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A bibliometric analysis on fundamental motor skill in Indian children

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Abstract
This bibliometric analysis explores the research landscape on Fundamental Motor Skill (FMS) proficiency among Indian children between 2020 and 2025. Drawing from 97 peer-reviewed journal documents indexed in Scopus, the study highlights a growing scholarly interest in FMS as a critical foundation for children's physical, cognitive, and psychosocial development. The analysis identifies trends in publication volume, subject areas, influential journals, and geographic contributions. Findings reveal that most studies are concentrated in the fields of health sciences, medicine, psychology, and social sciences, with India contributing the majority of publications. Despite this rise in academic focus, several critical gaps persist. The research remains heavily urban-centric, with limited representation of rural, tribal, and economically disadvantaged populations. There is also a lack of longitudinal and intervention-based studies, inadequate cultural adaptation of motor assessment tools, and minimal research addressing gender disparities or children with disabilities. Furthermore, integration with school curricula and national physical activity programs such as Fit India and Khelo India is insufficient. The absence of international collaboration and the underutilization of modern technology further limit the field's growth. This study emphasizes the need for inclusive, interdisciplinary, and policy-aligned research to foster equitable and effective motor skill development for all Indian children. These insights are crucial for shaping future research, education policies, and community-based intervention strategies that promote holistic child development.

Keywords: Fundamental motor skills, Indian children, motor development, bibliometric analysis, physical literacy

Introduction
Indian children have faced growing developmental challenges, particularly in the domain of motor skills. Rapid urbanization, academic pressure, digital dependency, and shrinking access to play spaces have significantly impacted children's physical activity levels (Raj *et al*., 2021) [17]. Sedentary behaviour, largely driven by screen time, has reached alarming levels. According to the India Report Card on Physical Activity for Children and Youth (2022), only 25% of Indian children meet the World Health Organization's recommended guidelines for physical activity (Agarwal *et al*., 2022) [1]. Urban children, in particular, show lower levels of outdoor play due to limited access to safe recreational spaces and increased time spent in academic tuition or digital entertainment (Sarkar & Chatterjee, 2021) [19].
A national survey conducted during 2023 reported that over 40% of Indian parents observed delays in their children's physical and language development, with excessive screen exposure cited as a major factor (Times of India, 2023). Children who spend more than three hours a day on screens often lack time for exploratory movement, play, and social interaction activities essential for gross and fine motor development. Moreover, parents are often unaware of the early signs of motor delay and the importance of developmental screening. These environmental and behavioural barriers place a substantial number of Indian children at risk for poor motor proficiency and, by extension, lifelong physical inactivity.
Fundamental Motor Skills (FMS) are basic, observable movement patterns including locomotor skills (e.g., running, hopping), object-control skills (e.g., throwing, catching), and stability skills (e.g., balancing, twisting) (Logan *et al*., 2018) [13]. These foundational movements are considered essential precursors to more specialized and complex motor tasks performed in sports, recreation, and daily activities (Coppens *et al*., 2019) [6].

FMS development usually occurs between ages 3 and 8, a sensitive period when neural and muscular systems are highly responsive to movement-based learning (Clark, 2007; Robinson *et al*., 2015) [5, 18].

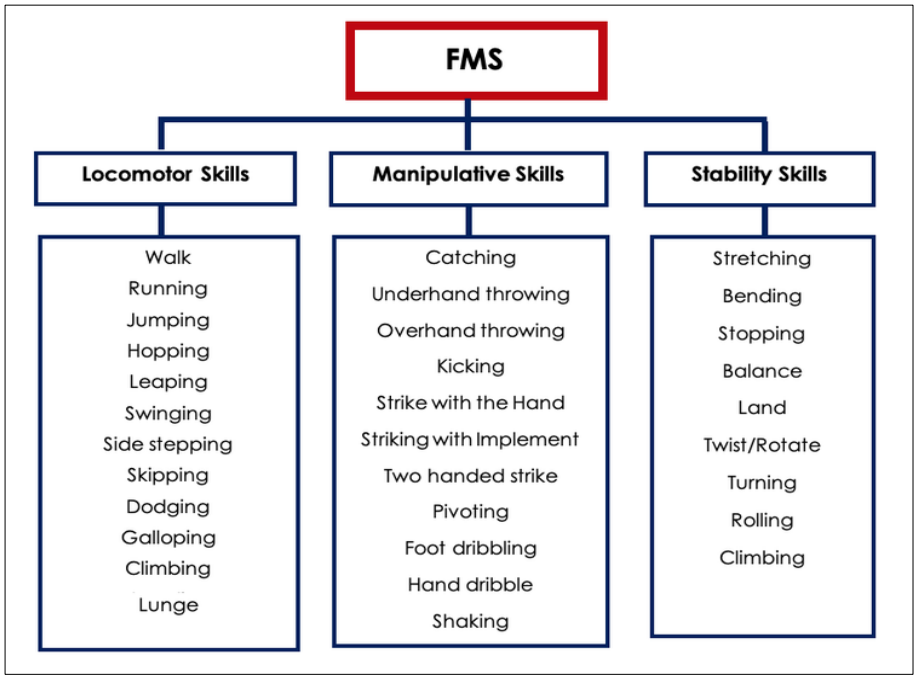

Fig 1: Categories of Fundamental Movement Skills

Despite the universal importance of FMS, proficiency levels among Indian children remain under-evaluated and often under-addressed in school physical education programs. In a study by Kaushal and Mandal (2019) [11], Indian children aged 6-12 showed significantly lower scores in object-control skills compared to international standards, highlighting the need for structured intervention and nationwide assessment.

Mastery of fundamental motor skills has far-reaching consequences for a child's physical, cognitive, and psychosocial health. Research has consistently shown that children with higher motor proficiency are more likely to engage in regular physical activity, maintain healthy body composition, and exhibit improved executive functioning (Lubans *et al*., 2010; Logan *et al*., 2020) [14, 12]. A recent meta-analysis by Zeng *et al*. (2022) [20] confirmed that interventions targeting FMS significantly improve motor competence, physical fitness, and even classroom behaviour in children aged 4-10.

Furthermore, motor skill proficiency has been linked to academic performance, emotional well-being, and social inclusion. Children with poor FMS are more likely to experience anxiety, avoid physical tasks, and face exclusion in peer-based activities, leading to a decline in confidence and long-term disengagement from physical activity (Babic *et al*., 2017) [3]. Hence, early identification and development of FMS is vital for setting children on a healthy developmental trajectory.

Improved FMS proficiency translates into lifelong benefits. Intervention-based studies have shown that children who participate in structured physical activity programs for just 8-12 weeks demonstrate substantial improvements in balance, coordination, strength, and social behavior (Hardy *et al*., 2018) [9]. These gains not only enhance children's engagement in physical activity but also support their academic focus and emotional resilience. As motor competence increases, children are more likely to participate in organized sports, adopt physically active lifestyles, and avoid the onset of non-communicable diseases later in life (Robinson *et al*., 2015; Zeng *et al*., 2022) [18, 20].

Bibliometric analysis is a scientific method that applies statistical and computational tools to evaluate and visualize trends in scholarly publications. It involves quantitative analysis of articles, citations, keywords, co-authorship networks, and research output patterns over time (Donthu *et al*., 2021) [7]. Bibliometric methods are particularly valuable for identifying research gaps, tracking knowledge evolution, mapping thematic clusters, and informing funding or policy decisions (Aria & Cuccurullo, 2017) [2].

In the context of physical education and motor skill research, bibliometrics can reveal which domains are underrepresented, which assessment tools are widely used (e.g., TGMD-2, BOT-2), and how national and international collaborations have shaped the field (Ji *et al*., 2023) [10]. It helps policymakers, educators, and researchers understand where research efforts are concentrated and where interventions are most needed.

Theoretical Framework and Previous Studies on FMS

Recent research underscores the critical role of FMS in shaping children's physical, cognitive, and psychosocial development. Globally, Barnett *et al*. (2016) found that higher FMS proficiency is associated with improved physical activity levels, healthier weight status, and better fitness outcomes in children. Similarly, Logan *et al*. (2018) [13] emphasized the bidirectional relationship between FMS and physical activity, suggesting that enhancing motor competence encourages active lifestyles. Focusing on the Indian context, Singh *et al*. (2020) revealed significant delays in motor skill development among urban school children, attributing this to limited physical activity opportunities and growing screen dependency. Coppens *et al*. (2021) [6] highlighted how socioeconomic disparities further impact motor development, pointing to the need for equitable physical education strategies in under-resourced settings. These findings collectively point to the urgent requirement

for structured interventions and deeper research into FMS proficiency among Indian children.

Objectives of the study

- To examine the annual publication trends in the field of FMS research from 2020 to 2025.
- To identify the geographical distribution of research output by analyzing country-wise contributions to FMS literature.
- To categorize the FMS research output according to various academic subject areas to understand disciplinary focus and intersections.
- To evaluate the journal-wise publication patterns and determine the most influential journals publishing FMS-related studies over the years.

Methodology

Research Design

This study adopts a **bibliometric research design**, which is a quantitative analysis of scientific publications used to evaluate the structure, trends, and patterns of research within a specific field (Donthu *et al*., 2021) [7]. The aim is to systematically analyze the literature on FMS proficiency among Indian children, focusing on publication output, influential source.

Data Source

Data were collected from the Scopus database, focusing specifically on literature published from 2020 to 2025. This timeframe ensures a current and relevant overview of publication trends in the field.

Search Strategy

The search targeted documents containing the phrase "Fundamental Motor Skills" in their title, abstract, or keywords (TITLE-ABS-KEY). The following search refinements were applied:

- **Document Types:** Articles
- **Language:** English
- **Subject Areas:** Health, Psychology, Social Sciences, Multidisciplinary, Arts and Humanities
- **Publication Stage:** Final published versions
- **Accessibility:** All regardless of open access status

Screening and Inclusion Criteria

- Publications dated between 2020 and 2025
- Must include "Fundamental Motor Skills" in TITLE-ABS-KEY
- Must be categorized under the specified subject areas and meet document type and language filters.

Characteristic	Scopus
Journals Identified	568
Duration	2020 to 2025
Subject Area	Health Professions (130), Social Science (89), Psychology (79), Multidisciplinary (07), Arts & Humanities (06)
Document Type	Inclusion: Article (213); Exclusion: Review (14), Book Chapter (4), Conference Paper (01), Note (01)
Language	Inclusion: English (198); Exclusion: Spanish (09), Chinese (03), Afrikaans (01), Persian (01), Portuguese (01)
Publication Stage	Final (189)
Open Access	Inclusion: All Open (97); Exclusion: Gold (55), Green (44), Hybrid Gold (23), Bronze (06)

Chart 1: Flow Chart 1

Results

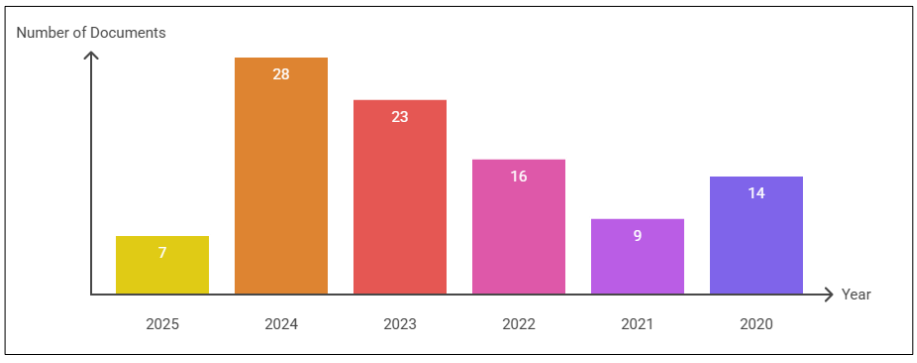

Fig 2: Year-wise Distribution of Publications on FMS (2020-2025)

The vertical bar chart illustrates the annual distribution of published documents from 2020 to 2025. A noticeable trend is the significant increase in publications from 2020 (14 documents) to a peak in 2024 (28 documents), indicating growing academic or research interest in the respective field. In 2023, there were 23 documents, showing a steady build-up leading to 2024. However, there is a sharp decline in 2025 with only 7 documents, possibly due to the partial year or delays in indexing. The lowest output before 2025 was in 2021 with just 9 documents, suggesting that interest began to rise more prominently from 2022 onwards. Overall, the data suggests a surge in scholarly attention peaking in 2024, followed by a temporary drop, possibly influenced by external or temporal factors.

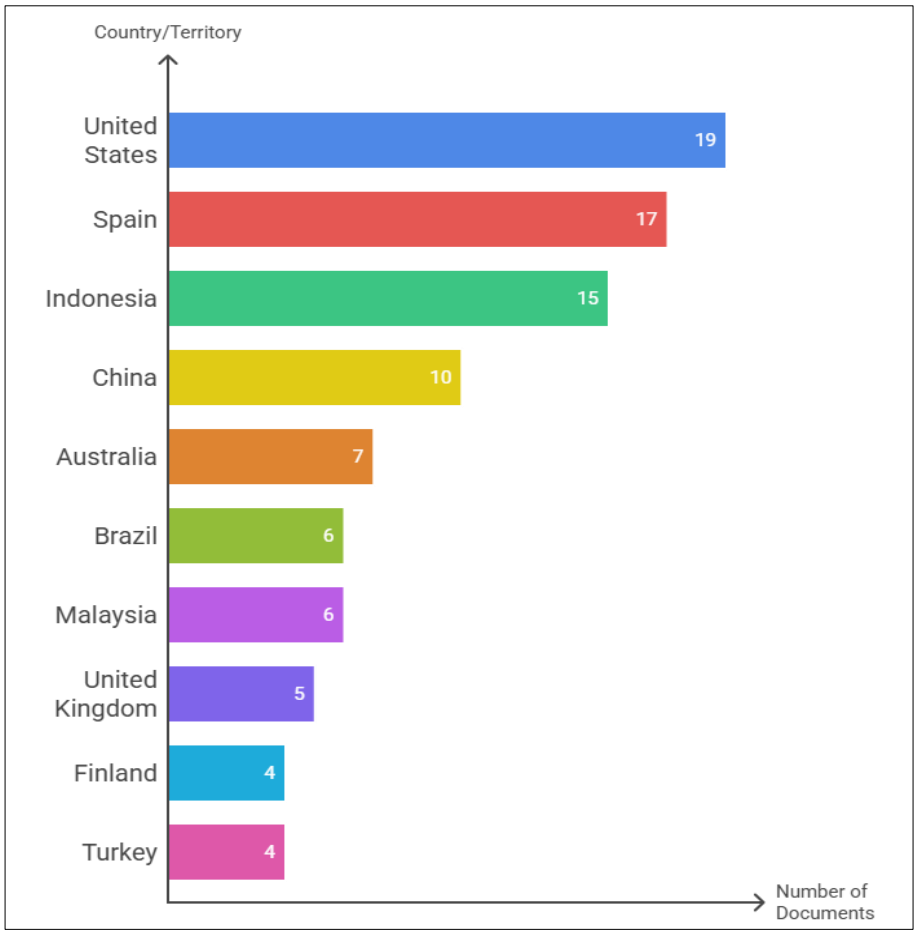

Fig 3: Number of FMS Documents Published by Country/Territory

The horizontal bar chart titled "Documents by country/territory" presents a comparative analysis of research document contributions from various countries. The data reveals that the United States holds the leading position, contributing the highest number of documents, indicating its dominant role in research productivity within the analyzed context. Following closely are Spain and Indonesia, showcasing strong academic engagement with significant contributions. China also appears as a key contributor, although with a moderate number of documents compared to the top three. Countries like Australia, Brazil, Malaysia, and the United Kingdom demonstrate a moderate level of research output, suggesting active but relatively smaller-scale participation. Towards the lower end, Finland and Turkey have contributed fewer documents, reflecting either limited research activity in this area or underrepresentation in the dataset. Overall, the chart highlights the global diversity in research contributions, with notable involvement from both developed and developing nations.

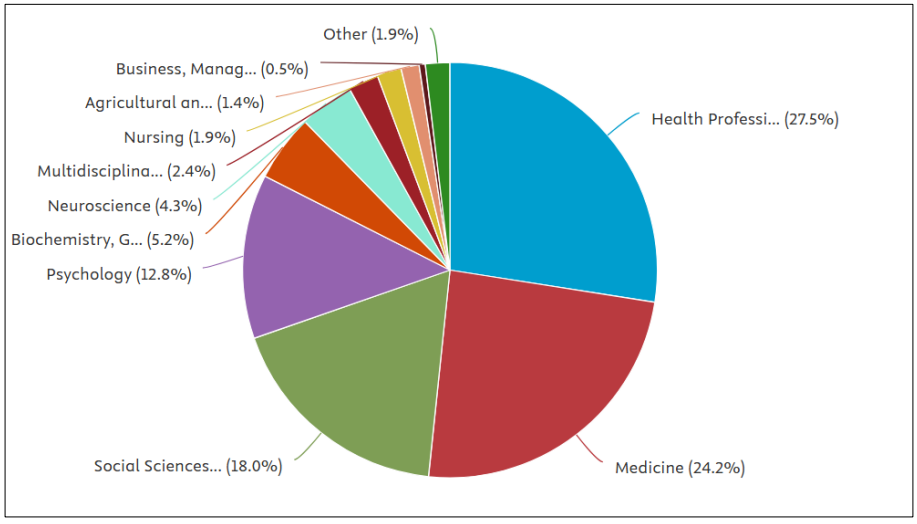

Fig 4: Number of FMS Documents by Subject Area

The pie chart represents the subject-wise distribution of documents, highlighting the interdisciplinary nature of research in the analyzed area. The majority of publications fall under health professions (27.5%) and medicine (24.2%),

indicating that the primary focus of the research is healthcare-oriented, possibly addressing medical conditions, treatments, or healthcare interventions. Social sciences also constitute a significant portion at 18.0%, reflecting the inclusion of societal, behavioral, or psychological aspects in the research. Psychology (12.8%) and biochemistry, genetics and molecular biology (5.2%) further emphasize the bio-psycho-social approach in the field. Other disciplines like neuroscience (4.3%), multidisciplinary (2.4%), nursing (1.9%), and agricultural and biological sciences (1.4%) contribute to a smaller yet notable extent, showing the integration of multiple domains. Areas such as business, management and accounting (0.5%) and other (1.9%) have minimal representation, indicating limited focus or emerging interest. This distribution underscores a strong leaning toward clinical and health sciences while maintaining a broad interdisciplinary framework essential for comprehensive, holistic research.

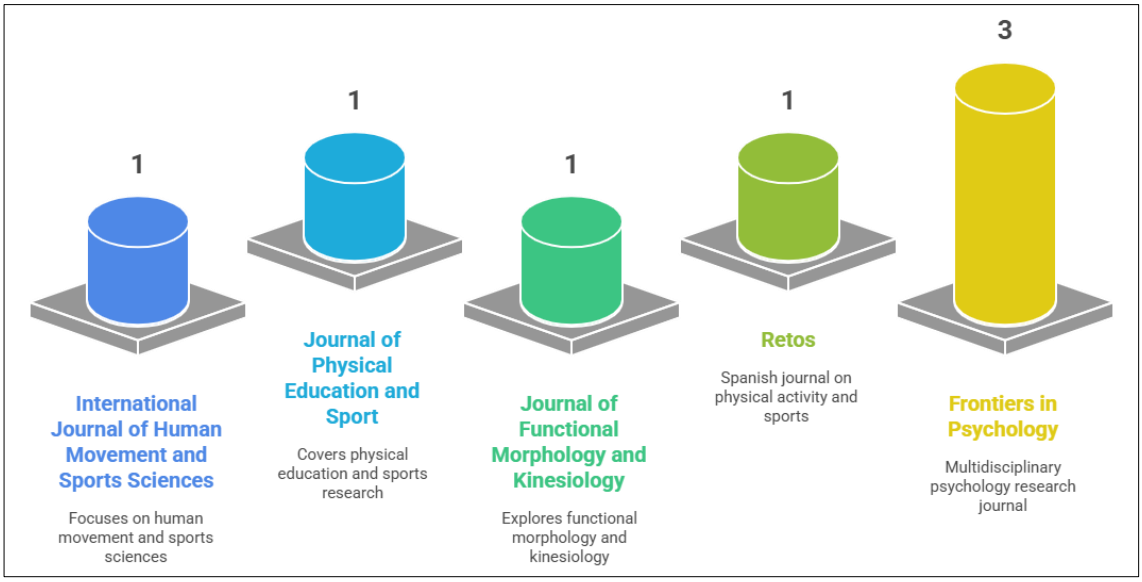

Fig 5: Number of FMS Documents Published Per Journal by Year

The Column chart illustrates the publication trends across five different journals from 2021 to 2025. Among them, the Journal of Physical Education and Sport showed a significant rise in publication count, peaking at 4 documents in 2023, before declining to zero in the subsequent years. The International Journal of Human Movement and Sports Sciences maintained a consistent presence with 1 publication in both 2021 and 2022, followed by an increase to 2 in 2023, but did not record any publications in 2024 and 2025. The Journal of Functional Morphology and Kinesiology remained stable at 1 document per year from 2021 to 2023, then showed a slight rise to 2 documents in 2024, with no publications in 2025. Notably, Retos displayed a steady growth, starting from 1 publication in 2022 and maintaining 3 publications each year from 2023 to 2025, indicating sustained academic interest. On the other hand, Frontiers in Psychology showed an early peak with 3 documents in 2022, but experienced a decline in the following years, stabilizing at 1 document annually from 2024 onwards.

Discussion

The bibliometric analysis of 97 journal documents on FMS proficiency in Indian children reveals distinct trends and notable research gaps across four key areas: journal-wise publication output, subject area classification, country-wise contributions, and year-wise distribution. The steady rise in academic output-especially from 2020 onward, peaking in 2024-2025-signals growing recognition of motor skills as foundational during early childhood (Kaushal & Mandal, 2019) [11]. Yet, research remains clustered within niche journals, limiting broader engagement across pediatrics and educational sciences.

Subject area distribution is richly multidisciplinary, with health professions, medicine, psychology, and social sciences at the forefront. However, education and developmental studies appear underrepresented, despite evidence that fine motor skills correlate with age, gender, and academic performance among Indian children (Manna *et al*., 2018) [15]. The documented delays in motor proficiency among socioeconomically disadvantaged groups-such as undernourished children in Kolkata performing below average on BOT-2 SF assessments-further underscore the need for inclusive studies. Moreover, urban-rural comparisons in Tamil Nadu reveal significantly different motor profiles in children assessed using TGMD-2 (Janardhana *et al*., 2024), highlighting socio-structural disparities.

Although India dominates publication output, the scarcity of international collaboration limits cross-cultural benchmarking. Year-wise, the surge in research corresponds with national initiatives like Fit India and NEP 2020, yet there is a shortage of intervention-based or longitudinal studies that can test program efficacy over time. Global evidence indicates that structured FMS interventions yield gains in motor competence and classroom behavior (Zeng *et al*., 2022) [20], but such models remain underutilized in India.

Taken together, these four domains point to an evolving but still fragmented research field. To address emerging gaps, future efforts must embrace interdisciplinary approaches, inclusive sampling (covering rural, tribal, and disadvantaged contexts), and longitudinal designs. There is also a pressing opportunity to integrate culturally validated assessment tools and link findings to educational practices and policy frameworks aimed at enhancing motor development among all Indian children.

Finally, the year-wise distribution shows a clear upward trend, with the highest output recorded in recent years. This surge aligns with the introduction of national initiatives such

as the Fit India Movement and revisions in the National Education Policy (NEP 2020), which emphasize physical education and motor development in schools.

Research Gaps

Research on FMS proficiency in Indian children highlights several key gaps. Most studies are cross-sectional, lacking longitudinal or intervention-based designs that track motor development over time. Despite FMS being crucial for physical literacy, there is minimal integration with school curricula or PE policies, limiting practical application. Studies are largely focused on urban populations, with rural, tribal, and low-income children underrepresented. Gender-specific research and inclusion of children with disabilities are scarce, leading to limited understanding of diverse developmental needs. Additionally, many studies rely on Western tools like TGMD without proper cultural adaptation, raising concerns about validity in the Indian context. Interdisciplinary collaboration is limited, and connections between motor skills, cognition, nutrition, and mental health are rarely explored. International collaborations are few, restricting global benchmarking. Moreover, there is little use of technology such as digital tools or gamified interventions in Indian research. Lastly, policy-oriented studies are minimal, showing a need for research that informs national programs like Fit India and Khelo India.

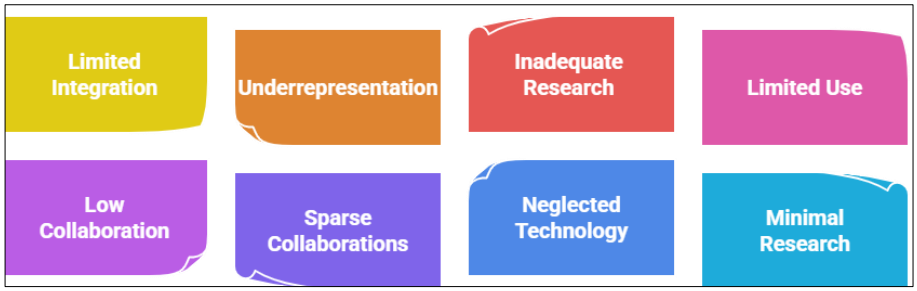

Fig 6: Illustrates the research gaps in the area of Fundamental Motor Skills (FMS)

Conclusion

The bibliometric analysis of FMS research in Indian children reveals a growing academic interest, particularly in recent years, highlighting the increasing recognition of FMS as a critical component of early childhood development and physical literacy. While publications have expanded across health, education, and social sciences, several research gaps persist. There is a lack of longitudinal and intervention-based studies that evaluate developmental progress or the impact of school/community programs. Rural, tribal, and economically disadvantaged children remain underrepresented, limiting the generalizability of findings. Furthermore, many studies rely on Western tools without cultural adaptation, and there is limited focus on gender differences, children with disabilities, and use of modern technologies like digital assessments or gamified interventions. Integration with educational curricula and alignment with national policies such as Fit India and Khelo India is also insufficient. To bridge these gaps, future research must prioritize inclusive, interdisciplinary, and contextually relevant approaches that support the holistic motor development of Indian children across diverse backgrounds.

Recommendation

- Encourage studies that track motor skill development over time and evaluate the effectiveness of school- or community-based FMS intervention programs.
- Expand research to include rural, tribal, and economically disadvantaged populations, as well as children with disabilities, to ensure findings are generalizable and equitable.
- Collaborate with educational boards to embed motor skill development into physical education policies, curricula, and teacher training programs.
- Create standardized FMS assessment tools tailored to the Indian context to improve the reliability and relevance of research outcomes.
- Strengthen partnerships across health, education, psychology, and technology sectors both nationally and globally to enhance the scope, innovation, and impact of FMS research.

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