Home Learning Environments and Children's Language and Literacy Skills: A Meta-Analytic Review of Studies Conducted in Low- and Middle-Income Countries

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Abstract

A robust finding from research in high-income countries is that children living in resource-poor homes are vulnerable to difficulties with language and literacy but less is known about this association in low- and middle-income (LMI) countries. We present a meta-analysis of 6,678 correlations from studies in 43 LMI countries. Overall, the results indicate a small but significant association (r = .08) between home language and literacy environment and children's language and literacy skills. After examining a range of moderators, adult literacy practices and books at home had a significantly larger association with children's language and literacy skills than did home tutoring. Studies using customized measures demonstrated a more marked association between home attributes and children's outcomes (r = .14) than studies using a common measure across multiple sites (r = .06). Published studies showed significantly larger associations than unpublished studies, and countries with greater income inequality showed a larger association than relatively egalitarian societies. We conclude that the small overall association should not be taken as support for the absence of, or a vanishingly small relationship between the home learning environment and children's language and literacy skills in LMI countries. Rather, an important factor in detecting this relationship is that assessments must better reflect the nature of homes in different cultures to capture true variation in the population. Such contextually situated measurement would lead to an inclusive conceptualization of home learning environments and can better inform intervention programs to enhance children's educational success, a critical target for many LMI countries.

Keywords: home language and literacy environment, language skills, literacy skills, low- and middle-income countries, meta-analysis

Public Significance Statement

Studies demonstrate that resource-poor homes render children vulnerable to difficulties with language and literacy. Here we summarize data from studies conducted in low- and middle-income countries. Our meta-analysis (based on 6,678 correlations; from 43 low- and middle-income countries) shows a small but significant association between the language and literacy learning environment in children's homes and their language and literacy skills. The association is more marked for the adult literacy practices and book resources in the home than for home tutoring, and when studies use locally-situated measures. These socio-cultural and measurement factors are crucial to consider in designing studies in low- and middle-income countries where many children are behind in literacy learning.

Home Learning Environments and Children's Language and Literacy Skills: A Meta-Analytic Review of Studies Conducted in Low- and Middle-Income Countries

Poorly developed language and literacy skills make children more vulnerable to later unemployment, lower participation in society, and they also compromise personal life outcomes in general. Because a substantial number of children fail to meet minimum proficiency standards in literacy despite school participation (e.g., UNESCO, 2012; UNESCO Institute for Statistics, 2017), the United Nations (2014) Goals for Sustainable Development has made acquiring literacy skills a priority. Evidence from high-income countries indicates that children living in resource-poor homes are particularly vulnerable to difficulties with language, reading, and writing (e.g., Frijters et al., 2000; Levy et al., 2006). In the current meta-analysis based on studies conducted in 43 low- and middle-income (LMI) countries, we aim to examine the extent to which this relationship also applies in these countries.

It is well established that the environments in which children develop are major determinants of their educational achievement, and the home learning environment seems particularly critical in the preschool and early school years (Frijters et al., 2000; Levy et al., 2006; Niklas et al., 2015; Park, 2008; Phillips & Lonigan, 2005; Spratt et al., 1991). However, understanding the long-range effects of children's homes on their educational success is not straightforward (e.g., Crookston et al., 2014). In a bioecological framework (Bronfenbrenner & Ceci, 1994; Bronfenbrenner & Morris, 2006), child outcomes depend on a myriad of bidirectional factors relating to the child and the environment at different levels. "Distal" environmental factors that drive educational success include the quality of schooling, which depends on available resources, education policies, and cultural interpretations of valuable teaching practices (Nag et al., 2016; Parry et al., 2014). Closer to the child are factors relating to the home. Notably, for children who live with their

biological families, these factors strongly reflect gene-environment correlations more than any other ecological system to which a child is exposed.

To date, systematic reviews on the associations between home learning environments and child attainments have focused on studies from high-income countries (e.g., Dong et al., 2020; Manz et al., 2010; Sénéchal & Young, 2008), reflecting a wider trend in scientific publishing: A 2008 survey of top psychology journals found that 96% of samples in published articles were from Western, industrialized, educated, and rich countries (Henrich et al., 2010), and a survey reported a decade later found the skew remained, with results continuing to be interpreted in 'an unreflective way' (Rad et al., 2018). The underrepresentation of diverse contexts highlights questions concerning the applicability of theoretical models of the home learning environment to non-Western, non-industrialized, not formally educated, poor homes in which most of the world's children reside. Two reviews of this literature (35 studies: Nag et al., 2019; 18 studies: Zuilkowski et al., 2019) provide valuable insights but a meta-analytical synthesis is still not available.

Here, we present a systematic review of the literature conducted in LMI countries that provides an overview of the associations (correlations) between home learning environment, language, and literacy, as well as their moderators. The dynamics of languages in the child's environment are as critical as the literacy-related resources and practices in the home, both are studied together in the present review under the construct of the Home Language and Learning Environment (HLLE). The meta-analysis has a broad scope and investigates core constructs in relation to HLLE indicators of language and literacy. For the study of language and literacy skills, we initially focus on the language skills that create the foundation for later literacy skills and are critical for general communication, such as vocabulary and listening comprehension (Lervåg et al., 2018; Snowling & Hulme, 2021). We proceed to consider emergent literacy skills–a construct

that is often used to describe the reading and writing experiences of young children before they learn to write and read conventionally and typically includes such skills as name writing, letter naming, and awareness of the sounds in words (phonological awareness). As for more established literacy skills, we consider list reading, the ability to decode lists of words accurately, and text reading fluency (the ability to read with speed, accuracy, and proper expression). Finally, we assess reading comprehension–- the ability to extract meaning from text. Reading comprehension is the product of language and decoding—and the primary goal of literacy instruction (Gough & Tunmer, 1986).

Although correlations do not imply causation, clarifying the magnitude of correlations and potential moderators is a crucial first step toward determining pathways of influence. Another initial step is clarifying whether the construct of the home learning environment and its association with language and literacy in the contexts seen in LMI countries maps onto that reported in the wider literature (Nag et al., 2019). Together, these findings will aid the development of an inclusive conceptualization of the home learning environment.

Home Environment as a Context for Language and Literacy Learning: Theoretical Frameworks

We are guided by a theoretical framework proposed by Nag et al. (2019) in which the attributes of the home were inductively derived from ethnographic, multifactorial, and mixed-methods studies in LMI countries. Within this framework, homes may be characterized for the books, tutoring, and adult literacy practices found in the home, and whether there is a match or mismatch between the home language and the language(s) the child must learn in school. As shown in Table 1 (middle panel), a variety of measures are subsumed under these four home attributes. Examples include the number of books at home, who tutors the child, parents' values and expectations toward education, and match-

mismatch in the language of assessment and the child's home language. Many of these attributes were found to be defining characteristics of homes and home-school connections across multiple country contexts. More details of the framework are discussed in the following sections.

Sénéchal and LeFevre (2002) proposed a highly influential framework that has guided significant research on home learning environments. In this model informal and formal home-based literacy interactions are distinguished. In informal interactions, parents and children share interactions including 'talk' with books, typically without reference to printed words. Such shared reading provides an important context for language learning and vocabulary growth. In contrast, in formal reading interactions, adults may be involved in direct instruction about print concepts and skills directly related to understanding how a writing system (print) captures language as well as providing copywriting practice. Evidence suggests that, whereas informal practices, such as shared reading in the home, predict language and reading comprehension, direct instructional practices such as teaching phonics predict code-based skills, including decoding (e.g., Martini & Sénéchal, 2012; Sénéchal, 2006; Sénéchal & LeFevre, 2014; Sénéchal et al., 2017). The evidence regarding the specific pathways of influence of the HLLE from diverse contexts is more mixed. Indeed, cultural variation is to be expected and it is also possible that these pathways will vary according to the writing system being used, particularly for the content of formal instruction to teach concepts about print (e.g., Dulay et al., 2019; Kalia & Reese, 2009; Kim, 2009; Krijnen et al., 2020; Manolitsis et al., 2011). The current meta-analysis will examine the Sénéchal and LeFevre Model (2002) against a range of home contexts using the Nag et al. (2019) framework derived from research in LMI countries.

The bioecological framework (Bronfenbrenner & Ceci, 1996) presents multiple levels of influence; at the macro level, there are laws, economic, and sociopolitical

systems. Nested within the macrosystem is the microsystem, with the influence of the home and school. Between macro- and microlevels is the mesosystem, with interactions between key constituents within and across all levels (Bronfenbrenner & Morris, 2006). Taking one aspect of the HLLE—shared or storybook reading—and with a focus on the person and the micro-system, Grolig (2020) conceptualized the nature, frequency, and quality of literacy-related interactions as depending on so-called resource characteristics of the adult, the book, and the child. Specific to the adult, resources hinge on socioeconomic status (SES) and level of education and are embedded in sociocultural practices and values, languages of the home, and adult literacy practices (e.g., Buckingham et al., 2014; Dulay et al., 2018; Heath, 1982; LeVine et al., 2012; Parry et al., 2014; Vagh, 2009). In contrast, the idea of books as a resource includes conceptions of access to print and other media, the number of books in the household (e.g., Vagh, 2009; Yu & Thomas, 2008), and the encounters with rich language that books can provide (Dawson et al., 2021; Nag, 2021). At the level of resources and the child, Whitehurst and Lonigan (1998) made a useful contrast between outside-in skills, which include language and the conceptual knowledge necessary to engage meaningfully with texts, and inside-out skills, which are directly related to translating writing into spoken words, such as letter knowledge and phonological awareness (code-related skills). Together, inside-out and outside-in skills are critical determinants of learning to read. Indeed, evidence suggests that decoding and language comprehension explain over 99% of the variation of initial levels in text comprehension—the main goal of learning to read—although their relative importance differs across development and writing systems (Foorman et al., 2018; Hjetland et al., 2019; Ho et al., 2017; Lervåg et al., 2018; Vagh & Sharma, 2018). The evidence on how children's skills predict their literacy abilities will inform the selection of outcome variables for our meta-analysis. In addition, we will examine all levels of the bioecological model, including the

largely understudied macrosystem in the context of associations between home learning environments and child attainments.

Home Attributes in Relation to Language and Literacy Skills in High-Income Countries

Studies of the home language and literacy environment in high-income countries have focused on a wide range of factors, typically operationalized in measures derived from questionnaires to clarify the amount of shared reading in the home, the number of children's books, parental leisure habits, and the frequency of library visits and/or other literary pursuits. A rich language and print environment at home, defined according to these measures, is associated with higher skills in language and literacy in children both cross-sectionally (e.g., Hart & Risley, 1995; Hood et al., 2008; Inoue et al., 2018; Kim, 2009; Sénéchal et al., 1998; Tabors et al., 2001; Zucker et al., 2013), and longitudinally (e.g., Hamilton et al., 2016; Sénéchal & LeFevre, 2014; Storch & Whitehurst, 2001).

Although it is likely that self-reported measures of the home learning environment are prone to social desirability effects (see Vesely & Klöckner, 2020), the three HLLE dimensions in the Nag et al. (2019) framework (books at home, home tutoring, and adult literacy practices) are significant predictors of individual differences in children's language and literacy skills. Four meta-analyses attest to this. At the level of books at home, Bus et al. (1995; 34 studies) showed that the frequency of book reading to preschoolers has a small to moderate correlation, $r = .26$, with oral language skills, emergent literacy, and reading achievement. Another meta-analysis on the association between home tutoring/parental involvement and achievement (Castro et al., 2015; 37 studies), in contrast, showed a small overall association, $r = .12$. A more recent meta-analysis from high-income countries showed overall positive correlations between home attributes and children's reading comprehension; the mean correlation was small to moderate, $r = .32$

(Dong et al., 2020; 59 studies). Two home attributes—adult literacy practices and books-at-home —contributed in different ways: Parents' involvement and parental literacy beliefs had a significantly higher correlation with children's reading comprehension than home literacy resources.

Finally, an important consideration is the match or mismatch between home language and school language because attributes of the home often reconfigure to address demands from the school (the meso-system). A meta-analysis examining the home literacy environment and its association with second language learning (Dong & Chow, 2022; 18 studies) reported a small to moderate effect size, $r = .32$. Here, direct teaching from parents (home tutoring) had larger effects on children's second language learning than did either parental beliefs (adult literacy practices) or books at home.

In summary, although the availability of literacy-related resources is important, data from high-income countries suggest that what adults do with resources is a key home attribute. The importance of quality interactions in the HLLE is further confirmed by meta-analyses of randomized controlled trials, which show large effects (Dowdall et al., 2020; Heidlage et al., 2020).

Home Attributes and Language and Literacy Skills in Low- and Middle-Income Countries

This section is again structured around the four dimensions of the home within the Nag et al. (2019) framework: Books at home, home tutoring, adult literacy practices, and the match-mismatch in home-school languages. The frequently studied of these is the books-at-home dimension, incorporating the number of books at home and engagement with them. Ethnographic studies reveal much variation in dimensions of the home; for example, there may be few or no books at home, low or no interactions around print, and fluency in the school language within the home may be limited or absent (Azuara, 2009;

Parry et al., 2014). Very few studies have examined the causal effects of parental interventions targeting children's literacy in these contexts, but available evidence suggests effects, albeit small (e.g., Kağitçibaşi et al., 2009; Kim et al., 2020).

Multi-country studies provide further information. In a comparison spanning high-income and LMI countries using a common set of measures, Park (2008) showed that early home literacy activities, parental attitudes toward reading, and number of books at home were positively related to children's reading performance, but the strength of these associations varied by country. A contrasting finding reported by Smith and Barrett (2011) from a study of 10 African countries is that, irrespective of the economic wealth of a country, its population size, and ranking based on the Human Development Index (a summary of a country's life expectancy, educational level, and standard of living), the availability of books and other literacy artifacts was a predictor of performance on grade-level language tests. Furthermore, book use (indicated by the item "parents read to child often" vs. "not at all") in Latin America was positively associated with grade-level language tests in 11 countries, although the association reached significance in only five countries (see Willms & Somer, 2001, for further discussion). Thus, the trends in the LMI country literature confirm varying effects of the home on children's attainments, leading to the question of whether the pattern and size of effects are similar to those in high-income countries.

The diversity of outcome measures and study methodologies in the review of books at home, engagement in books, and children's language and literacy attainments in LMI countries by Nag et al. (2019) precluded statistical synthesis. However, Zuilkowski et al. (2019), using comparable measures from 18 project sites of the humanitarian agency Save the Children, showed that SES, frequency of reading and engagement in literacy activities with the child at home, and home reading materials were related but separate constructs.

Whereas materials in the home was a moderately strong predictor of early reading, frequency of reading and other literacy activities were not. These findings contrast with those from the meta-analytic review by Dong et al. (2020) on high-income countries, in which materials in the home had the smallest association with children's reading comprehension, smaller even than the frequency of book reading. These mixed trends highlight issues concerning how home attributes are measured and whether they give similar information in different countries. The findings also suggest that rather than focusing exclusively on formal and informal literacy-supporting activities (after Sénéchal & LeFevre, 2002), access to books at home, needs to be taken into account in models of the HLLE.

Home tutoring is another attribute with mixed findings. In a 10-country analysis by Smith and Barrett (2011) examining the association between home tutoring and reading comprehension, positive associations were found in nine countries (but only three of these were statistically significant); in one country, the association was negative. Although positive associations suggest that home tutoring can be enabling, negative associations may result when struggling readers receive the tutoring (Smith & Barret, 2011; Vagh, 2009; Willms & Somer, 2001), and null findings may be driven by a combination of both trends. In addition, there is ethnographic evidence of processes that may be left unmeasured in studies of home learning environment: Tutoring may mimic ineffective classroom practices by only engaging children passively (Akrofi, 2003; Kvalsvig et al., 1991) or falter because of the parent's lack of fluency or literacy in the school language (e.g., Azuara, 2009; Rolleston & Krutikova, 2014), explaining why the expected boost in child outcomes is not seen.

Finally, adult literacy practices refer to reading and writing habits among family members, values and expectations toward education, and access to technology and media,

such as TV, radio, and computers. As yet, there are few studies and no meta-analyses from LMI countries that can inform us about how adult literacy practices relate to children's language and literacy skills. Still, some of the indicators related to adult literacy practices overlap with measures that are often used as indicators of SES (e.g., access to books and technology). One meta-analysis showed a small correlation, $r = .11$, between SES (including access to books and information technology) and children's literacy skills (Kim et al., 2019; 47 studies).

In summary, there is a need for further research to better understand the associations between diverse home learning environments and children's outcomes, as well as the moderators of these associations. In parallel, there is a need to investigate the sensitivity of measures to diverse home learning environments. The variety available in LMI countries is ideal for such a study.

Factors Explaining Associations Between Home Attributes and Language and Literacy Skills in Low- and Middle-Income Countries

Previous findings across countries globally suggest that different home attributes relate differentially to different language and literacy outcomes. Thus, the primary moderators to be considered in the current meta-analysis are: (a) type of home attribute and (b) type of language/literacy skill. In line with the Nag et al. (2019) HLLE framework, the home attributes investigated are: (a) books at home including engagement with books, (b) home tutoring, (c) adult literacy practices, and the match-mismatch in home-school languages is assessed as a moderator. Criteria for adopting measures of these constructs are outlined in the method section and in Table 1. For type of language/literacy outcome, we evaluated: (a) language, (b) emergent literacy, (c) list reading, (d) text reading fluency and (e) reading comprehension.

We also consider several secondary moderators related to study context and study

methodology. Following the bioecological framework, we examine the person characteristics of age and grade. Interactions between the home and school are part of the mesosystem, and country-level characteristics of wealth inequality and geographical region are part of the macrosystem. We examine these person-, meso-, and macro-system moderators because they can affect not only the home but also the opportunities available for the child.

Given the distinct differences between high-income and LMI countries, and that our intent is to examine the conceptualization of home factors broadly, we investigate the assessment framework of studies as a moderator. The sensitivity of measures is also an important moderator. Thus, we examine floor effects in the measurement of home attributes and language and reading skills, and the variability of SES.

Contextual Moderators

Age and Grade Level. We examine both age and grade level because in LMI countries, these do not necessarily correspond; children may start school at different times or have interruptions in their schooling. Evidence from primary studies of books at home shows a tendency for the association with language and literacy to increase with age. Both child age and grade level could be potential moderators for the effect of several home attributes. For example, several studies find positive associations between home attributes (e.g., frequency of reading books outside school, number of books at home, book borrowing from school) and grade level tests in the later grades (grade 5: Rolleston & Krutikova, 2014; grade 6: Yu & Thomas, 2008). In contrast, in kindergarten-aged children, one study in an urban, high-poverty site in India (Vagh, 2009) found nonsignificant associations between a composite measure of books at home (number of children's books owned, frequency of book reading, frequency of borrowing books from the library) and children's language and emergent literacy skills. A similar pattern was also found in a

semirural site in Bhutan (Wuermli, 2016). For adult literacy practices, there are fewer studies of older children, but the trends are clear for preschool and the early grades: Adults' attitudes toward education are significantly associated with different component skills of language and literacy (Aturupane et al., 2013; Huang, 2009; Wagner, 1993). As for home tutoring, the association with age and grade level is less clear, and there are few studies of this dimension of the home in LMI country contexts.

Home-School Language Status. The language in which the attributes of the home are transacted is an important consideration. Using a different language in school than at home could also affect the size of the correlations between home attributes and child language and literacy outcomes in the school language. For instance, there is ample evidence to suggest that being taught in school in a language different from the home language can lead to lower attainments in the school language (Melby-Lervåg & Lervåg, 2014). Nevertheless, contextual factors, such as lower quality instruction in the home language or high quality instruction in the school language, can attenuate a home language advantage (Nag et al., 2019). Thus, the arguments for a home language advantage are not straightforward; and, the match between the language(s) in which children are assessed (the school language(s)) and their at-home language is a potentially important moderator.

Socioeconomic Variability. Socio-economic status (SES) is measured through multiple indicators including quantum of household assets, parental education and occupation level, and income. Socio-economic factors can affect child outcomes both directly and through the resources and capabilities available to their families (see, e.g., Elder & Caspi, 1988; Sen, 2009). There are two robust findings regarding the association between socioeconomic background, home attributes, language and literacy. First, the SES of a household is a predictor of children's learning outcomes (Aturupane et al., 2013; Psacharopoulos et al., 1993; Yu & Thomas, 2008). Second, SES correlates with home

attributes (Alcock et al., 2010; Dulay et al., 2018) and hence, variability in socio-economic status in a study sample could be an important moderator variable. Indeed, the extent of variation in socioeconomic indicators is an important predictor of the size of the correlation between home attributes, language attainments, and literacy attainments: If there is little variation in SES background, this will affect the variation in both home attributes and language and literacy, as well as weakening the association between them (Mendive et al., 2020).

Wealth Inequality in the Country. The distribution of wealth across a country—that is, income inequality—could also account for variation in the correlation between home attributes and language and literacy. There is considerable international evidence arguing for a policy focus on drivers of inequalities in educational success, although countries have often fallen short in staying targeted when it comes to supporting the most disadvantaged (Kintrea, 2021; Rose et al., 2017). Only a handful of studies have examined country-level inequality indicators in relation to home attributes and children's learning. For instance, Park (2008) found that the strength of the association between home attributes and children's language and literacy skills varied greatly between countries. Such variation between early home literacy and parental reading attitudes could be explained, at least in part, by the level of economic development of the country investigated, although the mechanisms that underpin the associations are under-theorized.

Geographical Region. Another factor that could affect the size of the correlation between home attributes and language and literacy is the geographical region in which the study has been conducted: Countries differ in economic development, and LMI countries tend to cluster within geographical regions. Views of childhood, child rearing, or value for formal school achievement filter through to factors in the home, such as the importance of print, respect for educators, and the level of school absence; these may also cluster within

regions and sub-regions (e.g., for a discussion about Asia, see Cheung et al., 2021). In turn, school systems in different regions are likely to differ in education policies, resource constraints, and quality of instruction (Blömeke et al., 2016). Since all of these factors could potentially lead to attenuation of the correlation between home attributes and language and literacy outcomes, regional differences are considered as a macrolevel moderator. At a practical level, information from countries grouped by region aligns with the administrative framework commonly used for investment and development aid for children's learning in LMI country contexts (e.g., World Bank, 2021).

Methodology-Related Moderators

Assessment Framework. To examine the correlation between home attributes and children's language and literacy, data may be collected using different assessment frameworks. A customized framework may be developed for an individual research site. Thus, in such studies, the design and data collection tool are often adapted and/or developed by the researchers for a specific site. In contrast, another type of data comes from assessment frameworks that are applied to multiple research sites by a single research team or organization. It can be argued that customized measures are bespoke and so can be more sensitive to a country context relative to common multisite frameworks. In turn, the type of assessment framework could affect study outcomes. In this review, the availability of multiple studies conducted by single research teams or organizations allows the inclusion of the assessment framework—site-specific (customized) versus multisite—as a unit for moderator analysis.

Restriction of Variation in the Data. Another important factor that may relate to differences in the magnitude of correlations between studies is whether there is restricted variation in the data. Floor effects in measures are particularly relevant in relation to parental questionnaires of home attributes and tests of language and literacy skills and

could attenuate correlations. It is particularly important to review restricted data because measures may not have been chosen or tailored to the contextual realities of the research site in LMI countries (Henrich et al., 2010; Nag et al., 2019). Two aspects are examined:

- *Floor effects for home attributes:* Floor effects and limited variability in the data may relate to issues of scale construction, such that the measures of home attributes do not capture all the variation in the sample. For example, if many parents cannot read, then asking about parental book reading may result in floor effects because these parents do not read to their children. Studies in LMI countries using popular measures of home attributes are particularly vulnerable to floor effects because of a focus on dimensions of the home that may be weak, including low access to print or limited resources for home tutoring.
- *Floor effects for child outcomes:* A measure of language and/or literacy skills may lack easy items and therefore fail to differentiate between children. Floor effects may also reflect the reality, for example, of poor school quality, few opportunities to practice, disrupted schooling, or poor proficiency in the school language (Nag, in press). On a reading test, if many children simply cannot read or cannot identify any letters, then there will be floor effects. Similarly, many children may perform poorly on a language task because they are not yet proficient in school languages (Melby-Lervåg & Lervåg, 2014; Vagh & Sharma, 2018). For these reasons, we investigate whether the presence of floor effects in the language and literacy measures is a moderator of outcomes.

Additionally, study quality and publication type (discussed below) were also accounted for.

The Current Study

The present study is a systematic review of the body of research on HLLE from

LMI countries using meta-analytic techniques. We examine a wide range of contexts with the intent of analyzing whether current theories of the HLLE capture local realities. To obtain a comprehensive picture, we accessed both published research and gray literature produced by key agencies. We also use novel statistical methods that allow full datasets to be exploited by taking dependency in the data into account (Tipton & Pustejovsky, 2019). In addition, we examine moderators at the level of the child and the meso- and macrosystem, as well as methodological issues related to the assessment framework, data distributions, and study quality. Finally, we examine publication type and publication bias on key variables. The novel contribution of the current study is in providing a synthesis of the overall associations between key home attributes and outcomes across the diverse contexts of 43 LMI countries while also examining a range of different moderators.

Based on the literature review, and in particular, based on prior studies from LMI country contexts, we examine the following research questions:

1. What is the overall correlation between home attributes and children's language and literacy skills? Are these correlations moderated by specific home attributes (i.e., books at home, home tutoring, adult literacy) and language and literacy domains (i.e., oral language, emergent literacy, reading fluency, and reading comprehension)?
2. Is the correlation between home attributes and children's language and literacy skills moderated by contextual factors such as age and grade level, the match between home language and school language, socioeconomic variation, the economic wealth of a country, and geographical region?
3. Is the correlation between home attributes and language and literacy related to methodologically dependent variables (type of assessment framework and study quality) and floor effects in the data?

4. Are there indications of publication bias (related to sample size) in the data, and do the results vary between published and unpublished studies?

Method

Transparency and Openness

This review's protocol was pre-registered at https://doi.org/10.17605/OSF.IO/R9BGV . Following are deviations from this protocol: (a) The study was reframed around research questions rather than hypotheses because the knowledge base provided few comparable studies to make informed predictions. (b) The planned analysis of a symbol-word decoding dimension was dropped because the number of available studies was too small. Symbol knowledge measures (letter-sound knowledge, symbol naming) and phonological awareness measures were assigned instead to the emergent literacy variable. This aligns well with the theoretical understanding of symbol knowledge and phonological awareness as an inside-out, code-related skill ascribed to the emergent literacy domain (Whitehurst & Lonigan, 1998) and the earlier work with LMI countries (Nag et al., 2019). Excluding word-decoding measures was acceptable because word accuracy is embedded in a list-reading fluency variable. And (c), additional moderator variables were added for the geographical region of the study country, studies using a site-specific or multisite assessment framework, the presence of floor effects in study variables and study quality. Fourth, a new co-author was added, and fifth, the literature search was extended to December, 2020.

We followed the PRISMA-P checklist when preparing the protocol, and we followed PRISMA reporting guidelines for the final report (Page et al., 2021). The meta-analytic analysis plan is available at https://doi.org/10.17605/OSF.IO/R9BGV. The meta-analytic data are shared at https://doi.org/10.17605/OSF.IO/CJ8KG. Table S2 (supplemental material) provides a summary of the characteristics of the included studies

and datasets; because the size of the dataset, which contains 6,678 correlations, is large and not all information from each study can be displayed in Table S2.

Eligibility Criteria and Reliability

This review, spanning from 1990 to 2020, extends empirical research from countries listed as LMI by the World Bank and Organisation for Economic Co-operation and Development (OECD) and initiated as part of a larger study examining children's learning outcomes (Nag et al., 2014). Search strategies were developed after several iterations with the Center for Reviews and Dissemination (University of York, UK) for use across several databases (ERIC, PsycINFO, Social Science Citation Index [SSCI], Conference Proceedings Citation Index – Social Science & Humanities [CPCI-SSH], EconLit, British Education Index [BEI], Australian Education Index [AEI], ASSIA, Dissertation Abstracts, Index to Theses, BLDS, Eldis, OAISTER, Zetoc, RePEc, ScienceDirect, and JSTOR).

Studies were also obtained from citations in the relevant literature, expert recommendations, and communications with relevant not-for-profit organizations. In line with the initial protocols, the review covered both published studies and unpublished doctoral theses, institutional reports, and working papers. Studies of interest were tagged based on a review of abstracts. All excluded abstracts were reviewed by a second reviewer, and disagreements were discussed between the two reviewers to reach consensus.

Figure 1 summarizes the data collection and inclusion processes. To be included, a study had to meet the following criteria: (a) examining aspects of the HLLE beyond parent education levels and family SES; (b) reporting or providing uncorrected simple correlation coefficients between the HLLE and measures of children's language and literacy skills or providing the raw datasets; (c) covering preschool children (aged 3 years) up to grade 8

children, including out-of-school children of the same age and (d) of moderate, moderate-high and high quality as per a study quality rating scale. Researchers and dataset owners were contacted for missing information. Inquiries were for disaggregated data for composite measures and clarifications about variable names and, specifically to researchers, for raw data or uncorrected simple correlation coefficients between the HLLE measures and measures of children's language and literacy.

Study quality was assessed using rating scales on multiple parameters based on ALNAP (ALNAP, 2013; Torgerson et al., 2013) and JBI (Ma et al., 2020; Moola et al., 2020). Two of three independent evaluators from the author team (SBV, KD, SN) assessed all studies, with the third acting as the moderator when ratings diverged. Quality ratings were on a five-point scale of low, low-moderate, moderate, moderate-high, and high; studies rated as either low or low-moderate were excluded (see section on Study Quality).

Coding and Coding Reliability

All relevant variables from each dataset were extracted and verified independently by two reviewers. If there was coding disagreement, this was discussed and arbitrated by a third reviewer until reaching agreement. Next, the uncorrected bivariate correlations (Pearson's *r*) and point-biserial correlations between all relevant variables were coded or calculated from the raw datasets. The extraction or estimation of all correlation coefficients was conducted by a research assistant under the supervision of one of the study authors. Coefficients from three raw datasets covering nine samples were extracted in parallel by the research assistant and one study author (KD) to check for interrater agreement, or the percentage of extracted correlation values that matched between researchers. The average interrater agreement was $\kappa = 0.93$, $p < .001$ (Cohen's Kappa). Discrepancies in ratings arose primarily because of coding errors. Protocols were revised to reduce the likelihood of errors in subsequent extractions.

The eligibility criteria for and coding of language, literacy, and HLLE tasks are outlined in the section on moderators. All correlations that met the inclusion criteria were coded from each study, as well as those that were measures of the same construct on the same samples; that is, we did not use averaging or selection of correlations in such cases, but coded data from subgroups of grade (early versus later grades) and home-school language status (match versus mismatch). However, the study identifier used for the analysis was based on the study level and not on subgroups of data. As we outline next, such dependencies were dealt with statistically. For intervention studies and longitudinal studies, only baseline information was coded.

In the meta-analysis, a positive correlation indicated that high resources or enriching home attributes were associated with improved language and literacy outcomes. Conversely, a negative correlation showed that fewer resources or diminished opportunities across home attributes were related to better language and literacy outcomes. In the analyses, the correlation coefficients (Pearson's *r*) were converted to Fisher's Z to correct for non-normality of the *r* distribution (Cohn & Becker, 2003) and then back again to Pearson's *r* to ease interpretation of results.

Moderator Variables

Primary Moderators

Language and Literacy Domain. Children's language and literacy outcomes were coded into the following five dimensions: language, emergent literacy, list-reading fluency, text-reading fluency, and reading comprehension. The language domain comprised measures of listening comprehension, typically assessed through questions about a just-heard sentence or short passage, and vocabulary assessed, for example, through a word definition task or a picture pointing task. Emergent literacy includes measures of concepts about print, emergent writing, phonological awareness, and early orthographic

knowledge—that is, symbol identification. Example tasks to assess some of these constructs include asking children to show the direction of print on a picture book with short text (concepts about print), to say if a word pair has a similar beginning or ending (phonological awareness), and to point to the right option for a letter named by the assessor (symbol identification). List-reading fluency is a composite of measures of words and nonwords that were accurately read, typically with a time limit (e.g., one minute). Text-reading fluency is the accurate reading of words in connected text, often within a time limit. Reading comprehension measures include measures of sentence and passage comprehension, with questions asked about the content of the text. Included measures of reading comprehension also covered international or state-mandated grade-level tests.

Home Attributes. This variable comprised three attributes, consistent with the inductively-derived HLLE framework (Nag et al., 2019): (a) books at home, (b) home tutoring, and (c) adult literacy practices. The category of books at home includes measures of book ownership and supply (e.g., how many books do you have at home? Do you have the school textbook?) and book engagement and use (e.g., has someone read a book to the child in the past week?). Home tutoring includes measures of frequency and duration of tutoring at home by family members, including access to paid tutoring enabled by the family. Adult literacy practices include the presence of literacy-relevant ambient events and artifacts (e.g., access to technology and media like TV, radio, and computers, reading habits among family members) and values and expectations (e.g., parents' educational aspirations for children).

Contextual Moderators

Child Age. The mean age of the overall sample was coded for each study and assessed as a continuous variable.

Grade Level. Grade was coded in two categories—namely, early and later grades.

Early grades include preschool, grade 1, and grade 2, whereas later grades include grades 3 to 8 (or children of equivalent age, as well as out-of-school children). The cutoff between early and later grades was implemented to approximate the theorized transition from a learning-to-read stage to a reading-to-learn stage.

Home-School Language Status. Home language and school language were coded using two categories—matched and mismatched—based on whether the reported home language(s) and the assessment language(s) are the same or different.

Variability in Socioeconomic Status. For SES, most studies reported questionnaire data related to owning different types of household possessions or composite variables that included household possessions, and other variables such as parent education and/or occupation. As the scales varied across studies and measures, we computed a coefficient of variation (ratio of the standard deviation to the mean), a continuous variable that represents the degree of dispersion in SES within the sample. A coefficient close to zero means that most of the participants are centered around the mean, whereas a coefficient of 0.3 indicates that the mean is three times larger than the standard deviation, which is comparative to a normal distribution. A coefficient larger than 0.3 implies that there is much variation in the SES level. In cases with more than one SES measure, the coefficients were averaged.

Wealth Inequality in the Country. A country's economic wealth distribution was represented by its Gini index. The Gini index quantifies the degree of income disparity (inequality) in a country; the higher the Gini index, the larger the disparity between high-income and low-income individuals. The coefficient ranges from 0% to 100%, with 0 representing perfect equality and 100% representing the highest level of inequality. Note that values over 100 are theoretically possible because of negative income or wealth. For our purposes, the Gini index for the year of data collection or the year closest but prior to

the year of data collection was taken from the World Bank Open Data (https://data.worldbank.org).

Geographical Region. To explore potential systematic trends in correlation magnitudes by geographic location, datasets were tagged according to geographical region classifications (i.e., Africa, Asia, or Latin America and the Caribbean) listed in the *World Economic Situation and Prospects* report (United Nations, 2014). These country groupings are comparable to the World Bank administrative country details (World Bank, 2021).

Methodology-Related Moderators

Assessment Framework. Because many datasets were sourced from initiatives by international agencies with multiple projects across countries, these datasets were coded to represent multisite assessment frameworks—namely, assessments linked to the Research Triangle Institute International (RTI), Save the Children, and the East Asia-Pacific Early Child Development Scales (EAP-ECDS) project. Single studies, typically conducted by university staff and students (e.g., for a PhD dissertation) with measures developed or selected for that particular site, were coded as a customized framework.

Floor Effects in the Data. The floor effects for language and literacy measures and home attributes were computed as the percentage of zero scores expressed as decimals; therefore, they were coded on a scale from 0 to 1. For example, if 46% of the children scored 0 on a particular outcome, this was given a value of .46; if 35% of homes responded as not having a certain home attribute, the floor metric was computed as .35. For both language and literacy measures and home attributes, the percentage of floor effects was derived for every available variable.

Study Quality. Studies were evaluated using the strength of evidence assessment developed by the Department of International Development, UK (ALNAP, 2013). This rating scheme was selected because it was developed specifically for studies conducted in

low- and middle-income country contexts, and converted to a data extraction template (Torgerson et al., 2013). For datasets received directly from organizations, the JBI scale was used (Ma et al., 2020; Moola et al., 2020). Both schemes provide data on a five-point scale and overlap in evaluation parameters.

Correcting for Dependency in the Data

All records that met the inclusion criteria were coded. In meta-analyses, the dependency due to collection of multiple outcome measures from one sample has traditionally been dealt with in two ways—namely, by calculating the mean correlation or by using the strategy of shifting units, that is, to decide an order of preferred measures to be chosen in the coding. Both of these methods are likely to give erroneous standard errors and thus erroneous reports of significance results, resulting in a loss of statistical power. A recently developed alternative, robust variance estimation (RVE), can adjust for dependencies in the data. RVE (corresponding to a random effects model) builds on heteroscedasticity—that is, robust and clustered *SEs* in the general linear model (Liang & Zeger, 1986; White, 1980). Heteroscedasticity is a systematic change in the spread of the residuals over the range of a predictor or moderator; in RVE was developed for use in meta-analyses to handle issues that occur in the weighting of studies when there is dependency in the data (Tanner-Smith & Tipton, 2014; Tanner-Smith et al., 2016). This RVE procedure is now a recommended method to deal with dependencies in meta-analysis (Hedges et al., 2010; Tanner-Smith & Tipton, 2014; Tanner-Smith et al., 2016).

Meta-Analytic Procedures

We conducted the analysis in R statistical software (R Core Team, 2020) using the RobuMeta and Metafor packages (Fisher & Tipton, 2015; Tipton & Pustejovsky, 2015; Viechtbauer, 2010). We implemented RVE based on a correlated effects model and small-sample corrections using RobuMeta for R (Fisher & Tipton, 2015; Tipton & Pustejovsky,

2015). We used correlational weights because we assumed that (a) the main issue with dependency was dependency within studies arising from multiple outcome measures being collected on the same samples and (b) biased estimates of standard errors. For details about computations and formulas, see Fisher and Tipton (2015) and Tipton and Pustejovsky (2015). Correlations between different associations reported within a study were set to 0.3; this value was chosen based on overall intercorrelations between home attributes and language and literacy skills found in previous studies (e.g., Bus et al., 1995; Dong et al., 2020).

In correlational models, τ examines the heterogeneity in results between studies, whereas I^2 estimates the proportion of variation in the effect sizes that reflect true variation rather than a sampling error (Borenstein et al., 2011, 2017). It should be noted that there is an alternative model to correlational weights—namely, the hierarchical model. In this model, it is possible to consider, for example, that different studies have been initiated by the same research group. However, the dependency because of clustering is accounted for as a moderator variable coded under the assessment framework. In summary, we used correlational weights because the main dependency issue was studies contributing more than one correlation.

In the analyses, we first examined the magnitude of the overall correlation. Thereafter, we estimated whether the moderators were related to the overall effect size. We therefore analyzed the effects of moderators on our outcome, assessing the variables one at a time in different RVE correlated models. The moderator analyses were conducted with regression models in the RobuMeta package. If the analyses had fewer than four degrees of freedom, the results were considered inconclusive and unreliable (Tanner-Smith et al., 2016). Multiple-contrast hypothesis tests were conducted using the approximate Hotelling's T^2 test proposed by Tipton and Pustejovsky (2015). Tests conducted this way

were originally based on the procedure proposed by Alexander and Govern (1994) and adapted for RVE for a heteroskedastic, one-way analysis of variance (ANOVA). The procedure was later further developed by Cai and Hayes (2008) in the context of multiple-contrast hypothesis tests based on RVE heteroscedasticity (see Tipton & Pustejovsky, 2015). Our multiple-contrast hypothesis tests were implemented via the Wald-test function in the clubSandwich package in R (Pustejovsky, 2017).

Publication Bias

We assessed publication bias using various methods. First, we examined publication type as a moderator in the meta-regression to compare the effect sizes for published and unpublished studies (e.g., data retrieved from peer-reviewed journals or studies conducted as part of organization projects and dissertations). Second, we conducted Egger's regression test (Egger et al., 1997), based on meta-regressions with standard errors used as predictors, on the single effect sizes by performing RVE models. According to Rodgers and Pustejovsky (2020), Egger's test examines the slope to determine if there is evidence of a publication bias (e.g., asymmetry in the funnel plot). When Egger's test is significant, the PET-PEESE analysis can be performed consisting of a precision effect test (Sterne & Egger, 2005) and a precision effect estimate using the standard error in the meta-regression (Egger et al., 1997; Stanley, 2008; Stanley & Doucouliagos, 2014). In this case, the intercepts are interpreted as unbiased estimates once accounting for small-study effects. Whereas the PET test uses standard errors as a moderator of variation in the effect sizes, PEESE examines variance as a predictor in the meta-regression. Thus, Egger's test determines whether there is an asymmetry in the funnel plot, whereas PET and PEESE shed light on how this asymmetry influences the results and indicate whether results are altered once small-study effects are accounted for (Egger et al., 1997; Stanley, 2008).

Finally, a substantial amount of work in LMI countries is undertaken by nonprofit

organizations and research institutes. This work is often documented in reports. To be comprehensive, our review includes the gray literature, reports, and doctoral dissertations, along with published studies. We particularly focus on unpublished reports from international agencies that are influential policy and practice stakeholders in LMI countries, even if the reports may not enter the academic publishing pipeline. Hence, we use publication status as a methodological moderator.

Results

Descriptive Summary of Studies

A brief description of the reviewed studies is as follows: 42% of studies were from Africa, with the largest number of studies from West Africa, 37.7% were from Asia, with the largest number from East Asia, and 20.3% of the studies from Latin America and the Caribbean. A few studies were from before the year 2000 (4.3%), with 20.3% conducted over 2000-2009, and the substantial number of 72.5% conducted in the decade of the 2010s. A little over a half of studies focused on one grade level (52%) with the rest focusing on multiple grades; the most studied grades were Grade 2 (46%) followed by Grade 3 (39%) and the preschool years (29%); overall, 78% of studies targeted the early grades. Among the other moderators of interest, 26% of studies used a customized framework; 59% of studies were of high quality, 9% of moderate-high, and 32% of moderate quality; with 71% unpublished reports and 29% published articles. There was a match between home and school language in 65% of the studies; only two studies measured parent's literacy skills directly (3%), 30% used reported data to establish if there was a literate member in the home, 29% estimated literacy levels at home through reports of parent/caregiver education level, and 14% used a proxy measure such as household members seen engaging in a literacy-related activity.

Overall Association Between Home Attributes and Language and Literacy Attainments

The association between home attributes, on the one hand, and language and literacy attainments, on the other, was examined in 69 independent clusters with 6,678 effect sizes. The descriptive statistics of children's age, variability in SES, wealth inequality in the country (Gini index), and floor effects for home attributes and child outcomes are reported in Table 2.

The overall meta-analytic estimate showed a positive and statistically significant association—although close to zero—between home learning attributes and language and literacy attainments, mean $r = .08$, 95% CI [.07, .10]. The heterogeneity observed was considerable, $I^2 = 81.12\%$, with $\tau = 0.08$[1]. Results were confirmed when using a hierarchical model, $r = .07$, 95% CI [.06, .08], that revealed study variation, $\tau = 0.03$ and $\Omega = 0.07$. Because there were numerous single effect sizes, $k = 6{,}678$, the forest plots show the single effect sizes (transformed to r) aggregated by independent samples and displayed by the assessment framework (see Figures 2, 3, 4, and 5).

A further step in our analysis was to analyze the effects of moderators on the association between home attributes and language and literacy attainments. First, we assessed the effect of primary moderators (i.e., type of home attributes and language and literacy domain) on the effect sizes. As for the type of home attributes, several studies assessed adult literacy practices (63 studies) and books at home (63 studies), and some investigated home tutoring (45 studies). The benefits of the home learning environment varied significantly across the three categories of home attributes examined, $F = 4.6$, $p = .014$, with home tutoring showing the smallest correlations, $r = .05$, 95% CI [.03, .08],

[1] Findings were consistent when the analysis was re-run by changing the correlation level of outcomes to 0.2, 0.4, 0.6, and 0.8, as r and SE remained unchanged, and τ change was trivial (0.0837 vs. 0.0838).

compared to adult literacy practices, r = .10, 95% CI [.07, .12], and books at home, r = .08, 95% CI [.07, .10]. Next, we examined emergent literacy (48 studies), language (47 studies), reading comprehension (43 studies), text reading fluency (40 studies), and list reading fluency (30 studies). These component skills did not vary significantly, F = 2.02, p = .106, as the estimates were comparable for reading comprehension, r = .11, 95% CI [.07, .15], language, r = .08, 95% CI [.06, .10], emergent literacy, r = .09, 95% CI [.06, .11], list reading fluency, r = .06, 95% CI [.05, .08], and text reading fluency, r = .07, 95% CI [.05, .08]. Study variation was I^2 = 80.43%, with τ = 0.08, for the type of home attributes, and I^2 = 80.53%, with τ = 0.08, for the language and literacy domain.

The Role of Contextual Factors at the Level of the Person, Meso-, and Macro-System

We then examined factors of interest within the bioecological framework (Bronfenbrenner & Morris, 2006). The focus was on the effects of secondary moderators concerning contextual moderators, such as children's age, grade level, home-school language status, variability in SES, wealth inequality in the country (Gini index), and geographical region. Almost all studies reported children's age (67 studies), which did not moderate effect sizes, B = 0.00004, p = .870. Study variation for this variable was I^2 = 81.10%, with τ = 0.08. As for grade level, early grades (54 studies) and later grades (30 studies) were examined. The moderator analysis did not show evidence of a difference between these two categories, F = 0.08, p = .773; the estimates for early grades, r = .08, 95% CI [.07, .10], and later grades, r = .08, 95% CI [.05, .10], were consistent. Study variation was I^2 = 78.94%, with τ = 0.08. Regarding home-school language status, there were studies with a match or mismatch between the reported home language(s) and the assessment language(s) (45 and 29 studies, respectively). This variable did not moderate effect sizes, F = 0.86, p = .359; the matched home-school language status, r = .07, 95% CI [.06, .09], and the mismatched home-school language status, r = .06, 95% CI [.05, .08],

were comparable. Study variation was I^2 = 75.87%, with τ = 0.07 for this variable. In addition, we computed the wealth inequality in the country at the time of the study (62 studies) and variability in SES in those studies that examined SES (43 studies). Notably, wealth inequality in the country, B = 0.003, p = .031, moderated the association between the variables of interest, with slightly higher correlations between home attributes and language and literacy attainment for countries with higher wealth inequality. Variability in socio-economic background did not moderate our outcome of interest, B = -0.06, p = .095. The study variation was I^2 = 77.89% with τ = 0.08 for wealth inequality in the country and I^2 = 84.47% with τ = 0.09 for SES. Studies were conducted in different geographical regions, including Africa (29 studies), Asia (26 studies), and Latin America and the Caribbean (14 studies). The moderator did not reach significance, F = 0.06, p = .941. The estimates were r = .08, 95% CI [.06, .11] for Africa, r = .08, 95% CI [.05, .11] for Asia, and r = .08, 95% CI [.05, .10] for Latin America and the Caribbean, and study variation I^2 = 81.21% with τ = 0.09.

The Role of Assessment Framework, Data Distributions, and Study Quality

For assessment framework, we examined customized frameworks (18 studies), and the multisite frameworks from RTI (31 studies), Save (14 studies), and EAP-ECDS (6 studies). This variable moderated effect sizes, F = 5.27, p = .007: the effect sizes were larger for Customized, r = .14, 95% CI [.10, .18], compared to RTI, r = .06, 95% CI [.04, .07], Save, r = .08, 95% CI [.06, .11], and EAP-ECDS, r = .06, 95% CI [.01, .11]. Study variation was I^2 = 78.17% and τ = 0.08. Information on floor effects in the data for home attributes (58 studies) and language and literacy (55 studies) was then evaluated. The presence of floor effects was a statistically significant moderator of the effect size in the data for home attributes, B = -0.07, p < .001, but not for language and literacy, B = -0.02, p = .269. Study variation was I^2 = 75.30% with τ = 0.07 for the former and I^2 = 81.29% with

$\tau = 0.09$ for the latter. Finally, study quality was considered. Of the included studies, quality ratings were moderate (22 studies), moderate-high (6 studies), and high (41 studies). This variable did not moderate effect sizes, $F = 0.10$, $p = .903$, with studies rated as moderate quality, $r = .08$, 95% CI [.05, .11], moderate-high quality $r = .09$, 95% CI [.01, .17], and high-quality $r = .08$, 95% CI [.60, .10], showing similar effects.

Publication Bias

We evaluated publication bias by first examining the moderator effect of publication type. In our dataset, there were published and unpublished studies (20 and 49, respectively). The moderator reached significance, $F = 5.4$, $p = .026$. Published studies reported larger correlations, $r = .11$, 95% CI [.08, .14] than did unpublished ones, $r = .07$, 95% CI [.05, .09]. Study variation was $I^2 = 81.05\%$, with of $\tau = 0.08$. We next performed Egger's test via a correlated RVE model on the 6,678 effect sizes and found a nonsignificant effect, B = 0.10, $p = .697$. Thus, publication bias related to small-study effects had little influence on the correlations between home attributes and language and literacy outcomes.

Discussion

This meta-analysis reveals several important findings regarding home attributes and children's language and literacy skills in LMI countries. The overall association between home attributes and language and literacy skills was significant but small. There was also significant heterogeneity, indicating that the associations across studies were more different from one another than would be expected from sampling error alone; the implication of this is that the associations between HLLE and child language and literacy outcomes differed across study contexts. The strength of associations across types of home attributes also differed. Books at home and adult literacy practices had a significantly higher correlation with children's language and literacy skills than home tutoring.

However, for all home attributes, the correlations were below 0.1, and the strength of association did not differ for the different language and literacy component skills. In addition, consistent with the well-established finding that published studies typically have larger effects than unpublished ones (e.g., Francis, 2012), we found that published studies yielded higher correlations between home attributes and child outcomes, $r = .11$, compared with unpublished ones, $r = .07$.

Turning next to the moderators, of the contextual moderators, country-level wealth inequality alone moderated a significant association between home attributes and children's attainments (and will be discussed later). The person-level variables of age and grade, the meso-level variable of match between home language and school language and the macrolevel variable of geographical region were not significant moderators. The lack of a clear trend with age and grade effects and the absence of a clear home language advantage extends findings of a narrative review of LMI country data (Nag et al., 2019). Together these findings highlight the fact that quality of input per se matters more than child age, grade, or language of instruction. Moreover, the finding that geographical region is not a moderator suggests that the findings apply to LMI countries irrespective of continent, and further, that an administrative clustering of countries (e.g., World Bank, 2021) is not a substantive unit of analysis for assessing HLLE and child outcomes. Published studies showed significantly larger correlations than unpublished studies, and neither study quality nor floor effects for home attributes or language and literacy outcomes were significant moderators. In contrast, assessment framework moderated findings.

Association Between Home Attributes and Language and Literacy Skills

Overall, the associations in LMI country contexts between the home attributes of books at home, adult literacy practices and home tutoring, and child outcomes in the

language and literacy domains are much smaller than has been reported in studies from high-income countries. The magnitude of the correlation estimated in the current meta-analysis is close to zero, $r = .08$. There are no benchmarks for the correlations from LMI countries, but Evans and Yuan's (2020) meta-analysis provides a reference point. Based on 827 effect sizes from 156 randomized controlled trial studies and 439 effect sizes from 143 quasi-experimental studies in LMI countries, Evans and Yuan found a median effect size corresponding to $r = .05$. Thus, the effect size we see here is aligned with that from another meta-analysis of studies conducted in LMI countries although the designs are not directly comparable because Evans and Yuan (2020) include a range of learning outcomes and examine interventions beyond the home, including health and safety, teacher professional development, and supply of learning materials.

In contrast, four meta-analyses from high-income countries showed larger associations: For home attributes, oral language skills, emergent literacy, and reading achievement, a meta-analysis shows a mean correlation of $r = .27$ (Bus et al., 1995); for home attributes and reading comprehension, mean correlations from two meta-analyses were $r = .32$ (Dong & Chow, 2022; Dong et al., 2020), and for home tutoring with language and literacy skills, $r = .12$ (Castro et al., 2015). For comparitive purposes, the benchmark for the effect size from a meta-analysis of 147,328 correlations in personnel and applied psychology from two leading journals is $r = .22$ (after correcting for sampling error) (Bosco et al., 2015). Thus, the effect sizes for HLLE and children's language and literacy skills in high-income countries are on average slightly larger than what is typical in general psychology, and considerably larger than noted from LMI countries.

Association Between Type of Home Attribute and Language and Literacy Skills

A main finding from high-income countries is that informal practices (such as shared reading in the home), predict language and reading comprehension, whereas direct

instructional practices predict code-based skills such as word decoding (e.g., Martini & Sénéchal, 2012; Sénéchal & LeFevre, 2014, but see Hamilton et al., 2016). The findings reported here are different and suggest that practices in the home relate similarly across language and literacy outcomes. A possibility raised by this difference is that the home learning environment in LMI countries are not captured well by 'conventional' measures that otherwise align well with, for example, the Sénéchal and LeFevre (2002) model – for instance, if there are neither formal nor informal activities related to print in the home, or if the nature of these activities is qualitatively different from the ways in which they are conceptualized in high-income countries, then measures used therein will not tap relevant processes in diverse contexts. Rather, a measure of the home's engagement with academic work might be, for example, the provision of a study space (Hungi, 2008) or an investment in resources to keep the child nourished and healthy so that they can attend school daily (Mount-Cors, 2011). These apparently distal factors are typically left unmeasured and, hence, are not available to inform current models of the home learning environment.

Notwithstanding the absence of differential effects, home tutoring had a significantly lower correlation with language and literacy skills, $r = .05$, than adult literacy practices, $r = .08$, and books at home, $r = .10$. This finding must be seen in the context of generally low parental education levels and their poor command of the school language in several studies in this review. Such constraints necessarily limit parents' ability to assist with homework and provide the children with direct instruction at home. In addition, it should be noted that in high-income countries, the correlation between home tutoring and literacy skills reported as $r = .12$, also seems smaller than correlations for other types of home attributes (Castro et al., 2015). A moderator analysis in Castro et al. (2015) showed that the strongest associations emerge when parents have high academic expectations for their children, begin and maintain communication with them about school activities, and

help them to develop reading habits. These variables remain largely unassessed in studies from LMI countries but findings from the few studies in which they are measured (e.g., Wagner, 1993) suggest that the associations between parental expectations, relevant parent-child communication, and parent education level is complex. In LMI countries, some parents with low education levels may hold high academic expectations of their children and closely monitor children's engagement with school work, whereas others do not.

Assessment Framework

The results concerning the assessment framework are clear. Studies with customized assessment frameworks that are adjusted or developed based on local knowledge demonstrate an average correlation of $r = .14$, whereas studies that use a common assessment framework across a number of sites is $r = .06$. Although high-income countries should not set the standard here, it is worth noting that the size of the average correlation in studies using a customized framework is lower than but approaching the correlation size we see in high-income countries. As noted earlier, the correlations from the different meta-analyses vary from .12 for home tutoring to .27 for oral language and .32 for reading comprehension (Bus et al., 1995; Castro et al., 2015; Dong & Chow, 2022; Dong et al., 2020).

Analysis of constructs assessed (what was measured) and type of data (e.g., binary, frequency scale, or a composite variable) provide preliminary insights into why customized assessment frameworks record higher correlations than common, multisite assessment frameworks (see Table S1, online supplemental material for details). Customized frameworks are probably more sensitive for capturing associations because they use measures that reflect local realities and have constructed context-informed scales. Here we suggest that the use of binary scales (which are common) is particularly problematic.

First, as argued by MacCallum et al. (2002), dichotomization of measures "has substantial negative consequences including the loss of information about individual differences; loss of effect size and power in the case of bivariate associations" (p. 38). Thus, that many of the multisite assessments here used dichotomization or other types of scales with categories not suited to capture variation in the data is probably an important reason for the correlations to be attenuated. Moreover, when Pearson's *r* is used on binary data it is mathematically equivalent to a point-biserial correlation (Kemery et al., 1988) but, depending on the nature of the split on the binary variable (how close is it to 50/50), it may not describe the full range in the data and hence also attenuate the size of the association.

Next, conceptually, binary scales are crude and typically unsuited to measurement across diverse contexts – for example, the use of a binary report to characterize the literacy learning environment (e.g., "read books with the child at home": Yes/No) is sensitive in some but not all contexts. A better approach, used by several customized frameworks is to use frequency scales (e.g., number of print materials at home, number of family members who read to the child), broader measures (e.g., consider book supply through library use) or other details regarding book engagement and use (e.g., age at first use of books with the child) - though it is notable that quality of book engagement and book use are seldom measured, a general trend also seen in the field internationally. Binary present/absent reports are also the preferred measurement of home tutoring (e.g., help with learning tasks, help with homework) and adult literacy practices (e.g., measuring ambient literacy artifacts by asking for the presence/absence of media in the home: own radio, TV, computer; has internet connectivity).

To summarise, customized frameworks can be distinguished from multisite frameworks because they go beyond binary reports, use continuous scales to a greater

extent and measure the less tangible home attributes of engagement, use, ambient events, literacy values, and expectations. Notwithstanding this, some studies that started out with a continuous scale (e.g., of book ownership) modified them if, for example, all responses ended up in two categories (e.g., if the study took place in an area where most families had no books or very few books, then all answers ended up in two categories even if other options were available, such as number ranges of 5-to-10 and 11-to-20 books). Using in-depth knowledge about the area where the study was carried out could probably have ensured the scale was constructed in another way to be more sensitive.

Wealth Distribution in the Country

Finally, a finding that is difficult to explain is that the higher the wealth inequality in the country, the higher the correlations between HLLE and children's language and literacy outcomes, though this association is small, $B = 0.003$ (a one-unit increase in the correlation is associated with a 0.3% higher Gini index in the country). It may be that this simply reflects a statistical issue – the more variation the greater the sensitivity of measurement across the population. Speculatively, however, where there are vast differences in economic circumstances across a country, there is likely to be increased differential access to literacy resources and activities. All three home attributes examined in this article—books at home, home tutoring and adult literacy practices—are potentially vulnerable to such access-related disparities within a country.

Conclusions, Limitations, and Prospects for Future Studies

This meta-analysis of LMI countries demonstrates that there is an association between the home environment and children's language and literacy development. We also find considerable variation in effect sizes across studies, and the summary effect estimate was small. The moderators we analyzed reduced the variation considerably and when a rigorous moderator analysis was applied, the significant pattern was that books-at-home

and adult literacy practices showed a significantly higher correlation with language and literacy skills than home tutoring. Although the study had sufficient power to detect small associations, and publication type was a significant moderator of mean effect size, many of the other moderators that we hypothesized were not related to child outcomes, including several contextual factors (age, grade, home language and school language, geographical location of the study). Rather the distal, macrolevel factor of within-country wealth inequality was significant, as was one methodological factor – assessment framework. Together, the findings underline the importance of accounting for the macro-level environment within which a home is situated and of interrogating what and how the language and literacy environments in these homes are assessed. In turn, the findings have theoretical implications, most notably for the development of an inclusive conceptualization of the home language and literacy environment.

The associations between home learning environments and child outcomes in LMI countries were much smaller compared with those from high-income countries. However, this finding should not be read as showing that home learning environments are not important enablers for child outcomes in these countries or that such home attributes as adult literacy practices do not play a beneficial role in promoting children's language and literacy development. For the studies with customized assessments, we observed that the correlations were higher. Thus, in considering these results, it is clear that future studies should invest in assessment material that systematically takes account of local realities rather than apply assessments developed in one context to another. By rigorous contextualization, future studies might be better suited to detect associations than what has been possible in most previous studies. Tailored assessments are particularly important for research in LMI countries which are highly diverse at the level of language, writing system, and access to resources, for example.

The present meta-analysis has at least three limitations. First, at the theoretical level, one key attribute of the home that is missing in this analysis is related to the interlinked constructs of parenting practices and the socio-emotional climate of the home. Studies on books-at-home, for example, have linked socioemotional processes during shared reading interactions to both positive parenting factors such as warmth, sensitivity and reduced stress, as well as harsh parenting (Canfield et al., 2020; Jimenez et al., 2019). Second, also at the theoretical level, is the under-theorized area of child agency and how this modifies and impacts attributes of the home and child outcomes. In the Nag et al. (2019) narrative review, only one of the 35 studies examined these associations, and in this study, child interest was found to interact with child outcomes (Vagh, 2009). More research is needed to better articulate the dynamic ways in which children themselves shape the home environment and their own language and literacy learning. The third limitation is related to the macro-level moderator for geographical region. Our study focused on country-level clusters, yet macro-level constraints may also differentiate geographical regions within a country. This is because wealth and social-educational investments may be concentrated in certain geographical areas, with homes and schools in politically and administratively neglected territories showing less resources, and poorer child outcomes (e.g., Ikeda, 2010 on isolated regions within Vietnam). A more comprehensive understanding of the developmental associations between home environments and child outcomes requires all these factors to be included.

Despite the limitations of this work, the evidence presented here highlights the need for a reconceptualization of models of home language and learning environments. In particular, models must consider the relationship that exists between within-country economic inequalities and the critical attributes of the home that support child outcomes. Arguably, the nature and mechanisms that underpin the relationships between a

macrosystem factor and a microsystem factor are undertheorized. Despite Bronfenbrenner and Ceci's (1994) proposal that interactions will be present across these systems and likely bidirectional at least over time (the chronosystem), the influential nature of within-country economic inequality on actual day-to-day home attributes is unclear. Also unclear are the pathways by which within-country inequality affects language and literacy outcomes; a first step to addressing this could be to examine how wealth inequality affects the dimensions of books-at-home, home tutoring, and adult literacy practices. Earlier work flagged the role of community, neighborhoods, and the school as influential in a multifactorial model of the relationship between HLLE and child outcomes (Nag et al., 2019). This meta-analysis adds the role of within-country wealth inequality to the multifactorial model.

We also show that customized measures that reflect homes within diverse communities are more sensitive when compared to common multisite assessment systems. The vital importance of considering local realities when constructing measures for studies in LMI countries and the need for "locally situated measures" (Nag et al., 2019, p. 49) has been widely debated in many other research areas: Howe et al. (2012) argued that scales to measure socioeconomic background that are valid in high-income countries are often not valid in LMI countries and should be reconstructed to improve reliability. The same has also been pointed out in relation to measures of early childhood development (Fernald et al., 2017), financial literacy (Holzmann, 2010), and educational interventions (Snilstveit et al., 2016). Models of home learning environments also must consider contextual factors. Our study has shown that the influential home literacy model, Sénéchal and LeFevre (2002), although offering an excellent framework for the analysis of direct instruction and shared interactions with the child is, however, agnostic to several attributes that define homes and influence learning. These influential home attributes are related to a) adult

literacy practices that we have shown go beyond direct interactions with and instructions to the child and b) books-at-home where print resources that matter are more varied than the age-level books used in formal and informal interactions with children.

Taken together, a macrosystems perspective on the one hand and the localization of measures on the other are likely to allow for a better and more inclusive conceptualization of the attributes of diverse homes. Thus, the emerging picture from our review is that there is some distance to go before a universal view can be reached of the various types of associations that exist between home attributes and children's outcomes. The vital role of the home learning environment in providing a strong foundation for language and literacy should be reexamined in the context of wider socioeconomic and sociocultural factors, and the different constructs also measured with sensitive indicators. To achieve this, meaningful collaborations with local scientists and the community where the data is collected can be an important step (Adame, 2021; Minasny et al., 2020; Newbury et al., 2022; Scheidecker et al., 2023). In turn, educational investment by governments and third-sector organizations is needed across the multiple systems conceptualized within a bioecological framework and the Nag et al. model (2019) to effectively raise children's literacy attainments in LMI countries.

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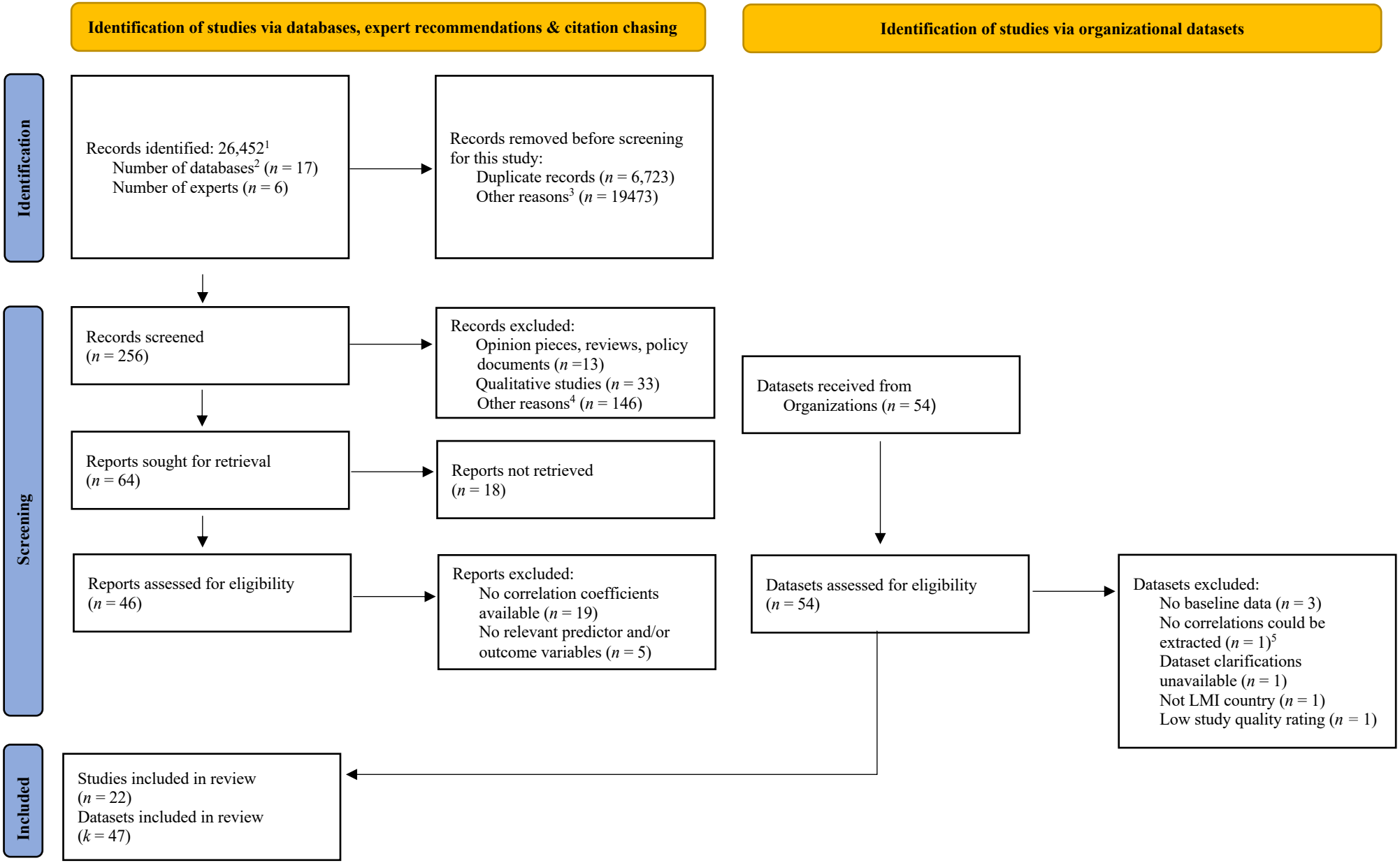
Psychology, *50*(4), 539–555.

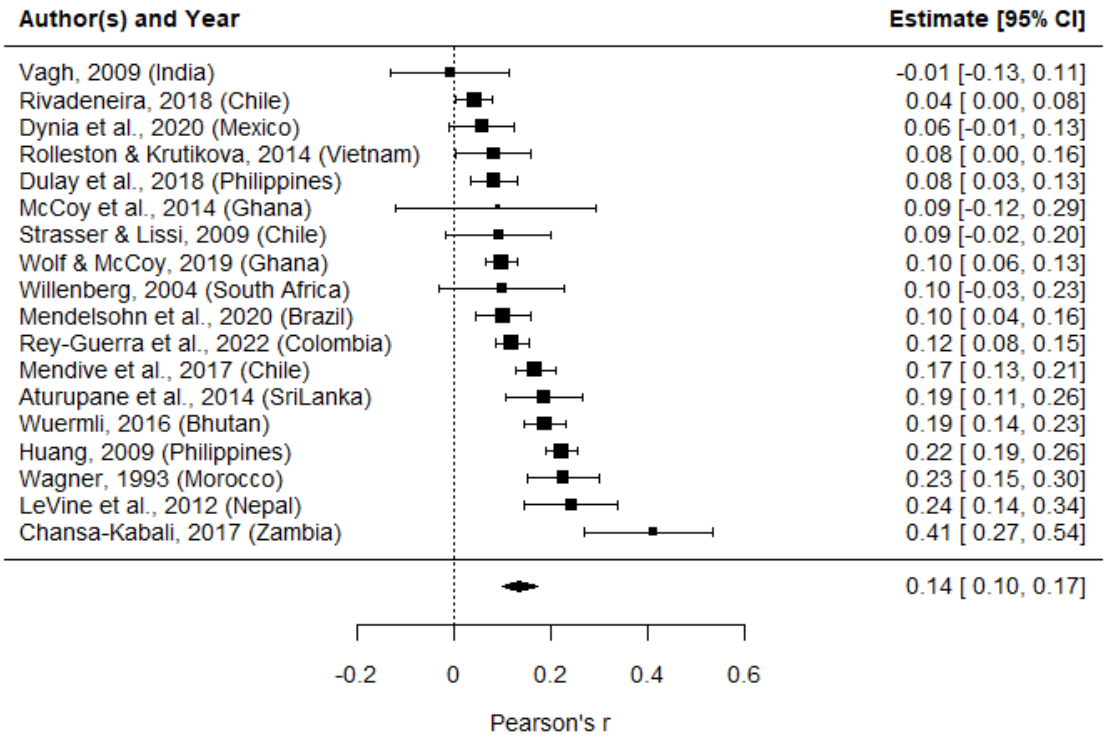
Figure 1 *Flow Diagram for the Search and Inclusion of Studies (adapted from Liberati et al., 2009)*



Note. [1] Includes three consecutive waves for the periods 1991–2014, 2013–2016, and 2017–2020. [2] $N = 11$ in 2020 because of merging of electronic databases. [3] Records screened for other strands of a larger review study covering language and literacy learning, numeracy, classroom practices, and social stratifiers, or not meeting criteria for any strand (Nag et al., 2014). [4] Reasons include samples in the wrong country or grades or equivalent if with out-of-school children, predictor variables exclusively for household income, family member wellbeing, child variables related exclusively to access, attendance, interest in literacy activities, or attainments in other domains, or if HLLE variable used exclusively as a grouping variable or sample is exclusively children with neurodevelopmental delays. [5] Lack of variance on the HLLE variable did not allow correlational estimates.

Figure 2

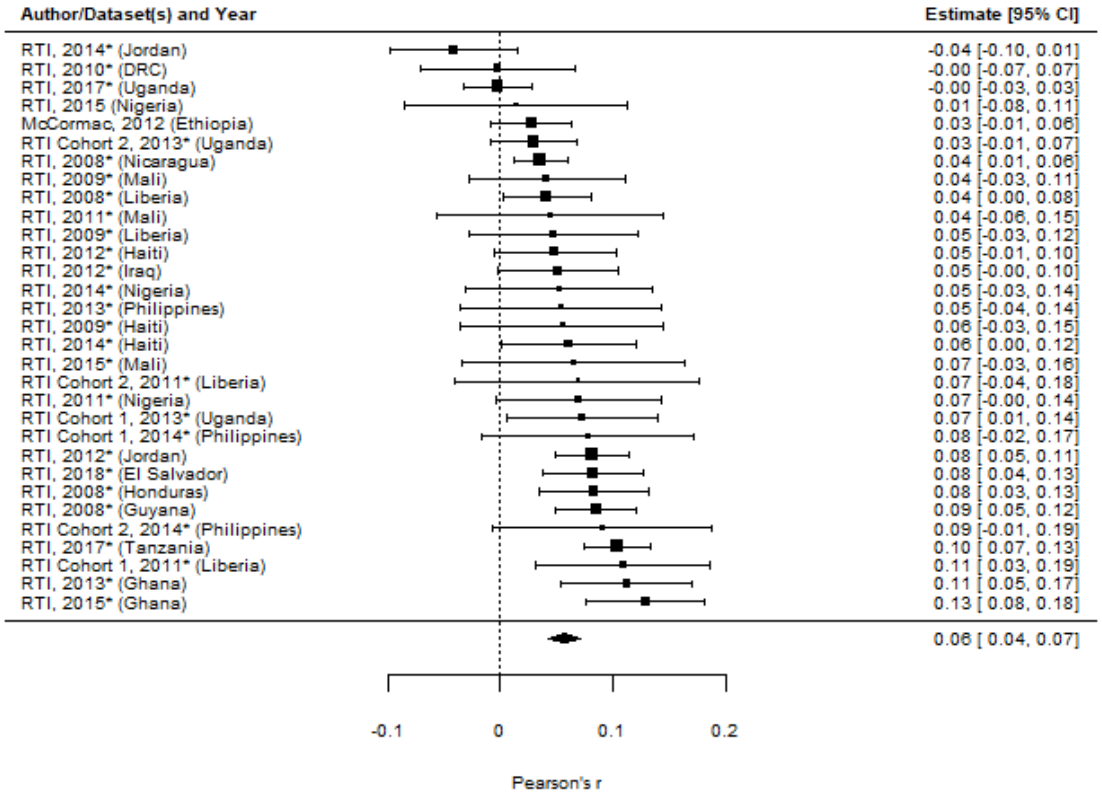
Forest Plot of All Effects of Interest for Customized Framework Studies



Note. Forest plot of the random effect meta-analytical model performed on single effect sizes (Fisher's Z) aggregated by study. In the figure, effect sizes and CIs are transformed to Pearson's *r* to ease interpretation. Error bars represent the 95% CIs of the random effects. The summary diamond represents the overall meta-analytical estimate with a 95% CI.

Figure 3

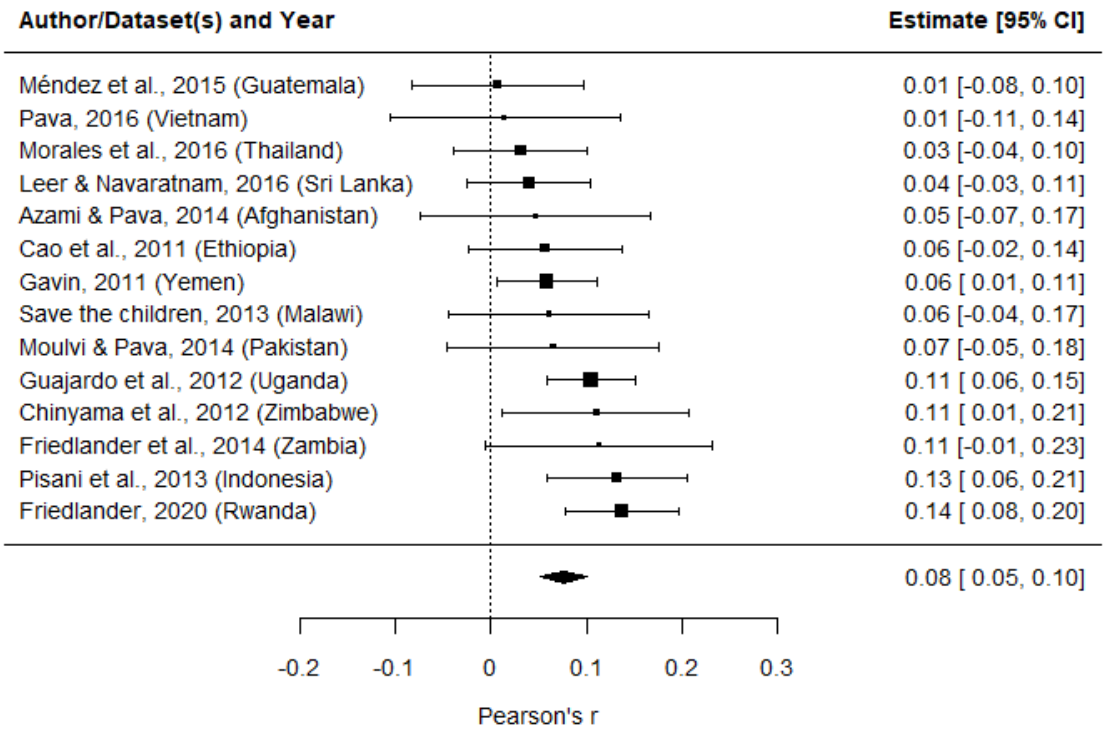
Forest Plot of All Effects of Interest for RTI Multisite Framework Studies



Note. Forest plot of the random effect meta-analytical model performed on single effect sizes (Fisher's Z) aggregated by study. In the figure, effect sizes and CIs are transformed to Pearson's *r* to ease interpretation. Error bars represent the 95% CIs of the random effects. The summary diamond represents the overall meta-analytical estimate with a 95% CI. *Year of data collection.

Figure 4

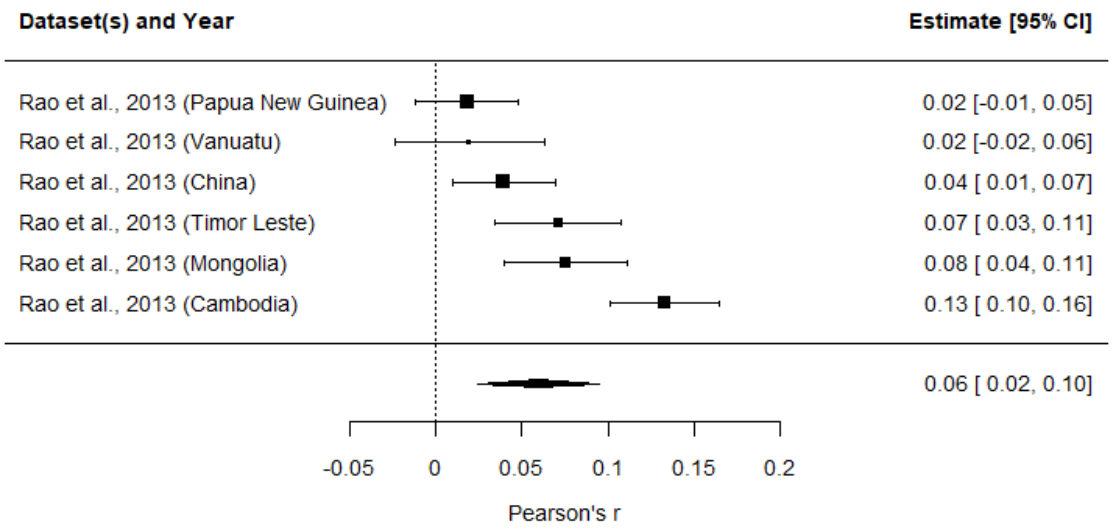
Forest Plot of All Effects of Interest for Save the Children Multisite Framework Studies



Note. Forest plot of the random effect meta-analytical model performed on single effect sizes (Fisher's Z) aggregated by study. In the figure, effect sizes and CIs are transformed to Pearson's *r* to ease interpretation. Error bars represent the 95% CIs of the random effects. The summary diamond represents the overall meta-analytical estimate with a 95% CI.

Figure 5

Forest Plot of All Effects of Interest for EAP-ECDS Multisite Framework Studies



Note. Forest plot of the random effect meta-analytical model performed on single effect sizes (Fisher's Z) aggregated by study. In the figure, effect sizes and CIs are transformed to Pearson's *r* to ease interpretation. Error bars represent the 95% CIs of the random effects. The summary diamond represents the overall meta-analytical estimate with a 95% CI.

Table 1

Description of the Home Attributes Based on the Nag et al. (2019) Framework

Home Attribute	Description[1]	Most Frequently Occurring Variables[1]
Books at home	Availability of number and/or type of reading resources; child-centered engagement with print resources (includes children engaging in independent reading, adults reading to child, and child reading to adults).	For book ownership and supply: availability of print materials; for book engagement and use: book reading with child at home
Home tutoring	Child tutoring at home by parents, siblings, other literate family member; a community member or paid tutorial services.	Help with homework; teaching skills
Adult literacy practices	Activities by adults at home using resources that have the potential to also enhance children's language and literacy skills (e.g., reading habits; parents' values and expectations toward education; access to information technology and media such as the TV, radio, and computer).	Reading habits; literacy of family members
Home-school language	Matched/mismatch at-home language and school language; matched/mismatched at-home language and assessment language	Match/mismatch with school language

Note: [1]Based on variables coded in the meta-analysis.

Table 2

Descriptive Statistics for Continuous Moderators

Moderator	*k*	M (*SD*)	Median	Range
Child age (in months)	6611	106.31 (25.49)	105.6	3.12 – 18.11
Variability in socio-economic background (SES)	6032	0.50 (0.20)	0.47	0.09 – 1.65
Wealth inequality in the country (Gini index)	5862	41.16 (5.15)	41.10	28.70 – 57.80
Floor effects for home attributes	6486	0.40 (0.28)	0.35	0.00 – 1.00
Floor effects for language and literacy skills	6435	0.37 (0.31)	0.30	0.00 – 1.00

Note. *k* = number of effects.