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Motor milestones and physical activity: A scoping review of ECD practitioners' contributions

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Background: Early childhood development (ECD) practitioners are crucial to young children's motor milestone achievement, motor development and physical activity (PA) participation. Their role in helping young children reach appropriate PA levels and gross motor milestones has not received sufficient attention.

Aim: This study examined the contribution of ECD practitioners to the acquisition of gross motor milestones and PA participation in children aged 0–4 years.

Setting: A literature search was conducted using specified search terms. Search parameters were set between 1994 and 26 May 2021.

Methods: The Manual for Evidence Synthesis was used for this scoping review. The mapping of evidence based on research about the contribution of ECD practitioners to the acquisition of gross motor milestones and sufficient PA levels, particularly in children aged 0–4 years, was performed using the nine stages of the scoping review approach.

Results: Early childhood development practitioner-led PA interventions positively influence children's overall PA, especially when thoroughly executed by sufficiently trained practitioners. In addition, ECD practitioners' PA correlated positively with children's PA.

Conclusion: Physical activity interventions presented by ECD practitioners might have a positive influence on children's overall PA levels, if interventions were thoroughly executed and ECD practitioners received sufficient training. Gaps identified in the current literature include a lack of longitudinal studies and research investigating ECD practitioners' contribution to young children acquiring gross motor milestones.

Contribution: The study contributed to the limited information regarding practitioners' contribution to gross motor milestone acquisition and adequate PA, highlighting several gaps where research is required.

Keywords: early childhood development; ECD; ECD practitioner; ECD centre; gross motor milestones; physical activity; scoping review.

Introduction

Young children spend a great deal of time in early childhood development centres (ECDCs), and many of them have their first encounter with regular physical activity (PA) in an ECDC (Lu & Montague 2016; Wilke et al. 2013). Consequently, early childhood development (ECD) practitioners can strongly influence children's development in the motor or physical domain (Martyniuk & Tucker 2014; Smit et al. 2021; Wilke et al. 2013) and play an important role in the achievement of children's gross motor milestones and their PA levels.

The term ECD practitioner refers to an individual, either formally or informally trained, who provides ECD services through a set ECD programme (South African Qualifications Authority [SAQA] n.d.; UNICEF 2006). In South African ECDCs, these services are provided for children from birth up to 4 years, or until these children enter the formal school system (Atmore, Van Niekerk & Ashley-Cooper 2012; Department of Basic Education 2009; Smit et al. 2021). Early childhood development practitioners are responsible for creating an inclusive, play-based environment that supports the holistic development of children. This is performed through planning and preparing early childhood activities, facilitating and mediating learning, observing and assessing the progress of children and reflecting on children's learning (SAQA n.d.; UNICEF 2006).

The play-based environment created by ECD practitioners to promote children's holistic development should include age-appropriate activities that support milestone acquisition.

Attaining milestones forms an important part of childhood development and represents the changes and the developmental stages during the early childhood years (Tecklin 2015). Milestones are typically used as a form of evaluation for development and are standards for age of skill development as they refer to the age at which most children attain certain skills (Sabanathan, Wills & Gladstone 2015; Tecklin 2015). Developmental milestones can be divided into four main categories, namely motor or physical, cognitive or intellectual, social and emotional, and communication and speech, or language (Tecklin 2015). This review will focus only on the motor or physical domain because of the scope and expertise of the researchers.

Motor (or physical) development can be described as attained skills or performances related to the musculoskeletal system (Gerber, Wilks & Erdie-Lalena 2010). These skills enable infants to learn from their environment through exploration and independent movement, when skills such as lifting their heads, sitting, crawling, walking, running and jumping are achieved (Gerber et al. 2010). Motor milestones are regarded as the building blocks of motor development. Achieving milestones not only allows children to acquire locomotor, object manipulation and stability skills but also enables continuous development and refinement of these skills, leading to improvement of balance, coordination, speed, strength and bilateral integration (Gerber et al. 2010; Goodway, Ozmun & Gallahue 2019; Hulteen et al. 2018; Tomaz et al. 2019; Veldman et al. 2019). Acquiring motor milestones directly influences a child's ability to participate in physical activities and perform task- or sports-specific skills (Goodway et al. 2019), laying the foundation for future movement competence and participation in PA (Loprinzi et al. 2012; Tomaz et al. 2019).

Physical activity during early childhood primarily involves activities such as crawling, walking, running, jumping, balancing, climbing in, through and over objects, dancing, riding wheeled toys, cycling and jumping rope (World Health Organization [WHO] 2019). Physical activity is viewed as a modifiable lifestyle behaviour and regular engagement in PA results in benefits such as improved motor, cognitive, social, psychological and physiological development (Brouwer, Stolk & Corpeleijn 2019; Carson et al. 2017; Copeland, Khoury & Kalkwarf 2016; Martyniuk & Tucker 2014; Schmutz et al. 2018; Wolfenden et al. 2019). Furthermore, regular participation in PA has been linked to a reduced risk of chronic conditions and obesity, while improving fitness, bone and skeletal health, cardiometabolic health and maintaining a healthy weight (Brouwer et al. 2019; Carson et al. 2017; Copeland et al. 2016; Martyniuk & Tucker 2014; Schmutz et al. 2018; Wolfenden et al. 2019).

The WHO and several countries, including Australia, Canada, New Zealand and South Africa, emphasise the importance of PA for child health and development (Carson et al. 2020; DST-NRF Centre of Excellence in Human Development 2019; WHO 2019). The WHO, South Africa, Canada and Australia have similar PA guidelines for children aged 0–5 years and recommend corresponding amounts of time on physical activities, sedentary behaviour, screen time and sleep (Canadian Society for Exercise Physiology 2021; Department of Health 2021; DST-NRF Centre of Excellence in Human Development 2019; WHO 2019). Daily guidelines for infants from birth to 1 year old include being physically active several times a day, spending at least 30 min on tummy time (DST-NRF Centre of Excellence in Human Development 2019). It is recommended that children between the ages of 1 and 5 years spend at least 180 min per day on physically active play, of which 60 min should be at moderate to vigorous intensity rates (DST-NRF Centre of Excellence in Human Development 2019).

In addition to the importance of both attaining gross motor milestones and being involved in PA, a reciprocal relationship exists between these aspects (Loprinzi et al. 2012; Matarma et al. 2018; Wilke et al. 2013). Motor skill acquisition is often cultivated through PA and active play; therefore, sufficient and versatile activities are a prerequisite for children developing specific motor skills. Consequently, children with inadequate motor skills or developmental delays are less likely to participate in physical activities or may have limited opportunities for successful engagement in PA later in life (Loprinzi et al. 2012; Matarma et al. 2018; Robinson 2011; Wilke et al. 2013; Wouters, Evenhuis & Hilgenkamp 2019). As ECD practitioners frequently engage with young children in ECDCs, they have an opportunity to build a strong foundation to enhance this reciprocal relationship, placing children's future development on a positive trajectory.

The ECD setting has been researched extensively. However, ECD practitioners' involvement in contributing to the acquisition of gross motor milestones and the achievement of adequate PA levels in young children has not received sufficient attention. The aim of this study was to explore if, and to what extent, ECD practitioners contribute to the acquisition of gross motor milestones and the achievement of adequate levels of PA of children from birth to 4 years.

Research methods and design

Inclusion criteria

Types of participants in included articles

We included published material targeting ECD practitioners, as well as children from birth to 4 years. This age category not only forms part of the early childhood years where children attend ECDCs but is also a time where ECD practitioners play a pivotal role in children's development.

Concept and context

Qualitative and quantitative published research with a focus on ECD practitioners' involvement in PA interventions and acquisition of gross motor milestones, within the ECD milieu, were included. Only articles reporting on research conducted in the ECD setting were included and only when PA interventions were led by ECD practitioners themselves. Search parameters were set between 1994 and 26 May 2021, and although extensive,

this date range provided the best reflection on all available and applicable sources within the democratic South Africa established in 1994. With the inclusion criteria applied, the oldest articles included were published in 2009.

The Joanna Briggs Institute (JBI) Manual for Evidence Synthesis (Peters et al. 2020) was used as a guide during the planning and conceptualisation of this scoping review. The nine levels of the scoping review framework, as outlined by Peters et al. (2020), were used to map science-based evidence on ECD practitioners' contribution to gross motor milestone acquisition and adequate PA levels, specifically in children aged 0–4 years.

Search strategy

A literature search was conducted with the assistance of an experienced librarian at the University of the Free State on the following electronic databases: StateAcademic Search Ultimate, Africa-Wide Information, CINAHL with Full Text, ERIC, Health Source – Consumer Edition, Health Source: Nursing/Academic Edition, MEDLINE, APA PsycArticles, APA PsycInfo, SPORTDiscus with Full Text.

The following search terms were included: ('motor* milestone*' or 'gross motor' or 'physical activit*' or 'structured play' or 'motor* ability'); and (caregiver* or teacher* or 'teaching assistant*' or educator* or 'care giver*'); and (daycare or 'day care' or preschool* or pre-school* or 'nursery school*' or creche* or childcare or 'early childhood'); and ('motor* milestone*' or 'gross motor' or 'physical activit*' or 'structured play' or 'motor* ability' or caregiver* or teacher* or 'teaching assistant*' or educator* or 'care giver*').

To ensure the inclusion of other studies that might be valuable and relevant to the search terms and definitions, a backward reference search (snowballing) was performed. This included hand-searching the reference lists of relevant resources identified at the end of level 2 (see Figure 1, Adapted from Page et al. 2021).

Source of evidence screening and selection

The list of sources generated from the search was screened by title and then by abstract, using the inclusion criteria for possible addition to the sample. The first and second authors individually screened titles and abstracts for relevance, after which full texts of all articles identified as possibly being suitable were sourced. Opinion pieces and magazine articles, as well as all sources published in languages other than English, were excluded. If the focus of a study was mainly on practitioners' perceptions, children of older ages, children with disabilities, and PA interventions with no involvement of the practitioners, these articles were also excluded.

Data extraction

As the scope and nature of the studies were not fully known in advance, we did not use a standardised extraction form. A list of potential extraction fields was rather drawn up for mapping purposes, while additional fields of importance were tabulated continuously as the data were extracted. Initial fields included author(s), year of publication, location, population, aim of the study (PA or gross motor milestone), methodology, outcome measures, important results and limitations, if any (Arksey & O'Malley 2005; Peters et al. 2020). The following items were added: PA contribution solely from ECD practitioners or with assistance from initiatives outside the ECD; indirect contributions when PA levels of practitioners were observed; additional variables measured or observed; and ECD practitioners' training to present PA intervention.

Analysis and presentation of results

Publications were firstly grouped based on the nature of the study (e.g. experimental versus systematic review, research proposals). Data of experimental studies were then synthesised narratively by the following two author-defined categories: (1) ECD practitioners' contribution by means of presenting PA interventions; and (2) ECD practitioners' contribution by means of modelling adequate PA levels. These studies were mapped, based on the population profile (children's age), frequency and duration of interventions, measurements (accelerometers, pedometer, observations), outcomes and study design (qualitative versus quantitative; cross-sectional cohort versus longitudinal).

Ethical considerations

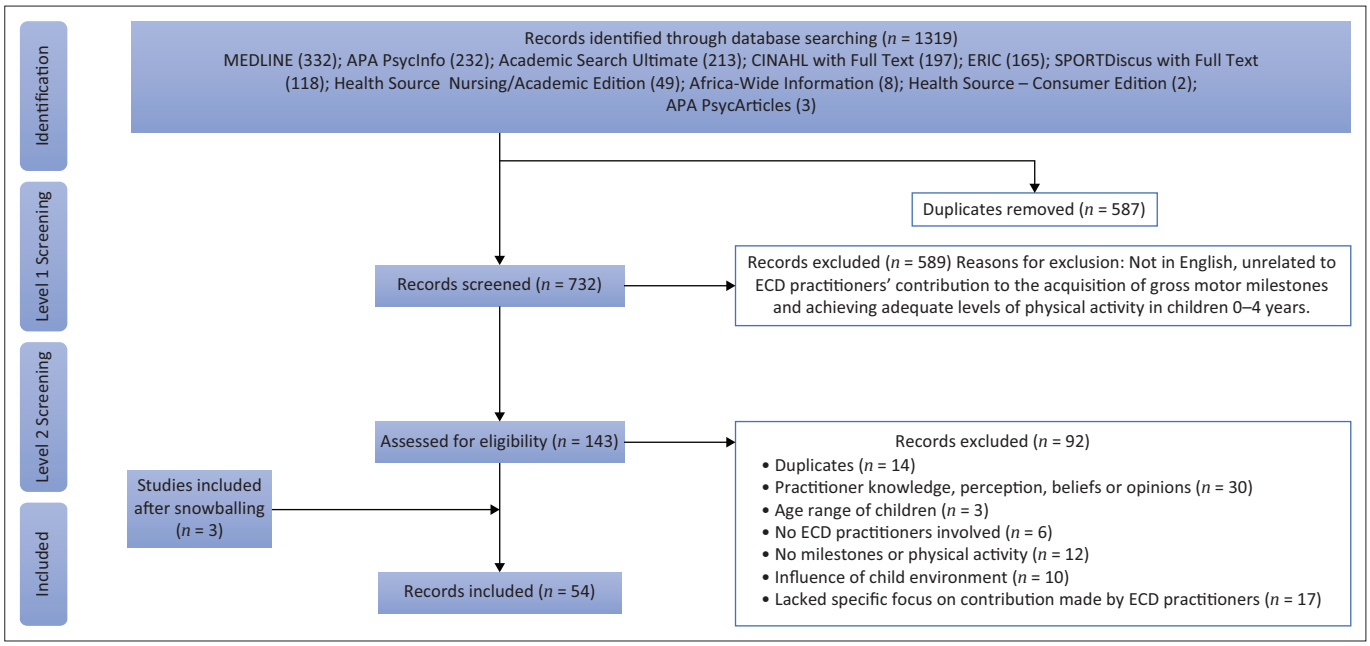
Ethical clearance to conduct the study was obtained from the Health Sciences Research Ethics Committee of the University of the Free State. (No. UFS-HSD2019/2198/2502).

Results

Search results

The literature search yielded a total of 1319 sources (see Figure 1, Adapted from Page et al. 2021), of which 587 were removed as duplicates. Upon completion of the title and abstract screening, 143 sources seemed to be potentially relevant and were screened. Subsequently, 51 publications fulfilled the inclusion criteria. Backward snowballing was performed on the 51 publications' lists of references and another three publications were added. A total of 54 publications were included for discussion in this scoping review. The 54 publications represented 44 experimental studies (of which 7 were pilot studies), 4 research proposals, 5 systematic reviews and 1 discussion piece. In total, 39 publications reported on PA interventions presented by ECD practitioners. However, all these interventions were initiated by an external stakeholder. Five publications reported on the relationship between ECD practitioners' and children's PA. Results of publications were mainly discussed quantitatively, with only a limited number of publications using a mixed-methods approach.

Of the 54 publications included, 22 were randomised controlled trials, 6 were quasi-experimental studies, 5



Source: Adapted from Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D. et al., 2021, 'The PRISMA 2020 statement: an updated guideline for reporting systematic reviews', *BMJ* 372, n71. https://doi.org/10.1136/bmj.n71

ECD, early childhood development.

FIGURE 1: Flow diagram illustrating the process applied for the selection of articles to be included in the study.

were cross-sectional in nature, 2 were mainly observational, 6 were reviews, while 8 made use of several other study designs and 5 did not specifically indicate what designs had been used. Most studies represented in the current body of evidence were quantitative research, with no longitudinal studies among the publications selected for analysis.

Inclusion of source evidence

Review findings

Experimental studies: ECD practitioners' contribution by means of presenting PA interventions: Thirty-nine publications summarised in Table 1 investigated PA interventions presented by ECD practitioners. The publications mainly focussed on children between the ages of 3 and 5 years, with some studies reporting on younger children and only one study including children from birth up to 8 years of age. Furthermore, all these studies were conducted in an ECD setting.

Accelerometers were used as a measuring tool for PA by 26 studies, while only three studies used pedometers. In addition to accelerometers and pedometers, nine studies also used direct observation, while five studies only made use of direct observational methods (not including measuring devices). Direct observations were mainly performed using the Observational System for Recording Physical Activity in Pre-schoolers (OSRAC-P), System for Observing Fitness Instruction Time (SOFIT), PlayCheck, and Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC). Five studies did not measure children's PA levels, but rather the development of their motor skills while they participated in PA interventions.

In addition to PA measurements, 30 publications reported some form of ECD practitioner training through workshops, lesson plans, PA routines on DVD, self-paced manuals, seminars or ongoing support throughout the intervention. In the other nine studies, training of ECD practitioners was not specified (n = 7), or PA was present as part of a specific curriculum, or the practitioners were already experienced (n = 2).

Sedentary behaviour of children was measured by 58% (n = 23) of studies, while 41% (n = 16) of the studies took children's body mass index (BMI) into account when reporting on intervention results. Twenty-three studies reported an increase in children's PA levels through either an increase in time spent in various PA intensities, daily steps taken or time spent in structured PA at school. Furthermore, five studies did not find any changes in children's PA levels post-intervention, while two studies reported a regression in children's PA, specifically moderate-to-vigorous PA (MVPA).

Other variables, such as pre-literacy skills, motor proficiency, gross motor skills, barriers to the implementation of intervention programmes, fidelity of intervention programmes, play equipment, educator behaviour and PA policies applicable to the ECD setting, were also explored throughout the publications listed in Table 1.

Experimental studies: ECD practitioners' contribution by means of modelling adequate PA levels: Five publications, experimental in nature, met the inclusion criteria and investigated the relationship between ECD practitioners' and children's PA (Table 2). These five studies took place in ECD settings and included children between 19 months and 6 years of age. Four studies used accelerometers to measure educators' and children's PA, while one study used pedometers. One study included the use of

TABLE 1: Studies investigating early childhood development practitioners' contribution by means of presenting physical activity interventions.

Author	Population age and size (*n*)	Study design	Method of measuring PA	Measuring sedentary behaviour	Additional variables	Intervention				Outcome
						Frequency	Duration	Name or type	Practitioner training	↑/↓/⦸
Alesi et al. (2021)	Older than 4 and younger than 6 years (*n* = 174)	Cluster randomised trial; quasi-experimental	No PA measured – motor skills	No	Pre-literacy skills, motor proficiency	3 times per week × 60 min	3 months	EMP	None – used practitioners with previous experience	↑ motor proficiency and literacy skills
Alhassan et al. (2012)	2.9–5 years (*n* = 28)	Not specified	Accelerometer	Yes	BMI, locomotor skills	Daily 30 min	6 months	The LMS-PA	2 h, (playtime) 8 h (PA)	↓ sedentary, ↑ leaping skills
Alhassan and Whitt-Glover (2014)	2.9–5 years (*n* = 250–300)	Six-month cluster randomised intervention	Not measured	No	Study fidelity, barriers for implementation	30 min	6 months	SBS-PA	3 h and refresher training	⦸ PA
Alhassan et al. (2016)	4.1 ± 0.8 years of age, on average (*n* = 248)	6-month cluster randomised study	Accelerometer, Modified OSRAC-P	Yes	BMI, process evaluation and fidelity	5 days per week × 30 min	6 months	SBS-PA	Routines available on DVD	↑ light and MVPA, ↓ MVPA at 3 and 6 months
Andersen et al. (2020)	3–4 years (*n* = 130)	Cluster randomised controlled trial	Accelerometer	Yes	None	Not specified	12 weeks	Active Kindergarten–Active Children	6 h, 2 course follow-ups, ongoing reflection	↑ MVPA, ↑ daily steps, ↓ sedentary
Annesi et al. (2013a)	3–5 years (*n* = 275)	Clustered randomised controlled design	Accelerometer	Yes	PA and sedentary (classroom as a unit)	Daily × 30 min	8 weeks	The Start For Life	4 h	↑ MVPA and VPA, ⦸ sedentary
Annesi et al. (2013b)	Final-year preschoolers (*n* = 885–1154)	Not specified	Accelerometer	Yes	BMI	Daily × 30 min	9 months	The Start For Life	4 h	↑ MVPA, ⦸ sedentary, ↓ BMI
Bonvin et al. (2013)	3 years (*n* = 648)	Cluster randomised controlled trial	Accelerometer	No	BMI, motor skills, educator satisfaction with intervention, predictors of PA	Not specified	9 months	Youp'là Bouge	Five workshops	⦸ motor skills, ⦸ PA predictors ☑ associated
Brian et al. (2017)	3–6 years (*n* = 57)	Pretest–post-test quasi-experimental	Not measured – object control	No	Object control skills, lesson fidelity	2 × 30 min per week	6 weeks	SKIP	2 × 30 min and ongoing support	↑ object control skills
Brown et al. (2009)	4 years (*n* = 5)	A single-case withdrawal of intervention	OSRPAC-P	No	None	Unspecified	30 min	Track Team or Dance Party	Not specified	↑ MVPA
Cardon et al. (2009)	4–5 years (*n* = 583)	Cluster randomised controlled trial	Accelerometer	Yes	Play equipment, play equipment markings	1 h of introducing play equipment to children			Not specified	⦸ play, MVPA, sedentary
De Marco et al. (2015)	1–5 years (*n* = 60)	Single case study, multiple baseline design	PlayCheck	Yes	Practitioner demographics	Not specified	Not specified	Be Active Kids	2 h	↑ L to MVPA
Duff et al. (2019)	3–5 years (*n* = 141)	Quasi-experimental randomised controlled trial	Accelerometer	Yes	BMI, FMS, practitioner confidence about activity and nutrition	Not specified	6 weeks	Kids Active	2 × 2 h	↑ practitioner confidence, ⦸ PA, ↑ throwing
Finch et al. (2014)	3–5 years (*n* = 459)	Cluster wait-list randomised controlled trial	Pedometer, EPAO	Yes	Intervention acceptability and reach	Daily × 20 min	4 months	Structured FMS	6 h	↑ PA
Froehlich Chow et al. (2016)	3–5 years (*n* = 69)	A wait-list comparison intervention	Accelerometer	Yes	BMI, FMS, menu review, environment and policy assessment and observation	Not specified	Not specified	Healthy Start–Départ Santé	Teacher training, ongoing support	↑ PA
Herriott (2012)	3.7–5.7 years (*n* = 15)	A single subject, randomising alternating treatment	Accelerometer, modified OSRAC-P	Yes	BMI, recess PA, fidelity	2–3 sessions per week, 10 min per activity	10 sessions	Dance party, activity dice, and obstacle course	2 meetings, weekly emails	↑ MVPA, ↓ sedentary
Hoffman et al. (2020)	Preschool-aged children (*n* = 57)	A pilot cluster randomised controlled trial	Accelerometer	No	BMI, practitioner outcomes	Not specified	4 weeks	WE PLAY	Manual and self-paced training	↑ MVPA, Gained 63 min MVPA per school week
Hoza et al. (2021)	Pre-K–Mean age 4 years (*n* = 143)	Not specified	Accelerometer	No	Fidelity, school readiness	2–3 times a week × 30 min	19–22 weeks	PA programme	Not specified	↑ MVPA, meeting PA guideline, ↑ fidelity

Table 1 continues on the next page →

TABLE 1 (Continues...): Studies investigating early childhood development practitioners' contribution by means of presenting physical activity interventions.

Author	Population age and size (*n*)	Study design	Method of measuring PA	Measuring sedentary behaviour	Additional variables	Intervention				Outcome
						Frequency	Duration	Name or type	Practitioner training	↑/↓/⦸
Jones et al. (2016)	3–5 years (*n* = 150)	6-month, 2-arm parallel group pilot randomised controlled trial	Accelerometer	Yes	Gross motor skills, evaluation and fidelity of intervention	3 days per week × 20 min	6 months	Jump Start	2 × 90 min and 60 min	⦸ motor skill and PA differences
Kahan et al. (2016)	4–5 years (*n* = 12)	ABA multiple-baseline-across-subjects withdrawal	Accelerometer, direct observation	Yes	BMI, prompting, whole recess PA, PA level pre- and post-prompt	Prompted – based on SED	Not specified	Not specified	Monthly staff-dev. programme	↓ sedentary, ↑ MVPA
Kipling Webster et al. (2020)	Mean age 3.80 years (*n* = 99)	Quasi-experimental design (cross-sectional)	Accelerometer	No	BMI, motor skill competency	10 min	2 days	CRAB in a Head Start population	Provided with two structured routines	Regression btw. FMS and MVPA, ⦸ cor. btw. BMI and MVPA, Locomotor predict, MVPA
Kirk and Kirk (2016)	Mean age 4.1 years (*n* = 54)	2-group, quasi-experimental	SOFIT	No	BMI, early literacy skills, alliteration, rhyming, picture naming, fidelity of implementation, practitioner satisfaction	5 days per week 2 × 30 min	8 months	Academic lessons taught using PA	1 full day	↑ rhyming, picture naming and alliteration with ↑ MVPA
Lahuerta-Contell et al. (2021)	3–4 years (*n* = 125)	Cross-sectional, correlational	Accelerometer, SOFIT	Yes	Activity type, lesson context, practitioner behaviour, child waist circumference	Once a week × 45 min	Not specified	Own curriculum	Not specified	Boys more active, lesson associated with↓ SB, ↑ MVPA
LaRowe et al. (2016)	2–5 years (*n* = 327)	Quasi-experimental active early intervention	Accelerometer, EPAO	Yes	Movement opportunities, play equipment, staff behaviours, PA training and education, PA policy	Not specified	12 months	Active Early	5 h	↑ PA, ↓ sedentary, ↑ PA environment
Leis et al. (2020)	3–5 years (*n* = 895)	Cluster randomised controlled trial	Accelerometer, NAP SACC	Yes	BMI, FMS, food intake, food served, opportunities for PA and healthy eating	Not specified	Not specified	Healthy Start–Départ Santé	3 h, resources, 90 min booster session	↑ locomotor ⦸ object control, PA and food intake
Mavilidi et al. (2021)	3–5 years (*n* = 150)	Quasi experimental study	Pedometer	No	BMI	Practitioner training was main intervention			4 weeks: 2 h per week	Boys ↑ steps than girls
Mazzucca (2017)	3–5 years (*n* = 559)	Group-randomised controlled trial	Accelerometer	Yes	Practitioner PA, ECE environment, play equipment, practitioner reports, practices and perceptions	10 min activities	10 weeks	Move, Play Learn!	2 weeks and 4 modules and workshops	+ associations with MVPA - associations with sedentary
McCrady-Spitzer et al. (2016)	3–5 years (*n* = 25)	Not specified	Accelerometer	No	Height, weight, overall education score	2 days per week, 3 × 5-min activity breaks	8 weeks	Follow-the-leader style	Not specified	↑ PA, ↑ educational scores
Mitchell et al. (2013)	0–8 years (*n* = 598)	The multicomponent programme	FMS – no PA	No	Fundamental movement skills	Not specified	Not specified	Project Energize	Received PE plans	↑ all FMS
Monsalves-Álvarez et al. (2015)	3–4 years (*n* = 70)	Cohort	Motor skills – no PA	No	BMI, motor skills (standing long-jump and 12 meter run), nutritional status	3 days per week × 45 min	6 months	Short PA breaks	3-day seminar	⦸ nutritional status; ↑ weight and height ↑ standing long-jump
O'Dwyer et al. (2013)	3–4.9 years (*n* = 218)	Cluster randomised controlled trial	Accelerometer	Yes	BMI	weekly × 60 min	6 weeks	The active play intervention	4 weeks and ongoing support	⦸ sedentary, ⦸ PA, gender and hours at school predict PA
Pate et al. (2016)	3–5 years (*n* = 379)	Group randomised design – preschool as the unit of randomisation	Accelerometer	Yes	BMI	Practitioners' flexibility	Not specified	SHAPES	Not specified	↑ MVPA
Roth et al. (2015)	4–5 years (*n* = 709)	Cluster randomised controlled trial	Accelerometer	No	Motor skills	Daily × 30 min, PA-homework	One academic year	PAKT	2 workshops	↑ motor skills ↑ MVPA

Table 1 continues on the next page →

TABLE 1 (Continues...): Studies investigating early childhood development practitioners' contribution by means of presenting physical activity interventions.

Author	Population age and size (*n*)	Study design	Method of measuring PA	Measuring sedentary behaviour	Additional variables	Intervention				Outcome
						Frequency	Duration	Name or type	Practitioner training	↑/↓/⦸
Slining et al. (2021)	3–5 years (*n* = 10 ECDCs)	Quasi-experimental study	Go-NAP SACC	Yes	PA policies, practices, and environments	Not specified	2 years	CBPR Livewell intervention	Not specified	☑ Goals: 16 nutrition, 6 play, 11 PA, 8 screen time
Tandon et al. (2019)	3–5 years (*n* = 97)	A matched-pair, cluster randomised trial	Accelerometer, direct observation	Yes	Acceptability and satisfaction of intervention	No intervention – observation of play opportunities and PA levels		Active Play, Outdoor Play	3 h and materials	↑ PA opportunity, ⦸ sedentary/ light and MVPA, ↑ active play
Toussaint et al. (2020)	2.5–4 years (*n* = 249)	Randomised controlled trial	Modified SOPLAY	No	Activating role of practitioner, FMS	Not specified	Not specified	PLAYTOD	3 sessions	↑ active practitioner role ↑ quality of PA
Van Cauwenberghe et al. (2013)	4–6 years (*n* = 200)	Observational study	Accelerometer	Yes	None	Once off	Approximately 33 minutes	Teacher-led structured PA session	Exposure to the Flemish preschool curriculum	↓ sedentary ↑ light and MVPA
Veldman et al. (2018)	3–5 years (*n* = 225)	Randomised controlled trial using a nested cohort	Accelerometer, direct observation	Yes	Practitioners' intentionality	Not specified	18 months	Jump Start	6–8 h and on-going learning opportunities and monthly support	↑ MVPA ↑ practitioners' active participation
Williams et al. (2009)	3–5 years (*n* = 270)	Pilot observational study	Pedometer	No	Practitioner step counts, effectiveness of curriculum and AT activities implemented	Daily × 10 min	10 weeks	AT curriculum	1.5 h	Added 47 min structured PA per week

Note: Please see full references in the reference list of this article.

BMI, body mass index; btw., between; cor., correlation; ECDCs, early childhood development centres; FMS, fundamental movement skills; L, light physical activity; MVPA, moderate-to-vigorous physical activity; PA, physical activity; SB, sedentary behaviour; h, hours.

videotapes in addition to the measuring instruments. Three studies indicated that children's PA or play in an outdoor setting increased as educators' PA levels increased. Four studies observed or compared educators' and children's sedentary behaviours, with one study reporting an association between sedentary behaviour of educators and children. Furthermore, the measurement of BMI was included in three of the studies listed in Table 2.

Proposals

Four research proposals met the inclusion criteria and are summarised in Table 3. One research proposal focussed only on childcare workers and the implementation of a PA intervention into their daily routines and schedules. All four research proposals planned to use accelerometers to measure PA and aimed to improve the PA of children between 2 and 6 years of age.

Systematic reviews and discussion pieces

Four systematic reviews, one systematic review research proposal and one discussion piece were included after publications had been screened against the inclusion criteria (Table 4). All these publications focussed on children predominantly in the ECDC setting, with the exception of only one study including children from 2 up to 18 years of age.

The discussion piece included 24 studies and focussed on similarities and differences in PA interventions based on Early Childhood Education and Care (ECEC). The systematic review research proposal and one other systematic review (including 23 studies) explored the role of educators and their involvement in children's PA levels. Two systematic reviews (including 34 and 14 studies, respectively) evaluated the effectiveness of interventions to promote PA in children. Lastly, one systematic review investigated the correlates of PA and sedentary behaviour of children in ECEC services.

Less than half of the studies reviewed in the discussion piece reported positive changes in PA outcomes, while the systematic review exploring the role of educators and their involvement in children's PA levels found little or no difference when adding a parent or caregiver component to PA interventions. Small significant differences in MVPA, as well as positive interventions involving manipulation of the playground, equipment and goal setting, were identified in the systematic reviews evaluating the effectiveness of interventions to promote PA in children.

Discussion

This scoping review aimed to explore ECD practitioners' contribution to the acquisition of gross motor milestones and the achievement of adequate levels of PA of children from birth to 4 years.

TABLE 2: Studies investigating early childhood development practitioners' contribution by means of modelling adequate physical activity levels.

Author	Population age and size (*n*)	Study design	Method of measuring PA	Measuring sedentary behaviour	Additional variables	Intervention	Outcome
						Frequency, duration, type, practitioner training	±
Carson et al. (2020)	19–60 months (*n* = 187)	Cross-sectional	Accelerometer	Yes	Practitioner PA	Healthy Active Childcare setting (HATCH)	↑ practitioner sedentary time = ↓ child MVPA, ↑ practitioner MVPA = ↑ child MVPA
Chakravarthi (2009)	3.5–5 years (*n* = 58)	Not specified	Accelerometer, videotapes	Yes	Practitioner PA, BMI, playground and practitioner info	Not specified	↑ practitioner act. = ↑ act. and play, outdoor settings = NB
Chen et al. (2020)	3–5 years (*n* = 369)	Cross-sectional observational study	Accelerometer	Yes	Practitioner PA, steps, BMI, environment, policies and time outdoors	Not specified	Formalised PA policy = ↑ activity, but ⦸ sedentary Practitioner PA and steps = ⦸PA
Cheung (2020)	4–6 years (*n* = 248)	Case-control design	Pedometer	No	Practitioner PA, BMI	4 × 30 min 4 weeks AEROFit programme 1 x training session and lesson plans	↑ active practitioner = ↑ PA levels
Tonge et al. (2021)	2–5 years (*n* = 490)	Cross-sectional	Accelerometer	Yes	Practitioner PA, sedentary time, practitioner demographics	Not specified	☑ Association between practitioner and child sedentary behaviour, ⦸ associations between practitioner and child PA

Note: Please see full references in the reference list of this article.

BMI, body mass index; FMS, fundamental movement skills; MVPA, moderate-to-vigorous physical activity; PA, physical activity.

TABLE 3: Study characteristics of research proposals.

Author	Population age and proposed size (*n*)	Study design	Method of measuring PA	Measuring sedentary behaviour	Additional variables	Intervention			
						Frequency	Duration	Type	Practitioner training
Delaney et al. (2019)	3–6 years (*n* = 420)	Parallel cluster randomised controlled trail design	Accelerometer, pre-PAQ	Yes	Cognitive function, centre characteristics and PA policy, fidelity and acceptability of delivering energisers	5 min energisers, 3 times a day	6 months	Everybody Energise Trail	Received a box with 60 'Energiser Activity Cards'
Lidegaard et al. (2020)	Childcare Workers (*n* = 132)	Cluster randomised trial	Accelerometer	No	Anthropometry, PA type, body posture, cardiorespiratory fitness, consumables	Implement into daily routines and schedules		10 weeks	Goldilocks–childcare study
Tonge et al. (2017)	2–5 years (*n* = 500)	Cross-sectional study	Combination of RTLS, accelerometer, direct observation	No	Practitioner PA, quality of practitioner interactions, ECEC setting characteristics	Not specified			
Toussaint et al. (2019)	2.5–3.5 years (*n* = 249)	Cluster randomised controlled trial	Accelerometer	No	BMI, dietary intake, PA, practitioners' role, motor develop, parents' Knowledge and perceptions	Modified versions of two existing Dutch programmes: 'A Healthy Start' and 'PLAYgrounds'		PreSchool@ HealthyWeight	Three meetings × 2 h and modules, two training sessions, 1 × one evaluation session

Note: Please see full references in the reference list of this article.

BMI, body mass index; PA, physical activity; ECEC, Early Childhood Education and Care.

TABLE 4: Study characteristics of systematic reviews[a] and discussion pieces[b].

Author	Setting or population age	Aim and objective of study	Studies include	Outcomes and recommendations
Hnatiuk et al. (2019)[a]	0–5.9 years	Evaluated the effectiveness of interventions to increase PA in 0–5-year-olds and determine what works, for whom, in what circumstances	34	⦸ Non-significant difference for light-intensity PA. ☑ Small significant difference for moderate- to vigorous-intensity PA. The synthesis provided insights into the key contexts and mechanisms that appeared to be effective at changing children's PA.
Jones et al. (2019)[b]	ECEC setting, mainly targeted children aged 3–5 years	Discussed similarities and differences in ECEC-based PA interventions, highlighted current trends and issues in the ECEC sector relating to such interventions, and provided recommendations for future interventions	24	Less than half of the studies discussed ☑ positive changes in PA outcomes reported. Future interventions need to consider current national and international trends in the ECEC sector, as well as creative and unique ways of delivering ECEC-based PA interventions.
Morgan et al. (2020)[a]	2–18 years	Assessed effects of caregiver involvement in interventions for improving children's dietary intake and PA behaviours, described intervention content and behaviour change techniques employed, identified content and techniques related to reported outcomes	23	Adding a parent or caregiver component to dietary behaviour or PA interventions = ⦸ little or no difference. Interventions targeting both diet and PA behaviours, involving a parent or caregiver = slightly ↓ sugar-sweetened beverage intake. No data available on any adverse effects in these types of interventions.
Temple and Robinson (2014)[a]	Preschool setting	Reviewed effective interventions that combat excess weight gain and obesity, and promoted healthy habits in preschool-aged children	14	Positive interventions involving preschool children included manipulation of the playground with the number of children playing at one time, markings, or equipment and goal setting and reinforcement.
Tonge, Jones and Okely (2016)[a]	ECEC setting	Systematically reviewed the correlates of PA and sedentary behaviour of children in ECEC services	66	Strongest associations of PA = child's gender and age, gross motor coordination, active opportunities for PA and features of outdoor environments. The only strong association for sedentary behaviour was the presence of outdoor environments.
Ward et al. (2015) (protocol)	Preschool	Identified the potential role of childcare educators as models for the development of healthy eating and PA behaviours of children, and suggested avenues for future research	–	None – research proposals

Note: Please see full references in the reference list of this article.

PA, physical activity; ECEC, Early Childhood Education and Care.

a, Systematic review; b, Discussion piece.

Early childhood development practitioners' contribution by means of presenting physical activity interventions

All the experimental studies included in the current review employed a cross-sectional study design, with no longitudinal studies investigating the long-term effects of PA interventions presented by ECD practitioners. The majority of publications relating to PA interventions presented by ECD practitioners were published between 2013 and 2021, with the highest number of publications occurring in 2016 (n = 9). A growing research interest in PA interventions presented by ECD practitioners is highlighted, with six publications in both 2013 and 2019 and seven in 2020. The largest proportion of the studies (n = 19; 35.2%) were conducted in the United States and none in South Africa. This clearly indicates a lack of research regarding PA interventions presented by ECD practitioners not only in South Africa but also globally.

Fourteen studies reported an increase in light, moderate-to-vigorous or vigorous PA because of interventions presented by ECD practitioners (Alhassan et al. 2016; Andersen et al. 2020; Annesi et al. 2013a, 2013b; Brown et al. 2009; De Marco, Zeisel & Odom 2015; Herriott 2012; Hoffman et al. 2020; Hoza et al. 2021; Kahan, Nicaise & Reuben 2016; Kirk & Kirk 2016; Pate et al. 2016; Van Cauwenberghe et al. 2013; Veldman et al. 2018). In addition, the systematic review by Hnatiuk et al. (2019) reported a small significant positive effect for MVPA. Furthermore, four studies reported an increase in overall time spent on PA (Finch et al. 2014; Froehlich Chow et al. 2016; LaRowe et al. 2016; McCrady-Spitzer et al. 2016), and two studies reported an increase of 63 min and 47 min, respectively, of structured PA per week (Hoffman et al. 2020; Williams et al. 2009). Moreover, gender differences were reported in two studies, indicating that boys tend to have a higher daily step count and spend more time participating in MVPA (Lahuerta-Contell et al. 2021; Mavilidi, Rigoutsos & Venetsanou 2021).

Although the majority of publications reported positive findings of a PA intervention presented by ECD practitioners, multiple studies found no significant changes in children's PA after intervention (Alhassan & Whitt-Glover, 2014; Cardon et al. 2009; Duff et al. 2019; Jones et al. 2016; Leis et al. 2020; O'Dwyer et al. 2013). Furthermore, a systematic review (Hnatiuk et al. 2019) and a discussion piece (Jones et al. 2019) reported similar findings of non-significant differences in PA. Jones et al. (2019) summarised that more than half of the 24 articles included in the discussion reported no significant positive changes in PA outcomes. Of note is that although Alhassan et al. (2016) reported an increase in light and MVPA, these numbers significantly decreased at 3 and 6 months post-intervention. Kipling Webster, Robinson and Wadsworth (2020) also reported a significant moderate regression between fundamental movement skills and MVPA, and no correlation between BMI and MVPA.

Publications investigated a variety of variables in addition to PA, such as play, sedentary behaviour, motor skills, literacy skills and educational scores, educators' confidence and their active participation in physical activities. Several studies reported on the effect of ECD practitioner-led PA interventions on children's outside play, in addition to the effect it had on their PA. Two studies reported on play as a result of ECD practitioner-led PA interventions. Tandon et al. (2019) found an increase in active play in children between 3 and 5 years, while Cardon et al. (2009) did not report any significant changes in play time. The absence of an increase in active play reported by Cardon et al. (2009) could be an indication of limited practitioner training on the intervention, as well as the quality of the intervention. Practitioner training for the intervention was not specified and practitioner involvement only included introducing children to various play equipment in a single 1-h session.

Six studies reported a decrease in children's sedentary behaviour as a result of PA interventions presented by ECD practitioners (Alhassan et al. 2012; Andersen et al. 2020; Herriott 2012; Kahan et al. 2016; Lahuerta-Contell et al. 2021; Van Cauwenberghe et al. 2013). In contrast, five other studies did not report any changes in children's sedentary behaviour (Annesi et al. 2013a, 2013b; Cardon et al. 2009; O'Dwyer et al. 2013; Tandon et al. 2019). Overall, the studies reported an increase in children's motor skills as a result of ECD practitioner-led PA interventions. Eight studies reported an improvement in children's motor skills, with some of the studies specifically highlighting leaping, standing long-jump, throwing, object control and locomotor skills (Alesi et al. 2021; Alhassan & Whitt-Glover, 2014; Brian et al. 2017; Duff et al. 2019; Leis et al. 2020; Mitchell et al. 2013; Monsalves-Álvarez et al. 2015; Roth et al. 2015). However, Bonvin et al. (2013) and Jones et al. (2016) reported no improvement in children's motor skills, with Leis et al. (2020) reporting no improvement in children's object control. Differences in results might be attributed to various study designs having been used, different sample sizes and inconsistencies in the presentation of PA interventions and the quality of practitioner training.

In addition to motor skills, PA interventions presented by ECD practitioners improved children's literacy skills and educational scores (Alesi et al. 2021; Kirk & Kirk 2016; McCrady-Spitzer et al. 2016). The ECD practitioners also benefitted from the PA interventions, with Duff et al. (2019) reporting an increase in educators' confidence regarding PA. In addition, both Toussaint et al. (2020) and Veldman et al. (2018) reported an increase in educators' active participation in physical activities as a result of PA interventions presented by ECD practitioners.

Early childhood development practitioners' contribution by means of modelling adequate physical activity levels

Research findings mainly indicated a relationship between ECD practitioners' and children's PA, favouring children's PA when practitioners had higher PA levels (Carson

et al. 2020; Chakravarthi 2009; Chen et al. 2020; Cheung 2020; Morgan et al. 2020; Tonge, Jones & Okely 2021). Most of the publications regarding the relationship between ECD practitioners' PA and children's PA were published in 2020 (66.67%). There is, however, limited evidence available to compare the data, which warrants further investigation. Studies on the relationship between ECD practitioners' and children's PA were conducted in Australia, Canada, the United States, Sweden and Hong Kong. Despite the importance of educators' relationship to children's PA, no studies were found that investigated this relationship in the South African ECD setting.

Three of the studies indicated that children's PA or play in an outdoor setting increased when educators' PA levels increased (Carson et al. 2020; Chakravarthi 2009; Cheung 2020). In addition, three studies compared educators' sedentary behaviours with those of the children (Carson et al. 2020; Chen et al. 2020; Tonge et al. 2021), while one study (Tonge et al. 2021) found an association between educator and child sedentary behaviour. These results highlight the importance of ECD practitioners to be physically active in order to reduce the time children spend in sedentary behaviour in the ECD setting. Furthermore, the measurement of BMI was included in three of the five studies investigating the relationship between practitioners' and children's PA (Chakravarthi 2009; Chen et al. 2020; Cheung 2020).

Notably, the overall findings of these studies also indicated the absence of clear descriptions of the intervention programmes and the training that practitioners might have received to increase children's PA. Furthermore, results had been influenced by missing data and the misclassification of data. The limited research, as well as data collection and reporting errors, are problematic for reporting on this topic.

Early childhood development practitioners' contribution to gross motor milestone acquisition

Evidence from this review is challenged by a lack of studies reporting on ECD practitioners' contribution to gross motor milestone acquisition of children from birth to 4 years of age. No studies investigating this particular contribution met the inclusion criteria. This scoping review identified a clear gap in the literature. Although previous research did not investigate ECD practitioners' contribution to children's milestone acquisition, these studies indicated that the role played by ECD practitioners in children achieving motor milestones is becoming more important, as children are spending more time at ECDCs (Wilke et al. 2013). Although milestones should develop naturally, ECD practitioners can play a key role in providing stimulating environments to promote the achievement of milestones and contribute to milestone attainment when delays in milestone development are noticed (Atmore et al. 2012; Egert, Fukkink & Eckhardt 2018; Gerber et al. 2010; Sabanathan et al. 2015; SAQA, n.d.; Siraj, Kingston & Neilsen-Hewett 2019; Tecklin 2015). Thus, the necessity of more research on this topic and equipping ECD practitioners with knowledge on gross motor milestones must be emphasised.

Implications of the findings for research

No longitudinal studies are represented in this body of evidence, limiting our knowledge of the long-term effects of ECD practitioner-led PA. Future research on this topic based on a longitudinal study design is recommended.

Non-significant outcomes were the result of short intervention periods, an absence of structured PA, an inadequate amount of ECD practitioner-led PA interventions and minimal training provided to practitioners. In addition, results were also influenced by sample sizes, incomplete or missing data, reported accelerometer cutoff points used for the MVPA threshold being criticised as too high, and uncontrollable factors influencing the programme implementation and fidelity. Future research should carefully consider these limitations and researchers should plan and conduct studies with sound methodologies.

Limited studies observed the relation between ECD practitioners' and children's PA levels, and we are thus recommending that future research take ECD practitioners' PA into account when exploring young children's PA levels. Furthermore, no studies could be found investigating ECD practitioners' contribution to the acquisition of gross motor milestones, indicating another gap in the literature. Future research regarding the importance of milestone acquisition in the ECD setting and the contribution of ECD practitioners to the acquisition of gross motor milestones is warranted. None of the studies included had been conducted in developing countries. This clearly indicates a shortage of research regarding ECD practitioner-led PA interventions and their contribution to children's milestone acquisition in such countries, thus highlighting the need for future studies to explore these topics in developing counties, including South Africa.

Implications of the findings for practice

It is evident from the review that ECD practitioners play a vital role in young children's PA within the ECD setting. It is therefore recommended that ECD practitioners acquire the necessary knowledge and training to ensure that they effectively enhance the quality and quantity of children's PA participation.

Limitations

The priori protocol of this review only formed part of the ethical application protocol and was not formally published. The scoping review included publications exclusively written in English and studies published after 26 May 2021 were not reviewed. Consequently, more recent published findings fulfilling the inclusion criteria, or studies published in other languages, were not included in the review.

Conclusion

Valuable information emerged from this scoping review where definite literature gaps have been clearly identified. From these gaps, noteworthy recommendations are made for future research and for practitioners in the ECD setting. The majority of research described in the publications included in this scoping review had been conducted relatively recently. In addition, results of 22 randomised controlled studies indicated a strong base of evidence containing reliable results. Furthermore, it could be concluded that PA interventions presented by ECD practitioners might have a positive influence on children's overall PA levels, if interventions were thoroughly executed and ECD practitioners received sufficient training.

Although the PA of ECD practitioners seems to positively correlate with children's PA levels, limited studies were found in this regard. Moreover, no studies were found that investigated ECD practitioners' contribution to the acquisition of gross motor milestones by children from birth to 4 years.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

This article formed part of a master's degree, where E.v.d.M. and B.A.C. were supervisors and V.G. was the student. All three were part of the planning and conceptualisation of study. V.G. collected all data with the assistance of E.v.d.M. Writing of the first draft was carried out by V.G., while E.v.d.M. and B.A.C. contributed to the refinement of the article. All three authors contributed to the final article.

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Data availability

The data that support the findings of this study are available on reasonable request from the corresponding author, V.G.

Disclaimer

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