Unclear
Was appropriate statistical analysis used?	Yes

Appendix A3. Summary of Key Study Findings (*n* = 11)

Author (year) & Country	Key Findings*
Agbaria (2020) Israel	Q1. The CBT intervention delivered to parents in the experimental group yielded statistical significance in 8 domains including the children's ability to manage anger and obedience to rules with the overall score for the intervention group pre-test (M = 2.56, SD = 0.26) to post-test: (M = 3.21, SD = 0.34) resulting in: a t-test score of (T = 3.68; p<.01). Q2. The cognitive behavioural intervention (experimental group) was more effective in comparison to the art therapy intervention (control group) where no significant improvements were observed for participants when t-tests were conducted comparing pre and post participation.
Beh-Pajooh et al. (2018) Iran	Q1. The painting therapy programme delivered to the children in the intervention group decreased externalising behaviours from pre-test (M = 52, SD = 0.73) to post-test (M = 45, SD = 0.80) where (p < 0.01). Q2. The painting therapy programme was the only intervention implemented.
Ekins et al. (2019) Germany	Q1. The intervention had a positive effect on participant's behaviour. The statistical difference between the 2 groups at the end of the Drums Alive intervention was significant (p = 0.007). Results of the developmental behavioural checklist reduced for participants from (1.08/2) at week 1 to (0.52/2) at week 7. Q3. This study compared two drums alive sessions and two physical exercise classes per week in comparison to three physical exercise classes per week only. The drums alive intervention had a significantly better effect on observed behaviour patterns over the seven weeks in comparison to the physical exercise intervention on its own for the control group.
Faria et al. (2019) Portugal	Q1. The interventions had a positive effect on participant's behaviours indirectly as the programme enabled participants to learn and understand their emotions. Significant statistical differences were notes in the experimental group overall resulting in the mean pre-test (M = 0.54, SD = 0.19) and the mean post-test (M = 0.96, SD = 0.07) (p < 0.05). Significant differences were noted in all components for the experimental group, except for component 1. Q2. The SEC programme was the only intervention implemented in this study.
Grey et al. (2018) United Arab Emirates	Q1. The intervention had a positive effect on participant's CB's. 6 of the 7 participants reduced their frequency of CB's from baseline which were maintained in the months following implementation of the intervention and a reduction in pharmacological interventions pre and post the non-pharmacological intervention of PBS/BSP. 5 participants were receiving psychotropic medications at the beginning of the study, following implementation of the intervention 2 of these 5 participants significantly reduced medications and medication was eliminated completely for 1 participant. Q2. This study utilised a multiple baseline across individual design for 7 participants. The interventions varied depending on the CBs of each participant. Interventions were not compared.
Inoue and Oda (2020) Japan	Q1. The interventions had positive effects on most participants CBs, reporting statistically significant results in total scores pre and post-test. The pre average score of the CDSPB was 17.38 (SD 8.40) with the post average score decreasing to 9 points, a statistically significant improvement of 0.05 (p <0.10), the total scores of the ABC were statistically significant (0.02; p < 0.05) and statistically significant improvements were reported in the total (0.02; P < 0.05) and externalising (0.02; P < 0.05) scores in the CBCL. Two target behaviours were not reported due to high frequency occurrence leading to recording issues. Q2. The specific interventions recommended through consultations varied dependant on the CB's displayed by each participant and analysis through functional assessment. Interventions were not compared.
Kalgotra and Warwal (2017) India	Q1. The effect of the music intervention using strategies of ABA positively reduced CBs for participants in both groups particularly destructive and violent behaviour. The mean differences were significant for children with mild ID as (F(1,2) =36.937; p = 0.26) and for children with moderate ID as (F(1,13)=71.686; p=.000) where measures of significance were (p < 0.05, p<.01). Q2. The music intervention using ABA strategies was the only intervention reported.
Moskowitz et al. (2017) USA	Q1. The CBT intervention had a positive effect on the participant's anxiety and CB reduced for all participants. Ratings for anxiety decreased from baseline to intervention sessions: 1st participant (M = 2.8, SD = 0.5) to (M = 0.21, SD = 0.38), 2nd participant (M = 3, SD = 0) to (M = 0.46, SD = 0.52) and 3rd participant (M = 2.67, SD = 0.4) to (M = 0.17, SD = 0.26). Ratings for CB reduced from baseline to intervention sessions: 1st participant (SD = 7%) to (SD = 4%), 2nd participant (SD = 27%) to (SD = 5%) and 3rd participant (SD = 16%) to 0% which is a 100% mean baseline reduction. Q2. This study utilised multicomponent intervention plans which were specific for each participants CB and anxiety. The elements of which were not compared individually or across participants.
Perilli et al. (2019) Italy	Q1. The microswitch cluster technology had a positive effect on reducing all participant's CB's. The most significant result where (p<.01) was for 1 participant who's mean value of CB decreased from 9.17/60 at the first baseline (A) to 4.67/60 at the second cluster phase (B1) and finally to 4.3/60 at the end of the 1 year follow up phase. Q2. The microswitch cluster technology was effective, there was no other intervention

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Author (year) & Country	Key Findings*
Stasolla et al (2018) Italy	Q1. The microswitch cluster programme had a positive effect on reducing all participants CB's. The most significant result (where (p<.01)) was for 1 participant who's mean value of CB decreased from 94.00/100 at the first baseline (A) to 10.33/100 at the fourth contingent intervention (B). Q2. The programme was effective, there was no other intervention
Stasolla et al (2017) Italy	Q1. The microswitch cluster technology had a positive effect on significantly reducing the participants CB's. The 6 participants commenced their baseline with a mean frequency free of CB of 0/30. During the intervention phase participants mean frequency free of CB increased from 11.7 to 14.4/30. During the first cluster phase this increased from 13.8 to 21.3/30, the second baseline increased from 1.5 to 3.2/30 while the second cluster phase increased from 17.6 to 21.5/30. During follow up participants time free of CB increased from 16.4 to 21.6/30 where (p<.01). Q2. The microswitch cluster technology was effective, there was no other intervention.

*Findings sorted according to review questions (Q):

O1. The effect of interventions compared with baseline and/or control conditions used to reduce/manage CBs among this population

O2. Is there a specific intervention that is more effective than others compared with baseline and/or control conditions in reducing/managing CB among this population?

Abbreviations: ABA = Applied Behaviour Analysis, ABC = Aberrant Behaviour Checklist, BSP = Behaviour Support Plan, CB = Challenging Behaviours/ Behaviours that Challenge, CBCL = Child Behaviour Checklist /4-18, CBT = Cognitive Behavioural Therapy, CDSPB = Criteria for Determining Severe Problem Behaviour, ID = Intellectual Disability, NR = Not Reported, O = Objective, PBS = Positive Behaviour Support, SEL = Socioemotional Learning.