

RESEARCH ARTICLE

A meta-analytic review of paraprofessional-implemented interventions for students with autism spectrum disorder

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Abstract

The purpose of this meta-analysis was to summarize single-case design studies in which paraprofessionals delivered interventions to students with autism spectrum disorder in school settings. We descriptively analyzed participant and intervention characteristics and study quality and estimated intervention effect using Tau-U across student participants. Overall, paraprofessional-implemented interventions resulted in large to very large changes across a range of student outcomes and intervention conditions. Interventions delivered by paraprofessionals in inclusive school settings and within the context of whole group instructional arrangements resulted in significant changes in student outcomes as compared to interventions delivered in self-contained classrooms and within one-to-one and small group instructional arrangements. We present implications for research and practice and discuss limitations.

KEYWORDS

autism spectrum disorder, meta-analysis, paraprofessional, single-case design

1 | INTRODUCTION

Approximately one in 54 children is identified with autism spectrum disorder (ASD; Centers for Disease Control, 2020). Individuals with ASD experience: (a) persistent deficits in social communication and social interaction and (b) restricted

interests or repetitive behaviors (American Psychiatric Association, 2013). Social communication includes skills such as social reciprocity, nonverbal social behaviors, and social relationships, whereas restrictive and repetitive behaviors include stereotypic behavior, rigidity in regard to routines, and specific interests (Wong et al., 2015). Students with ASD are eligible to receive special education services under the Individuals with Disabilities Education Act (IDEA, 2004), and the number of students with ASD who receive these services has continued to increase over time (U.S. Department of Education, 2018). According to the most recent federal report, over 710,000 students ages 3–21 years received IDEA Part B services under a diagnosis of ASD during the 2017–2018 school year (U.S. Department of Education, 2018). Students with ASD who receive special education services often require individualized, intensive supports to address their unique needs (National Research Council, 2001; Simpson, 2004). There has been a growing emphasis on establishing evidence-based practices (EBPs) to address these unique needs, especially for school-aged students with ASD (Wong et al., 2015). Although EBPs have been identified, there is a gap between what we know are EBPs and those practices taking place in classrooms (Lang et al., 2010).

This gap between research and practice may be a result of factors which include teachers receiving limited instruction and support in implementing EBPs and variation in the degree to which institutes of higher education have specialized training programs for teaching children with ASD (Barnhill, Polloway, & Sumutka, 2011; Morrier, Hess, & Juane Heflin, 2011; National Research Council, 2001). In addition, researchers have found that teachers focus more so on feasibility factors of interventions, their personal beliefs, and what they perceive to be effective rather than the effectiveness of an intervention (Boardman, Arguelles, Vaughn, Hughes, & Klingner, 2005). The implementation of EBPs for students with ASD is complicated further as paraprofessionals often take the lead in providing support to students with ASD (Biggs, Gilson, & Carter, 2019; Carter, O'Rourke, Sisco, & Pelsue, 2009; Giangreco, Suter, & Doyle, 2010). As defined by IDEA (2004), a paraprofessional is a school employee who works under the direction of a certified staff member to support and assist in providing instructional programs and services to children with disabilities or eligible young children. However, paraprofessionals often are the least prepared to support students with ASD due to their lack of training and limited professional development opportunities (Brown & Stanton-Chapman, 2017; Giangreco et al., 2010; Walker, Douglas, & Chung, 2017). Furthermore, teachers commonly lack of preparation to supervise and train paraprofessionals (Douglas, Chapin, & Nolan, 2016).

Identifying effective professional development and training strategies for paraprofessionals is important because there is an emerging body of research that suggests, with appropriate supports, paraprofessionals can implement a variety of practices with fidelity (Brock & Carter, 2013; Brock & Carter, 2017; Rispoli, Neely, Lang, & Ganz, 2011; Walker & Smith, 2015). For example, Brock and Carter (2013) found that modeling and performance feedback across 13 single-case design studies resulted in paraprofessionals' use of interventions with primarily elementary-aged students who had intellectual and developmental disabilities. Positive results were reported across a majority of students and paraprofessionals. Additionally, Rispoli et al. (2011) reviewed 12 studies involving students with ASD and found that paraprofessionals received training to implement a variety of practices, including several EBPs. Paraprofessionals received written and verbal information, modeling, video demonstrations, opportunities to role play, and performance feedback. Positive results were reported in a majority of the reviewed studies. In both reviews, however, researchers largely were responsible for delivering paraprofessional training.

Although results from these reviews are promising, there are gaps remaining in the paraprofessional literature. For example, neither of these reviews examined the effectiveness of paraprofessional-implemented practices with meta-analytic approaches, but instead relied on descriptive approaches to summarize study outcomes. Meta-analytic research is advantageous in that it allows for the quantification of intervention effect within and across studies and identification of participant and study characteristics that contribute to more or less pronounced intervention outcomes (Vannest & Ninci, 2015). It is important to examine the extent to which paraprofessional-implemented practices are successful among students with ASD given the increased reliance on paraprofessionals in the provision of special education and related services to students with ASD (Biggs et al., 2019; Carter et al., 2009; Giangreco et al., 2010). Furthermore, understanding whether certain variables influence the effectiveness of paraprofessional-implemented

interventions may provide practitioners with important guidelines for selecting appropriate practices for use in school settings and researchers with future research directions.

Another critical area to explore is the effectiveness of paraprofessional-delivered interventions for students with ASD in *school settings* specifically. This is an important area of focus, as there is a growing population of students with ASD receiving special education services (U.S. Department of Education, 2018). Although Rispoli et al. (2011) examined paraprofessional-implemented practices for students with ASD, their review focused on interventions delivered in school, residential, and rehabilitation settings. Therefore, the purpose of this research was to summarize intervention studies involving paraprofessional-implemented interventions for students with ASD in school settings. The research questions we addressed include: (a) What were the characteristics of paraprofessional and student participants, paraprofessional training, and paraprofessional-implemented interventions reported across studies? (b) What was the overall quality of the studies? (c) What was the overall effect of paraprofessional-implemented interventions on intervention outcomes among students with ASD in school settings? and (d) What study characteristics moderated intervention outcomes?

2 | METHOD

2.1 | Search procedures

We conducted a comprehensive literature search to identify studies available before 2018 that involved paraprofessional-implemented interventions for students with ASD. First, we searched four online databases (PsychINFO, ERIC, Medline, ProQuest) to identify studies available in English by applying the following search terms: *paraprofessional*, *paraeducator*, *assistant*, or *aide* in combination with *autism*, *autistic*, *ASD*, *Asperger*, *pervasive developmental disorder*, *PDD-NOS*, or *developmental disability*. We included both published and unpublished references to address the risk of publication bias (Gage, Cook, & Reichow, 2017; Tincani & Travers, 2019). The online database search resulted in 1,031 references. Second, we reviewed the following bibliographic database pertaining to paraprofessionals to identify additional references: <https://www.uvm.edu/cess/cdci/selected-paraprofessional-references>. The bibliographic database search yielded 113 references for consideration. Third, we reviewed the titles and abstracts of publications across all volumes and issues of 33 peer-reviewed journals that regularly publish research in the fields of special education, ASD, and early childhood special education (list of journals available from the first author). We identified journals based on previous literature reviews (e.g., Walker & Smith, 2015) and our experiences as consumers of research published in these journals. This hand search resulted in 442 potentially-relevant references. Finally, we reviewed the reference lists of other paraprofessional-focused literature reviews (i.e., Brock & Carter, 2013; Rispoli et al., 2011; Walker & Smith, 2015), yielding 53 additional references. After eliminating duplicates, nonresearch references (e.g., perspective pieces, book chapters), and references unrelated to the topic, we included the remaining 243 references in the screening process as described in the section that follows.

2.2 | Screening process

We initially reviewed the abstract of each reference to determine whether studies met the following three inclusion criteria: (a) experimental single-case design (Ledford & Gast, 2018) was used to demonstrate effect of paraprofessional-implemented intervention, (b) at least one school-aged (i.e., preschool through high school) student with ASD received intervention in a school setting, and (c) intervention was delivered by a paraprofessional. We included single-case research given our aim to code studies at the student participant level. We excluded studies if nonexperimental single-case designs (e.g., AB case series), group designs, or qualitative approaches (e.g., interview, survey) were used. In addition, we excluded studies in which students were older than 21 years or received intervention in a community, residential, or rehabilitation setting. A total of 53 studies initially met the inclusion criteria based on a

review of the abstract. However, because not all abstracts provided detailed information to make a screening decision (e.g., setting or interventionist was not clearly identified), we reviewed the full text of those studies to apply the same inclusion criteria, resulting in a total of 23 studies meeting the inclusion criteria.

To assess inter-rater reliability for the abstract review, two coders (both doctoral students in special education) independently coded 50% of the studies as primary coder and 30% of the primary coder's studies as secondary coder. Similarly, to assess reliability for the full-text review, two different coders (both assistant professors in special education and first and second authors of the current study) independently coded 50% of the studies as primary coder and 30% of the primary coder's studies as secondary coder. The coders met to discuss disagreements and reach a consensus on the correct code to select. Agreement was calculated on a code-by-code basis as the number of agreements divided by the number of agreements plus disagreements and multiplied by 100 to yield a percentage of agreement. Agreement was high for both the abstract (91%) and full text (97%) reviews.

2.3 | Data extraction

For the purposes of this review, we treated the student participant as the unit of analysis. As such, we applied the data extraction procedures to each of the 59 qualifying student participants (i.e., students with ASD who received paraprofessional-implemented intervention in a school setting) rather than to the study as a whole.

2.3.1 | Descriptive coding

To summarize studies included in the current review, we used a researcher-developed coding form (available from the first author) to collect descriptive information pertaining to participant, intervention, and study quality characteristics across each qualifying student among the 23 included studies. The coding form included 26 items organized under five coding categories as follows: (a) *student participant codes* (grade level, gender, cooccurring disability diagnosis, race/ethnicity), (b) *paraprofessional participant codes* (age, educational level, race/ethnicity, prior training related to student intervention), (c) *student intervention codes* (target skill/behavior, intervention, intervention setting, other interventionist, intervention dosage, research design), (d) *paraprofessional training codes* (trainer, training type, research design), and (e) *quality indicators* (reliability measures, social validity, generalization, and maintenance for student and paraprofessional outcome measures and the What Works Clearinghouse (WWC) standards for single-case research; Horner et al., 2005; WWC, 2017). The WWC standards include criteria related to study design and the overall effectiveness of the intervention, resulting in a rating of “meets standards without reservations,” “meets standards with reservations,” or “does not meet standards.” It should be noted that, given the review's focus on student outcomes, the WWC standards were applied to student data only despite there being a few cases in which paraprofessional implementation data was treated as the primary dependent variable.

2.3.2 | Tau-U calculation

We examined the effect of paraprofessional-implemented interventions on outcomes for students with ASD and whether study characteristics moderated these outcomes. Researchers have used a variety of strategies to estimate intervention effect among studies involving single-case designs, including several nonoverlap techniques (Vannest & Ninci, 2015). Tau-U, a nonoverlap index commonly used in meta-analytic reviews involving

single-case research, has outperformed other nonoverlap indices and accounts for undesirable trends within baseline conditions (Parker, Vannest, Davis, & Sauber, 2011). Tau-U can be interpreted with the following guidelines set forth by Vannest and Ninci (2015): <0.20: small change, 0.20–0.60: moderate change, 0.60–0.80: large change, and >0.80: large to very large change. To calculate Tau-U for each student outcome measure, we first extracted raw data values from student graphs using WebPlotDigitizer (Rohatgi, 2018), a valid and reliable digitizing program that extracts numerical values from graphs in which data are visually displayed (Drevon, Fursa, & Malcolm, 2017).

Next, we estimated intervention effect by analyzing the extracted baseline and intervention data using an online Tau-U calculator (Vannest, Parker, Gonen, & Adiguzel, 2016) and following the design-specific guidelines described by Walker, Chung, and Bonnet (2018). We corrected baseline when a monotonic trend was present, weighted Tau-U scores to account for design complexity (Parker et al., 2011), and combined weighted Tau-U scores to produce aggregate Tau-U scores for each student participant. In addition, we used the absolute value for Tau-U to account for participant outcomes with different expected behavior change directions (e.g., decrease in challenging behavior, increase in appropriate behavior). This process produced Tau-U scores for each student participant across each student outcome measure that we used for the moderator analyses.

2.3.3 | Inter-rater reliability

To assess inter-rater reliability for data extraction, two coders (the first and third authors of the current study, an assistant professor in special education and research associate, respectively) independently coded 48% and 52% of the studies as primary coder and 42% and 45% of the primary coder's studies as secondary coder, respectively. The coders met to discuss disagreements and reach consensus on the correct code to select. Agreement was high with an average of 97% across coding items (range: 82–100%).

2.4 | Data analysis

To analyze descriptive data, we calculated the percentage of instances each code was selected for multiple-option coding items (e.g., race/ethnicity, targeted skill/behavior, instructional arrangement) and the average and range for numerical fill-in-the-blank coding items (e.g., paraprofessional age, intervention dosage). It should be noted that, because it was possible to select more than one response option on certain coding items (e.g., cooccurring disability diagnosis, targeted skill/behavior, trainer), the reported percentages for these coding items exceed 100% in some cases. Similarly, because it was possible to select "cannot determine," the reported percentages for some coding items did not always total to 100%. The overall Tau-U score was calculated in the Tau-U calculator as the aggregate of all Tau-U scores across student participants and intervention outcome measures. We combined Tau-U scores across all students and weighted these estimates to account for study complexity. To determine whether certain study characteristics moderated intervention outcomes, we conducted nonparametric moderator analyses (e.g., Walker et al., 2018; Wiseman, McArdell, Bottini, & Gillis, 2017) across seven qualifying coding items: student grade, cooccurring disability diagnosis, paraprofessional educational level, targeted skill/behavior for intervention, intervention setting, instructional arrangement, and paraprofessional training type. In particular, we conducted Kruskal-Wallis one-way analysis of variance tests on SPSS 25.0 for Mac to detect significant differences in Tau-U scores for each coding item, with follow-up pairwise comparisons using Bonferroni corrections for statistically significant items requiring three or more comparisons.

3 | RESULTS

Table 1 provides a descriptive summary of study characteristics across the included studies. In the following sections, we report results from the descriptive and moderator analyses. These analyses reflect data at the student participant level.

3.1 | Descriptive results

3.1.1 | Student participants

A total of 59 students with ASD, 90% male and 10% female, received paraprofessional-implemented interventions in school settings across the 23 reviewed studies. A majority of students were in Grades K–5 (72%) at the time of the study, with fewer in Grades 6–8 (14%) and early childhood levels (14%). Additional diagnoses reported among students included speech and language or other health impairment (17%), intellectual disability or developmental delay (14%), and sensory impairment (e.g., visual and hearing impairments; 2%). Race/ethnicity was reported across 33 participants as follows: White (25%), Black or African American (12%), Hispanic/Latino (12%), Asian (5%), other (e.g., Indian, Iranian American; 3%), and Native American/Pacific Islander (2%).

3.1.2 | Paraprofessional participants

A total of 59 paraprofessionals delivered intervention to students with ASD. Paraprofessional participants ranged in age from 18 to 60 years, with an average of 34 years. Twenty percent of paraprofessionals were reported to have a high school degree and 43% had college experience as follows: 4-year degree (20%), some college (12%), 2-year degree (9%), and a graduate degree (2%). The highest educational level was not reported for 37% of the participating paraprofessionals. Race/ethnicity was reported across 29 participants as follows: 29% of paraprofessionals described as White, 10% as Hispanic/Latino, 7% as Black or African American, 2% as Asian, and 2% as Native American/Pacific Islander. Race/ethnicity was not described for 50% of paraprofessionals. Prior training in a related area was not reported for 46% of paraprofessionals and an additional 46% did not receive related training before the study. Only 8% of paraprofessionals received training related to the paraprofessional-implemented intervention before the study.

3.1.3 | Student interventions

Paraprofessional-implemented interventions focused on a range of targeted skills/behaviors among student participants. A large percentage of students received interventions to improve communication and social skills (78%), with fewer interventions focused on challenging behavior (24%), academic skills (5%), life skills (e.g., domestic tasks; 3%), and other skills (e.g., fluency development, following routine; 3%). The specific intervention strategies delivered by paraprofessionals are described in Table 1. Interventions took place in both inclusive settings with peers without disabilities (48%) and noninclusive settings separate from peers without disabilities (46%). The instructional arrangements under which paraprofessionals implemented intervention varied as follows: one-to-one instruction (32%), small group instruction (25%), and whole group instruction (20%). In most cases (85%), the paraprofessional was the only school member implementing the intervention. However, special education teachers (12%), general education teachers (2%), and the researcher (2%) also participated in implementation across a limited number of cases. One or more elements of intervention dosage (sessions per day, sessions per week, and/or duration in days, weeks, or months) were reported for 40% of student participants. For students for whom dosage

TABLE 1 Summary of studies

Study	#	Aggregate Tau-U	WWC design standards	WWC evidence standards	Grade level	Setting	Intervention	Target skill/behavior
Blair, Umbreit, Dunlap, and Jung (2007)	1	1.00	1	1	K-5	Inclusive	Function-based intervention	Challenging behavior
Chung and Douglas (2015)	3	0.95	0	0	K-5	Inclusive	Facilitative strategies for peer interaction	Communication/social
Collins (2010)	3	0.67	2	0	K-5	Noninclusive	Functional communication training	Communication/social; challenging behavior
Conroy, Asmus, Sellers, and Ludwig (2005)	1	0.32	2	1	K-5	Inclusive	Antecedent-based strategies	Challenging behavior
Dib and Sturme (2007)	3	0.92	1	0	K-5; 6-8	Noninclusive	Discrete trial training	Challenging behavior
Douglas, McNaughton, and Light (2014)	1	0.76	2	2	K-5	Inclusive	PoWR strategy	Communication/social
Feldman and Matos (2013)	3	0.98	1	1	K-5	Inclusive	Pivotal response treatment	Communication/social
Fienup and Deopke (2008)	1	0.77	0	0	K-5	Noninclusive	Skill fluency training	Fluent responding
Hall, McClannahan, and Krantz (1995)	1	0.50	1	1	K-5	Inclusive	Prompt reduction, picture activity schedules	Following steps in routine
Kim (2014)	3	0.98	1	1	K-5	Inclusive	Increased proximity, cooperative arrangements, embedding child interests	Communication/social
Koegel, Kim, and Koegel (2014)	3	0.83	1	1	K-5	Inclusive	Increased proximity, cooperative arrangements, embedding child interests	Communication/social

TABLE 1 (Continued)

Study	#	Aggregate Tau-U	WWC design standards	WWC evidence standards	Grade level	Setting	Intervention	Target skill/behavior
Licciardello, Harchik, and Luiselli (2008)	4	0.88	0	0	K-5	Inclusive	Preteaching, prompting, rewards	Communication/social
McCulloch and Noonan (2013)	1	0.58	1	1	K-5	Noninclusive	Mand training	Communication/social
O'Guin (2010)	5	0.78	0	0	6-8	Noninclusive	Discrete trial training	Communication/social
Osborn (2015)	3	1.00	0	0	K-5	Inclusive; CD	Modified psychosocial intervention	Communication/social
Quilty (2007)	3	0.18	2	0	K-5	Inclusive; noninclusive	Social Stories™	Challenging behavior
Robinson (2011)	4	0.87	0	0	EC; K-5	Inclusive	Pivotal response treatment	Communication/social
Schepis, Reid, Behrmann, and Sutton (1998)	4	1.00	0	0	EC; K-5	Noninclusive	Naturalistic teaching	Communication/social
Sennott (2013)	2	1.00	2	2	EC	Noninclusive	ModelER	Communication/social
Tan (2014)	3	0.63	2	1	K-5	Noninclusive	Dialogic reading intervention	Academic; communication/social
Toelken and Miltenberger (2012)	2	1.00	1	1	EC; K-5	Inclusive	Embedded instruction, system of least prompts	Domestic; multiple domains
Vincent (2015)	2	0.70	2	1	K-5	Noninclusive	Naturalistic teaching	Communication/social
Walker and Snell (2017)	3	1.00	1	1	K-5	Inclusive; noninclusive	Function-based intervention	Communication/social; challenging behavior

Note: # = number of qualifying student participants. 0 = does not meet standards; 1 = meets standards with reservations; 2 = meets standards without reservations. Abbreviations: CD, cannot determine; EC, early childhood; WWC, What Works Clearinghouse.

was reported, intervention sessions were implemented once per day, 3 days per week on average (range: 1–5 days per week), and over the course of 1 week to 3 months. To experimentally evaluate student outcomes, three single-case research designs were used: multiple baseline design (91%), alternating treatment design (7%), and changing criterion design (2%).

3.1.4 | Paraprofessional training

All paraprofessionals received training related to the intervention as part of the study. Researchers (88%), trainers in other roles (e.g., school's staff trainer, online training program; 7%), and special education teachers (5%) delivered such training. A majority of paraprofessionals (87%) received didactic training outside of applied settings (e.g., discussion, review of training materials, role play with other adults, video models), whereas fewer (63%) received experiential training within applied settings (e.g., performance-based feedback, coaching). In over half of the cases (59%), the effect of training on paraprofessional outcomes was experimentally evaluated through a multiple baseline design; the other 41% of cases were not evaluated.

3.1.5 | Study quality

Reliability assessments for student outcome measures were reported for 85% of student participants, with results considered acceptable across all students (i.e., 80% or higher for percent agreement; 0.60 or higher for Cohen's kappa coefficient [κ]). Among the 48 paraprofessionals for whom outcome measures were reported, reliability assessments were conducted for only 60%, with results considered acceptable across all paraprofessionals. Positive social validity related to the paraprofessional-implemented intervention and paraprofessional training was reported across 64% and 36% of student and paraprofessional participants, respectively. Measures of skill generalization were reported for 20% of students and 23% of paraprofessionals. Measures of skill maintenance were more common, with measures reported across 46% of students and 35% of paraprofessionals. A majority of studies met the WWC standards with reservations (48%) or did not meet the standards (43%) for primary student outcome measures. Studies failed to meet the standards largely due to having fewer than three data points within a phase and/or not collecting inter-assessor agreement on at least 20% of sessions. Only two studies (9%) met the standards without reservations for student outcome measures.

3.2 | Intervention effectiveness

We calculated Tau-U for each student participant and corresponding intervention outcome measures, resulting in Tau-U scores for 95 different outcome measures across the 59 student participants. The aggregate Tau-U score across all students was 0.81 (standard deviation = 0.46; range = 0.00–1.00), which can be interpreted as an overall large to very large change in student behavior with the range of scores reflecting no change to very large changes in student behavior (Vannest & Ninci, 2015). A majority of Tau-U scores (65%) reflected a large to very large change, with the other scores reflecting a moderate change (17%), large change (14%), and small change (4%) in student behavior. We also conducted moderator analyses across the following qualifying coding items: student grade/age, cooccurring disability diagnosis, paraprofessional educational level, targeted skill/behavior for intervention, intervention setting, instructional arrangement, and paraprofessional training type. These results are presented in Table 2.

We found that a majority of analyzed study characteristics did not contribute to statistically significant differences in student outcomes as estimated by Tau-U. However, our analyses revealed that the setting in which

TABLE 2 Results for moderator analyses

Study characteristic (n)	Tau-U		χ^2
	M	SD	
Student grade level			0.55
Grades 6–8/middle school (11)	0.86	0.19	
Grades K–5/elementary school (74)	0.81	0.28	
Early childhood (11)	0.80	0.37	
Disability diagnosis			0.48
Cooccurring disability (27)	0.84	0.25	
ASD only (66)	0.79	0.30	
Paraprofessional educational level			0.69
High school degree (22)	0.80	0.33	
College experience (32)	0.80	0.31	
Targeted skill/behavior			0.65
Communication/social skills (78)	0.83	0.26	
Challenging behavior (18)	0.71	0.41	
Intervention setting			5.63*
Inclusive (53)	0.85	0.26	
Noninclusive (36)	0.72	0.32	
Intervention instructional arrangement			7.56*
Whole group (19)	0.96	0.27	
Small group (34)	0.81	0.30	
One-to-one (25)	0.78	0.29	
Paraprofessional training type			0.54
Didactic only (29)	0.85	0.25	
Didactic plus experiential (55)	0.81	0.29	

Note: χ^2 derived from Kruskal–Wallis one-way ANOVA tests.

Abbreviations: ANOVA, analysis of variance; SD, standard deviation.

* $p < .05$.

paraprofessional-implemented interventions took place contributed to statistically significant differences in student outcomes, $\chi^2 (1, N = 89) = 5.63, p = .02$. Tau-U scores were significantly higher when intervention was implemented in inclusive school settings ($M = 0.85$) as compared to noninclusive school settings ($M = 0.72$). We also found that the instructional arrangement contributed to significant differences in student outcomes, $\chi^2 (2, N = 78) = 7.56, p = .02$. Follow-up pairwise comparisons revealed that Tau-U scores were significantly higher for students who received intervention during whole group instruction ($M = 0.96$) than for those who received one-to-one paraprofessional support ($M = 0.78; p < .05/3$). Likewise, Tau-U scores were significantly higher for students who received intervention during whole group instruction ($M = 0.96$) than for those who received paraprofessional support during small group instruction ($M = 0.81; p < .05/3$).

4 | DISCUSSION

The purpose of this meta-analysis was to review single-case design studies involving paraprofessional-implemented interventions for students with ASD in school settings. Specifically, we sought to descriptively summarize study characteristics, estimate intervention effect across study participants and outcomes, and identify study

characteristics that affected intervention outcomes. There are several key findings from the current review that contribute to the existing literature pertaining to paraprofessional-implemented practices. In particular, our review extends findings of other literature reviews focused on paraprofessionals (Brock & Carter, 2013; Rispoli et al., 2011; Walker & Smith, 2015) by summarizing studies in which students with ASD in school settings received paraprofessional-implemented interventions. With increasing reliance on paraprofessionals to support students with ASD (Biggs et al., 2019; Carter et al., 2009; Giangreco et al., 2010), it is important to understand the success of paraprofessional-implemented practices for this student population and the conditions under which such practices are effective. In the sections that follow, we provide a detailed discussion of key findings, implications for practice, and study limitations that can inform future research directions.

4.1 | Key findings and implications for practice

There are several key findings from our study that have important implications for practice. We found that paraprofessional-implemented interventions generally resulted in positive student outcomes across a range of students with ASD and intervention conditions. This finding is consistent with other paraprofessional literature reviews (e.g., Brock & Carter, 2013; Rispoli et al., 2011; Walker & Smith, 2015). Together, these findings suggest that paraprofessionals can be successful in effectively supporting students with ASD in school settings and when provided with training to do so, as was the case in the current review. Because of the continued reliance on paraprofessionals to support the growing population of students with ASD receiving special education services (U.S. Department of Education, 2018), it is important to continue efforts within schools to ensure that paraprofessionals are equipped with the knowledge and skills necessary to be effective in their roles (e.g., see paraprofessional preparation standards by the Council for Exceptional Children, 2015); this includes being able to implement EBPs (Wong et al., 2015) under the supervision of teachers and other professionals (e.g., ASD specialist, school psychologists).

We also found that the setting and instructional arrangement under which intervention was delivered contributed to statistically significant differences in student outcomes. First, positive student outcomes were more substantial when delivered by a paraprofessional in an inclusive, general education setting as opposed to a non-inclusive, self-contained setting. This highlights the important role that paraprofessionals can play in the inclusive classroom, where general education teachers are likely to face challenges in supporting the unique needs of students with ASD (e.g., Busby, Ingram, Bowron, Oliver, & Lyons, 2012). When interpreting this particular finding, one must consider the range of variables that might have contributed to this outcome. For example, a majority of interventions in the review focused on social and communication skills, and instruction of these skills might be more conducive to inclusive settings where peer supports and communication opportunities are more readily available, thereby resulting in more pronounced improvements in social and communication skills. It is important to note that, regardless of the setting, paraprofessional supports were effective, with interventions in noninclusive settings also producing large changes in student outcomes. Second, we found that positive student outcomes were stronger when intervention was delivered within a whole group instructional arrangement. Whole group instructional arrangements are common within inclusive, general education settings (Chung, Carter, & Sisco, 2012) and may foster peer-to-peer interactions. Because inclusive settings and whole group instruction provide opportunities for students with ASD to benefit from observing peer models and can promote appropriate behavior (e.g., Walker et al., 2018), student outcomes focused on social and communication skills might have been more pronounced.

There are several key findings from the descriptive analysis that warrant additional discussion. Our review suggests that the current body of research primarily focuses on paraprofessional support for elementary-aged students with ASD. Our review included few studies conducted in middle and early childhood settings and no studies conducted in high school settings. As such, the results from this review might have stronger implications for those working with elementary-aged students. Nonetheless, practitioners working in secondary and early childhood settings will likely supervise paraprofessionals (Carter et al., 2009), and therefore might consider these findings in

decision-making for students with ASD. We also found that a majority of interventions focused on social and communication skills. This finding is not surprising given that persistent deficits in social communication and social interaction is a key characteristic of ASD (American Psychiatric Association, 2013). Paraprofessionals can facilitate peer relationships and encourage socially appropriate communication and social skills to promote a more inclusive culture within the general education classroom (e.g., Chung & Douglas, 2015). However, it will be important to identify alternatives to *overreliance* on paraprofessionals in inclusive settings where paraprofessionals should receive guidance and supervision from teachers in navigating the potential challenges of assisting students in inclusive environments (Giangreco et al., 2010).

Another key finding relates to the training provided to paraprofessional participants. We found that, in a majority of cases, the researcher delivered paraprofessional training as opposed to a school member, a common theme found among paraprofessional training studies (e.g., Walker & Smith, 2015). Although researcher-delivered training generally resulted in accurate intervention implementation, special education teachers are typically responsible for supervising and training paraprofessionals and therefore are encouraged to be involved in the training process. School psychologists also can play an important role in overseeing paraprofessional supervision and training (Douglas et al., 2016). In their role as consultant and collaborator (National Association of School Psychologists, 2010), school psychologists can lend their expertise to develop, implement, and/or monitor implementation of paraprofessional training practices while collaborating with and coaching a range of school personnel, including special and general education teachers (Ern, Head, & Anderson, 2009). Having outside experts provide ongoing, individualized training is not a sustainable practice and conflicts with budget issues that many schools and school divisions are facing. Schools must consider different approaches to support teachers to be effective paraprofessional trainers and supervisors (e.g., assigning school psychologists and other professionals to lead and support educators in paraprofessional training efforts), as teachers often feel unprepared to serve in this role (Douglas et al., 2016). If teachers are able to use training practices that are effective and feasible (e.g., modeling and performance feedback; Brock & Carter, 2017), paraprofessionals are more likely to implement interventions with fidelity, which improves the likelihood of student success. Teachers also might benefit from targeted instruction on paraprofessional supervision and training within their teacher education programs to ensure adequate preparation for this role, a competency area often missing from teacher preparation content (Biggs et al., 2019).

4.2 | Limitations and future research

There are several limitations to the current review that highlight the need for additional research. First, we found that a majority of studies focused on elementary-aged students with ASD. It will be critical for future research to focus on other age levels so that guidelines for practitioners working outside of elementary schools can be developed. This is particularly important in early childhood settings as children are being identified with ASD younger in age than ever before, and the majority of preschool-aged children with ASD are receiving special education services within preschool classrooms (Guthrie, Swineford, Nottke, & Wetherby, 2013). Second, student interventions primarily focused on social and communication skills, as was the case in other reviews (Brock & Carter, 2013; Rispoli et al., 2011). Given that students with ASD have a range of support needs, more information about paraprofessional-implemented practices across all skill domains (e.g., academics, life skills) needs to be gathered through future research efforts, especially in relation to students receiving special education services in inclusive settings where academic instruction is central.

Third, a limited number of studies involved teacher-delivered paraprofessional training. Given the important role that teachers play in supervising paraprofessionals, it will be necessary to focus efforts on rigorous evaluations of teacher-delivered paraprofessional training approaches that are not only effective in producing high levels of implementation fidelity but also socially valid from the perspective of the paraprofessional and the teacher. Research consistently demonstrates that modeling and performance feedback are critical aspects to training that

contribute to strong implementation outcomes (e.g., Brock & Carter, 2013; Brock & Carter, 2017), with recent research suggesting that training dosage may have less of an influence on implementation fidelity (e.g., Brock & Carter, 2017). Although we did not find differences in student outcomes based on the type of paraprofessional training, an evaluation of such will be necessary to examine the effects on paraprofessional implementation fidelity. In addition, future research should explore whether the dosage of training as delivered by teachers and other professionals influences the accuracy with which paraprofessionals implement interventions among students with ASD. In the current review, we were unable to explore training dosage as a majority of the studies did not provide clear descriptions of dosage, likely due to there being no standard way of reporting such information. This limitation highlights the importance of documenting such information in future research reports.

Fourth, we found that the quality of the reviewed studies was questionable in relation to the inclusion of measures of generalization, maintenance, and social validity. These measures were common for student outcomes but less common for paraprofessional outcomes. This is problematic, as the effectiveness of paraprofessional training under different conditions and across time once training has ended and the feasibility and contextual fit of the training all are important to consider when selecting appropriate training approaches. In relation to the WWC standards, a large percentage of studies failed to meet the WWC standards for student outcome measures for a number of reasons (e.g., no report of inter-assessor agreement, insufficient number of data points across phases, demonstrations of noneffects). These findings highlight the importance of conducting additional high-quality research to establish a more robust evidence-base around paraprofessional-implemented practices for students with ASD.

The fifth and final limitation relates to the meta-analytic process through which this review was completed. We chose to include studies that did not reflect all quality characteristics, thereby potentially limiting the interpretation of the study's findings in relation to intervention effect and moderator variables; therefore, these findings should be considered as preliminary in identifying potential areas for future research. Additionally, because we used Tau-U to estimate intervention effect, we were unable to (a) compare results with other reviews that used different indices to estimate student outcomes and (b) determine the magnitude of intervention effect, as Tau-U is an index that provides information about the extent of data overlap. Given the continued advancement in alternative methods for quantitative synthesis of single-case research (Ledford & Gast, 2018), it will be important in the future to explore a range of methods to address the limitations of the current review. For example, multilevel modeling is advantageous over traditional meta-analysis for a number of reasons, including that different outcome measures (i.e., continuous variables, count variables) and various single-case research designs can be modeled and that moderators can be modeled at different levels (e.g., student characteristics, study characteristics; Moeyaert, Manolov, & Rodabaugh, 2020). As the field reaches consensus on best practices for synthesizing single-case research, it will be critical for future research efforts involving synthesis of the paraprofessional literature to include agreed-upon data analysis strategies.

5 | CONCLUSION

Based on the results of this meta-analysis, it is clear that paraprofessional-implemented interventions can improve a range of student outcomes under different intervention conditions. Interventions delivered by paraprofessionals in inclusive school settings and within the context of whole group instructional arrangements were found to produce stronger outcomes for students with ASD. However, these potential moderating variables must be explored in greater depth. It also is imperative for future research to focus on early childhood, middle, and high school settings and to expand the range of skills to focus on academic and life skills, with emphasis on teacher-delivered paraprofessional training. With proper training, paraprofessionals can implement interventions for students with ASD, leading to growth in student success.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

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