



Impact of Home Parenting Environment on Cognitive and Psychomotor Development in Children Under 5 Years Old: A Meta-Analysis

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This study aims to evaluate the relationship between home parenting environment and the cognitive and psychomotor development in children under 5 years old by using meta-analysis. A systematic search of the Chinese and English databases including Pubmed, Embase, the Cochrane Library, CNKI, Weipu, Wanfang, and CBMdisc databases from January 1, 1990, to July 31, 2021, was performed. Articles concerning the relationship between home parenting environment and the cognitive and psychomotor development in children under 5 years old were included. Review Manager 5.4 was used for meta-analysis. Subgroup analysis in terms of age and region were performed. A total of 12 articles were included, including 11 in English and 1 in Chinese. Meta-analysis showed that there was significant relationship between home parenting environment and the cognitive and psychomotor development of children ($r = 0.31$; $r = 0.21$). Subgroup analysis showed that correlation between home parenting environment and the cognitive and psychomotor development of children was stronger in children over 18 months compared to those under 17 months [$(r = 0.33, r = 0.21)$ vs. $(r = 0.28, r = 0.17)$]. The converted summary r value between home parenting environment and cognitive development in developing and developed countries was both 0.32. Conclusively, there is a positive correlation between the home parenting environment and the cognitive and psychomotor development of children under 5 years old. Improving the home parenting environment of children is beneficial to promote their early development.

Keywords: home parenting environment, children, cognitive development, psychomotor development, meta-analysis

INTRODUCTION

Studies (1, 2) have shown that the number of children under 5 years of age who have development deficiency due to poverty, disease, neglect of care and other reasons in developing countries worldwide has increased from 200 million to 250 million from 2007 to 2017, which includes 17.1 million in China. According to the 2020 Global Nutrition Report on malnutrition, nearly one in every four children under 5 years old (149 million) is stunted (3). In 2021, the prevalence rates

of stunting in children under 5 years old in Ecuador, Nigeria, and Ethiopia were, respectively, 23.2, 36.2, and 39% (4–6). In China, 17.07% of children of 3–5 years old had a high risk of early development deficiency in 2021 (7). Early childhood is a critical period of life development, which has a crucial impact on the development and function of the brain (8); plays an important role in the formation of human intelligence, behavior, and social adaptability (9); and even affects adulthood achievement. A study in the field of economics has shown (10) that the average income in adulthood will drop by 26% in a setting of neglect of the key period of child development. Therefore, improving early childhood development is vital to promoting future social development.

Human development is the product of the interaction between certain congenital conditions and acquired developmental environment (11). During the rapid growth in early childhood, the brain particularly is vulnerable to external factors such as nutritional status, socioeconomic factors, and parent–child relationships (1, 12). Such stimuli directly or indirectly have a positive or negative impact on children (13). In developing countries, due to long-term living in poverty, many children experience chronic diseases such as malnutrition and infection in their infancy and toddlerhood. Even if they survive, they easily suffer from neurodevelopmental defects (14). It has been confirmed that in low-income and middle-income environments, high-quality diets in childhood are positively correlated with the cognitive development scores of 24-month-old children, and chronic diseases are negatively correlated with cognitive development (15). Meanwhile, malnutrition affects gastrointestinal function. In a resource-poor environment, many children suffer from impaired intestinal function and environmental enteric dysfunction (16). This has been confirmed as an important cause of developmental delay in children (17). It is worth noting that due to economic development and urbanization transformation, many developing countries are experiencing the double burden of malnutrition and nutrition transition. The increase rate of overweight and obesity is much greater than the decrease rate of malnutrition (18), which will bring new challenges to national policy makers and health professionals. Finally, early education is an important factor in early childhood development (1). In economically developed countries and regions, early childhood education resources are abundant, and more families send their children to professional institutions as early as possible to receive early education and develop their potential (19). On the contrary, 25% of children under the age of 5 years old in developing countries live in extreme poverty (1). Poverty and other factors make early childhood education opportunities in professional institutions very limited. All these have increased the risk of early developmental delay in children in developing countries to a certain extent.

Parenting mainly refers to the care provided by the family for children's health promotion, nutritional needs, response, emotional support, developmental stimulation, etc. (1). Based on the Ecological Systems Theory (20), the parenting environment is the main influencing factor of children's

development, which is a nested ecosystem with a core of children. The inner micro-system, i.e., home, has the most direct and significant impact on children development. The home parenting environment includes parental quality, family structure, parent-child response, family resource availability, learning conditions, etc. (1, 21). Family structure, parenting styles, and family relationships are closely related to child development (21). Supporting parents and other child caregivers and improving parenting quality at the family level can promote child developmental potential (22). A multi-arm, cluster-randomized community effectiveness trial in rural western Kenya also reported that parental intervention could effectively promote the early development of children aged 6–24 months (23).

Cognitive and psychomotor development are important indicators of early childhood development (1), including thinking ability, attention, problem solving ability, memory, fine motor, gross motor, and other abilities that help children understand the world (24). In recent decades, the number of studies concerning family environment and child development, especially cognitive development, have gradually increased, but most of them (25, 26) have focused on the impact of general factors such as family economic status, parent's educational level, and parenting methods on child development. Moreover, some studies, which evaluate home environment as a complete system and focus on child development, have small sample sizes; are of single-center design; and do not involve cultural background, socioeconomic differences, and other issues, finally leading to controversial results. For example, Ribe et al. (27) showed that there was no statistically significant relationship between family parenting and the early development of the children of 15 months old. However, McCormick et al. (28) showed that there was a positive correlation between family parenting and the early childhood development.

Herein, we conducted a meta-analysis to evaluate the overall effect size of the relationship between family parenting environment and early cognition and psychomotor development in children under 5 years old. The observational studies published in Chinese and English from the 1990s focusing on relationship between the family parenting environment and the cognitive and psychomotor development of children under 5 years of age were included in this meta-analysis. Our findings may provide a basis for promoting early childhood development and potential development.

MATERIALS AND METHODS

Literature Research

The databases of Pubmed, Embase, The Cochrane Library, CNKI, Weipu, Wanfang databases, and CBMdisc databases were searched from January 1, 1990, to July 31, 2021. Each database was searched by using the following key terms: (cognitive development OR psychomotor development OR neuropsychological development) AND (home environment OR development environment) AND (child OR children OR infant OR infants), limited to English or Chinese language.

Inclusion and Exclusion Criteria

The inclusion criteria were as follows: (1) Observational study. (2) The study population consisted exclusively of children under 5-years-old. (3) Pearson correlation or Spearman correlation was used to investigate the relationship between home parenting environment and children's cognitive development or psychomotor development, and, the correlation coefficient [Pearson correlation coefficient (r) or Spearman correlation coefficient (r_s)] was reported. (4) Home parenting environment and children's cognitive and psychomotor development were assessed by validated and reliable scales.

The exclusion criteria were as follows: (1) Non-observational study. (2) Study population was children over 6 years old. (3) Study population involved children with disorders affecting cognitive and psychomotor development. (4) The correlation coefficients between home parenting environment and children's cognitive development or psychomotor development was not reported; (5) The data were incomplete or the effect size cannot be extracted.

Data Extraction

Two researchers (Yang Q and Yang JL) conducted independent literature search and data extraction according to the search strategy and inclusion and exclusion criteria. The extracted data included the first author, publication year, research location, sample size, sex ratio, measurement tools, age of children at the time of evaluation, and correlation coefficient (r or r_s) between home parenting environment and child development. Finally, the two researchers cross-checked the extracted data.

Outcome Variables

The outcome variables were defined as relationship between home parenting environment and children's cognitive development or psychomotor development, which was represented by correlation coefficient (r or r_s).

Quality Evaluation

The study quality was evaluated according to the STROBE statement (29). A total of 22 items including six aspects of title, abstract, introduction, methods, results, and discussion were assessed. One item was scored 1 point and there were 22 points in total.

Statistical Analysis

Review Manager 5.4 was used for meta-analysis. Before merging the effect size, Fisher's Z values and SE values were converted according to the formula. The summary Fisher's Z was obtained based on Fisher's Z values and SE values. Cochran Q -test and I^2 test were used for heterogeneity test. If $p > 0.10$ and $I^2 < 50\%$, there was no statistical heterogeneity between the studies, and the fixed effects model was used. $p < 0.10$ or $I^2 > 50\%$ indicates that there is heterogeneity between the studies, and the random effects model was used. The subgroup analysis was performed according to the age of children and the research area. The funnel plot was used to analyze publication bias, and each included study was eliminated one by one to assess sensitivity. Finally, summary r was calculated according to summary Fisher's Z to determine the correlation of home parenting environment and child development. The value range of $r \geq 0.4$ was defined as

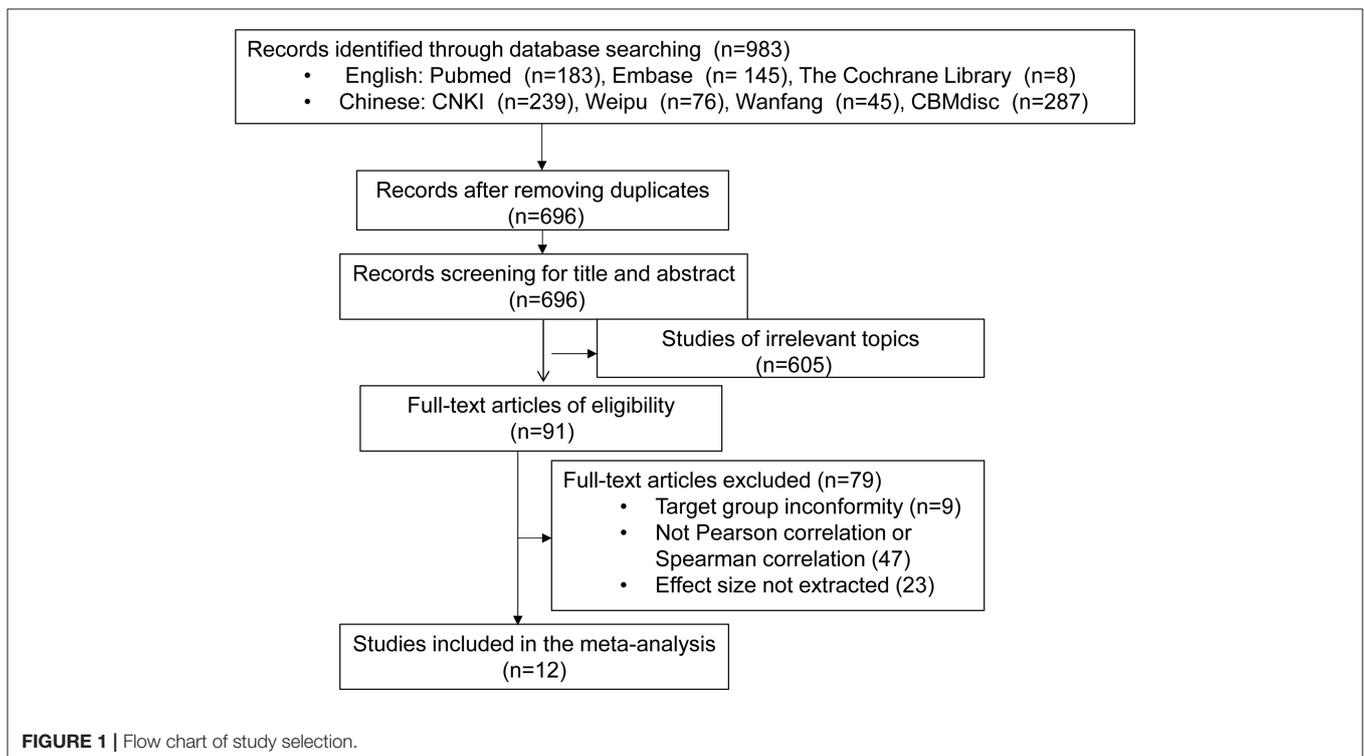


TABLE 1 | Basic characteristics and quality evaluation of the included studies.

| Included studies | Location | Cases | Male/female | Home environment (evaluation tools/age) | Children development (evaluation tools/age) | | Quality evaluation |
|-------------------------|----------------------------|-------|-------------|---|---|-------------------------|--------------------|
| | | | | | Cognitive development | Psychomotor development | |
| Nampijja et al. (41) | America | 146 | Unknown | HOME/5 y | Bdpv/5 y | – | 15 |
| Barreto et al. (40) | Spain | 295 | 145/150 | HES/2 y | MSCA/4 y | – | 17 |
| Ding et al. (39) | China | 188 | 97/91 | CNEQ/12 m | – | NDIC (0–6 y)/2 y | 11 |
| Miquelote et al. (19) | Brazil | 32 | 16/16 | AHEMD-IS/15 m | Bayley-III/15 m | Bayley-III/15 m | 15 |
| Oliveira et al. (38) | Brazil | 23 | 9/14 | HOME/5–6 y | WISC III/5–6 y | – | 16 |
| Wu et al. (42) | Taiwan China | 1,630 | 900/730 | HOME/3 y | TBCS-36/3 y | TBCS-36/3 y | 14 |
| Hamadani et al. (37) | Bangladesh | 797 | Unknown | HOME/18 m | Bayley-III/18 m | Bayley-III/18 m | 14 |
| Black et al. (35) | India | 162 | Unknown | HOME/10 m | Bayley/10 m | Bayley/10 m | 19 |
| Kolobe (36) | America (Mexican American) | 62 | 29/33 | HOME/12 m | Bayley-III/12 m | Bayley-III/12 m | 14 |
| Health (34) | America | 260 | Unknown | HOME/24 m | Bayley-III/24 m | – | 17 |
| Andersson et al. (33) | Norway | 142 | 66/76 | HSQ/13 m | FTII/7 m | – | 11 |
| Richter and Grieve (32) | South Africa | 183 | 98/85 | HSQ/2–17 m | Bayley/2–17 m | Bayley/2–17 m | 10 |
| Richter and Grieve (32) | South Africa | 122 | 64/58 | HSQ/18–30 m | Bayley/18–30 m | Bayley/18–30 m | 10 |

strong correlation; $0.1 < r < 0.4$ as medium correlation; and $r \leq 0.1$ as weak correlation (30). The formula was as follows (31):

$$r = 2\sin\left(rs\frac{\pi}{6}\right) \tag{1}$$

$$\text{Fisher's } Z = 0.5 \times \ln\left(\frac{1+r}{1-r}\right) \tag{2}$$

$$SE = \sqrt{\frac{1}{n-3}} \tag{3}$$

$$\text{Summary } r = \frac{e^{2Z} - 1}{e^{2Z} + 1} \tag{4}$$

Note: *r*, Pearson correlation coefficient; *rs*, Spearman correlation coefficient; SE, standard error; Z, summary Fisher's Z.

RESULTS

Literature Research Results

The study flowchart is shown in **Figure 1**. A total of 983 articles were obtained after initial screening, including 336 in English and 647 in Chinese. After excluding duplicate articles, studies of obviously irrelevant topics, studies of inconsistent outcome indicators, or studies without extractable effect size, 12 articles (19, 32–42) were finally included in the meta-analysis. Among them, there were 11 articles in English (19, 32–38, 40–42) and one article in Chinese (39). One article (32) divided the subjects into the 0–17-month-old group and the 18–30 month old group, and investigated the relationship between the early development of children and home parenting environment. Thus, the two groups of data were extracted independently. The study subjects came from eight countries including China, South Africa, the United States, Brazil, Spain, Norway, India, and Bangladesh. One group of the study subjects was Mexican-American (36). The basic characteristics and literature quality of all studies are shown

in **Table 1**. The quality score of the included studies ranged from 10 to 19 points, and the quality scores of three studies were less than half of the total score (≤ 11 points), which were rated as low quality in this study (32, 33, 39).

Early Development of Children Under 5 Years of Age Is Moderately Correlated With Home Parenting Environment

A total of 12 independent samples in 11 studies (19, 32–38, 40–42) reported the correlation coefficients between home parenting environment and cognitive development in children. The results of meta-analysis under random-effects model ($p = 0.08$, $I^2 = 40\%$) showed that the summary Fisher's Z value was 0.32 (95% CI: 0.27–0.37) ($p < 0.001$). The converted summary *r* value was 0.31. This indicates that cognitive development of children under 5 years old is moderately correlated with the home parenting environment.

A total of eight independent samples in seven studies (19, 32, 35–37, 39, 42) reported the correlation coefficients between home parenting environment and psychomotor development in children. The results of meta-analysis under fixed-effects model ($p = 0.46$, $I^2 = 0\%$) showed that the summary Fisher's Z value was 0.21 (95% CI: 0.17–0.24) ($p < 0.001$) and that the summary *r* value was 0.21. This indicates that psychomotor development of children under 5 years old is moderately correlated with the home parenting environment.

Subgroup Analysis

The age of children under development assessment and the national economic level may have a certain impact on the relationship between the home parenting environment and child development. Thus, the included studies were divided into groups of 0–17 months and over 18 months according to the age of children under development assessment. According to

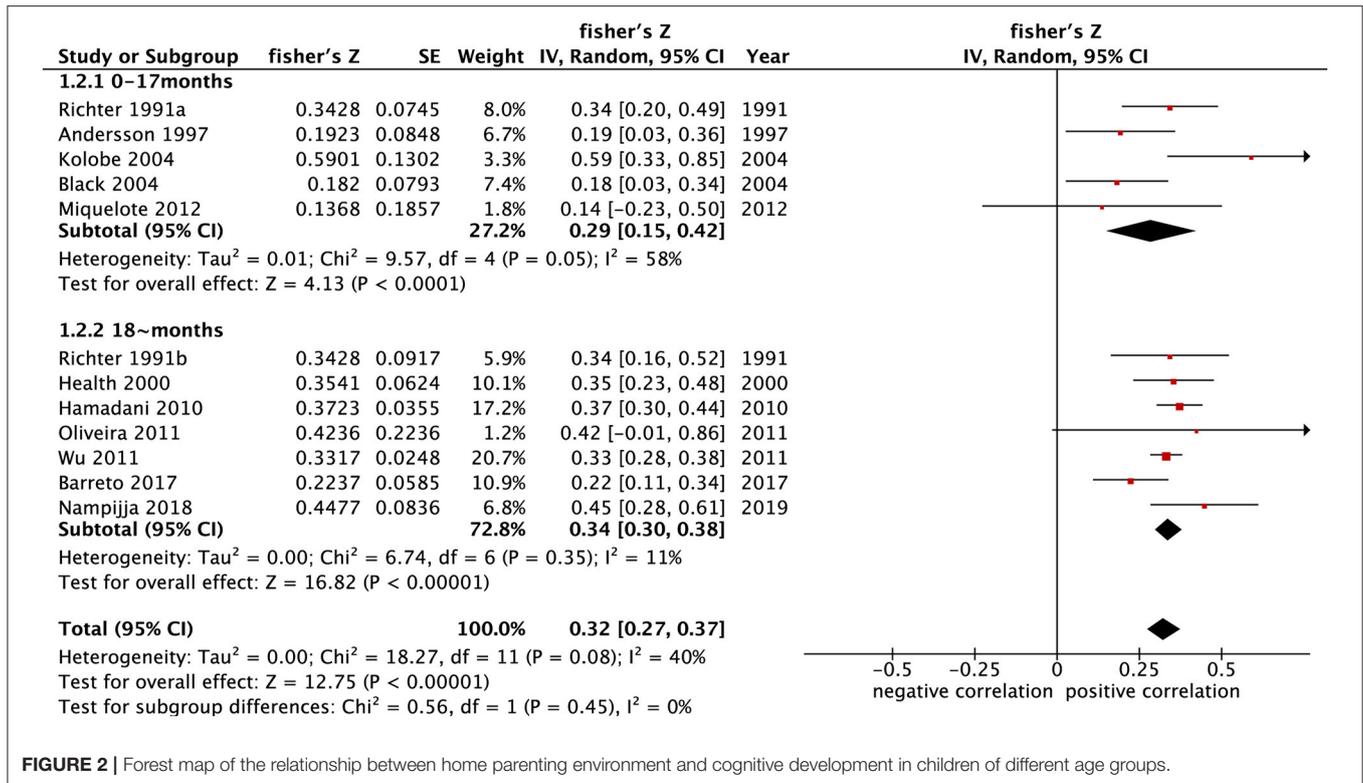


FIGURE 2 | Forest map of the relationship between home parenting environment and cognitive development in children of different age groups.

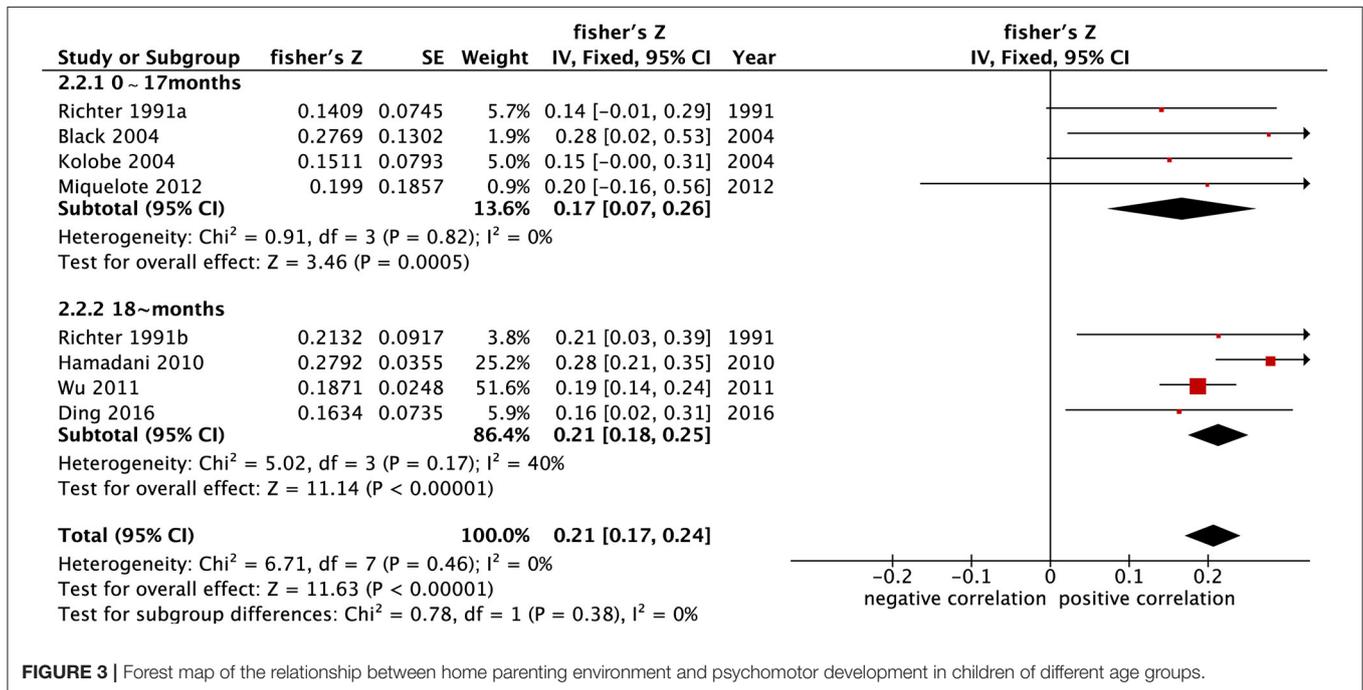


FIGURE 3 | Forest map of the relationship between home parenting environment and psychomotor development in children of different age groups.

economic level, the included studies were divided into a group of developed countries and that of developing countries.

The results of the meta-analysis grouped by age of children under development assessment showed that the correlation coefficients combined with the summary Fisher's Z value between

home parenting environment and cognitive and psychomotor development in the 0-17 months group were [0.29 (95% CI: 0.15-0.42)] and [0.17 (95% CI: 0.07-0.26), *p* < 0.001] (Figures 2, 3), respectively. The correlation coefficients combined with summary Fisher's Z values of home parenting environment

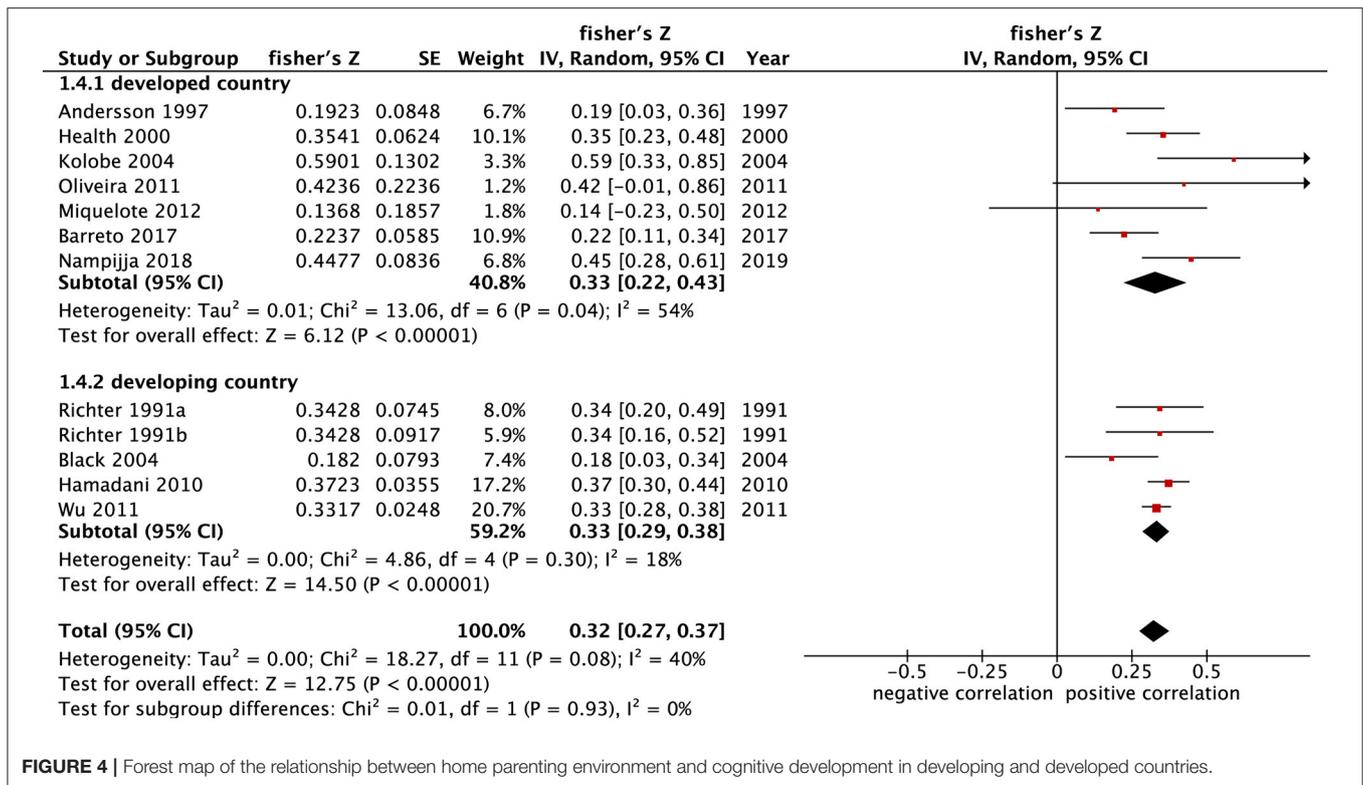


FIGURE 4 | Forest map of the relationship between home parenting environment and cognitive development in developing and developed countries.

and cognitive development and psychomotor development in over 18 months group were [0.34 (95% CI: 0.30–0.38), *p* < 0.001] and [0.21 (95% CI: 0.18–0.25), *p* < 0.001] (Figures 2, 3), respectively. The converted summary *r* values were 0.28, 0.17, 0.33, and 0.21, respectively. From the value of the summary correlation coefficient, the correlation between early childhood development and home parenting environment after 18 months may be stronger than before 17 months.

Since there were only two developing countries that evaluated the relationship between home parenting environment and psychomotor development, subgroup analysis was not performed on psychomotor development. However, the studies evaluating the relationship between home parenting environment and cognitive development were subjected to subgroup analysis. The results showed that the correlation coefficients combined with summary Fisher's *Z* values of home parenting environment and cognitive development in developing and developed countries were [0.33 (95% CI: 0.29–0.38), *p* < 0.001], and [0.33 (95% CI: 0.22–0.43), *p* < 0.001] (Figure 4). The converted summary *r* value between home parenting environment and cognitive development was both 0.32 in developing and developed countries, suggesting that the correlation between home parenting environment and cognitive development is the same between countries with different economic levels.

Publication Bias

Funnel plot was used to analyze the bias of 11 enrolled studies reporting the relationship between home parenting environment and cognitive development. The results were

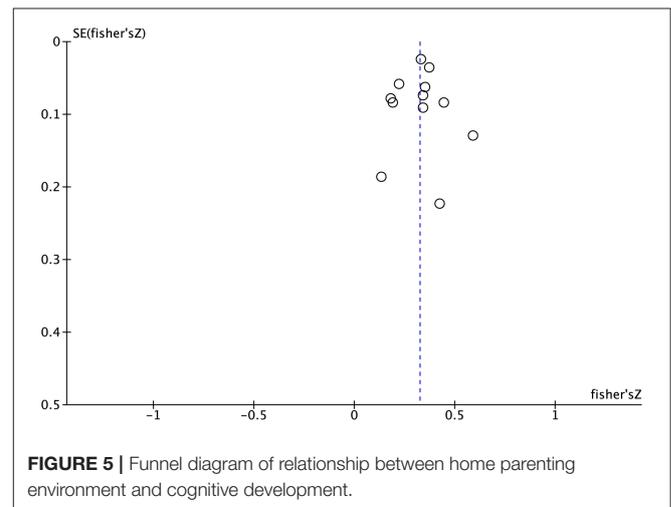


FIGURE 5 | Funnel diagram of relationship between home parenting environment and cognitive development.

slightly asymmetrical, and there may be a certain degree of publication bias (Figure 5).

Sensitivity Analysis

The method of eliminating each study one by one was used to observe the influence of a single study on the total combined effect size, and the results were not significantly different from the total combined effect size, suggesting that the study was stable. The results are shown in Table 2.

TABLE 2 | Sensitivity analysis of relationship between home parenting environment and children's cognitive development (excluding individual studies one by one).

| Deleted studies | Heterogeneity analysis | | Summary Fisher's Z (95% CI) |
|-------------------------|------------------------|---------------------------|--------------------------------|
| | <i>p</i> | <i>I</i> ² (%) | |
| Nampijja et al. (41) | 0.09 | 38 | 0.33 (0.30–0.36) |
| Barreto et al. (40) | 0.14 | 32 | 0.34 (0.31–0.37) |
| Miquelote et al. (19) | 0.07 | 42 | 0.33 (0.30–0.36) |
| Oliveira et al. (38) | 0.05 | 45 | 0.33 (0.30–0.36) |
| Wu et al. (42) | 0.05 | 45 | 0.33 (0.29–0.37) |
| Hamadani et al. (37) | 0.09 | 39 | 0.32 (0.28–0.35) |
| Black et al. (35) | 0.15 | 32 | 0.34 (0.30–0.37) |
| Kolobe (36) | 0.16 | 30 | 0.33 (0.29–0.36) |
| Health (34) | 0.05 | 45 | 0.33 (0.30–0.36) |
| Andersson et al. (33) | 0.11 | 36 | 0.34 (0.30–0.37) |
| Richter and Grieve (32) | 0.05 | 45 | 0.33 (0.30–0.36) |
| Richter and Grieve (32) | 0.05 | 45 | 0.33 (0.30–0.36) |

DISCUSSION

The development of cognition and movement in infants and young children is very rapid and has strong plasticity, which is known as “golden moment” of neuropsychological development. Among the three major living environments of children (natural environment, social environment, and family environment), the home parenting environment is the most exposed one in early childhood surroundings. This meta-analysis showed that the home parenting environment was moderately positively correlated with the cognitive development of children under 5 years old ($r = 0.31$). Previous studies have also shown that a high-quality home parenting environment has a continuous positive effect on the cognitive development of children under 5 years old (28), which may be because the high-quality home parenting environment can provide children with safe environment, learning support, emotional and verbal responsiveness (15), and sufficient stimulation (43) that are conducive to children's cognitive development. Meanwhile, the reasoning ability and depressive symptoms of the mothers, as relevant factors of home parenting environment, also may have an impact on children's early development; however, the negative roles of illness, infection, and poor infant feeding practices will increase the risk of constrained cognitive development in settings with less promotion of development (15). We also found that the home parenting environment was moderately positively correlated with the psychomotor development of children under 5 years old ($r = 0.21$), which is consistent with the results by White-Traut et al. (44). Therefore, improving the home parenting environment in early childhood and providing positive stimulation is conducive to early childhood cognitive and psychomotor development (45, 46).

In order to further explore the factors affecting the relationship between home parenting environment and child development, subgroup analysis was performed in terms of

the age of child development assessment and the survey area. Subgroup analysis showed that the home parenting environment was positively correlated with the cognitive development and psychomotor development of children under 17 months and over 18 months. From the perspective of the correlation coefficient, the relationship between the home parenting environment and the development of children over 18 months was stronger than that of children under 17 months [($r = 0.33$, $r = 0.21$) vs. ($r = 0.28$, $r = 0.17$)]. Miquelote et al. (19) found that the correlation between home parenting environment and child development was stronger at 15 months of age than at 9 months of age. McCormick et al. (15) reported that the home parenting environment at 24 months and 60 months of age could better distinguish the cognitive development trajectory than that at 6 months of age. The results of this meta-analysis are consistent with their results, suggesting that the positive impact of home parenting environment on child development gradually increases with age and that the home parenting environment has continuous effect on the development of children (44). The subgroup analysis also showed that the combined correlation coefficient between home parenting environment and cognitive development was both 0.32 in developing and developed countries, indicating that this correlation of home parenting environment and cognitive development is the same in countries with different economic levels.

There were some limitations in this study. First, papers in languages other than Chinese and English and those using regression analysis to investigate the correlation between home parenting environment and child development were excluded. Second, the funnel plot showed that there may be a certain publication bias, which may have a certain impact on the final effect. Third, this study did not include children over 5 years old and could not provide evidence for the long-term effects of the home parenting environment on children's cognitive and psychomotor development. Finally, the quality of the included papers was mostly between 10 and 19 points, of which the quality scores of three studies were less than half of the total score. Almost all the studies lacked a reasonable description of the research samples, which may affect the scientificity of conclusions. Future studies with more high-quality articles are warranted to investigate the long-term impact of the home parenting environment on the development of children.

In conclusion, the home parenting environment was positively correlated with the cognitive and psychomotor development of children under 5 years old. The older the age, the stronger the correlation, indicating that the home parenting environment may have a continuous positive impact on the development of children. The early development potential of children in the family environment of high quality is relatively better. These results indicate that the main caregivers of children should not only provide children with reasonable dietary nutrition and economic security, but also enhance parent-child interactions, provide appropriate support and stimulation, and create a family environment conducive to the development of children.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

LY and QY designed the study. QY and JY collected the data and searched the literatures. QY and LZ analyzed and

interpreted the data. LZ and WS prepared the study. QY collected the funds and wrote the paper. LY revised the paper. All authors contributed to the article and approved the submitted version.

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