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Raising educational outcomes for individuals with Down syndrome: Findings from a larger systematic review of targeted interventions for individuals with SEND

Jo Van Herwegen[1,2] | **Thomas Masterman**[1] | **Julie Dockrell**[1] | **Rebecca Gordon**[1,2] | **Chloe Marshall**[1,2] | **Michael S. C. Thomas**[2,3]

[1]Department of Psychology and Human Development, IOE UCL's Faculty of Education and Society, London, UK

[2]Centre for Educational Neuroscience, University of London, London, UK

[3]School of Psychological Sciences, Birkbeck, University of London, London, UK

Correspondence
Jo Van Herwegen, Centre for Educational Neuroscience, Department for Psychology and Human Development, UCL Institute of Education, 20 Bedford Way, London, WC1H 1AO, UK.
Email: j.vanherwegen@ucl.ac.uk

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Abstract

No previous systematic reviews have focused on which targeted interventions successfully raise educational outcomes (i.e. reading, writing, mathematics, science and general attainment outcomes) for students with Down syndrome. This study reports on the findings from a larger pre-registered systematic review of targeted interventions for students with special educational needs and disabilities (SEND). Here, we examined studies that have used a randomised controlled trial (RCT) or quasi-experimental design (QED) to evaluate a targeted intervention for students with Down syndrome to establish evidence of positive outcomes and to identify any research gaps. Six studies were identified. Four of these focused on interventions designed to improve reading abilities, and two focused on improving mathematical outcomes. Some positive outcomes were reported, despite the studies using small sample sizes and reporting on interventions that were implemented for less than one school term. This study highlights that individualised programmes delivered by an adult rather than by computer provide the most likely success for raising educational outcomes in students with Down syndrome. However, there are few RCT and QED studies that have evaluated what interventions can be beneficial for this population. The implications of these results and directions for future research are discussed.

KEYWORDS
Down syndrome, interventions, mathematics, quasi-experimental design, randomised controlled trial, reading, systematic review

Key points

- This is the first systematic review to examine which targeted interventions, using high-quality RCTs and QEDs research methodologies, successfully raise educational outcomes (i.e. reading, writing, mathematics, science and general attainment outcomes) for students with Down syndrome.
- Out of 467 studies that focus on raising outcomes for students with SEND, only six examined the impact of interventions that benefit students with Down syndrome specifically, which limits any conclusions about what kinds of approaches might work best for these students.

- Our review did not identify any studies that examined how writing abilities, science outcomes, or general attainment scores (e.g. high-stake formal examination outcomes) can be improved.
- The six studies that evaluated an intervention for students with Down syndrome were delivered on a one-to-one basis, and thus it is not possible to examine differences in impact between one-to-one delivered approaches and small group approaches.

INTRODUCTION

Educational outcomes for individuals with Special Educational Needs and Disabilities (SEND), including those with Down syndrome, often lag behind those for pupils without SEND (Tuckett et al., 2023). Targeted interventions, administered by educational professionals following a manualised format, are considered an effective way to narrow the gap. Our MetaSENse meta-analysis study (http://www.educationalneuroscience.org.uk/metasense) considered studies that have examined the effect of manualised interventions for diverse SEND needs, exploring variations in context and implementation. In this paper, we focus on a sub-sample of the MetaSENse review, producing a systematic review of the intervention studies that have evaluated what works for individuals with Down syndrome. First of all, such a review would allow for the first time an overview of all targeted interventions that have been evaluated for students with Down syndrome and what the gaps are. Reviewing what works specifically for students with Down syndrome allows further insight into the specific needs of students with Down syndrome while identifying overlaps with other populations with learning difficulties. From a practical point of view, reviewing what works for students with Down syndrome allows for actionable guidance for effective classroom strategies. Students with Down syndrome often face educational inequalities. A review of what targeted interventions may benefit this student population helps address these disparities by ensuring interventions target their specific challenges.

Down syndrome

Down syndrome, also sometimes referred to as Trisomy 21, is a neurodevelopmental condition with a prevalence of approximately 1 in 700–1000 live births. The most common cause of Down syndrome is the presence of an extra copy of chromosome 21, but some individuals have a translocation of genes. Individuals with Down syndrome exhibit distinct facial, medical, genetic, behavioural and cognitive characteristics (Silverman, 2007).

While individuals with Down syndrome typically experience cognitive delays, there is considerable variability in their IQ scores, which can range from 30 to well above 70 (Grieco et al., 2015). Individuals with Down syndrome often encounter challenges related to language development, especially in receptive and expressive vocabulary (Thomas et al., 2020). Furthermore, their performance on tasks drawing on the cognitive processes of updating, inhibition and set-shifting (together commonly referred to as executive function) tends to be significantly below their chronological age based on standardised norms (Tungate & Conners, 2021). Both fine and gross motor abilities also develop at a slower pace (D'Souza & D'Souza, 2020).

As a result of these difficulties, most individuals with Down syndrome require additional support at school (Van Herwegen et al., 2018). Furthermore, approximately half of individuals with Down syndrome have low educational outcomes related to reading, writing and mathematics. These can be extreme, resulting in them not being able to read sentences, or them having writing and mathematical abilities that remain at foundational or pre-school levels as they grow older (Turner & Alborz, 2003). As a result of their lower cognitive and often educational outcomes, as well as issues around stigma and lack of social structures, most individuals with Down syndrome are not in full-time employment and are unable to live full lives without support (Ijezie et al., 2023; Kumin & Schoenbrodt, 2016).

What works to raise educational outcomes for students with Down syndrome?

Two systematic reviews have examined interventions for school-aged students with Down syndrome; one focusing on the impact of language interventions (Smith et al., 2020) and the second examining targeted interventions to raise mathematical abilities (Lemons et al., 2015). However, to date, there are no reviews that have examined which interventions might raise educational outcomes for individuals with Down syndrome by comparing different outcome domains (i.e. reading, mathematics, writing, science and general attainment). This is important for two reasons: First, comparison of the different domains provides further insight into the strengths and difficulties that students with Down syndrome might experience in school. Secondly, it is possible that certain interventions may impact several outcome domains at once, making these interventions potentially more cost-effective for teachers to implement in their practice.

In addition, the previous reviews have often included a wide range of study designs to evaluate what works for students with Down syndrome. Lemons et al. (2015) included studies published between 1989 and 2012 and identified nine that focused mainly on early mathematical abilities. Although the review reported mainly positive outcomes for students with Down syndrome, the review highlighted that no study met criteria for methodological rigor and that more rigorous methods should be used to evaluate what works for students with Down syndrome. In contrast, Smith et al. (2020) only included studies with a control group but also included single case studies and identified nine studies that focused on improving the language abilities of individuals with Down syndrome aged 0–18 years old. Their review highlights that whilst the overall effect of the interventions that included a control group was large ($g=1.01$), very few studies found transfer effects to untrained language abilities. Smith et al. (2020) also highlight a moderate to high risk of bias across the studies.

The present study was part of a larger review that investigated the available evidence from randomised controlled trials (RCTs) and quasi-experimental design (QEDs) controlled trials to identify effective interventions aimed at improving educational outcomes across different outcome domains (i.e. reading, mathematics, writing, science and general attainment) for individuals with SEND. Here, we present the data for students with Down syndrome only. Although there has been ongoing discussion regarding what constitutes high-quality evidence of effective practices in classroom settings, RCTs and QEDs have long been the gold standard for evaluating the efficacy of interventions (Shawn Green et al., 2019) because they allow for objective assessment to establish causal relationships between an intervention and its outcomes. By systematically reviewing the existing literature, our study aimed to delineate which interventions have demonstrated efficacy, which have not been effective and to highlight areas where the evidence base is lacking.

MATERIALS AND METHODS

The review reported adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the review protocol was preregistered at (link removed for review purposes). The review encompassed studies published between January 2000 and February 2023 which evaluated targeted interventions for students with SEND aged four to 25 years of age using RCT and QED study designs. The age range was chosen as it covers the start of formal education at the lower end and the extended age range covered by statutory support for SEND pupils with an Education Health and Care plan in England at the upper end. Including studies during this time period allows sufficient overlap between previous reports (Lemons et al., 2015; Smith et al., 2020), yet also provides an updated review. In addition, whilst we were interested in studies from around the globe, the aim of the wider review was to examine what evidence was available from England.

Included studies used research designs that are high on the evidence base hierarchy (i.e. randomised control trials (RCTs) and quasi-experimental designs (QEDs)). Studies using matched group designs, cross-over designs, single-subject designs and correlational designs were excluded. To be included, studies needed to have reported on educational outcomes related to reading, writing, mathematics, science, or general attainment. There were no restrictions on the type of control group (e.g. active control or business as usual) or the type or focus of the intervention (e.g. a narrow focus on reading, writing, or mathematics or a wider focus on meta-cognitive abilities or even behavioural aspects).

The following databases were searched: PsycINFO, PsycEXTRA, Web of Science, Scopus, Education Resource Information Centre (ERIC), British Education Index (BEI), Applied Social Sciences Index & Abstracts, Education Database, PubMed as well as the following grey literature: Nuffield Foundation research reports, Education Endowment Foundation completed projects, What Works Clearinghouse, Council for Exceptional Children, Blueprints for Healthy Youth Development, Early Intervention Foundation, Evidence for ESSA/Best Evidence Encyclopedia, European Platform for Investing in Children, National Dropout Prevention Centre, British Psychological Society, Nest and National Foundation for Educational Research (NFER) using the search words available in Appendix S1.

Screening of studies was undertaken in EPPI-Reviewer Web (Thomas et al., 2022) and the 'Mark Automatically' deduplication feature was used to remove any duplicates. Trained research assistants ($n=11$) completed the initial screening on title and abstract, following the pre-registered search strategy. Ten percent of titles and abstracts were checked independently by the first and second authors against the inclusion/exclusion criteria. The inter-rater reliability (based on percentage agreement) was very high at 0.93. Full texts of potentially eligible studies were located and again screened independently by seven research assistants. Ten percent of full texts were independently double-screened by two members of the review team, and a very high inter-rater reliability of 0.85 was achieved. Reasons for excluding studies were documented.

The quality of included studies was assessed using adapted versions of the Joanna Briggs Institute quality assessment tools for RCTs and QEDs (Tufanaru et al., 2017). There were 12 questions for the RCT studies (including randomisation, blinding, attrition) and 10 questions for the QED studies (including matching and reliability of the measures). Each question was scored as either 0 (absent), 1 (some evidence) or 2 (strong evidence),

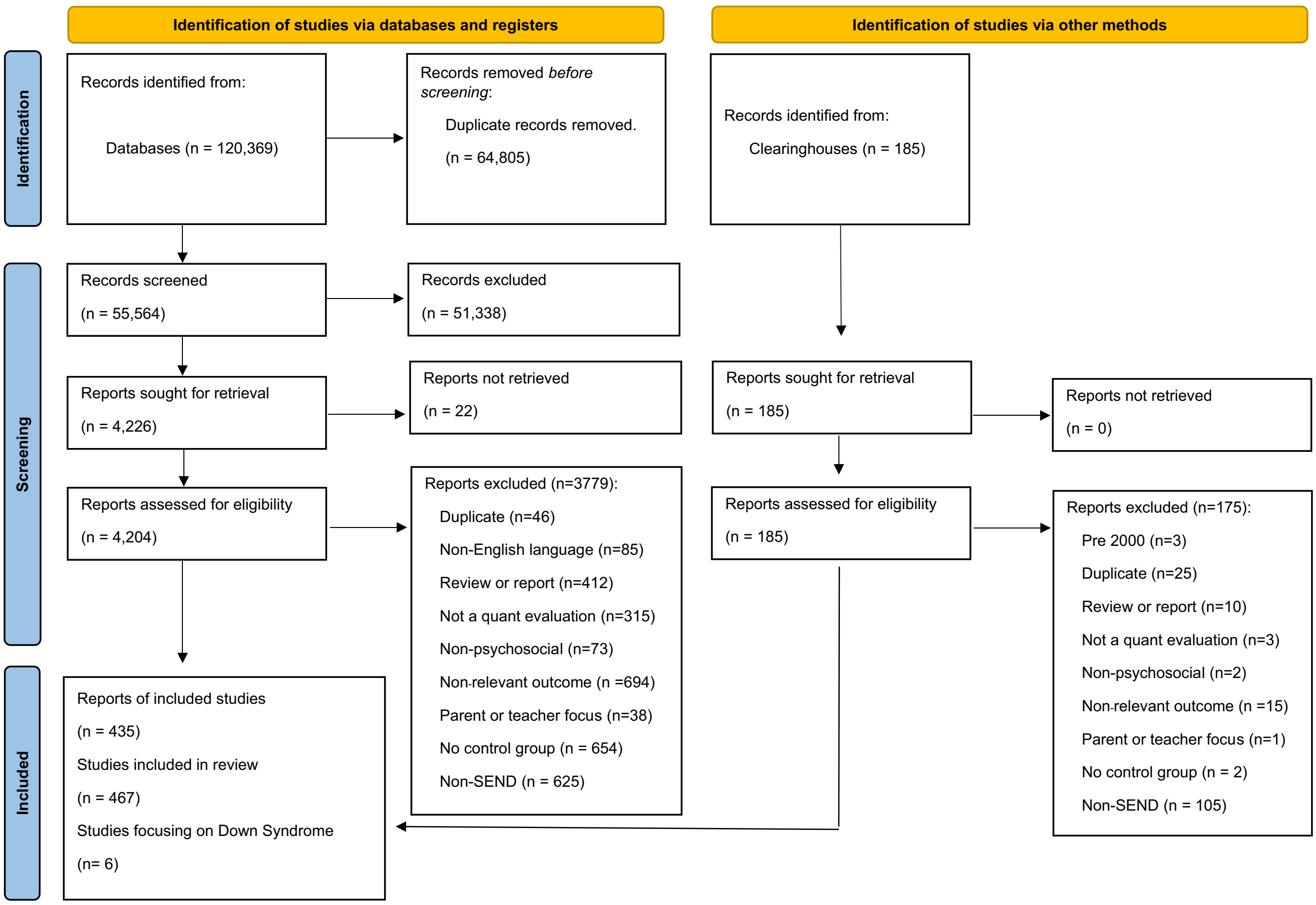

FIGURE 1 PRISMA flow diagram.

and these scores were summed to produce a quality index. For the RCT studies, quality was considered low if scores were below 10, medium for scores 10–17 and high for scores of 18 and above. Similarly, for QED studies, quality was considered low for scores below 9, medium for scores between 9 and 15 and high for scores above 15.

Hedge's g effect sizes relative to the control group were calculated for each outcome measurement based on between-group differences at the first post-intervention assessment using means and standard deviations.

RESULTS

Screening of 55,564 studies resulted in 435 records that reported on 467 studies. Only six of these evaluation studies were found to focus explicitly on individuals with Down syndrome (see PRISMA flow diagram in Figure 1). It may be the case that other studies did include students with Down syndrome as part of a larger group of students with learning difficulties. However, many studies did not explicitly state which groups of learning difficulties were included and simply described participants as having intellectual or learning disabilities. Even when studies stated that they did include students with Down syndrome, it was not possible to extract data for those individuals specifically. As such, these studies were not considered for this short review. This indicates that there are limited educational intervention studies that have targeted and reported on individuals with Down syndrome specifically.

Overview of studies included

Descriptive data for the six studies that met the inclusion criteria can be found in Table 1 below. As shown, most studies included a wide age range with students in primary and secondary school. Also, most studies used a small sample size (i.e. less than 50 participants). Finally, most of the studies were moderately short in that the interventions lasted less than one term (i.e. less than 12 weeks). All studies were of moderate quality in terms of their research designs. Although some studies (Burgoyne et al., 2012; Goetz et al., 2008; Lim et al., 2019; Nakeva von Mentzer et al., 2021) provide some details about the number of sessions completed or about actions taken to increase implementation fidelity (e.g. observations and feedback on intervention sessions or further intervention training), only Burgoyne et al. (2012) provided any measures or outcomes related to implementation fidelity (i.e. the

TABLE 1 Overview of the studies that focused on students with Down syndrome as a specific group, including their focus, the country in which the study was conducted, the type of study (RCT or QED), phase of education (P&S=primary and secondary), age range of the participants (in years; months), type of control group included, number of participants across all groups, length of intervention in weeks to first post-test, quality rating of the study, whether a follow-up assessment was included and the implementor of the intervention.

Short reference	Focus	Country		Phase of education	Age range (years; months)	Control group	Number of participants	Length (weeks) to first post-test	Quality	Follow-up	Implementor
Goetz et al. (2008)	Reading	UK	QED	P&S	8; 3–14; 6	Waitlist control	15	8	Moderate	Yes (5 months)	Teac hing assistants
Burgoyne et al. (2012)	Reading	UK	RCT	Primary	5; 2–10; 0	Waitlist control	54	20	Moderate	No	Teaching assistants
Nakeva von Mentzer et al. (2021)	Reading	Sweden	RCT	P&S	5; 8–16; 8	Waitlist control	17	4	Moderate	No	Computer
Lim et al. (2019)	Reading	Singapore	QED	P&S	9; 2–17; 8	Waitlist control	15	12	Moderate	No	Clinician
Sella et al. (2021)	Maths	Italy	QED	P&S	5; 10–17; 3	Active control	41	10	Moderate	Yes (3 months)	Computer
Lanfranchi et al. (2015)	Maths	Italy	QED	P&S	10; 0–15; 0	Business as Usual	36	8	Moderate	No	Trained instructor

degree to which the intervention was delivered as intended). However, Burgoyne et al. (2012) failed to describe how participants were randomised to groups in their RCT. Also, for QEDs, there were issues with groups not being matched at baseline, with the exception of Lim et al. (2019).

Interventions targeting reading outcomes

Four studies evaluated a specific manualised intervention to improve the reading abilities of students with Down syndrome. These will be briefly discussed first before overall findings are discussed later.

Goetz et al. (2008) evaluated a short-term reading intervention programme based on Jolly Phonics (Lloyd et al., 1998) and a reading intervention by Hatcher (1992) with 15 students with Down syndrome who attended primary and secondary mainstream education, of which seven were allocated to a waiting control group. All participants were selected based on having emerging' reading skills, defined by being able to read at least five words on the Early Word Recognition Test and scoring 50% or less on a nonword reading test. The intervention focused on phoneme segmentation and blending skills in the context of learning letter-sounds and working with words in books as well as speech production exercises. This was delivered in daily 40 min sessions by learning support assistants on a 1-to-1 basis. Compared to the waiting group controls, eight of the children in the treatment group improved significantly on measures of early literacy skills (letter-sound knowledge, Early Word Recognition) after participating in the 8-week intervention. However, there was no significant change in the scores for word reading (reading aloud of existing words), nonword reading (reading aloud of non-existing but plausible words), alliteration, or phoneme matching (performance scores were at floor). See Table 2 for outcome measures and effect sizes. Although some effect sizes were quite large, those for word reading and nonword reading did not reach statistical significance, possibly as a result of the small sample size. For the phonological awareness tasks (alliteration and phoneme matching) the groups scored close to ceiling, so improvement in performance could not be measured. The participants were followed up 5 months later and there was still an effect for the alliteration matching task, suggesting that progress was maintained. This study showed that the reading ages of the children who received 16 weeks of a holistic reading intervention improved on average by 2.25 months.

Burgoyne et al. (2012) evaluated a reading and language intervention (RLI), with 57 primary school students with Down syndrome. Half of them were randomly allocated to a waiting control group who received the intervention 20 weeks later (weeks 20–40), and half to the intervention group who received immediate intervention in intervention weeks 1–20. The intervention was

TABLE 2 Overview of outcome measures and effect sizes.

Short reference	Outcome measure	Difference between intervention and control group	Between group effect size (Hedge's *G*)[a]
Goetz et al. (2008)	Letter-Sound knowledge	Significant	$G=1.1964$
	Early Word Recognition	Significant	$G=0.9701$
	Word reading	Not significant	$G=0.7529$
	Nonword reading	Not significant	$G=0.3765$
	Alliteration	Not significant	$G=0.2421$
	Phoneme matching	Not reported	Not reported
Burgoyne et al. (2012)	Single word reading	Significant	$G=0.2267$
	Letter-Sound Knowledge	Significant	$G=0.4139$
	Phoneme blending	Significant	$G=0.5322$
	Nonword reading	Not significant	$G=0.2464$
	Phonetic spelling	Not significant	$G=0.0690$
	Taught expressive vocabulary	Significant	$G=0.4632$
	Taught receptive vocabulary	Significant	$G=0.3252$
	Expressive vocabulary	Not significant	$G=0.0000$
	Receptive vocabulary	Not significant	$G=0.0099$
	Expressive grammar	Not significant	$G=0.2168$
	Expressive information	Not significant	$G=0.0296$
Nakeva von Mentzer et al. (2021)	Letter sound identification	Not significant	Not reported
	Letter naming	Significant but only in group 2	$G=1.2986$
	GraphoGame words (total)	Not significant	Not reported
	Real words (total)	Not significant	Not reported
	Nonwords (total)	Not significant	Not reported
Lim et al. (2019)	Phonological Awareness	Significant	$G=0.6416$
	Word reading	Significant	$G=0.2792$
	Word spelling	Significant	$G=0.7366$
Sella et al. (2021)	Numerical intelligence	Significant	$G=0.3590$
	Number word comparison	Significant	$G=-0.6221$
	Mental calculation	Not Significant	$G=0.1993$
	Number-to-position task 1	Not significant	$G=-0.2789$
	Number-to-position task 2	Not significant	$G=-0.5410$
	Match-to-sample task	Not significant	$G=0.4704$
	Number naming	Not significant	$G=-0.1411$
	Counting	Not significant	$G=0.3512$
	Digital comparison	Not significant	$G=0.3300$
	Letter recognition task	Not significant	$G=0.0717$
	Syllable reading	Not significant	$G=0.0039$
	Word reading	Not significant	$G=-0.0315$
	Pseudoword reading	Not significant	$G=-0.032$
Lanfranchi et al. (2015)[b]	Numerical intelligence scale	Significant	$G=0.3129$
	Lexical processing	Not significant	Not reported
	Semantic processing	Not significant	Not reported
	Pre-syntactic processes	Significant	$G=0.3324$
	Counting	Significant	$G=0.3520$
	Mental calculations	Significant	$G=0.2151$
	Written calculations	Significant	$G=0.2151$
	Number writing	Not significant	Not reported

[a]Hedge's G calculated by study authors using between group post-test means and pooled standard deviation.

[b]Based on conversions of study reported partial eta-squared estimates.

implemented by teaching assistants on a 1-to-1 basis and included the provision of daily 40-min sessions that focused on reading (including phonics) and language (new vocabulary and promoting newly-learnt words in oral and written language). After 20 weeks, the intervention group showed significantly greater progress than the waiting control group on measures of single word reading, letter-sound knowledge, phoneme blending and the expressive vocabulary included in the sessions. As can be seen in Table 2, effects did not transfer to secondary outcomes (nonword reading, spelling, standardised expressive and receptive vocabulary, expressive information and expressive grammar). Despite the intervention group retaining higher scores compared to the control group after the first 20 weeks, these differences were no longer significant once both groups had received the intervention.

Nakeva von Mentzer et al. (2021) evaluated the effect of an intensive computer-based phonics programme (GraphoGame) with 17 children with Down syndrome from primary and secondary school in a wait list control study. Half of the participants were randomly assigned to receiving the programme immediately for 4 weeks and the other half received the programme after 4 weeks. The program followed the synthetic phonics approach of 'small units first', meaning that phoneme–grapheme correspondence training was introduced first, followed by short word-decoding tasks and simple word-forming tasks (blending/spelling). At a group level, there were no significant differences in performance between the intervention and control groups for letter naming, letter-sound tasks, real words and nonword reading. However, some children did show differences in post-test assessments, and they tended to be those who attended schools for moderate to severe learning difficulties. This study showed large variability and gains differed individually. However, research with larger sample sizes is required before any solid conclusions can be made about what drives these individual differences.

Lim et al. (2019) examined the impact of the MULTILIT ("Making Up Lost Time in Literacy") literacy instruction program with 15 students with Down syndrome in Singapore. Half of the students received the intervention on a 1-to-1 basis for 12 weeks after 12 weeks of baseline control (immediate intervention group). The other half completed the intervention after 24 weeks of baseline control (control group). The intervention was delivered by a clinician and focused on reading accuracy, teaching letter sound correspondences and decoding strategies, as well as spelling. In addition, students received intensive training on 200 high frequency sight words for reading aloud and spelling. The study found that both groups showed significant improvements in phonological awareness, word reading accuracy and word spelling accuracy from pre- to post-instruction. These improvements had large effect sizes. There were no significant differences between the two groups in their improvements, indicating that the length of the control period did not affect the outcomes.

All reading intervention studies included a waitlist control group. Three of the studies (Burgoyne et al., 2012; Goetz et al., 2008; Lim et al., 2019) included a holistic reading approach that combined phonics with wider reading activities, and these studies showed significant impacts on reading outcomes, whilst the remaining study (Nakeva von Mentzer et al., 2021) focused mainly on phoneme–grapheme correspondence and showed more varied results. However, with the exception of Burgoyne et al., 2012, sample sizes for each group were very small and all had large age ranges (approximately 5–11 years).

Interventions that target mathematical outcomes

Only two studies thus far have evaluated an intervention to improve mathematical abilities for students with Down syndrome.

Sella et al. (2021) examined the impact of a non-commercial mathematical computerised game, 'The Number Race'. Whilst 41 students with Down syndrome aged 6 years to 17 years old were recruited, data from only 39 students were included in the analyses as some participants could not complete the pre-or post-tasks. Twenty participants were assigned to an experimental group (EG) that used 'The Number Race' game, while 21 participants were assigned to an active control group (CG) and received a reading intervention using the software 'Fondiamoleletterine' or 'Lettura di base 3.' The training lasted 10 weeks with two weekly sessions of 20–30 min each. The Number Race game aims to enhance number sense, cement links between representations of number, conceptualise and automatise arithmetic and maximise motivation. The participants in the intervention group showed better number comparison, and mental calculation scores at post-test compared to the control group. Whilst both groups improved their scores from pre-test to post-test and from pre-test to follow-up on the Numerical Intelligence Battery (BIN), the experimental group showed more substantial improvements. Participants in the active control group improved in their reading abilities. In contrast to the prediction that all mathematical abilities would improve, effects on other mathematical tasks such as number-to-position task, digit comparison and match-to-sample task did not significantly improve compared to the control group. The authors speculated that the training had deeper effects on quantity understanding and manipulation, thereby yielding larger improvements in tasks that force children to actively manipulate numerical information (BIN, number comparison and calculation) compared to others that do so to a lesser extent (e.g. number naming, counting). The authors also note that there was a lot of individual variability and that the training may have been too short to find stronger effects. However, effects for the number comparison task remained after 3 months, though for the mental calculation task scores no longer differed significantly from the control group.

Lanfranchi et al. (2015) explored the impact of a numerical skills training program on basic mathematical skills and logical thinking in children with Down syndrome. This was based on the known cognitive profile of individuals with Down syndrome, and learning activities included a high proportion of visuo-spatial materials with minimal verbal instruction, concrete situations, and a reduced working memory load. Twenty-seven students with Down syndrome received the training twice a week for 2 months, lasting 30 min per session. This was delivered by a trained instructor. A control group of 9 children received school instruction as usual. This study did not clarify whether the intervention was delivered on a 1-to-1 basis or in small groups. The intervention program was divided into five activities, corresponding to each of the following numerical skills: lexical processing (learning number sequences, writing and reading numbers), semantic processing (matching numbers to their quantities), pre-syntactic processing (classifying objects based on their characteristics), counting and mental calculation. The intervention group showed significant improvements in semantic, counting and pre-syntactic processes, as measured by the Numerical Intelligence Scale. They also showed improvements in number knowledge, written and mental calculation, but not in lexical processing (specifically number writing). The authors concluded that a training program specifically designed to suit the cognitive profile of children with Down syndrome could improve these children's numerical skills after 2 months.

There are only two studies thus far that have examined the impact of targeted interventions delivered on a one-to-one basis with individuals with Down syndrome. Whilst both studies found that structured interventions led to improvements in numerical skills, gains were more prominent in specific areas rather than across all mathematical tasks. In addition, both studies mention the large individual variability in the outcomes of these targeted interventions.

DISCUSSION

Findings from this review reveal that there is currently a paucity of research using RCTs and QEDs to examine interventions that might benefit students with Down syndrome. Furthermore, this review was unable to identify any studies that examined how writing abilities, science outcomes, or general attainment scores (e.g. high-stake formal examination outcomes) might be improved. It is possible that other studies included students with Down syndrome as part of their participant sample, and thus it might be that other successful approaches identified by the full meta-analysis are also effective for students with Down syndrome. However, given that only six studies focused explicitly on students with Down syndrome, it is not possible to identify what kind of approaches might work best for these students, given their specific cognitive profile, and further research examining targeted interventions for students with Down syndrome is required.

Despite these limitations, some findings from this review are worth noting. First, all studies provided intervention support on a one-to-one basis or a highly individualised basis. This is not unexpected given the focus on targeted interventions that are usually provided on a one-to-one basis (Fuchs & Fuchs, 2006). However, the two studies using computerised programmes rather than a trained practitioner reported fewer successful results. Several studies have reported that students with Down syndrome have problems with attention and staying on task, as well as language comprehension difficulties (Thomas et al., 2020; Tungate & Conners, 2021). Thus, it is possible that students with Down syndrome benefit from interventions that are highly individually tailored but also provided in person, possibly so that the instructor can repeat instructions and check that the person with Down syndrome is still engaged with the task at hand. Indeed, Lanfranchi et al. (2015) suggest that programmes that are tailored to the strengths and difficulties of individuals with Down syndrome are most likely to result in positive outcomes. However, further research is required that assesses this hypothesis directly.

Secondly, only two of the studies included reported on follow-up assessments a few months later within the same study, and both showed that gains made during the intervention remained, but that differences with the control group often became non-significant. This makes sense, as it shows that the control group is also making progress on these educational outcomes, but does so more slowly without the intervention. Still, these findings show that targeted interventions can make a difference to build foundations for learning for students with Down syndrome, which in turn would allow students with Down syndrome to access new concepts and new interventions at a faster rate than when they do not have access to these interventions.

All four intervention studies related to reading abilities in individuals with Down syndrome focused on phonics and early reading abilities and showed successful impacts, with the exception of the computerised intervention, at least for early reading abilities and sound–phoneme knowledge. The more recent studies provide similar results to Sims et al. (2023) in that there was little evidence of transfer effects to broader reading skills. As there were only two studies that have examined the impact of targeted interventions for individuals with Down syndrome, it is too early to make any firm conclusions about how mathematical abilities can be improved. Both studies demonstrated that structured interventions enhanced numerical skills, though the improvements were more noticeable in certain areas rather than uniformly across all mathematical tasks. This indicates that targeted interventions can effectively enhance educational outcomes for individuals with Down syndrome, with the benefits appearing to be sustained over time.

There are several limitations that need to be addressed when making inferences from the studies conducted so far. The studies in this review used small sample sizes, which could increase the likelihood of a Type 1 error (Sims et al., 2023). In addition, all interventions were delivered for a relatively short amount of time (i.e. 4–20 weeks). So, whilst this might be an appropriate time to raise basic literacy and numeracy skills, it might be too short to impact academic outcomes. Furthermore, most studies included participants across a wide age range, making it difficult to identify which age groups or ability levels might benefit most from the interventions. Therefore, results from this review need to be interpreted with caution and replicated with studies using larger samples in order to understand the impact of age, individual differences and ability profiles (Lemons et al., 2015).

Future studies might consider more detailed reporting on the type of students included in the studies to make it clear whether the entire Down syndrome population (in terms of socio-demographics and cognitive ability) is represented in the study, the implementation of the interventions including duration, frequency, dosage and other implementation strategies (e.g. delivery person and group vs. 1-to-1 delivery). In addition to addressing issues around the reporting of demographic data, future studies are required that include larger sample sizes, but also should include more diverse students with Down syndrome, as often those with more severe needs are excluded from research studies. Most studies reported large variability within the outcomes before and after the intervention, yet studies did not explore what abilities and factors could explain this variability. Future studies should examine this further to provide a better understanding of what interventions work best for different students with Down syndrome.

Lastly, future research would be supported by building larger databases of children and research findings to assemble an evidence base that will support improvements in their future educational outcomes. In order to address the difficulties of recruiting large sample sizes from this population, it might be beneficial to collaborate with teachers and other research groups to facilitate the implementation of the interventions. For example, the WiSDOM network is a multi-lab approach that brings together data from different research groups to examine cognitive development in Williams syndrome using larger sample sizes compared to previous single-lab studies (https://blogs.ac.ucl.ac.uk/wisdom).

Summary

The current review shows that some intervention approaches can improve educational outcomes for students with Down syndrome and that effects from targeted interventions are mostly maintained. However, further research is required to understand what approaches work best, for whom, and whether any improvements transfer to other domains. While it is still premature to draw specific practical conclusions for educational settings regarding effective strategies for improving outcomes in students with Down syndrome, evidence suggests that targeted interventions hold significant promise. Therefore, from both funding and policy perspectives, greater investment and attention should be directed toward evaluating targeted interventions for this population.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest related to the publication of this manuscript. The research was conducted independently, and no financial, personal, or professional relationships that could influence or bias the work have been disclosed.

DATA AVAILABILITY STATEMENT

All data related to this manuscript will be made openly available on Open Science Framework: https://osf.io/2hy5t/.

ETHICS STATEMENT

Ethical approval was obtained via the UCL Institute of Education, University College London REC1876. This study is a meta-analysis and did not involve the collection of primary data from human or animal participants.

ORCID

Jo Van Herwegen https://orcid.org/0000-0001-5316-1818

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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