

# The Impact of Visual-Motor Integration through Art-Based Activities on Fine Motor Skills in Preschools: A Scoping Review

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## ABSTRACT

Visual-motor integration (VMI) is the ability to coordinate visual perceptual and motor skills. The Beery Developmental Test of Visual-Motor Integration (Beery VMI test) is a standardised copy forms-type test that is frequently used to assess visual-motor integration. This scoping review explores the impact of VMI through art-based activities on fine motor skills development in preschoolers with a focus on early childhood education settings. A total of 13 studies from various countries, including Malaysia, Indonesia, Taiwan, Canada, and Switzerland, were reviewed to identify the types of art-based activities implemented, their effects on VMI and fine motor skills development, and the research gaps in current practices. Findings indicate that activities such as drawing, folding, cutting, colouring, and origami significantly enhance visual-motor coordination and fine motor precision. Several international studies report measurable improvements in manual dexterity, hand-eye coordination, and symbolic representation as a result of structured art interventions. However, within the preschools context, art is often treated as a recreational component rather than an intentional developmental tool. The review highlights key gaps, including the lack of local empirical studies, limited teacher training in VMI-based pedagogy, and the absence of standardised assessment tools. This paper underscores the need for context-specific, evidence-based interventions that integrate structured visual art-based activities to support motor skill acquisition and holistic development in preschool education.

**Keywords:** scoping review, art-based activities, visual motor integration, fine motor skill, preschool

## INTRODUCTION

Art-based activities are a vital component of early childhood education, providing preschoolers with opportunities for creative expression while supporting multiple aspects of their development. These activities include a variety of lived experiences such as drawing, colouring, painting, cutting, shaping, and organising. Studio-based art practices, including drawing, painting, and sculpture, have been shown to foster critical thinking skills in young learners by engaging them in creative problem-solving and experimentation (Ankyiah & Bamfo, 2023). Creativity promotes emotional control, social interaction, and basic learning skills. According to Carsone et al. (2021), by engaging with a variety of materials and tools, children build accuracy, control, and self-confidence. These are fundamental competencies for their academic readiness and overall development.

Visual-motor integration (VMI) refers to the ability to coordinate between visual perception and motor movement. It is the ability to interpret the visual information and respond with the appropriate motor action, such as controlling a pencil or using scissors. This study shows that art-based activities involving copying, colouring, and drawing are very much dependent on VMI's capabilities, and can be a standard assessment tool as in the Beery-VMI test (Zhang et al., 2023). Therefore, the continued use of art-based activities in the preschool environment is a natural and meaningful way to enhance visual-motor function in preparation for more complex



academic tasks such as writing, copying, and problem solving (Lidstone & Mostofsky, 2021). It allows children to receive and process visual information and then use it to guide and control physical movement, especially in fine motor tasks such as drawing, writing, cutting, or copying shapes. VMI is very important in early childhood development as it supports children's ability to perform academic tasks and build self-esteem which require accurate eye coordination (Kaiser et al., 2009). Components such as visual perception, fine motor, eye coordination, visual space awareness, motor planning, visual memory, and left-hand orientation all play a role in the effectiveness of VMI (Rosenblum et al., 2019; Zhang et al., 2023). In the early education environment, activities such as drawing, pasting, copying, and colouring are daily learning routines that serve as natural training to strengthen children's VMI.

### **Visual-Motor Integration through Art-Based Activities on Fine Motor Skills**

The use of art-based activities is not always aligned with developmental objectives, and assessment of fine motor progress is rarely associated with children's involvement in VMI assignments. A combination of origami and copying activities had the strongest associations with children's VMI (Huang et al., 2023). These visual art-based activities actively support visual-motor integration, as they require children to simultaneously process visual information and perform coordinated motor responses. As a result, despite the natural overlaps between these three elements, the potential of art as a medium for strengthening visual-motor integration and fine motor development is still less explored. This gap shows the need for more evidence-based studies and practices in designing art interventions aimed at explicitly supporting visual-motor coordination among preschool children.

However, one of the main issues is the limited understanding of how VMI supports these skills through art-based activities. Although art is included in the early childhood programmes, its implementation is often not accompanied by a specific focus on development outcomes such as fine motor improvements. Recent experimental studies have found that, although art-based activities such as plasticine play can improve fine motor skills and creativity at the preschool level, their implementation is not systematically integrated into most early childhood curricula (Iffah & Aulina, 2024).

In addition, meta reviews show that explicit interventions of VMI need to be included (Józsa et al., 2023; Faber et al., 2024). Many preschool teachers may have less exposure or training in understanding how structured art-based activities such as clipping, cutting, or drawing directly contribute to VMI, which is essential for proper eye coordination and motor control. In addition, in the preschoolers' context, there is still lack of standard guidelines or instruments to evaluate the extent to which art-based activities contribute to fine motor development. The inconsistency between the implementation of the curricula and the goals of this development limits the potential of art as a medium for strengthening motor skills. Therefore, it is important to identify and coordinate VMI-based art interventions with fine motor development outcomes to ensure more optimal learning experiences and holistic development in preschoolers. The strength of evidence is moderate, indicating that preschool programmes targeting fine and visual-motor skills can improve fine motor outcomes.

## **MATERIALS AND METHOD**

A scoping review is a form of evidence synthesis that systematically identifies and maps the breadth of research available on a particular topic, field, concept, or issue, with the aim of providing an overview of the available evidence rather than to deliver a definitive answer to a specific research question.

Systematic Literature Reviews (SLRs) and Scoping Reviews (SRs) are both methods of synthesising research evidence, but they differ in purpose and methodology. SLRs are designed to answer specific, narrowly focused research questions often framed using the PICO (Population, Intervention, Comparison, Outcome) format, by systematically identifying, appraising, and synthesising relevant studies, sometimes including meta-analysis for quantitative data or meta-synthesis for qualitative data. In contrast, SRs aim to broadly map existing literature within a particular field, often to identify knowledge gaps, clarify key concepts, or explore how research is conducted, especially in emerging or complex areas. Unlike SLRs, SRs do not typically assess study quality or produce summary effect sizes; instead, they focus on providing an overview of the scope and range of evidence available. This research article employs the six-step methodology developed by Arksey and O'Malley (2005), as explained in the section below:



### Step 1: Identifying the research question.

This scoping review examines the impact of VMI through art-based activities on fine motor skills in preschoolers. The following research questions are presented in this study to ensure a comprehensive review of the literature: what types of art-based activities have been implemented in preschool settings to support VMI; how has VMI through these art-based activities been shown to impact the development of fine motor skills among preschoolers; and what gaps or limitations exist in the current body of research regarding the use of visual-motor-based art interventions in early childhood education within the preschools context.

### Step 2: Identifying relevant past research.

To ensure a comprehensive review of the available literature, relevant search phrases were employed in three established databases: the Web of Science (WoS), Scopus, and ERIC. These databases provide access to leading publications in disciplines such as leadership, education, and organisational management. In line with the thematic search process, studies on the impact of VMI through art-based activities on fine motor skills in preschools were gathered using the established themes and search phrases.

### Step 3: Selection of articles for analysis.

This scoping review applied specific inclusion and exclusion criteria to select publication for analysis. Firstly, only publications in the context of education were included. Secondly, only research articles were eligible for inclusion in the scoping review; conference papers, book chapters, conference reviews, and books were excluded. Thirdly, only English language papers published between 2020 and 2025 were included.

### Step 4: Charting the data.

Microsoft Excel was used to present the data graphically, supporting both thematic and comparative analysis. A comprehensive table was presented, detailing the author's name, year of publication, location, studied variables, implications of the research, art-based activities, and fine motor skills. This table facilitated understanding of the findings and provided a clear basis for answering the research questions.

### Step 5: Collating, summarising, and reporting the data.

To analyse and present the impact of VMI through art-based activities on fine motor skills in preschools, the findings were reorganised according to topics, major themes, and sub-themes. Each article was classified and discussed based on themes and sub-themes identified through thematic and comparative analysis (Table 1). Figures 2 and 3 illustrate the characteristics of the published scientific literature.

### Step 6: Discussion of the results.

The findings are discussed in relation to the objectives of this paper. Given that this topic is relatively new among early childhood educators, limitations and general suggestions for future studies on VMI are discussed.

## FINDINGS

A total of 7,263 records were identified from the database search. However, upon applying the inclusion criteria requiring empirical studies in the field of education, that is, articles in the subject of education with a social scientific status, published between 2020 and 2025, only 5,591 publications met the requirements. After removing six duplicate papers, 5,585 publications remained eligible for screening. Of these 5,578 articles were found to be unrelated to the objectives of this scoping review. Ultimately, 13 studies employing quantitative techniques were selected, as they met the reporting requirements for the thematic review and aligned most closely with the research aims.

The primary criteria established serve as the basis for selecting articles in this scoping review. These criteria are threefold: First, given the readily available sources and databases, this analysis exclusively includes journal papers while excluding other types of publications. For instance, the WoS database contains over 760 million

references across numerous fields. Second, only papers employing quantitative research techniques were selected, as quantitative approaches are generally considered more robust than other methodologies in education research. Third, only empirical articles published English were included.

Lastly, only empirical publications from the past five years were included. This timeframe was chosen to ensure that the review reflect research of greater maturity and quality, particularly in the context of a scoping review.

Figure 1 below illustrates the research selection process using the Preferred Reporting Items for Systematic Reviews (PRISMA), adapted from Moher et al. (2015).

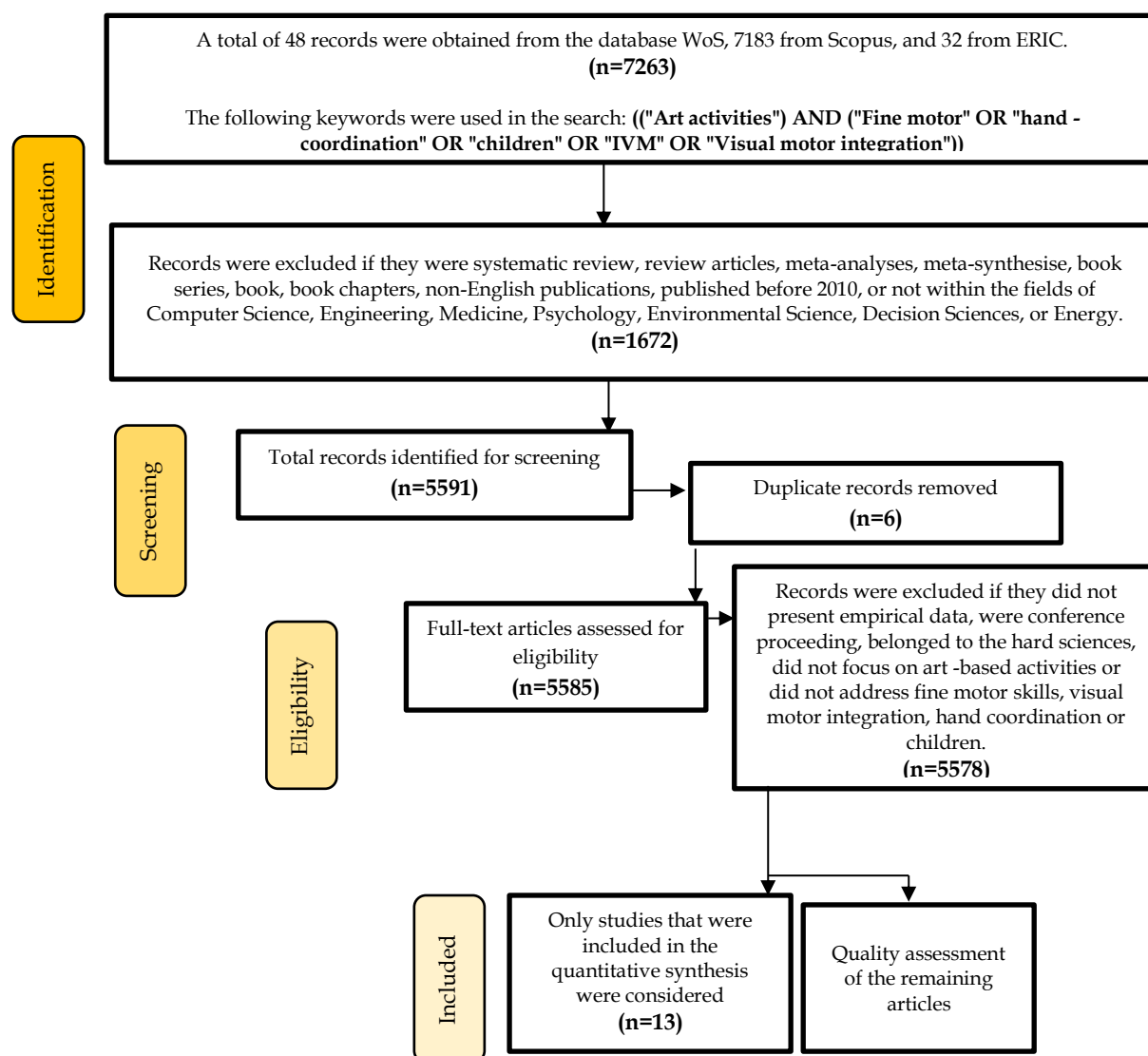


Figure 1: PRISMA flow diagram of the study selection process) (adapted from Moher et al., 2015).

## Main Findings

Table 1 presents the 13 research publications included in the scoping review based on the criteria outlined above. [8, 2, 19, 29, 26, 11, 24, 28, 16, 17, 21, 23, 9]. The analysis revealed that VMI through art-based activities has a positive and significant impact on the development of fine motor skills among pre-schoolers. When effectively implemented, these activities can enhance hand–eye coordination, precision, and overall motor control, which are essential for tasks such as writing, cutting, and manipulating small objects. VMI, as an independent variable, plays a crucial role in shaping children's motor development by offering structured yet creative opportunities to practice fine motor skills in engaging and meaningful ways. This highlights the importance of incorporating



well-designed art-based tasks in early childhood education to support fine motor skills development that are vital for academic readiness and daily functioning.

The scoping review addressed the second research question regarding the impact of VMI through art-based activities. A growing body of research highlights the potential of art-based activities in supporting VMI and fine motor skill development among preschoolers. In the preschool context, although structured documentation is limited, commonly implemented art-based activities that align with VMI goals include folding, cutting, drawing, colouring, and object manipulation embedded in visual art practices. These activities, while prevalent, are frequently delivered without intentional alignment to developmental objectives such as improving hand-eye coordination or fine motor control.

Studies conducted in other countries, including Indonesia, Canada, Taiwan, and Hong Kong, have demonstrated that VMI-focused art interventions such as mirror drawing, origami, sewing patterns, and collaborative tactile art can significantly improve fine motor precision, reaction time, manual dexterity, and symbolic expression (Gidion, 2020; Straffon et al., 2024; Huang et al., 2025; Liao et al., 2025). For instance, drawing tasks have been shown to naturally strengthen motor control and visual-perceptual accuracy, while cutting and folding activities activate bilateral hand use and support foundational writing and reading. Despite these promising findings, the current literature reveals several key gaps within the preschools context. These include a lack of localised intervention studies that explicitly examine the effects of structured art activities on VMI and motor development, limited use of standardised assessments, insufficient teacher training in integrating VMI principles into art instruction, and the tendency to treat art primarily as a creative outlet rather than a developmental tool. Consequently, there is a pressing need for empirical, context-specific research and intervention models that systematically incorporate VMI-based art activities into early childhood education to enhance fine motor outcomes and holistic development.

Table 1. Charting the data

| Publication Location                                                                          | Variables/<br>Construct                                                                                                                                              | Impact of VMI                                                                                                                                                                                                        | Art Activities                                                                                                                                                                                           | Fine Motor Skills                                                                                        |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Mohamed Frikha, and Raghad Saad Alharbi (2023) – Basel, Switzerland                           | Independent: Type of intervention (Mixed: Art, motor accuracy, accuracy only, control)<br><br>Dependent: Fine motor coordination, selective attention, reaction time | The combined programme based on motor accuracy exercises and visual art activities best assists accuracy, manual dexterity, reaction time, and selective attention.                                                  | Art-based interventions using various fields of visual art (techniques, materials, expressive methods, and concepts) had a positive effect on the children's perseverance, attention, and concentration. | The ceramic formation programme enhanced fine motor skills in children with Down's Syndrome.             |
| Zainab Alrubayel, Moaaz Hudhud Mughrabi, Banu Manav and Anil Ufuk Batmaz (2024) – Switzerland | Independent: Type of environment (virtual vs real world), colour cue (red, green, blue)<br><br>Dependent: Task completion time                                       | The consistent practice of mirror drawing exercises improves the hand-eye coordination of the children, while enhancing the synchronisation and alignment between visual information processing and motor movements. | Mirror drawing is a motor learning task used to evaluate and improve children's hand-eye coordination and can be implemented in immersive Virtual Reality (VR) Head-Mounted Displays                     | Over time, these iterative refinements lead to incremental advancements in execution speed and accuracy. |



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|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                            |                                                                                                          |                                                                                                                                                                                                                                                                                                                    | (HMDs) for training purposes.                                                                                                                                                                                                           |                                                                                                                                                                                                           |
| Gennie Mansi, Jessica Roberts, Sue Reon Kim Georgia (2022) – Institute of Technology Atlanta, Georgia, USA | Independent: Technology needs and tools<br>Dependent: Art Education for K–2 (Kindergarten to Year 2)     | National standards emphasise the use of art tools (e.g., pencils, brushes, scissors, etc.) to apply artistic principles as a form of creative expression, while also developing fine motor skills, spatial skills.                                                                                                 | Teachers reported that hands-on interactions, such as trying art techniques and developing motor skills through art tool use, were the most important outcomes for children, but also the most difficult to achieve in remote settings. | Tangible technology helps maintain engagement, encourage creativity, and supports the development of fine motor skills.                                                                                   |
| Dinghuang Zhang, Baoli Lu, Jing Guo, Yu He and Honghai Liu (2023) – United Kingdom                         | Independent: Hand-drawn imitation task<br>Dependent: Visual-Motor Integration (VMI) performance or score | VMI or perception–action coupling, refers to the synchrony between visual perception and fine motor control. It is the ability of the vision system to coordinate information received through the eyes in order to control, guide, and direct the hands in accomplishing a given task.                            | The hand-drawn imitation heavily involves visual perception to guide hand movements and fine motor control in precisely copying geometric shapes. The key lies in modelling hand-eye behaviour.                                         | The hand-drawn imitation task primarily involves visual perception (head and eyes) and fine motor behaviours (hand, fingers and upper arms) in real-time.                                                 |
| Sebastian P. Suggate Viktoria L. Karle b, Tanja Kipfelsberger, Heidrun Stoegerb (2023) – Germany           | Independent: Fine motor<br>Dependent: Reading development                                                | We emphasise the importance of high-quality perceptual-motor stimulation during PE sessions, particularly in the early stages of young children’s development, in order to minimise the potential negative impact that poor perceptual abilities may have on academic task execution later in their school career. | The ability to use vision to coordinate hand and finger movements (e.g., handwriting) in young children requires not only cognitive processes but also the integration of perceptual and motor processes.                               | The ability to use vision to coordinate hand and finger movements (e.g., handwriting) in young children requires not only cognitive processes but also the integration of perceptual and motor processes. |
| Chien-Yu Huang, Yen-Ting Yu, Kuan-Lin Chen, Jenn-Jier Lien, Gong-Hong Lin, Ching-Lin                       | Independent: Visual Perception<br>Dependent: Visual Motor Integration (VMI)                              | Origami activities and their outcomes can help therapists assess children’s development levels, including developmental age and VMI skills, by examining both the                                                                                                                                                  | From an occupational therapist’s perspective, the quality of origami products can reflect a child’s developmental age                                                                                                                   | Several developmental assessments incorporate origami tasks to evaluate children’s fine motor skills. For instance, the                                                                                   |



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|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hsieh (2025) – Taiwan                 |                                                                                                                                      | process and the quality of finished products.                                                                                                                                                                                                                                                                      | and visual-motor integration (VMI) skills.                                                                                                                                                                | Peabody Developmental Motor Scales-Second Edition (PDMS-2); the Comprehensive Developmental Inventory for Infants and Toddlers (CDIIT); the Stanford-Binet Intelligence Scale, Fifth Edition; and the Bruininks-Oseretsky Test of Motor Proficiency-Second Edition (BOT-2) each include paper-folding items designed to measure VMI, visual-spatial skills, or fine motor skills. |
| Daleen Struwig, (2023) – South Africa | Independent: Physical Education (PE) intervention using the KaziKidz toolkit perception<br>Dependent: Visual-Motor Integration (VMI) | We emphasise the importance of high-quality perceptual-motor stimulation during PE sessions, particularly in the early stages of young children's development, in order to minimise the potential negative impact that poor perceptual abilities may have on academic task execution later in their school career. | The ability to use vision to coordinate hand and finger movements (e.g., handwriting) in young children requires not only cognitive processes but also the integration of perceptual and motor processes. | The ability to use vision to coordinate hand and finger movements (e.g., handwriting) in young children requires not only cognitive processes but also the integration of perceptual and motor processes.                                                                                                                                                                         |
| Vasiliki Vasilak (2024) – Greece      | Independent: Visual arts education<br>Dependent: Development of pre-school children                                                  | -                                                                                                                                                                                                                                                                                                                  | Art-based activities promote emotional expression, creativity, and cooperation among pre-schoolers, contributing significantly to their holistic development.                                             | Visual arts affect the development of imagination and creativity, as well as other cognitive and motor skills.                                                                                                                                                                                                                                                                    |



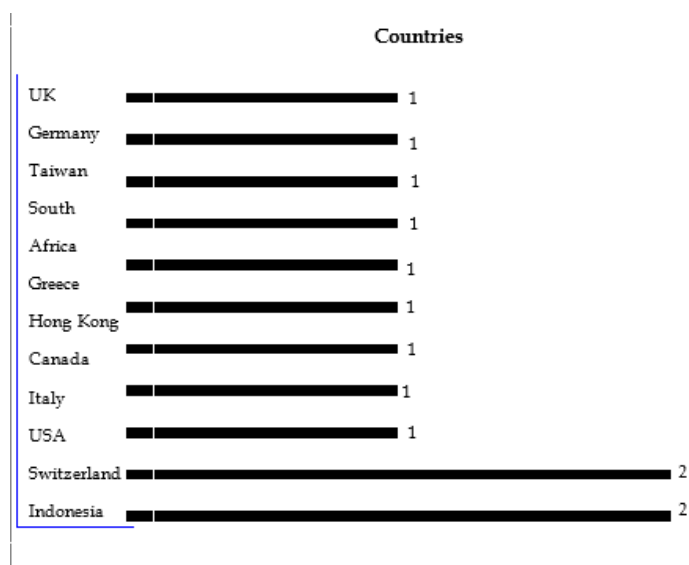
|                                                   |                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kustiawan et al. (2021) – Indonesia               | <p>Independent: Art-based learning activities, specifically simple sewing using clothing pattern designs</p> <p>Dependent: Fine motor skills development in young children</p>                                                                | <p>The sewing process, which involves inserting a ribbon into the holes along each edge of the pattern, is a form of hand-eye coordination exercise for children.</p> <p>Hand-eye coordination exercises are a form of fine motor development stimulation.</p>                             | <p>The choice of particular learning methods and materials becomes integral to helping children express and create unique ideas, as well as use their imaginations in works that are meaningful and personally relevant.</p> | <p>Fine motor skills refer to ability to control finger movements, especially those of the index finger and thumb (i.e., holding, grasping, tearing, and cutting).</p> <p>Additionally, fine motor skills include the use of tools for tasks and the manipulation of small objects, as well as control over outcomes (i.e., typing and sewing) (Kustiawan et al., 2021, p.11).</p> |
| Liao et al. (2025) – Hong Kong                    | <p>Independent: Participation in integrated arts-based activities using loose parts</p> <p>Dependent: Development of aesthetic and fine motor skills (e.g., hand-eye coordination, creative expression, tactile and sensory integration).</p> | -                                                                                                                                                                                                                                                                                          | <p>The integration of music, visual arts, and drama facilitated children's aesthetic expression and symbolic understanding, while also promoting communication, collaboration, and empathy.</p>                              | <p>Through transforming loose parts into musical instruments and engaging in collaborative art-making, children explored materials with their hands, fostering tactile sensitivity, coordination, and motor precision.</p>                                                                                                                                                         |
| Giuliana Pinto & Oriana Incognito, (2022) – Italy | <p>Independent: Visual-motor integration (VMI)</p> <p>Dependent: Emergent drawing &amp; emergent writing</p>                                                                                                                                  | <p>Visual-motor coordination has been found to be crucially associated with drawing for 3-, 4-, and 5-year-old children (Toomela, 2002). Both younger and older children produce more accurate and realistic drawing as they master the pictorial equivalents of represented concepts.</p> | <p>Drawing and writing share several characteristics: both leave visible marks—unlike speech—and both are symbolic systems, where signs stands in place of meaning.</p>                                                      | <p>To advance in pictorial ability, a child must be able to create graphic signs or pictorial equivalents that are increasingly complex and finely articulated.</p>                                                                                                                                                                                                                |



|                                                                                     |                                                                                                            |                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Straffon, D.,<br>Bremer, E.,<br>Logan, S. W.,<br>& Cairney, J<br>(2024) –<br>Canada | Independent:<br>Visual–Motor<br>Integration (VMI),<br>Fine Motor Skills<br><br>Dependent:<br>Drawing Skill | VMI proved to be<br>crucially associated<br>with drawing in 3-, 4-,<br>and 5-year-old children.<br>In the executive process<br>of drawing, both<br>younger and older<br>children produce more<br>accurate and realistic<br>outcomes as they<br>master the pictorial<br>representations of the<br>concepts. | The act of drawing<br>itself requires<br>visual–motor<br>coordination,<br>making it a natural<br>context in which to<br>observe and assess<br>VMI development<br>in young children.                                                                                                | Fine motor skill<br>proficiency has<br>been found to<br>significantly<br>correlate with<br>drawing complexity<br>in children,<br>suggesting that<br>motor control is an<br>integral part of<br>drawing<br>development.                                                                                                                             |
| Hermito Gidion<br>(2020) –<br>Indonesia                                             | Independent:<br>Motor learning<br>activities<br><br>Dependent:<br>Children’s fine<br>motor skill           | -                                                                                                                                                                                                                                                                                                          | Some examples of<br>fine motor skill<br>learning activities<br>include folding,<br>cutting, choosing<br>colours, colouring<br>drawings,<br>assembling or<br>matching objects,<br>and other tasks that<br>involve hand–eye<br>coordination and<br>manipulation of<br>small objects. | Fine motor skills<br>involve the<br>organisation and<br>use of small muscle<br>groups, such as the<br>fingers and hands,<br>which are essential<br>for performing<br>tasks that require<br>precision and<br>coordination.<br><br>Writing, drawing,<br>and playing the<br>piano are examples<br>of activities that<br>rely on fine motor<br>skills. |

## Background of The Research Included In The Review

Figure 2 depicts the locations of research on the impact of VMI through art-based activities on fine motor skills in preschools, highlighting the context of studies reviewed.



**Figure 2: Distribution of research by country**



## DISCUSSION

This study provides a comprehensive overview of how VMI through art-based activities impacts the fine motor skills development in preschoolers. This study shows that art-based activities can positively influence VMI in children. A 10-week psycho-educational intervention improved VMI scores among first graders (Taverna et al., 2020). Structured art-based activities such as drawing, colouring, and cutting can enhance hand-eye coordination, spatial awareness, and finger dexterity, all of which are essential for fine motor control. An artificial intelligence analysis revealed that origami and copying activities are strongly associated with preschoolers' VMI performance (Huang et al., 2023). When art-based activities are regularly implemented in preschool or kindergarten, they help develop the motor skills needed for academic readiness, particularly in writing and object manipulation. These art-based activities not only strengthen manual skills essential for writing but also foster creativity, self-esteem, and social interaction (Nurjanah et al., 2023). VMI skills are positively correlated with reading, writing, and mathematics achievement in grades 5–9 (Al-Attiyah & Emam, 2020). Based on the results of the study, the impact of VMI through art-based activities extends to three main areas, namely, child development, educator teaching methods, and the capacity of the curriculum to integrate cognitive learning goals.

VMI through art-based activities has been found to positively impact the development of children's fine motor skills. Structured art-based activities such as drawing, colouring, and cutting help improve hand-eye coordination, strengthen finger muscles, and increase precision in movement. In addition, they serve as a fun and practical medium for enhancing children's fine motor development, particularly in early writing and school readiness. Engagement in VMI-based art activities can also promote focus, spatial awareness, and perseverance, while supporting children's cognitive and physical preparation for formal learning. A combined programme of motor accuracy exercises and visual art activities has been shown to enhance fine motor coordination, reaction time, and selective attention in middle childhood (Frikha & Alharbi, 2023). Therefore, VMI contributes to the holistic development of children. When implemented effectively, VMI through art-based activities can build motor skills and enrich the overall learning experience in early childhood education.

Based on this study, various types of art-based activities support the fine motor skills development by strengthening VMI among preschoolers. Among them are drawing and colouring activities that require controlled hand movements guided by visual input and that simultaneously support grip strength, hand-eye coordination, and spatial awareness. According to Jumiya et al. (2023), the implementation of colouring activities in early childhood education showed good results as an effective, fun, and simple method for developing fine motor skills. Tracing shapes and patterns strengthens both aspects of VMI and motor planning, because children need to process shapes visually and reproduce them with consistent accuracy. The results of the study by Cohen et al. (2021), which used both drawing and tracing tasks to evaluate fine motor control, are rapid, economical, and valuable for monitoring motor development among elementary school children. In addition, drawing with tools such as small brush or cotton bud helps children control wrist movements, finger dexterity, and grip suitability. Art-based activities such as collage, which include cutting, gluing, and pasting, help improve hand-eye coordination and finger dexterity (Hanafiah et al., 2023). These visual and tactile-based activities not only encourage creative expression but also serve as effective tools for strengthening fine motor development, especially when structured with specific developmental goals.

Despite these promising findings, the successful implementation of VMI-based art activities depends not only on the activities themselves but also on teachers' pedagogical knowledge and classroom conditions. Although the findings consistently demonstrate the positive contribution of VMI-based art activities to preschool children's fine motor development, translating these interventions into everyday classroom practice remains challenging. Many preschool teachers have limited formal training in visual-motor integration and may implement art activities primarily for creative expression rather than as structured developmental interventions. Previous studies have reported that teachers often lack sufficient knowledge and practical experience in integrating art activities with motor development objectives, resulting in fragmented learning experiences where art and motor skills are addressed as separate components rather than interconnected domains (Liao et al., 2025; Jayani & Mawaddah, 2025; Olanrewaju, 2025). In addition, factors such as limited instructional time, inadequate teaching materials, varying teacher competency, and differences in children's developmental readiness may influence the



effectiveness of these activities. Therefore, integrating structured VMI principles into preschool teaching modules and professional development programmes could enhance the consistency and quality of implementation across different educational settings. This would enable art-based activities to function not only as creative experiences but also as evidence-based pedagogical strategies that systematically strengthen children's fine motor development.

## LIMITATION AND RECOMMENDATIONS

The focal point of this study's limitations lies in the scarcity and fragmentation of empirical data related to VMI within the preschool context. While the study draws on selected peer-reviewed sources, the majority of existing literature originates from Western educational systems, thereby constraining the contextual relevance and cultural alignment of the findings. This gap provokes a broader academic conversation surrounding the urgent need to establish locally grounded research and standardised frameworks that specifically address how art-based interventions influence fine motor development through VMI in early childhood education. Furthermore, challenges persist in sourcing structured data due to the absence of systematic documentation on how art-based activities are integrated into preschool curricula. The complexity of VMI as a multi-dimensional construct further complicates the isolation of variables, making it difficult to determine causality with precision. Looking ahead, future scholarly efforts may benefit from the inclusion of more diverse data sources, such as regional educational databases and institutional reports, which would enhance the comprehensiveness of analysis. Additionally, incorporating longitudinal or statistically driven methodologies may offer more nuanced insights into the developmental trajectories influenced by VMI-based art interventions.

Another limitation of this review relates to the relatively small number of empirical studies that met the inclusion criteria. Although thirteen studies provided sufficient evidence to map the current landscape of research, they may not comprehensively represent global evidence on VMI-based art interventions. Furthermore, considerable variation exists across the included studies regarding intervention types, research designs, outcome measures, and educational contexts. Such heterogeneity limits direct comparison between studies and prevents definitive conclusions regarding the effectiveness of specific intervention approaches. In line with the objectives of a scoping review and the methodological framework proposed by Arksey and O'Malley (2005), this review did not undertake a formal methodological quality appraisal or risk-of-bias assessment of the included studies. Instead, the primary purpose was to map existing evidence, identify knowledge gaps, and describe current research trends. Consequently, the findings should be interpreted as an overview of available evidence rather than conclusive evidence of intervention effectiveness.

## IMPLICATIONS

This study conducted an in-depth exploration of VMI within the context of early childhood art education, systematically identifying core components, sub-constructs, and pedagogical mechanisms that shape the development of fine motor skills among preschoolers. Through a structured and focused scoping review, this research not only reinforces the theoretical foundations and developmental rationale linking VMI to fine motor proficiency but also highlights critical pedagogical gaps and areas warranting further scholarly investigation. The theoretical implication arising from the findings suggests that VMI should not be viewed solely as a neurological or cognitive construct but rather as an active bridge between visual perception, motor coordination, and creative learning experiences. This contributes to a broader understanding of motor and cognitive development theories, particularly in supporting holistic models of early childhood education that integrate sensory, motor, and expressive domains. Overall, the study offers meaningful insights for educators, curriculum designers, and policymakers by presenting an integrated framework that aligns artistic activities with key developmental milestones. The implications extend beyond classroom practice, reinforcing the value of VMI-informed art interventions in promoting well-rounded growth during the formative preschool years.

From a practical perspective, the findings support the development of structured VMI-based teaching modules for preschool classrooms. Such modules could provide teachers with developmentally appropriate art activities, implementation guidelines, and standardised assessment procedures for monitoring children's progress. Teacher education institutions and professional development providers should also integrate VMI-based instructional



strategies into pre-service and in-service training programmes to strengthen teachers' pedagogical knowledge and instructional confidence.

## CONCLUSION

In recent years, VMI has emerged as a critical component of early childhood education, particularly in supporting the development of fine motor skills through creative and structured art-based activities. Although the existing literature provides valuable insights, it remains fragmented and lacks a unified perspective, especially within the preschool context. This scoping review explores a broad spectrum of studies that examine the intersection of VMI and fine motor skill development, revealing significant themes and highlighting art-based interventions as tools for enhancing hand-eye coordination, dexterity, and spatial awareness. The review underscores the importance of developmentally appropriate art-based activities in reinforcing VMI, while also identifying inconsistencies in implementation and the limited availability of empirical data locally. These findings point to the need for further research that incorporates diverse methodological approaches, as well as the expansion of data sources to provide a more robust understanding of VMI's impact. Overall, this review provides a comprehensive overview of current research, identifies gaps, and suggests promising directions for future investigation, ultimately contributing to the refinement of early childhood pedagogy and developmental theory.

Future research should extend beyond evidence mapping by conducting systematic reviews and meta-analyses to establish stronger evidence regarding the effectiveness of VMI-based art interventions. Moreover, longitudinal and experimental studies within local preschool settings are required to determine long-term developmental outcomes and validate context-specific intervention models. The development of standardised VMI assessment tools and structured instructional modules will further strengthen evidence-based practices in early childhood education.

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