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Effects of writing instruction on the reading outcomes of students with literacy difficulties in pre-kindergarten to fifth grade: a meta-analysis

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Abstract

Although writing instruction can positively impact reading for students across grades and levels of literacy, the extent to which these findings generalize to young students with literacy difficulties is unclear due to the dynamic nature of reading-writing relations. The purpose of this meta-analysis was to examine the effects of writing instruction on the reading outcomes of students in grades pre-K–5 who have reading, writing, or co-occurring reading and writing difficulties. Across 19 studies and 72 effects, writing instruction had a positive effect on reading outcomes in English ($g = 0.27$, 95% CI [0.13, 0.41], $p < .01$). Descriptively different subset effects for higher-intensity instruction (small student group, greater total hours) could not be reliably estimated. Effects were moderated by the focus of instruction, with transcription instruction associated with larger effects. Percentage of instructional time spent writing and type of comparison condition (reading treatment or control) did not moderate effects. Implications for the design of early writing interventions are discussed.

Keywords Writing · Instruction · Literacy · Preschool · Elementary school · Meta-analysis

Introduction

Despite researchers' and educators' efforts, reading and writing remain significant challenges for students (National Center on Educational Statistics, 2012, 2022). A potential contribution to this issue is siloed research on remediating reading and

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writing difficulties, despite their connection (e.g., Shanahan, 2022). Meta-analytic evidence indicates that writing instruction can positively affect reading (Graham & Hebert, 2011; Graham & Santangelo, 2014). Yet, the extent to which these findings generalize to young students with literacy difficulties is unclear (Graham, 2020). Without knowledge of how writing can support these students' reading, the design of effective, efficient early writing interventions may remain elusive.

The purpose of this meta-analysis was to examine the effects of writing instruction on the reading outcomes of students with literacy difficulties in pre-kindergarten through fifth grade (pre-K–5). We also examined whether effects varied by instructional factors. We aligned our analysis with current reading-writing development theory (Kim, 2020) and aimed to provide insight on the extent to which, and how, early writing interventions can promote reading.

The importance and challenge of reading and writing

The importance of both reading and writing for children's academic and postsecondary success cannot be overstated. Beginning in preschool, students read and write to create and understand new ideas (Shanahan, 1987). These skills are essential for college and career readiness, serving the purposes of acquiring and sharing information effectively (National Association of Colleges & Employers, 2020; National Commission on Writing, 2003).

Unfortunately, many students in the United States experience reading difficulties and even more acute writing difficulties. According to the National Assessment of Educational Progress, 32% of all fourth graders and 11% of fourth graders with disabilities scored at or above proficient in reading (NCES, 2022). Twenty-seven percent of all eighth graders and 5% of eighth graders with disabilities scored at or above proficient in writing (NCES, 2012). Many students experience challenges in both domains; 75% of children with writing difficulties may have co-occurring reading difficulties (Katusic et al., 2009). This co-occurrence begins as early as preschool and remains stable across elementary grades (Costa et al., 2016; Thomas et al., 2020).

Young students may face co-occurring challenges as reading and writing develop from shared cognitive processes and linguistic knowledge (e.g., Berninger & Abbott, 2010; Shanahan, 1987). A recent theory explaining these connections is the *Interactive Dynamic Literacy Model* (IDLM; Kim, 2020). Building on prior literacy development theories (Berninger & Winn, 2006; Gough & Turner, 1986; Shanahan, 1987), the IDLM specifies relations among component skills and processes for reading, writing, and oral language at sublexical (orthographic, morphological, and phonological knowledge), lexical (spelling and word reading), sentence (e.g., syntax), and discourse (written composition and reading comprehension) levels. These components are hypothesized to interact and influence each other across this hierarchy, resulting in connections between reading and writing.

The IDLM applies to students with literacy difficulties, meaning children with reading, writing, or oral language challenges, with or without co-occurring disabilities (Kim, 2022). Elementary students with English literacy difficulties

have correlated skills across hierarchical levels, including spelling and reading comprehension ($r = 0.28$ to 0.60; Berninger et al., 2001; Raskind et al., 2000) and word reading and writing quality ($r = 0.52$; Lewis et al., 2011). Many students with disabilities are at risk for co-occurring challenges (Costa et al., 2016; Lewis et al., 2011; Mayes & Calhoun, 2006). Sources of these shared difficulties vary; for example, students with dyslexia have deficits in orthographic knowledge and phonological awareness (Georgiou et al., 2021), while those with attention deficit hyperactivity disorder experience difficulties with domain-general cognitive skills like inhibitory control (Adi-Japha et al., 2007). However, students with and without disabilities demonstrate broadly similar connections between the two domains (Katzir et al., 2006; Kim et al., 2023). Difficulties in one domain also predict future challenges in the other. For example, spelling uniquely predicts first-grade word reading for kindergarteners at risk for reading difficulties (Clemens et al., 2014). The existence of early co-developing challenges suggests the need for cross-domain intervention approaches.

Shared difficulties may persist, in part, due to siloed reading and writing instruction research. Many studies have explored the effects of pre-K and elementary reading interventions on reading (e.g., Gersten et al., 2020; Rice et al., 2022) and writing instruction on writing (e.g., Graham et al., 2012), but there is relatively less research on the effects of writing instruction on reading (Graham, 2020). Siloed efforts may contribute to a significant problem of practice. In U.S. schools, reading is generally valued more than writing, resulting in a de-emphasis on writing instruction (Shanahan, 2022). Elementary educators teach writing infrequently, and special educators even less so (Coker et al., 2016; Graham et al., 2023). Students with writing difficulties also often do not receive targeted support (Coker et al., 2016; Cutler & Graham, 2008). Understanding how early writing interventions contribute to reading may prompt key decision-makers to effectively support pre-K and elementary teachers' implementation.

Current knowledge of the effects of writing instruction on reading outcomes

Previous meta-analyses have found that writing instruction supports reading, but limited evidence was available related to young students with literacy difficulties. Graham and Hebert (2011) found that writing instruction improved reading outcomes for students in grades 1–12 ($ES = 0.22$–0.27), but only five of the 95 included studies focused on elementary students with reading, writing, or oral language challenges. In another meta-analysis, Graham and Santangelo (2014) found that spelling instruction improved K–12 students' reading ($ES = 0.44$). This synthesis included 11 relevant studies out of 53 total, but separate effects were not reported. In these reviews, students in preschool or attending schools for students with disabilities were excluded. Thus, the effect of writing for reading interventions for these populations is unknown.

Evidence specific to pre-K–5 students with literacy difficulties is needed because reading-writing relations are dynamic in terms of students' literacy development (Kim, 2022), and broader understandings of how writing supports reading may not be generalizable to these students (Graham, 2020). Beginning readers acquire

lexical and sentence-level skills by drawing on shared sublexical and lexical knowledge, respectively; as a result, their reading and writing are highly connected (Kim, 2020). Advanced readers and writers who have sufficient discourse skills may not experience the same close connections, as language and higher-order cognition make greater contributions (Kim et al., 2018). Students in pre-K–5 with literacy difficulties are often still developing lexical and sentence-level skills (Graham et al., 2020; Katzir et al., 2006; McNeill et al., 2017) and may therefore have much to gain from instruction that capitalizes on writing-reading connections (Ehri, 2000). Additionally, these students benefit from increased opportunities to practice new and previously learned tasks (Fuchs et al., 2018). By writing, these students can apply reciprocal reading skills in a new context (Graham, 2020).

Several factors may influence the effects of writing instruction on reading for pre-K–5 students with literacy difficulties. First, instruction delivered at a higher intensity, meaning in smaller groups or at a higher dosage, can have stronger effects on reading and writing outcomes (e.g., Jung et al., 2017; Wanzek & Vaughn, 2007). Prior meta-analyses indicate that small group literacy intervention yields larger subset effect sizes (Donegan & Wanzek, 2021; Gersten et al., 2020). Small group instruction allows teachers to give more feedback as students write, which may result in positive effects on writing and transfer effects on reading. However, previous writing instruction meta-analyses have not examined whether more intensive instruction yields larger reading effects (Graham & Hebert, 2011; Graham & Santangelo, 2014).

Instructional focus may also influence reading outcomes for these students. The *Simple View of Writing* (Berninger & Winn, 2006) specifies components of the writing task. Transcription, or handwriting and spelling, aligns with the IDLM's sublexical and lexical levels. Text generation, or translating ideas to text using written mechanics, syntax, and the writing process (e.g., planning, editing), aligns with sentence and discourse levels. Across developmental phases, lexical skills are more strongly correlated than discourse skills (Kim et al., 2023). This phenomenon holds for young students with literacy difficulties, as their reading-writing relations at sentence and discourse levels are even weaker than their typical peers (e.g., Tortorelli & Truckenmiller, 2023). Thus, transcription interventions likely have stronger cross-domain effects. For example, spelling words is theorized to strengthen weak orthographic representations and promote word reading (Ehri, 2000). However, if students struggle specifically with discourse skills, learning the writing process (e.g., questioning, summarizing) could better support application in reading (Graham, 2020). Investigating the relative benefits of transcription and text generation instruction for pre-K–5 students with various difficulties may indicate which has generally stronger transfer effects to reading. Previous meta-analyses have examined effects of these foci on reading separately and for more heterogenous groups (Graham & Hebert, 2011; Graham & Santangelo, 2014), so the moderating effect for this student subgroup is unknown.

Another consideration is the balance of time spent on writing versus reading objectives during writing instruction. In a previous meta-analysis, Graham et al., (2018) found that balanced reading and writing time during literacy instruction produced stronger effects on reading ($ES = 0.66$) than more writing time ($ES = 0.27$). However,

the moderating effect of writing time during writing instruction has not been explored (Graham & Hebert, 2011; Graham & Santangelo, 2014). For all students, reading-specific skills like inferencing must be taught directly and partially outside the context of writing (e.g., Shanahan, 2016). This type of targeted instruction is particularly critical for young students with literacy difficulties, who benefit from explicit teaching (Wanzek et al., 2006). Writing instruction that includes opportunities to build reading-specific skills (e.g., 60% writing and 40% reading time) may therefore have greater benefits for struggling readers and writers than instruction with more writing.

Finally, the nature of the experimental comparison may influence the observed effects of writing instruction. Writing treatments are likely more effective for reading than control conditions, given previous evidence (Graham & Hebert, 2011). In contrast, the relevant benefit of writing instruction compared to reading instruction is less clear. Reading and writing are not identical processes. For example, spelling and decoding difficulties both arise from constraints on orthographic knowledge (Georgiou et al., 2021), but only spelling is constrained by handwriting (Pritchard et al., 2021). For this reason, an intervention in one domain likely has stronger effects on skills in its own domain (e.g., Kim, 2020; Shanahan, 2016). Reading may also play a greater role in general literacy development than writing, given some evidence of unidirectional longitudinal relations from reading to writing for elementary students with and without literacy difficulties (Ahmed et al., 2014; Kim et al., 2018; Puranik et al., 2020). However, if trends in the literature do not indicate a meaningful difference between the effects of writing and reading instruction on reading for pre-K–5 students with literacy difficulties, such a finding may suggest that the domain of literacy intervention does not solely determine its success.

The current study

The purpose of this meta-analysis was to investigate whether writing instruction has positive effects on the reading outcomes of pre-K–5 students with literacy difficulties. We calculated an average weighted effect size of writing instruction, operationally defined as treatments where 50% or more of instructional time was focused on writing skills. Through subset analyses and a moderator analysis, we also examined aspects of pre-K–5 writing instruction that may have contributed to greater reading outcomes for these students. Thus, the meta-analysis was guided by the following research questions:

1. What are the effects of writing instruction on the reading outcomes of pre-K–5 students with literacy difficulties?
2. Is the intensity of writing instruction (i.e., student group size, instructional dosage) related to student reading outcomes?
3. Are the effects of writing instruction on reading outcomes moderated by the focus of writing instruction, percent of instructional time spent writing, and the type of comparison condition?

Method

Eligibility criteria

To investigate the effects of writing instruction on reading outcomes for pre-K–5 students with literacy difficulties, we conducted a systematic search of the literature. Inclusion criteria were: (a) participants were in pre-K–5 with difficulties in reading or writing (or effects were disaggregated); (b) the study used a randomized-control trial (RCT) or quasi-experimental (QE) design with a writing instruction treatment condition; (c) the comparison condition was a reading treatment or control; (d) instruction and outcome measures were in English; (e) the authors reported sufficient data to calculate effect sizes; and (f) the study was published in a peer-reviewed journal, doctoral dissertation, or research report.

For this meta-analysis, writing instruction was operationally defined as instructional treatments where 50% or more of instructional time was spent on activities targeting writing objectives, as opposed to reading objectives. We included writing instruction with an equal balance of reading time because writing inevitably involves reading (Ehri, 2000). We defined writing as creating text via handwriting, typing, or arranging letters. Students with literacy difficulties were (1) identified based on teacher report or study eligibility criteria or (2) students with disabilities who had literacy pretest scores averaging ≤ 75 on norm-referenced assessments. Students with oral language difficulties were eligible, but no such studies were identified. Comparison reading treatments could not include writing. Control comparison conditions were non-literacy treatments (e.g., math instruction), minimal-literacy controls, or business-as-usual controls. Minimal literacy controls had researcher contact related to literacy without instruction. We only included studies where instruction was in English because literacy relations vary by orthography (Graham et al., 2020). For screening criteria, see Supplementary Material 1.

Search procedures

See Fig. 1 for a flowchart of search results. First, we completed an electronic search of ERIC, Education Source, PsycINFO, and Dissertation and Theses Global to identify relevant studies without publication date limits. Our search terms (see Supplementary Material 2) captured the following topics: students with reading or writing difficulties (e.g., *struggle with* AND *writ**); reading or writing intervention and instruction (e.g., *intervention* AND *writ**); and study design (e.g., *random** OR *RCT*). This search yielded 2,790 records. Next, we identified eligible abstracts from the references of 11 literacy instruction syntheses (Gersten & Baker, 2001; Gillespie Rouse & Graham, 2014; Graham & Hebert, 2011; Graham & Santangelo, 2014; Graham et al., 2012, 2018; Koster et al., 2015; McMaster et al., 2018; Santangelo & Graham, 2016; Sun et al., 2022; Wanzek et al., 2006). This search yielded 207 records.

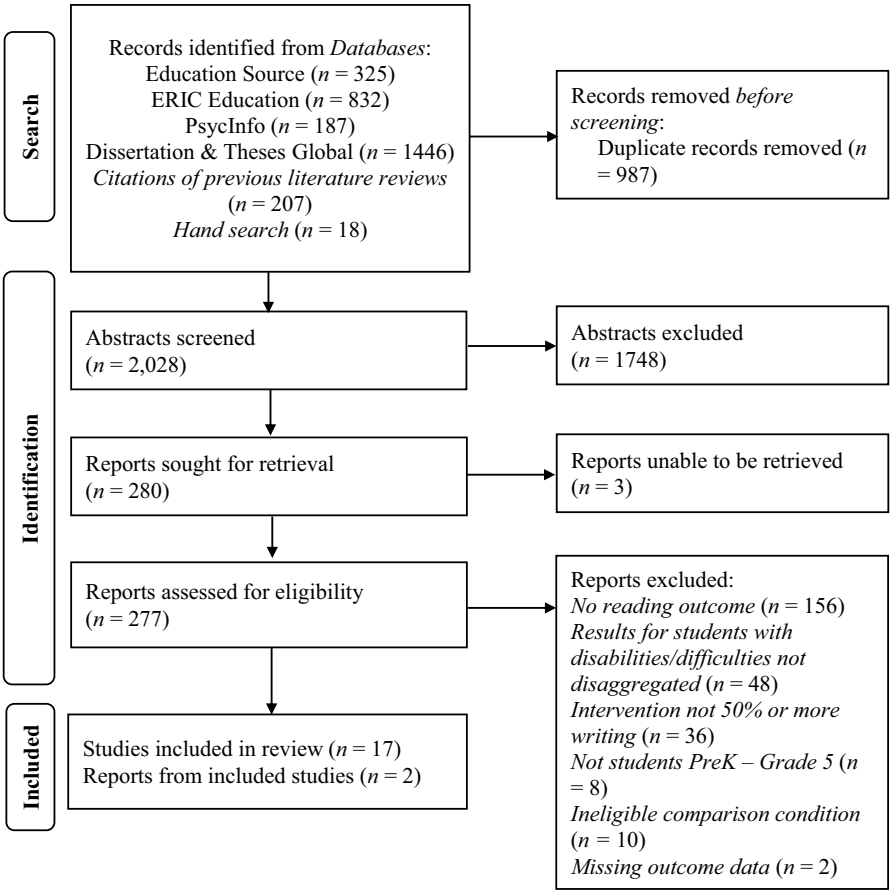

Fig. 1 Flow chart of search procedures and results

Last, we conducted a hand search of records published after January 2010 (when a related review's search was completed [Graham & Hebert, 2011]), in major journals that publish literacy intervention studies: *Annals of Dyslexia*, *The Elementary School Journal, Exceptional Children, Journal of Educational Psychology, Journal of Learning Disabilities, The Journal of Special Education, Learning Disability Quarterly, Reading and Writing, Reading and Writing Quarterly, Reading Research and Instruction, Reading Research Quarterly, Remedial and Special Education,* and *Scientific Studies of Reading*. This search yielded 18 records.

After completing those three searches, abstracts from all records were de-duplicated using Rayyan (Ouzzani et al., 2016), resulting in 2,028 abstracts for screening. If relevant information was missing (e.g., student grade levels), we included the abstract. We identified 277 abstracts for full-text review, resulting in 17 eligible studies. Studies were most often excluded because they did not include reading outcomes ($n = 156$) or findings for students with literacy difficulties ($n = 48$).

After identifying eligible studies, we screened their references and citations and identified two additional studies, bringing the total in this meta-analysis to 19.

The first author trained two additional authors to screen 20% of abstracts and full texts for interobserver agreement (IOA) at each stage. Agreement, calculated as the percentage of agreements divided by agreements plus disagreements, was 94.5% for abstract screening ($n = 618$ abstracts) and 97.6% for full-text screening ($n = 83$ records). All disagreements were discussed and resolved; this process did not lead to the inclusion of additional studies.

Coding of studies

We coded studies for characteristics of (a) the study and participants (e.g., design, student disability status and literacy difficulties); (b) instruction (e.g., skills targeted, dosage); (c) comparison conditions; (d) study quality; and (e) outcomes. Percentage of time spent writing was calculated as *writing activity duration* / *lesson duration* × 100. For studies without duration data (Roberts & Meiring, 2006; Weiss, 1992), we divided writing activities by total activities (Graham et al., 2018). Writing instruction foci were transcription (handwriting or spelling), text generation (grammar/syntax, sentence/passage construction, or writing process), or multicomponent (transcription and text generation). Phonemic awareness was coded as a general literacy activity as it was targeted in word reading and spelling, but a foundational reading outcome to align with prior meta-analyses (e.g., Donegan & Wanzek, 2021). Other reading outcomes were letter name or sound knowledge, word reading, reading fluency (foundational), vocabulary, comprehension, and achievement (meaning-related). We coded measures as researcher-created or standardized. For code descriptions, see Supplementary Material 3.

We rated study quality using a procedure that has yielded high IOA in education meta-analyses (e.g., Filderman et al., 2022). We rated each study as exemplary (score of 2), acceptable (1), or unacceptable (0) across three indicators totaling 10 points: research design, comparison group instruction, and implementation fidelity. For research design, RCTs were exemplary, QEs with pretest equivalence ($g < 0.25$) were acceptable, and QEs without pretest equivalence were unacceptable. For comparison groups, exemplary studies had a reading treatment comparison condition. Acceptable comparison conditions were minimal literacy controls, or no-contact controls with descriptions of typical literacy instruction. Unacceptable comparison conditions were non-literacy treatments or no-contact controls without description. For implementation fidelity, exemplary studies had clear and replicable procedures, intervention fidelity was ≥ 75%, and IOA was ≥ 90%. Acceptable studies had operational definitions of procedures, intervention fidelity ≥ 75%, and IOA ≥ 80%. Unacceptable studies had irreplicable descriptions (e.g., instructional activities not reported), intervention fidelity was < 75%, or IOA was < 80%.

Before coding, IOA was established between two authors. They independently coded 31.6% of studies ($n = 6$). Average IOA, measured by point-by-point agreement, was 93.5% (*range* = 91.2% to 98.8%). Disagreements were resolved and

the first author then coded the remaining 13 studies. The first author extracted data needed to calculate effect sizes in Excel twice and resolved discrepancies. Another author re-entered data for 32 outcomes (38.6%) across eight studies. Point-by-point agreement was 98.8%, and all discrepancies were resolved.

Data analysis

For research question 1, we used Hedges' g as the effect size measure with the formula $g = \frac{M_{\text{postT}} - M_{\text{postC}}}{SD_{pooled}} \times \varpi$, where $SD_{pooled} = \sqrt{\frac{((N_T - 1)SD_{\text{postT}}^2) + ((N_C - 1)SD_{\text{postC}}^2)}{df}}$ and $\varpi = 1 - \frac{3}{4df - 1}$. In cases where authors reported F-test results or pretest-adjusted unstandardized beta coefficients, we used formulas for g outlined by What Works Clearinghouse (2022). Subsequent analyses were conducted with the metafor package in R (Viechtbauer, 2010). To calculate a summary effect size, we used a random effects model weighing study effects by their inverse variances. We used robust variance estimation (RVE) to account for effect size dependency within studies (Hedges et al., 2010). We set $\rho = 0.80$ as the level of within-study correlation; varying ρ values did not alter g or its standard error. There were two outlying effect sizes (i.e., $g \geq |.25|$ *SD* above or below the mean). A sensitivity analysis indicated that g and its standard error were robust to their inclusion; thus, the outliers were included in analyses. Heterogeneity of effects was $I^2 = 45.16\%$, where $I^2 = \left(\frac{Q - df}{Q}\right) \times 100\%$ and Q is the sum of the squared deviations of each study effect size (Higgins et al., 2003), suggesting moderate heterogeneity.

For research question 2, we calculated summary effect sizes of intervention intensity variable subsets: instructional group size (maximum of ≤ 5 students, > 5 students) and instructional dosage (≥ 10 h, < 10 h). We descriptively compared subset effects based on significance levels and the extent to which confidence intervals overlapped. This purpose of this exploration was to avoid overfitting a metaregression with all variables of interest. For research question 3, we conducted metaregression to examine moderators: instructional focus (transcription or multicomponent/text generation), type of comparison condition (reading treatment or control), and percent of instructional time spent writing (50%–74.9%, 75%–100%). For instructional focus, we combined multicomponent and text generation into one category, as few studies targeted text generation only. Correlations between moderators ($\varphi = |.08|$ to $|.46|$) indicated low risk for multicollinearity (Vatcheva et al., 2016). For exploratory purposes, we also computed summary effects for more variable subsets: the moderator categories, student grade level (pre-K–2, grades 3–5), and reading outcome (foundational, meaning-related).

A funnel plot of study effect sizes against their standard errors indicated asymmetry, suggesting that studies were missing from this analysis. Egger's regression test indicated significant asymmetry ($z = 3.38$, $p < 0.001$), and trim and fill analyses suggested that 17 studies were missing. When tested separately, transcription and multicomponent/text generation instruction effects did not have significant asymmetry, suggesting systematic effect differences. Due to the small

number of studies, we included all effects in one metaregression. Additionally, we identified two studies that would have met inclusion criteria if data to calculate *g* for four outcomes were provided (Berninger et al., 1995, 2006, study 4). For two outcomes, non-significant effects were reported, suggesting slight inflation of effect sizes in this meta-analysis. See Supplementary Material 4 for sensitivity analyses and tests of asymmetry.

Results

Results are summarized by (a) participants, (b) study characteristics, and (c) research question findings. Descriptive information can be found in Table 1 and 2, subset analyses in Table 3, and moderator analysis in Table 4. For an exploratory metaregression of variables in Table 1, see Supplementary Material 5. For an effect size forest plot, see Supplemental Material 6. For a spreadsheet of study codes, see Supplementary Material 7.

Participants

In the 19 included studies, there were 1086 students across conditions. Most studies included pre-K–2 students ($n=14$), and seven included students in grades 3–5. Eleven studies reported including students with disabilities, most commonly learning disabilities ($n=4$). Three studies included English language learners and two did not; other studies did not report ($n=12$). Students were most often eligible for participation based on reading difficulty screening ($n=11$). Regarding literacy skill level, students were identified as having sublexical or lexical ($n=10$) or sentence or discourse ($n=3$) difficulties, or both ($n=6$).

Study characteristics

Twelve studies were journal articles, six were dissertation studies, and one was published as a research report. The mean quality score was 5.32 ($SD=2.24$) out of 10. For research design, 25 studies scored exemplary, three scored acceptable, and one scored unacceptable. For comparison condition, nine were exemplary, four were acceptable, and six were unacceptable. For implementation fidelity, two were exemplary, three were acceptable, and 14 were unacceptable due to the absence of treatment fidelity measurement IOA.

Among 21 writing treatments, most targeted transcription ($n=9$). Six others focused on text generation skills, and six were multicomponent. Spelling was the most frequently targeted skill ($n=14$, 67%); in 10 of these treatments, instruction also targeted phonemic awareness (71%). Eight of 12 treatments that targeted text generation taught the writing processes, including planning, paragraph structure, and editing (67%). Mechanics were not addressed and only one treatment targeted grammar or syntax (Wolbers et al., 2018). Fifteen treatments supported reading skills (71%), most often word reading ($n=9$). On average, 75% ($SD=20$%)

Table 1 Characteristics of included studies

Study	Design	*N*	Comp. condition	Quality	Reading Outcomes	Student grade	Literacy difficulty	Disability
Berninger et al., (1997)	RCT	105	RT	6	F	Pre-K-2	W	Inc, NR
Berninger et al., (2002)	RCT	72	ML	5	F	3	W	Inc, NR
Craig (2006)	RCT	31	RT	6	F, M	K	R	NR
Croes (1990)	QE	157	ML	2	M	1–5	Both	LD
Davis (2000)	RCT	18	RT	6	F	1	R	NR
Edwards (2001)	RCT	64	RT	8	F	K	R	NR
Fuchs et al., (2006)	RCT	33	C	4	F	1	R	SLI
Graham et al., (2002)	RCT	54	C	4	M	2	W	ADHD, EBD, ID, LD, SLI
Hebert et al., (2018)	RCT	61	C	8	M	4–5	R	Inc, NR
Mason et al., (2013)	RCT	77	ML, RT	5	F	4	Both	LD
O'Connor and Jenkins (1995)	RCT	10	RT	6	F	K	Both	DD
Roberts and Meiring (2006)	RCT	69	RT	10	F	1	R	NR
Sénéchal et al., (2012)	RCT	18	RT	6	F, M	K	R	NR
Simmons et al., (2007)	RCT	37	RT	8	F, M	K	R	NR
Thompson (2015)	QE	66	C	3	F	Pre-K	Both	Inc, NR
Torgesen et al., (2018)	RCT	24	C, RT	2	F, M	1	R	NR
Weiss (1992)	QE	99	ML	2	M	2–3	Both	NR
Wolbers et al., (2018)	QE	63	C	4	F	3–5	R	Deaf, HI
Woodruff (2014)	RCT	28	RT	6	F	3–5	R	NR

ADHD Attention deficit hyperactivity disorder; *C* Business-as-usual on non-literacy control; *Comp. condition* Comparison condition; *EBD* Emotional/behavioral disturbance; *F* Foundational reading outcome; *HI* Hearing impairment; *Inc* Included; *ID* Intellectual disability; *LD* Learning disability; *M* Meaning-related reading outcome; *ML* Minimal literacy control; *NR* Not reported; *QE* Quasi-experimental design; *R* Reading; *RCT* Randomized control trial; *RT* Reading treatment; *SLI* Speech/language impairment; *W* Writing

Table 2 Characteristics of writing instruction treatments

Study	PA[a]	Read skills	Write skills	Percent writing	Group size	Total hours
Berninger et al., (1997)		RF	HW, PC	81	3–6	8.0
Berninger et al., (2002)						
Composition-Only			PC, WP	100	6	8.0
Spelling + Composition	×	LS, WR	S, PC, WP	77	6	8.0
Spelling-Only	×	LS, WR	S	55	6	8.0
Craig (2006)	×	RC	S, SC	60	4–5	21.3
Croes (1990)			PC, WP	100	CW	82.5
Davis (2000)	×	WR	S	67	4–5	3.0
Edwards (2001)		LN, LS, WR, RF	HW, S	50	3–5	56.5
Fuchs et al., (2006)			S	100	1–2	8.3
Graham et al., (2002)		LS, WR	S	68	2	16.0
Hebert et al., (2018)			PC, WP	100	1–2	6.0
Mason et al., (2013)		RF, V, RC	PC, WP	50	4	10.0
O'Connor and Jenkins (1995)	×		S	100	1	3.3
Roberts and Meiring (2006)	×	WR	S	63[b]	CW	24.2
Sénéchal et al., (2012)			S	100	3–6	5.3
Simmons et al., (2007)	×	LS, LN, WR, RF	HW, S	50	5	54.0
Thompson (2015)	×	LS, WR, V, RC	HW, S, SC, WP	50	10	19.5
Torgesen et al., (2018)	×	LS, WR	S, PC	59	3	86.7
Weiss (1992)		RC	PC, WP	75[b]	CW	322.5
Wolbers et al., (2018)			G/S, PC, WP	100	CW	36.0
Woodruff (2014)		WR, RF	HW, S, SC	67	4–5	17.0

CW Class-wide instruction; *G/S* Grammar/syntax; *HW* Handwriting; *LN* Letter name recognition; *LS* Letter sound recognition; *PA* Phonemic awareness targeted; *PC* Passage construction; *RC* Reading comprehension; *RF* Reading fluency; *S* spelling; *SC* Sentence construction; *V* Vocabulary; *WP* Writing process (e.g., planning, editing, self-regulation); *WR* Word reading

[a]Studies marked with an × in this column addressed phonemic awareness as part of a word reading or spelling activity, or as a separate activity

[b]Percent writing time calculated based on the number of writing activities divided by total activities

of instructional time was spent writing. Average instructional dosage was 38.3 h ($SD = 69.8$). Most treatments had ≤ 5 students per group ($n = 12$); four were class-wide. Included reading outcomes were: word reading ($k = 34$), phonemic awareness ($k = 16$), reading comprehension ($k = 10$), letter name or sound knowledge ($k = 6$), reading fluency ($k = 3$), reading achievement ($k = 2$), and vocabulary ($k = 1$). For transcription interventions, almost all outcomes were foundational ($k = 35$, 97%).

Table 3 Subset variable effect size analysis

Variable	*k*	*n*	*g*	95% CI	*df*	I^2 (%)
Instructional group size[a]						
≤ 5 students	50	7	0.30*	0.13, 0.46	3.54	34.95
> 5 students	22	12	0.27	0.07, 0.46	4.27	48.77
Instructional dosage						
≥ 10 h	43	11	0.27	0.06, 0.48	3.60	54.83
< 10 h	29	8	0.27*	0.14, 0.41	4.76	23.26
Instructional focus						
Transcription	36	9	0.47**	0.36, 0.59	3.75	< .001
Multicomponent or text generation	36	11	0.11*	0.05, 0.17	3.24	47.24
% instructional time writing						
50–74.9%	47	11	0.27	0.07, 0.47	4.14	56.25
≥ 75%	25	9	0.25*	0.11, 0.38	5.77	< .001
Comparison condition						
Reading treatment	44	11	0.23	-0.07, 0.52	4.96	< .001
Control	28	19	0.35**	0.19, 0.50	5.33	29.32
Grade level						
Pre-K to 2	56	12	0.29*	0.09, 0.49	4.47	42.90
3 to 5	16	7	0.22	0.03, 0.41	3.38	57.80
Reading outcome type						
Foundational	59	15	0.30*	0.13, 0.48	6.01	44.30
Meaning	13	8	0.15	0.01, 0.30	4.59	43.57

k number of effect sizes, *n* number of studies. Effect sizes and standard errors reflect robust variance estimates. Subset effects with $df < 4$ are not reliably estimated

*$p < .05$, **$p < .01$, ***$p < .001$

[a]Instructional group size is the maximum number of students per group

Table 4 Results from metaregression moderator analysis

Moderator	Model 1	Model 2
Intercept	0.27 (0.074)**	0.29 (0.106)
Transcription focus		0.51 (0.087)*
≥ 75% writing time		-0.09 (0.104)
Reading treatment comparison		-0.37 (0.176)
I^2	45.16%	0.01%

$N = 19$; $k = 72$. Model 1 summary effect size; Model 2 metaregression moderator analysis. Effect sizes and standard errors reflect robust variance estimates. All estimates have ≥ 4 degrees of freedom

*$p < .05$, **$p < .01$, ***$p < .001$

Most multicomponent or text-generation treatments also had foundational reading outcomes ($k=24$, 67%). Most measures were standardized ($k=56$, 78%).

Effects of writing instruction on reading outcomes

For our first research question, the weighted mean effect size for writing instruction was $g=0.27$ ($k=72$, [0.13, 0.41],[1] $p<0.01$). For our second research question, we examined whether intervention intensity led to descriptively different subset effects. Instruction with ≤ 5 students per group had a significant positive effect ($g=0.30$, $k=50$, [0.13, 0.46], $p<0.05$); however, this effect was not reliable ($df<4$) and should be interpreted with caution (Tipton, 2015). Groups of >5 students had a reliable, nonsignificant effect ($g=0.27$, $k=22$, [0.07. 0.46], $p=0.51$). Instruction lasting ≥ 10 or more hours had a nonreliable effect ($g=0.27$, $k=43$, [0.06, 0.48], $p=0.08$); <10 h had a reliable and significant effect ($g=0.27$, $k=29$, [0.07, 0.41], $p<0.05$).

For our third research question, we examined whether reading effects were moderated by other instructional factors. Transcription instruction was associated with significantly larger effects than multicomponent or text generation instruction ($\beta=0.51$, [0.34, 0.68], $p<0.01$). Percent of instructional time spent writing did not moderate effects, with 75% or more instructional time not significantly associated with smaller effects ($\beta=-0.09$, [−0.29, 0.11], $p=0.40$). Comparing writing instruction to reading treatments did not result in significantly smaller effects than comparing writing instruction to control conditions ($\beta=-0.37$, [−0.71, −0.03], $p=0.10$). The I^2 was 0.01%, indicating almost all heterogeneity of effects was accounted for.

To explore specific effects of moderator variable categories, we calculated subset effects. Both transcription and multicomponent or text generation instruction had significant effects ($g=0.47$, $k=36$, [0.36, 0.59], $p<0.01$; $g=0.11$, $k=36$, [0.05, 0.17], $p<0.05$, respectively), but neither effect was reliable. Instruction with $\geq 75\%$ writing time had a significant effect ($g=0.25$, $k=47$, [0.07, 0.47], $p<0.05$); instruction with $<75\%$ writing time did not ($g=0.27$, $k=25$, [0.11, 0.38], $p=0.05$). Writing instruction had a significant effect on reading when compared to control conditions ($g=0.35$, $k=28$, [0.19, 0.50], $p<0.01$), but not when compared to reading treatments ($g=0.23$, $k=44$, [−0.07, 0.52], $p=0.19$).

Additional exploratory subset analyses indicated that writing instruction was effective for students in pre-K–2 ($g=0.29$, $k=56$, [0.09, 0.49], $p<0.05$), but the effect for grade 3–5 was not reliable ($g=0.22$, $k=16$, [0.03, 0.41], $p=0.10$). Writing instruction had significant positive effects on foundational reading outcomes ($g=0.30$, $k=59$, [0.13, 0.48], $p<0.05$) but not meaning-related reading outcomes ($g=0.15$, $k=13$, [0.01, 0.30], $p=0.09$).

[1] Square brackets signify 95% confidence intervals.

Discussion

The aim of this meta-analysis was to examine the effects of writing instruction on the reading outcomes of pre-K–5 students with literacy difficulties. A meta-analysis of 19 studies and 72 effects indicated a small, significant positive effect on reading in English. Subset analyses could not reliably indicate whether more intensive instruction (higher dosage or smaller group) was descriptively more effective. Our moderator analysis revealed that transcription instruction was associated with significantly larger effects than multi-component/text generation instruction. In the following sections, we discuss the extent to which our findings align with theory and previous research on reading-writing co-development and implications for designing early and elementary literacy interventions to support reading outcomes.

Effects of writing instruction on reading

The overall positive effect ($g = 0.27$) is similar to prior meta-analyses of the effects of writing instruction on reading outcomes across developmental stages ($ES = 0.22$–0.44; Graham & Hebert, 2011; Graham & Santangelo, 2014). The positive effect aligns with theory and correlational evidence suggesting that reading and writing are connected for young students with and without literacy difficulties (e.g., Ahmed et al., 2014; Berninger, 2001; Kim, 2022). The smaller effect is somewhat unexpected, given that these students are often still acquiring highly connected, lower-level literacy skills (Katzir et al., 2006; McNeill et al., 2017) and may also benefit from the applied practice opportunities that writing provides (Fuchs et al., 2018; Graham, 2020). However, young students with literacy difficulties often experience less growth during literacy instruction than their same-age peers (e.g., Stanovich, 1986), suggesting that this smaller effect is still educationally meaningful.

We hypothesized that more intensive writing instruction would produce descriptively larger subset effects than less intensive instruction. This hypothesis was informed by research indicating benefits for struggling readers and writers (Jung et al., 2017; Wanzek & Vaughn, 2007). Meta-analytic evidence also suggests that smaller group reading instruction yields larger subset effects for these students (Donegan & Wanzek, 2021), likely due to increased practice and feedback opportunities (Fuchs et al., 2018). Because effects of instruction delivered in groups of ≤ 5 students and for ≥ 10 h could not be reliably estimated, meaningful comparisons between categories could not be made. Yet, the non-reliable positive effect of instruction in groups of ≤ 5 students suggests that connections between this facet of writing instructional intensity and reading outcomes should be explored further.

Moderators of writing instruction effects

This meta-analysis extends previous research by exploring moderators of writing effects for a younger, high-need population. First, prior meta-analyses focused on

the effects of transcription and text generation instruction on reading outcomes separately (Graham & Hebert, 2011; Graham & Santangelo, 2014). In this meta-analysis, instructional focus moderated effects, with stronger effects from transcription instruction. This finding aligns with the IDLM (Kim et al., 2020), which posits that the strength of relations between reading and writing skills vary by skill grain size. Lexical difficulties often result from shared sublexical difficulties, while discourse-level difficulties may stem from challenges related to lexical skills, oral language, higher-order cognitive processes, or background knowledge (Berninger et al., 2001; Katzir et al., 2006). Consequently, reading comprehension and written composition difficulties are connected but may be more independent (Kim et al., 2018; Tortorelli & Truckenmiller, 2023). In line with this hypothesis, correlations among sublexical and lexical skills are stronger than sentence- and discourse-level skills for elementary students with literacy difficulties (e.g., Berninger et al., 2001; Raskind et al., 2000). Most student participants were eligible based on sublexical and lexical difficulties and were therefore particularly suited for transcription instruction. It is important to note, however, that most transcription treatments focused on spelling rather than handwriting, suggesting that the former may have driven this increased effect. Transcription instruction also typically targeted pre-K–2 students and foundational reading outcomes, leaving uncertainty about its impact on upper elementary students or higher-level reading skills.

Comparison condition type did not moderate effects, contrary to our hypothesis. We anticipated that comparisons between writing and reading instruction would be associated with significantly smaller effects than writing and control condition comparisons. In other words, students in reading comparison conditions would perform substantially better than control students. This lack of moderation can be further contextualized by our non-significant subset effect size for writing versus reading instruction. Logically, reading would yield greater effects than writing (i.e., negative *g*), given that successful early reading intervention requires direct instruction (e.g., Swanson, 1999), as reading and writing are not identical processes (e.g., Shanahan, 2016). This non-significant finding suggests that factors beyond the domain of literacy instruction contribute to its effectiveness for this population.

A higher percentage of writing time was also not associated with diminished impacts on reading. This finding differs from a previous meta-analysis, which found that instruction with equal reading and writing time improved reading more than writing-focused instruction (Graham et al., 2018). It also builds upon the implications of our other non-significant moderator, comparison condition, by suggesting that factors beyond the domain of literacy instruction *and* time devoted to each domain may influence reading effects for students with literacy difficulties. These factors may include treatment fidelity, which was not consistently measured, or explicitness of instruction. Explicit writing interventions can be more effective (e.g., Gersten & Baker, 2001; Gillespie Rouse & Graham, 2014) than the incidental approaches used in some studies in this meta-analysis (e.g., Craig, 2006; Sénéchal et al., 2012; Thompson, 2015). Making writing-to-reading connections explicit may also support struggling students in understanding how skills are related, promoting transfer effects (Graham, 2020).

Limitations

These findings must be considered in light of several limitations. First, funnel plot asymmetry could be explained by instructional focus, but there were insufficient studies to examine moderators of transcription and multi-component/text generation instruction separately. Second, the small number of studies precluded the exploration of additional moderators, such as writing instruction strategies. Third, the scope of students' literacy difficulties was unknown in many cases. Many students screened in one domain likely had difficulties in the other, but not all students with writing difficulties struggle in reading (e.g., Costa et al., 2016). Included students may therefore represent distinct profiles of need who may benefit differently from writing instruction for reading. However, because these profiles are unknown, this hypothesis cannot be tested. Finally, three treatments in this meta-analysis allotted equal time to reading and writing (Edwards, 2001; Mason et al., 2013; Simmons et al., 2007). As a result, reading and/or writing instruction could be responsible for reading effects from these studies. However, three of four experimental contrasts used a reading-only comparison condition that was identical to the reading portion of the writing treatment, potentially isolating an effect of writing.

Implications for practice

For teachers and teacher educators, it is important to emphasize that our results do not suggest that writing interventions can supplant reading interventions. Instead, trends in the literature suggest that writing may have a unique benefit for reading for young students struggling with literacy. Considering overlaps between variables mentioned previously, their pre-K–2 students who struggle with sublexical and lexical skills may benefit from an intervention where 50% or more of instructional time is spent teaching or providing opportunities to practice spelling. However, teachers must also address the full scope of their students' writing difficulties as the ability to generate meaningful text is a critical skill in its own right (NCW, 2003).

Given the challenge elementary teachers face in making time for writing instruction or interventions (e.g., Coker et al., 2016), they might first consider implementing simple instructional routines to incorporate transcription into reading interventions before beginning writing interventions. For instance, in letter-sound instruction, teachers can have students handwrite letters as they say their sounds (e.g., Simmons et al., 2007; Thompson, 2015). Alternatively, teachers can reinforce decodable word reading through explicit spelling instruction that incorporates phonemic awareness (e.g., Graham et al., 2002). Once teachers are prepared to prioritize writing, they can monitor students' progress in targeted reading and writing skills and adjust reading and writing time accordingly. Instructional leaders may take more advanced steps, such as selecting multicomponent writing intervention programs that include research-based practices (McMaster et al., 2018) and ensuring that teachers have sufficient training and resources to support their students struggling with reading and writing (Graham et al., 2023).

Directions for research

The comprehensiveness of our findings was limited due to a small number of studies, suggesting that continued research is needed. Many writing intervention studies were excluded because reading outcomes were not measured. In the future, researchers can use reading-writing skill correlations from prior meta-analytic research (Kim et al., 2023) to select reading outcomes that are closely and distally related to the writing skills targeted in their intervention.

Research that includes reading outcomes could prompt future meta-analyses that examine whether struggling upper elementary students benefit from transcription instruction in terms of reading. Upper and lower elementary students with literacy difficulties face comparable transcription challenges (Graham et al., 2020), yet only one study in this meta-analysis examined the impact of transcription instruction on reading for upper elementary students (Berninger et al., 2002). Continued research may lead to meaningful comparisons between effects for younger and older students with similar sublexical or lexical difficulties. These insights may inform theory on dynamic reading-writing relations and how age and literacy difficulty interact and influence the benefits of writing instruction for reading outcomes (Kim, 2022).

Importantly, students with a range of disabilities were included in this meta-analysis, and in some studies, specific disabilities were not reported. Students with different disabilities can experience reading or writing difficulties that emerge from various sources (Adi-Japha et al., 2007; Georgiou et al., 2021), and may benefit from writing support targeting reading to different extents. In a future meta-analysis with a larger pool of studies, researchers may examine whether reading outcomes vary depending on students' specific disabilities. These findings could inform how special educators can efficiently support the diverse literacy needs of their students.

Continued efforts are also needed to understand how text generation instruction impacts reading for students who are often just beginning to grasp discourse-level skills. Multicomponent or text generation instruction resulted in significantly smaller effects than transcription instruction. Also, writing instruction – typically multicomponent or text generation instruction – did not have a positive subset effect on meaning-related reading outcomes. By building the literature base, future meta-analyses may identify whether research-based text generation practices for struggling writers, such as sentence construction (Datchuk et al., 2022; McMaster et al., 2018) and Self-Regulated Strategy Development (Sun et al., 2022), also have transfer effects on reading, particularly at the sentence and discourse levels.

Conclusion

Informed by theories of reading-writing development and prior literacy intervention syntheses, this meta-analysis indicates that there are potential benefits of writing instruction, particularly transcription instruction, on the reading of pre-K–5 students with literacy difficulties. Yet, continued research is needed to understand if more intensive instruction is more effective, and as well as impacts on upper elementary students and meaning-related reading outcomes.

It is our hope that these continued efforts will not only explore the role that writing instruction can play in remediating and preventing literacy difficulties but also highlight the importance of writing as a critical component of literacy development.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11145-024-10527-6.

Declarations

Conflict of interest We have no known conflict of interest to disclose.

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