A Scoping Review on the Use of the Parents Evaluation of Developmental Status and PEDS: Developmental Milestones Screening Tools

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Abstract

The Parents' Evaluation of Developmental Status (PEDS), PEDS: Developmental Milestones (PEDS: DM) and PEDS tools (i.e., the PEDS and PEDS:DM combined for use) are parent-reported screening tools frequently used to identify young children requiring early intervention. An ideal screening tool for all contexts would be brief, inexpensive with appropriate test items and good psychometric properties. A scoping review was conducted to review studies that used the PEDS, PEDS:DM, and PEDS tools to screen for the need for further referrals and evaluation through parent report. Thirty articles, ranging from 2003 to 2020, conducted in high-income countries (HICs) and lower-middle income countries (LMICs), were included from the 1,468 records identified. Studies conducted in HICs ($n = 19$) included screening of special population groups and comparing validated tools. LMIC studies ($n = 11$) focused on translations, combination of the PEDS tools, validations of tools, and use of an app-based tool (mHealth). High referral rates were obtained with PEDS (23–41%) and PEDS:DM (12–54%) in LMICs where at-risk populations are more prevalent and cultural differences may affect tool validity. A global dearth of research on PEDS:DM and PEDS tools exist; the review highlights factors that influence the validity and impact widespread use of the screening measures, especially in diverse populations and LMICs.

Keywords

child development, assessment, teaming and collaboration with others

Introduction

The importance of developmental screening and surveillance, typically used for early identification and monitoring from infancy to the preschool period, is universally accepted (Richter et al.,

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2019; Woolfenden et al., 2016). Early identification of delays is strongly linked to later academic success (Kiing et al., 2019). Screening tools are typically aimed toward parents, who are necessary partners in assessment and intervention of their children (Bindlish et al., 2018). Many developmental screening programs are currently built on basic health services, where there is ongoing contact with families, parents, and children (Valla et al., 2019). Parents are an important source of information regarding their children's development and behavior and may provide information that could otherwise not be observed in a clinical setting (Miller et al., 2017). Focusing on parents' concerns makes health visits more relevant, fosters collaboration, facilitates early detection, and encourages parents to adhere to professionals' recommendations (Glascoe, 2013; Glascoe & Marks, 2011). Although accuracy of parent report and their ability to evaluate child development have been questioned in the past (Stokes et al., 2011) screening for developmental delay with parent-completed tools rather than clinician-administered tools is often recommended (Mackrides & Ryherd, 2011; Ozonoff et al., 2011). Parent report measures can be completed by any caregiver of the child—and, in some cases, even the child's teacher. Teachers also have extended contact with the child in the first few years of life and can thus be included in the screening process (Kiing et al., 2019). Parent report measures are increasingly preferred as they are quick, easy to use, and cost-effective relative to formal, clinician-administered direct evaluation (Miller et al., 2017; Schafer et al., 2014).

Two of the most widely used and validated parent-completed tools are the Parents' Evaluation of Developmental Status (Glascoe, 2003) and the Ages and Stages Questionnaire (Mackrides & Ryherd, 2011; Sheldrick et al., 2020; Squires et al., 1997). The Parents' Evaluation of Developmental Status (PEDS) has demonstrated high sensitivity to severe delays when compared with other tools including the widely used Ages & Stages Questionnaire–Third Edition (ASQ-3), and the Survey of Wellbeing of Young Children (SWYC): Milestones (Sheldrick et al., 2020; Sheldrick & Perrin, 2013). The PEDS has also shown promise when investigated in different socio-economic contexts, ranging from high-income countries (HICs; Sheldrick et al., 2020) to lower-middle income countries (LMICs) including South Africa (Maleka et al., 2019; van der Merwe et al., 2019), Serbia (Ilić et al., 2019), and countries in Asia such as Bhutan (Wong et al., 2019) and Iran (Shahshahani et al., 2017; Vameghi et al., 2015). It is essential to prioritize health care in LMICs where resources and access to health care can be limited. Even though LMICs such as South Africa have varying contexts within the country, ranging from higher income communities to lower income, it is still vital to understand how tools such as the PEDS are designed for specific populations within those contexts. In the case of the PEDS, it was created for use in a higher-income context, and the population of a lower-income context may thus require the tool to be adjusted or adapted across language and/or culture accordingly (Fyvie et al., 2016; Maleka et al., 2016, 2019; Vameghi et al., 2015; van der Merwe et al., 2019). Available resources also differ across economic contexts and countries. Understanding the feasibility of a tool as it applies to all contexts within a country serves to improve health care accessibility. To inform national or systemic changes within a health care system, it is important to know what is applicable to all communities and contexts within a greater region (Agampodi et al., 2015).

The PEDS is an evidence-based developmental screening tool that elicits and identifies parents' concerns about children's motor, language, self-help, early academic skills, behavior, and social-emotional development. The inclusion of all aspects of child development and the fact that the PEDS is a parent-completed tool may make it suitable to be used as a population outcome measure, especially in low resource settings (Limbos & Joyce, 2011; Maleka et al., 2019). The PEDS is reported to have a sensitivity of 91% to 97% and a specificity of 73% to 86% (Glascoe, 2013). In HICs, the PEDS has moderate sensitivity (74%) but low specificity (64%) when compared with the ASQ (78%; Limbos & Joyce, 2011), but the PEDS is also reported to have higher sensitivity (78%) to mild delays among older children (43–66 months; Sheldrick et al., 2020). In LMICs such as Iran, the PEDS is reported to have appropriate content validity (Shahshahani

et al., 2017; Vameghi et al., 2015). With adequate sensitivity and specificity, the PEDS adheres to standards for developmental screening tests and is also reliable when used by a range of professionals and individuals, including community health workers (Fischer et al., 2014; Glascoe, 2013; van der Merwe et al., 2019) and teachers (Kiing et al., 2019). The PEDS is often preferred for use in developmental screening, especially in the context of child care visits as the PEDS do not require additional equipment, and is quick to administer (Shahshahani et al., 2017). The PEDS has been utilized in disadvantaged and vulnerable populations, as well as in high, middle, and low income countries, and has been translated over 50 languages (Glascoe, 2013; Woolfenden et al., 2016). In addition to the PEDS, the PEDS: Developmental Milestones (PEDS: DM) was developed and released in 2003 (Glascoe, 2003). The PEDS:DM is a tool bridging screening and diagnosis, and while it is considered to be more comprehensive than screening tools, it only provides provisional diagnoses (Chunsuwan et al., 2016). While the PEDS helps to elicit and address parents' concerns using open-ended questions that elicit general concerns, the PEDS:DM provides information on the child's progress and facilitates skilled monitoring of development. The questions are more focused on specific developmental milestones, and questions differ according to the child's age. The PEDS:DM is a milestones-based checklist measure consisting of six to eight questions, depending on the age range, which is birth to 8 years, with additional academic measures available for older children and adolescents (Glascoe, 2013). Each item taps a different developmental domain: expressive language, receptive language, fine motor, gross motor, social-emotional, and self-help. With a clear scoring criteria and high sensitivity and specificity, the PEDS:DM provides accurate and reliable indicators of children's skills across domains in America (Glascoe, 2013). The PEDS:DM, also showed a moderate sensitivity for identifying signs of delays, in children from the United States and Bhutan (Soucy et al., 2012; Wong et al., 2019). The PEDS:DM is a fast test that highlights developmental milestones to parents, who can complete the PEDS:DM by reporting on or observing the behavior elicited in their child (Chunsuwan et al., 2016; Glascoe, 2013). The PEDS:DM facilitates progress monitoring and is especially useful for clinicians who are using the PEDS and require more specific information on children's skill levels and function (Brothers et al., 2008).

As illustrated by Table 1, the PEDS elicits parent concerns by posing questions probing whether they have any concerns regarding their child's development. The parent can choose between three answers: yes, no, or a little. This is followed by a "Comments" section that allows the parent to elaborate on their concerns. Conversely, the PEDS:DM is used to screen for specific developmental milestones; the example questions in Table 1 screen fine motor skills, receptive language skills, and expressive language skills, respectively. The use of the PEDS and PEDS:DM combined, also known as the PEDS tools, makes use of both forms of question from the two tools, allowing for a holistic view of the child's development by gathering information on what the parent is concerned about as well as specific developmental milestones their child may or may not have reached.

The PEDS is scored according to the five PEDS-path referral algorithms. This is a table of norms according to age distribution divided into five paths: Paths A to E. Path A results in further referral due to two or more predictive concerns being present, without the need for further screening. Paths B to E recommend the use of the PEDS:DM to screen further. Thereafter, if one or more milestone on the PEDS:DM is not met, the child is referred for further evaluation. This combined approach is per the authors' guidelines (Brothers et al., 2008).

There is value in using PEDS and PEDS:DM together, as one elicits and identifies parents' concerns while the other provides information on children's actual development (Glascoe, 2013). The combination facilitates skilled monitoring of development by parents, as they are informed on what to expect from their child. Once parental concerns are identified by the PEDS, they are clarified by the PEDS:DM, and with this approach, recommendations for screening and surveillance are being fulfilled (Glascoe, 2013). A number of studies have been using the tools in combination for the following reasons: to bridge the gap between screening and diagnosis by

Table 1. Example Questions From the PEDS, PEDS: DM, and PEDS Tools Combined.

	PEDS Tools Questions
PEDS response from questions	1. Do you have any concerns about how your child talks and makes speech sounds? Select one: No Yes A little Comments: 2. Do you have any concerns about how your child understands what you say? Select one: No Yes A little Comments: 3. Do you have any concerns about how your child uses his or her hands and fingers to do things? Select one: No Yes A little Comments:
PEDS: DM response from questions	1. Can your baby poke at things with just his or her first finger? No A little Yes 2. When you say your baby's name, does he or she stop and look at you? No Sometimes Most of the time 3. How many different sounds such as "muh," "bah," "duh," or "guh" does your baby say? None 1 2 or more

Note. PEDS = Parents Evaluation of Developmental Status; PEDS: DM = Parents Evaluation of Developmental Status: Developmental Milestones.

examining domain-specific results of the PEDS:DM to supplement the PEDS (Chunsuwan et al., 2016); to explore mobile health as a feasible method of developmental monitoring in LMICs (Maleka et al., 2019); to investigate whether community health workers can conduct accurate developmental screening using the PEDS tools (Maleka et al., 2016; van der Merwe et al., 2019); and to compare the performance of the PEDS tools to the Bayley Scales of Infant and Toddler Development III (Abdoola et al., 2019). Combining the PEDS and the PEDS:DM elicits and identifies parents' concerns, while monitoring milestones, and screening with validated tools periodically (i.e., surveillance). Parental frustration may be decreased with the opportunity to express their concerns, with adaptive parenting encouraged for children to reach milestones appropriately. In the case of the need for further referrals and evaluation being identified when conducting the PEDS:DM, the PEDS facilitates delivering this news via affirmation of existing parental concerns. The combined use of the PEDS and PEDS:DM reportedly enhances the accuracy of responses to parental concerns and guides the responses in terms of either support or further referral (Glascoe, 2013). The purpose of these screening tools is to identify the need for further referrals and evaluation. That is why to reduce unnecessary referrals, as well as to prioritize referrals for further evaluation, second-stage evaluation—or a tiered approach—has been recommended (Chunsuwan et al., 2016). A tiered approach may be beneficial within contexts such as LMICs where there is a high prevalence of developmental delays or disorders, even though this may take long. Selecting the most effective screening tools, and complementing parent-reported concerns with domain-specific results, may reduce high referral rates and prioritize the referrals that are most at-risk (Maleka et al., 2019).

An effective screening tool for both HICs as well as LMICs would be a brief, inexpensive tool with developmentally appropriate test items and good psychometric properties (Goldfeld & Yousafzai, 2018). However, it is highly unlikely to find a one size fits all approach that can be applied to all populations across HICs and LMICs. For a tool to be fit-for-purpose at an individual level, it should be available in local languages where it is used, validated on children of the specific population, and require minimal training (Marlow et al., 2019). As the PEDS, PEDS:DM, and PEDS tools have the potential to ascribe to these characteristics, they would be considered appropriate for use in various contexts. There is evidence on the use of the PEDS with other developmental screening tools (Fischer et al., 2014; Macy, 2012), but not on the PEDS:DM or the combination of the two measures. Thus, to better understand the use of these tools in isolation and in combination, as well as in different contexts, a scoping review of the studies using the three potential options for screening with PEDS tools (PEDS, PEDS:DM, and PEDS tools) globally was conducted. A scoping review is a method of synthesizing knowledge, to comprehensively summarize evidence with the aim of providing direction for future reference as well as to inform practice, programs and policy (Colquhoun et al., 2014). The purpose of this scoping review is to clarify concepts, address gaps in literature and make the information more accessible to health care professionals and other stakeholders who may need to use one or more of these tools in various contexts.

Method

Aim

This scoping review describes the global usage of the three screening options with the PEDS tools (PEDS, PEDS:DM, and PEDS tools) to screen for parental concerns and for further need of evaluation of developmental delays.

Eligibility Criteria

Peer reviewed journal publications were selected for inclusion to obtain high quality, reliable data. English publications were selected for ease of interpretation by the researcher and no limit

was placed on the date of publication or study setting. The age range of the study population was limited to birth to 8 years, as this is the age range covered by the PEDS, PEDS:DM, and PEDS tools. This review considered any study that used one or more of the three options for screening with the PEDS tools in its investigation.

Material

Both PEDS and PEDS:DM are validated and reliable tools. The PEDS has a sensitivity of 91% to 97% and a specificity of 73% to 86% (Glascoe, 2013). It has also been found to have a test–retest (correlation coefficient) reliability of 0.87, which is high (Vameghi et al., 2015). The sensitivity of the PEDS:DM is reported to be 83% while the specificity is 84%, and reliability is reported to be high (test–retest, .98–.99; inter-rater, .82–.96) using Guttman's coefficient (Brothers et al., 2008). A recent study conducted in the HICs of the United States with a primary aim of comparing the PEDS, ASQ-3, and the SWYC, and a secondary aim of exploring the accuracy of the PEDS:DM and PEDS Tools in combination, found that these tools have reliable validity and reliability (Sheldrick et al., 2020). Sheldrick also states that, with regards to the PEDS tools in combination, it has a sensitivity to severe delays of 55.4% to 91.9% for children <42 months, and a sensitivity of 41.8% to 94.5% for severe delays in children aged 43 to 66 months. The specificity of the PEDS tools is also reported to be desirable, with a specificity of 80.3% to 86.9% for children <42 months and 70.2% to 85.4% for children aged 43 to 66 months (Sheldrick et al., 2020). A recent study conducted in South Africa also found that the PEDS tools also have near perfect inter-rater reliability (Cohen's Kappa) of .87 to .96 (Maleka et al., 2016). Table 2 summarizes the current available information on the psychometric properties of these three tools.

Information Sources and Search Strategy

A search was conducted on the International Prospective Register of Systematic Reviews (PROSPERO) database to identify similar reviews. No records of studies evaluating the use of the PEDS, PEDS:DM, or PEDS tools were identified. The current study was then registered with PROSPERO to promote transparency, reduce bias, and avoid study duplication (Moher et al., 2015).

Five electronic databases, MEDLINE, Scopus, PsycINFO, PubMed, and Science Direct, were searched for publications meeting the eligibility criteria. Searches were conducted in from July 13th to 16th, using the following search phrases:

- "Parents evaluation of developmental status" AND "developmental delays"
- "Parents evaluation of developmental status" AND "developmental disorders"
- "PEDS" AND "developmental delays"
- "PEDS" AND "developmental disorders"
- "PEDS:DM" AND "developmental delays"
- "PEDS:DM" AND "developmental disorders"
- "PEDS tools" AND "developmental delays"
- "PEDS tools" AND "developmental disorders"

The use of the phrase "PEDS tools" was to identify articles wherein both the PEDS and PEDS:DM were used in combination.

Study Selection and Data Management

All the researchers reached consensus regarding the eligibility criteria as well as the search phrases prior to conducting the database searches. DistillerSR (Evidence Partners) is the

Table 2. Validity and Reliability of the PEDS, PEDS:DM, and PEDS Tools.

Tool	Study	Validity		Reliability	
		Sensitivity	Specificity	Test–retest	Inter-rater
PEDS	Glascoe (2013)	91–97%	73–86%		
	Vameghi et al. (2015)			Correlation coefficient: .87	
	Sheldrick et al. (2020)	Severe delays (0–42 months): 41.8%–94.5% Moderate-to-severe delays (0–42 months): 48.8%–69.8%Severe delays (43–66 months): 41.8%–94.5% Moderate-to-severe delays (43–66 months): 17.1%–70.8%	0–42 months: 75.7%–83.1% 43–66 months: 64.3%–81.3%		
PEDS:DM	Brothers et al. (2008)	83%	84%	Guttman's coefficient: .98–.99	Guttman's coefficient: .82– .96
	Sheldrick et al. (2020)	Severe delays (0–42 months): 49.6%–71% Moderate-to-severe delays (0–42 months): 73.4%–92.6% Severe delays (43–66 months): 78.3%–93.1% Moderate-to-severe delays (43–66 months): 77.1%–92.7%	0–42 months: 30.2%–56.2% 43–66 months: 6.7%–23.9%		
PEDS Tools	Sheldrick et al. (2020)	Severe delays (0–42 months): 55.4%–91.9% Moderate-to-severe delays (0–42 months): 44%–65.3% Severe delays (43–66 months): 41.8%–94.5% Moderate-to-severe delays (43–66 months): 17.1%–70.8%	0–42 months: 80.3–86.9% 43–66 months: 70.2%–85.4%		
	Maleka et al. (2016)				Cohen's Kappa: .87–.96

Note. PEDS = Parents Evaluation of Developmental Status; PEDS:DM = Parents Evaluation of Developmental Status: Developmental Milestones.

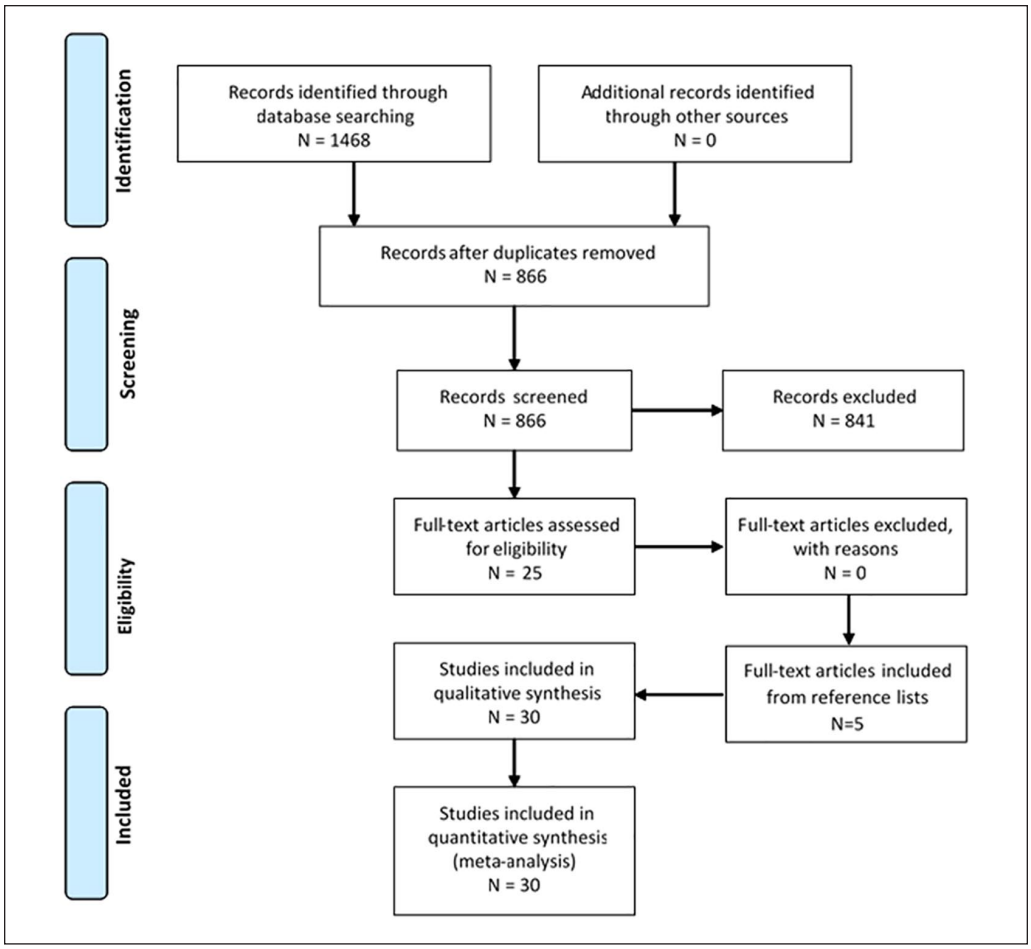

Figure 1. Search strategy used to identify articles for inclusion in scoping review.

web-based software that was used to was used to manage the scoping review data, as automated management of data helps reduce data entry errors (Moher et al., 2015). This software was used to import the initial selection of articles and to remove duplications. The titles and abstracts of articles were screened, after which full texts were reviewed using an eligibility form created from the inclusion criteria (Figure 1). To supplement electronic searches, reference lists of included studies were reviewed (Figure 1). A data extraction form was developed from the DistillerSR template and used to record data items from the final selection.

Data Collection Process and Data Items

The data items were selected according to the study objective and were evaluated for inclusion in the study. Data were extracted from all the eligible studies (Figure 1).

Data Synthesis

The use of the PEDS, PEDS:DM, and PEDS Tools to identify signs of developmental delays in the included studies were reviewed by the researcher. Data items were examined to identify

studies matched for age gender, as well as context. Due to the heterogeneity of the sample, meta-analysis was not conducted as it may result in a nonmeaningful summary of results (Haidich, 2010). Narrative synthesis, the use of a narrative versus statistical summary of the results, was used. The use of narrative synthesis allows for including different forms of evidence within a review (Rodgers et al., 2009).

Meta-Biases and Robustness of the Synthesis

To minimize publication bias, which refers to the likelihood of a study being published based on the findings of the study; all searches were conducted on five electronic databases, with no limit on setting or publication date (Song et al., 2012). Both significant and nonsignificant findings were reported in the studies and are included in the review. The overall risk for publication bias was thus minimal.

Risk of Bias in Individual Studies

The Newcastle–Ottawa Scale (Wells et al., 2010) was used to evaluate possible risk of bias. Determining risk of bias is not always straightforward and requires judgment on behalf of the reviewer (Lundh & Gøtzsche, 2008). In this case, a score of 1 to 3 was considered to be high risk of bias, while scores of 7 and higher were considered to be low risk by the reviewer. A second rater, who was a fellow speech-language therapist, subsequently rated the articles independent of the first rater, the researcher, which increases the integrity of the process.

Results

Publication date ranged across 2003 to 2020 and the studies originated from both HICs and LMICs (Appendix), including the United States, Canada, countries in Europe, Australia, countries in Asia and South Africa (Table 3). The sample was from various countries, with one in three studies conducted in HICs. In Table 3, the characteristics of the included studies are presented. The sample sizes in studies varied greatly, from 26 (Coghlan et al., 2003) to 91,642 (Simon et al., 2013). Twenty-two (73%) were cross-sectional studies, only one of which had a control group. Two studies were mixed method in design, while five studies were prospective cohort studies and one was a retrospective cohort study. Twenty-six studies (86%) comprised nonprobability, convenience, or volunteer samples. Most of the studies ($n = 22$, 73%) used the PEDS, three studies (10%) employed the PEDS:DM and five (16%) used a combination, that is, the PEDS tools (Table 3). High risk of bias was identified in two studies, while another 26 studies (84%) were rated to have low risk of bias (Appendix). The studies by Maleka et al. (2019), with a score of 3, and Richards et al. (2019), with a score of 2, were rated to have a very high risk of bias (Appendix).

In terms of the specific contexts investigated within the countries, many of the studies conducted in HICs involved higher-income contexts ($n = 12$, 63%). Some studies conducted in HICs focused on both high- and low-income contexts ($n = 6$, 31%) to determine the impact of socioeconomic status on development (Simon et al., 2013). Only one study in a HIC was conducted in a specifically low-income context. Conversely, the majority of studies in the LMICs reported on low-income communities and contexts ($n = 7$, 63%), whereas only two studies reported on high-income contexts and another two on mixed economic contexts.

As outlined in Table 3, the studies varied in sample populations. The studies conducted in HICs typically focused on the PEDS and/or PEDS:DM use in special contexts and with special populations, or the comparison of these tools with other tools of a similar nature (Table 4). A limited number of studies, with small sample sizes, were conducted on the PEDS:DM and PEDS

Table 3. Summary of Included Studies on the Use of the PEDS, PEDS: DM, and PEDS Tools ($n = 30$).

	ALL	PEDS	PEDS: DM	PEDS tools
Studies	30	22 (73%)	3 (10%)	5 (16%)
Date range of studies	2003–2020	2003–2020	2011–2019	2016–2019
Sample size (Average ± *SD*; Range)	3,396 ± 16,671; 26–91,642	−4,377 ± 19,028; 26–91,642	95 ± 23; 66–124	238 ± 93; 138–406
Age (years)	0.1–8	0.4–8	0–8	0.1–3.2
Countries (*n*)	11 Countries *11 United States* *6 South Africa* *3 Australia* *2 Canada* *2 Iran* *1 Serbia* *1 Israel* *1 Singapore* *1 New Zealand* *1 Bhutan* *1 Thailand*	9 Countries *9 United States* *3 Australia* *2 South Africa* *2 Canada* *2 Iran* *1 Serbia* *1 Ukraine* *1 Singapore* *1 New Zealand*	2 Countries *2 United States* *1 Bhutan*	2 Countries *4 SA* *1 Thailand*
Context (*n*)	14 High-income 8 Mixed 8 Low-income	13 High-income 6 Mixed 3 Low-income	1 High-income 2 Mixed	5 Low-income
Study types	22 (73%) Cross-sectional 5 (16%) Prospective cohort study 1 (4%) Retrospective cohort study 2 (8%) Mixed-method	17 (77%) Cross-sectional 4 (18%) Prospective cohort study 1 (6%) Mixed method	2 (67%) Cross-sectional 1 (33%) Prospective cohort study	3 (60%) Cross-sectional 1 (20%) Retrospective cohort study 1 (20%) Mixed method
Comparison to other tools	4 ASQ 2 M-CHAT 1 PEDS Northern Sotho (PEDS-NS) 1 BSID-III	4 ASQ 1 PEDS-NS 2 M-CHAT	No comparisons to other tools	1 BSID-III
Person completing	17 Parent/ caregivers 5 Clinician/ health care worker 2 other	21 Parents/caregivers 1 Teacher/child care worker	2 Clinician/health care worker 1 Children	1 Parents/ caregivers 3 Clinician/health care worker
Target population	18 TD[a] children 2 Children at risk for developmental disorder 5 Special population	18 TD children 1 Children at risk for developmental disorder 3 Special population	1 TD children 2 Special population	4 TD children 1 Children at risk for developmental disorder
Mode of completion	4 Digital (1 online; 3 mHealth) 21 Paper based	1 online 21 Paper-based	3 Paper-based	3 mHealth 2 paper based
Risk of bias	2 High risk of bias 2 Medium risk of bias 26 Low risk of bias	1 High risk of bias 2 Medium risk of bias 19 Low risk of bias	3 Low risk of bias	1 High risk of bias 4 Low risk of bias

Note. PEDS = Parents Evaluation of Developmental Status; PEDS: DM = Parents Evaluation of Developmental Status: Developmental Milestones; PEDS: NS = Parents Evaluation of Developmental Status: Northern Sotho; *SD* = standard deviation; ASQ = Ages & Stages Questionnaire; BSID-III = Bayley Scales of Infant Toddler Development III; M-CHAT = Modified Checklist for Autism in Toddlers.

[a]TD = Typically developing.

Table 4. Study Type and Country Characteristics ($n = 30$).

Study types	LMICs	HICs	Total
Adaptation and translation studies	3	3	6
Population description studies	2	5	7
Comparison studies	2	6	8
Evaluation studies	4	5	9
Total	11	19	30

Note. LMICs = lower-middle income countries; HICs = high-income countries.

tools with no comparative studies for the PEDS: DM with other tools (Table 3). The majority of studies involved the caregiver or parent's completion of the tool ($n = 23$, 76%). One study involved both the pediatrician and the caregiver for completion of the tool. A small number of studies required the pediatrician, child care worker, speech-language pathologist or a clinician to complete the tool ($n = 5$, 16%). Only one study involved the teachers of preschool children in the completion of the tool's form. Five studies compared the PEDS and ASQ. It was found that there is substantial discordance between PEDS and ASQ developmental screens (Sices et al., 2009). The ASQ showed higher sensitivity and specificity when compared with the PEDS (Limbos & Joyce, 2011; Sheldrick et al., 2020), particularly in older children (Sheldrick et al., 2020). The higher specificity of the ASQ among younger children was not statistically significant (Sheldrick et al., 2020) and in another study, the results of the test were similar in 93%, 94%, and 91% of cases in fine motor, gross motor and language domains of development, respectively (Shahshahani et al., 2017).

Three studies reported on special populations; two described the utility of the PEDS (Wessel et al., 2013) and PEDS:DM (Soucy et al., 2012) in detecting warning signs of delays in children with neurofibromatosis type 1. Both of these studies were conducted in the United States. The third study, conducted in New Zealand, made use of the PEDS to measure developmental outcomes of children at age four who had been exposed to maternal antiepileptic drug use (Richards et al., 2019). In HICs, use of the PEDS in studies was often for detection of autism spectrum disorder (ASD) and its comparison to ASD-specific tools such as the M-CHAT (Eapen et al., 2014; Pinto-Martin et al., 2008; Wiggins et al., 2014). Five of the 20 studies conducted in HICs (Table 4) focused on factors that could potentially influence the assessment such as foster care, inter-country adoption, multilingualism, culture, and low socio-economic status and the PEDS (Diamond et al., 2015; Hodges et al., 2016; Huntington et al., 2016; Kiing et al., 2012; Simon et al., 2013). Other studies focused on the use of the PEDS in contexts such as pediatric hospitals (Petersen et al., 2009) and primary care (Limbos & Joyce, 2011; Pinto-Martin et al., 2008). Referral rates of the PEDS from studies conducted in HICs ranged from 10% to 74% (Diamond et al., 2015; Limbos & Joyce, 2011). The PEDS: DM had referral rates of 68% in a study conducted in the United States, with significant delays in fine motor (35%) and gross motor (52%) skills (Soucy et al., 2012).

When compared with the studies conducted in HICs, the 11 LMIC studies have focused more on translations and adaptations, combination use of the PEDS tools, and the use of an app-based (mHealth) version of the tool. Three studies examined translations of the PEDS in two different LMIC countries—South Africa (Fyvie et al., 2016; van der Merwe et al., 2017) and Iran (Vameghi et al., 2015). With the use of the translated tool, high referral rates were reported when participants were from underserved communities, and positive and negative correspondence was high-proving that the tool translation was accurate (Fyvie et al., 2016; van der Merwe et al., 2017). The PEDS questions were found to have desirable content validity with no need for change (Vameghi et al., 2015). Several studies examined the usefulness of the PEDS in detecting parental concerns in LMICs (Chunsuwan et al., 2016; Ilić et al., 2019; Shahshahani et al., 2017; Wong et al., 2019).

Examining the usefulness and accuracy of a tool renders varying results, as noted in the studies included in the review (Appendix). Four of the studies examined the potential of the PEDS tools and the utilization of mHealth in South Africa, where a growing body of recent research has emerged (Abdoola et al., 2019; Maleka et al., 2016, 2019; van der Merwe et al., 2019). Five studies reported adaptations and/or translations and the impact of culture and language, three of which were translation studies. Translations of the PEDS, such as in Northern Sotho, Zulu, and Persian, showed desirable validity (Fyvie et al., 2016; Vameghi et al., 2015; van der Merwe et al., 2017). A study found a slight difference in referral rate with regards to translation—with a referral rate of 50% for English and 45% for the Zulu translation. This difference is suggestive of different understandings of questions in the two different languages (van der Merwe et al., 2017). A study conducted in Singapore found an increase of parents reporting concern, as "a little concern" is interpreted differently cross-culturally, and it was recommended that the word be substituted with a word like "worry" (Kiing et al., 2012). Conversely, in a HIC such as Australia, it was found that the PEDS is acceptable for the reporting of developmental concerns (Coghlan et al., 2003). Referral rates in studies conducted in LMICs ranged from 23% to 41% on the PEDS (Maleka et al., 2019; Shahshahani et al., 2017), 12% to 54% on the PEDS: DM (Maleka et al., 2019; Wong et al., 2019) and 56% to 69% on the PEDS tools (Abdoola et al., 2019; van der Merwe et al., 2019).

Discussion

The PEDS, PEDS:DM, and PEDS tools were used across 11 different countries on various populations with study types including cross-sectional, prospective as well as retrospective cohort and mixed method. The 30 studies are distributed globally. Far less research is currently available internationally on the PEDS:DM and PEDS Tools compared with the PEDS. This may in part be due to the fact that the latter are younger tools when compared with the PEDS. A large number of studies included in this review ($n = 22$, 73%) used the PEDS, only 3 (10%) studies used the PEDS:DM, and 5 (16%) used the PEDS tools (Table 3) to identify signs of developmental delays.

In describing the use of the tools to identify the need for referrals and further evaluation, there was a focus on expression of parental concern. Links between parental concern and child development, as well as the timing of concerns, indicate that parents appear to be sensitive to their child's development when answering the questions on the PEDS, specifically within the special population where reported concerns of developmental delay were high (Diamond et al., 2015; Hodges et al., 2016; Ilić et al., 2019; Restall & Borton, 2010). The included studies indicate that the PEDS may be used as a tool for detecting signs of delays in special population groups. It is well-established that the PEDS is sensitive for the identification of disabilities, including learning, intellectual, language, autism spectrum, and motor disorders (Glascoe, 2013).

Nineteen of the 30 studies were conducted in HICs. The PEDS and PEDS:DM are well established in the United States since it was also developed there (Sheldrick et al., 2020). Studies in HICs initially focused on validation, and subsequently more studies conducted in those contexts were typically more toward screening of special population groups such as children with autism and comparative studies with other validated tools such as the ASQ (Morelli et al., 2014; Sheldrick et al., 2020; Woolfenden et al., 2014). The only study that involved gathering information from the teacher was also conducted in a HIC (Kiing et al., 2012). The investigation of the value of teacher input using the PEDS requires further investigation, as it shows promise (Kiing et al., 2019). The HIC studies also used the PEDS when screening for signs of developmental delays with regards to foster care, adoption and drug exposure (Diamond et al., 2015; Hodges et al., 2016; Richards et al., 2019). Fewer HIC studies were concerned with culture and language differences (Huntington et al., 2016; Kiing et al., 2012; Simon et al., 2013) when compared with studies conducted in LMICs (Abdoola et al., 2019; Chunsuwan et al., 2016; Fyvie et al., 2016;

Ilić et al., 2019; Maleka et al., 2016, 2019; Shahshahani et al., 2017; Vameghi et al., 2015; van der Merwe et al., 2019; Wong et al., 2019). Those studies that reported on cultural and language differences in HICs, however, indicated that the PEDS works equally well between cultural groups (Huntington et al., 2016) and that higher rates of positive detection of developmental delay warning signs were only present when poverty was also a factor (Simon et al., 2013). Overall, there do not seem to be an association between home language and poor performance on the PEDS (Huntington et al., 2016; Simon et al., 2013). This may be attributed to parents' ability to communicate their knowledge of their child, irrespective of the language they use to express their concerns. Cultural interpretations of the PEDS content does not seem to affect the child's performance on the PEDS—rather, it appears to affect parent report, resulting in over- or under-reporting of concerns (Kiing et al., 2012). King also recommended that small cultural adaptations should be implemented to make the PEDS content more appropriate such as the substitution of a word like "concern" with "worry." In a study assessing the use of the PEDS:DM in Bhutan, there was a greater proportion of subjects being classified as being at medium risk for developmental delay due to cultural differences (Wong et al., 2019). An example of why this was the case is the following: The self-help question "can your child get dressed by himself or herself?" was met with a "no" response by a majority of the participants. This can be attributed to the fact that Bhutanese children are dressed in traditional clothing that is more complicated in comparison to Western-style clothes, resulting in children only being able to be able to independently dress themselves at a later age (Wong et al., 2019). While different cultural groups have different expectations and may consequently observe or interpret their child's behavior differently, children from different cultural backgrounds may perform equally well on the PEDS—such as an English- and a Spanish-speaking child (Huntington et al., 2016). This may be due to the nature of the PEDS, as parent report of concern for their child transcends the barriers of clinician-administered tools and cultural difference. However, as findings vary in HICs and LMICs, there is a need to explore the use of the tools globally, and it is recommended to examine how they perform in different contexts.

A high maximum referral rate of 74% was found with the PEDS in one study in a HIC, which was conducted on internationally adopted children mainly from Russia & Ukraine (Diamond et al., 2015). Consistent with other research, this high referral rate may be attributed to the at-risk nature of the children being adopted from Eastern Europe. These children are known to have significantly lower levels of developmental competence in most domains compared with children adopted from other regions (Welsh & Viana, 2012). Higher referral rates are typically obtained with the PEDS and PEDS:DM when administered in low-income settings, where at-risk populations are more prevalent (Maleka et al., 2019; van der Linde et al., 2015a), and where cultural differences may also potentially influence outcomes. A tiered screening approach to identifying developmental delays or disorders requires further investigation. Although the PEDS is sensitive to parental concern, the sensitivity and specificity of the tool by itself do not support the use of the PEDS as a stand-alone screening tool (Wake et al., 2005). This suggests that the PEDS has potential to be used in combination with another developmental screening tool, such as the PEDS:DM, to accurately detect developmental disabilities and delays. One of the benefits thereof would be the reduction of high referral rates by potentially identifying false positives from the initial screen (Chunsuwan et al., 2016).

Translating and adapting tools as well as adaptation of referral criteria of tests have been recommended to be more context-specific (Maleka et al., 2016; Marlow et al., 2019). Cross-culturally appropriate and affordable tools with good psychometric properties remain limited (Goldfeld & Yousafzai, 2018). In spite of this, studies from LMICs including Thailand, and South Africa found that if not adapted, the PEDS tools may not always be appropriate developmental surveillance tools within these contexts due to cultural and linguistic differences (Chunsuwan et al., 2016; Dreyer et al., 2016; Maleka et al., 2019).

Other studies have reported that the PEDS tools may be feasible in the South African public health care context (Maleka et al., 2019; van der Merwe et al., 2019). There was no research found on the usage of the PEDS tools in the HIC context; however, it is likely that it would perform well, as the PEDS in isolation has been used successfully in HIC school (Coghlan et al., 2003) and primary health contexts (Limbos & Joyce, 2011). The PEDS may therefore be used successfully in combination with the PEDS:DM in these contexts, and it is recommended that future research on the use of the PEDS tools in HICs is conducted. Translation studies have also been successful in South Africa (van der Merwe et al., 2017). This is particularly important, as there is a dearth of standardized screening tools used by practitioners in LMICs such as South Africa to detect developmental delays (Sabanathan et al., 2015; van der Linde et al., 2015b). There is also a lack of consensus around which screening tools are most effective, especially where tools are used in cultures other than those in which they were created (Marlow et al., 2019; Sabanathan et al., 2015). The investigation of standardized tools suitable for an LMIC context requires more attention. The PEDS and parent-report tools have gained more attention in many LMICs, especially with regard to using them in an mHealth format. However, as findings are not consistent between and within all LMIC contexts, they cannot be generalized to diverse populations and all LMICs at large. Further research is recommended to support the PEDS, PEDS:DM, and PEDS tools use for the diverse multilingual, multicultural, and socioeconomic populations in various LMICs. Few studies were conducted on the PEDS:DM and the PEDS tools independently, thus indicating a need for further research.

Conclusion

Existing information on the use of the three potential options for screening with PEDS tools (PEDS, PEDS:DM, and PEDS tools) to identify a need for referrals and further evaluation was reviewed. The findings revealed gaps in the literature regarding which tools are an exact fit for specific contexts, meaning the results could not be generalized to all populations and contexts. Existing research is largely focused on the use of the PEDS in HICs. The review identified a dearth of research conducted on the PEDS:DM and PEDS tools globally and highlights factors, such as cultural interpretation, that influence the validity and impact widespread use of the screening measures, especially from diverse settings, populations, and LMICs in general. Further research with these tools is recommended.

Appendix. Study Characteristics of Included Studies ($N = 30$).

Study	Author(s)	Year of publication	Study Design	Level of evidence	Target population	Population age range	Total sample size	Location	Test platform used	Individual who completed the tool/s	Risk of bias	Study outcomes
Developmental delays in children with neurofibromatosis type 1	E Soucy, F Gao, D Guttman and C Dunn	2011	Cross-sectional study	4	Children with neurofibromatosis type 1	7 months–8 years	66	United States	PEDS: DM; Paper-based	Parents and children	7	The PEDS: DM demonstrates the high presence of developmental delays in children with neurofibromatosis Type 1 and the need for aggressive and early screening. 68% of children with neurofibromatosis Type 1 were found to have a developmental delay in at least one of the eight areas tested by the PEDS: DM.
Comparing the results of developmental screening of 4- to 60-month-old children in Tehran using parents evaluation of developmental status and ages and stages questionnaires	S Shasshahani, R Vameghi, F Sajedi and A Biglarian	2017	Cross-sectional study	4	Children living in Tehran city	4–60 months	648	Iran	PEDS; Paper-based	Parent/ caregiver	8	The PEDS and ASQ have an acceptable agreement, thus it seems that PEDS can be used for children's developmental screening especially in child care visits.
Early identification of children with developmental delay and behavioral problems according to parents concerns in the Republic of Serbia	S Ilić, S Nikolić, D. Ilić-Stošović, and Š Golubović	2019	Cross-sectional study	3	Preschool children in Serbia	3–7 years	289	Serbia	PEDS; paper-based	Parents	7	According to the criteria of PEDS test, this research identified 56.4% of children whose development needed to be monitored, 27.7% of children who needed to be referred for detailed diagnostic procedures, and 1.7% who needed to be included in treatment or special education support.
The outcome of a developmental screening tool (PEDS) in English and Northern Sotho: A comparative study	L Fyvie, J Anderson, C Kruger, M le Roux, and J van der Linde	2016	Cross-sectional study	4	Caregivers who were literate in both English and Northern Sotho	2–5 years	95	South Africa	PEDS and PEDS-NS; Paper-based	Parents/ caregivers	8	This proved that the PEDS-NS is an accurate translation of the PEDS. Significant association ($p = .021$) was observed between age and respondents' language preference.
Validity and reliability determination of PEDS in 4–60 months old children in Tehran	R Vameghi, F Sajedi, S Shahshahani and A Biglarian	2015	Cross-sectional study	2	Persian children attending healthcare clinics	4–60 months	648	Iran	PEDS; Paper-based	Parents	8	This research showed that the PEDS has a good content validity and reliability and can be used for developmental screening of children in Tehran city. All of the questions in PEDS had desirable content validity. The estimated Kappa measure agreement between PEDS and ASQ was 0.30.
PEDS in screening: The Thai experience	I Chunsuwan, T Hansakunachai, and S Pornsamrit	2016	Cross-sectional study	4	Children attending 9, 18 and 30 month health checkups	9–30 months	266	Thailand	PEDS tools; paper-based	Parents and pediatricians	8	Implementation of PEDS in well-child visits could enhance early detection of developmental problems, but many Thai parents were unable to mention their concerns about delayed abilities in the correct PEDS question.

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Appendix. (Continued)

Study	Author(s)	Year of publication	Study Design	Level of evidence	Target population	Population age range	Total sample size	Location	Test platform used	Individual who completed the tool/s	Risk of bias	Study outcomes
Assessment of a neuro-developmental screening tool in children in Bhutan	B Wong, S Grundy, L Tshering, K Tshering, and F Mateen	2019	Cross-sectional study	2	Community-dwelling Bhutanese children without diagnosed neurocognitive conditions	3–7 years	96	Bhutan	PEDS: DM; paper-based	Pediatrician	7	The PEDS:DM requires further modifications and validation studies before it can be reliably implemented to assess developmental delay in children in Bhutan.
Screening for Autism spectrum disorders using the PEDS and M-CHAT	V Eapen, R Črnčec, S Woolfenden, and R Blackmore	2014	Cross-sectional study	4	Parents of children aged 16–60 months attending childcare centers	16–60 months	97	Australia	PEDS; paper-based	Parents	8	These data provide some support for tiered screening with the PEDS and M-CHAT in identifying children requiring specialized ASD assessment.
Screening strategies for autism spectrum disorders in pediatric primary care	J Pinto-Martin, L Young, D Mandell, L Poghosyan, E Giarelli, and S Levy	2008	Cross-sectional study	4	Children identified at risk for ASD at their well child visits	18–30 months	152	United States	PEDS; paper-based	Parents	8	The PEDS missed the majority of children who screened positive for ASD on the M-CHAT, suggesting that these two tools tap into very different domains of developmental concerns.
Developmental outcomes at age four following maternal antiepileptic drug use	N Richards, D Reith, M Stitely, and A Smith	2019	Prospective cohort study	4	Children with prenatal exposure to AEDs	4 years	606	New Zealand	PEDS; paper-based	Parents	2	Prenatal exposure to sodium valproate and lamotrigine is associated with an increased risk of concerns about emotional and behavioral development being reported by parents in a neurodevelopmental screening program.
Comparative Accuracy of Developmental Screening Questionnaires	RC Sheldrick, S Marakovitz, D Garfinkel, A Carter, and E. Perrin	2020	Cross-sectional study	4	Families of children aged 9–42 months	9–42 months	1495	United States	PEDS; paper-based	Parents	8	This study found that three frequently used screening questionnaires offer adequate specificity but modest sensitivity for detecting developmental delays among children aged 9 months to 5 years.
Developmental Screening With Spanish-Speaking Families in a Primary Care Setting	N Huntington, K Horan, A Epee-Bounya, and A Schonwald	2016	Cross-sectional study	4	Families attending an urban community health center where 75% of families are Spanish speaking	18–48 months	607	United States	PEDS; paper-based	Parents	7	The systematic inclusion of developmental screening as part of culturally competent primary care may aid in reducing current disparities in the identification of developmental concerns. There was no association with family language indicating that the PEDS performs equally well for English- and Spanish-speaking families.
Prioritized Surveillance of Young At-risk South African Children: An Evaluation of the PEDS Tools Referral and Response Characteristics	BK Maleka, J Van Der Linde, DW Swanepoel, and FP Glascoe	2019	Retrospective cohort study	4	Children at risk for developmental delays in a primary health care setting	5–36 months	406	South Africa	PEDS tools; paper-based	Parents/ caregivers	3	The PEDS tools must be evaluated for applicability in low- and middle-income countries. Referral criteria must be sensitive to the demands on under-resourced health care systems.

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Study	Author(s)	Year of publication	Study Design	Level of evidence	Target population	Population age range	Total sample size	Location	Test platform used	Individual who completed the tool/s	Risk of bias	Study outcomes
Developmental Screening-Evaluation of an m-Health Version of the Parents Evaluation Developmental Status Tools	BK Maleka, J Van Der Linde, FP Glascoe, and DW Swanepoel	2016	Cross-sectional study	4	CHWs in a primary health care setting	6–36 months	207	South Africa	PEDS tools; app-based	CHW and SLP	7	Outcomes of the smartphone application, operated by a CHW, corresponded closely to the gold standard PEDS tools operated by a health professional.
Early detection of developmental delays in vulnerable children by community care workers using an mHealth tool	M van der Merwe, R Mosca, DW Swanepoel, FP Glascoe, and J van der Linde	2019	Mixed method	4	CCWs in a primary health care setting	1–38 months	138	South Africa	PEDS tools; app-based	CCW	8	CCWs and mHealth-assisted developmental screening can facilitate better access to early detection and developmental surveillance for vulnerable populations. CCWs perceived mHealth screening as valuable in terms of utility, outcomes, and contribution to developmental knowledge for community members and CCWs.
Interpreting parents' concerns about their children's development with the Parents Evaluation of Developmental Status: Culture matters	J Kiing, P Low, Y Chan, and M Neihart	2012	Cross-sectional study	4	Parents, teachers and child care workers of preschool children in Singapore	1 month–6 years 11 months	1806	Singapore	PEDS; paper-based	Parents and teachers/ child care workers	8	Parents' interpretation of the concept of "concern" varies across language and culture. Findings highlight the importance of evaluating a screening tool's use in local contexts before its widespread implementation to yield clinically meaningful results. The reporting of significant parental concern was considerably higher than U.S. norms and Australian pilot figures when western cutoff scores were applied. When cutoff scores were adjusted, similar patterns of reporting of high, medium, and low risk for disability could be captured.
Comparison of a broad-based screen versus disorder-specific screen in detecting young children with an autism spectrum disorder	L Wiggins, V Piazza, and D Robins	2012	Cross-sectional study	4	Children evaluated for autism during 18- and 24-month well-child visits	18–24 months	52	United States	PEDS; paper-based	Parents	7	Findings support universal autism spectrum disorder-specific screening in addition to general developmental screening and offer considerations to encourage early identification of toddlers with autism spectrum disorder. Modified Checklist for Autism in Toddlers results showed higher agreement with autism spectrum disorder diagnosis than any individual Parents Evaluation of Developmental Status screen result, although the latter detected many children with other developmental concerns.

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Study	Author(s)	Year of publication	Study Design	Level of evidence	Target population	Population age range	Total sample size	Location	Test platform used	Individual who completed the tool/s	Risk of bias	Study outcomes
Socioeconomic disadvantage and developmental delay among U.S. children aged 18 months to 5 years	A Simon, PN Pastor, R Avila, and S Blumberg	2013	Cross-sectional study	4	All children aged 18 months to 5 years in the 2007 National Survey of Children's Health were categorized into three groups based on the likelihood of developmental delay	18–60 months	91 642	United States	PEDS; online survey	Parents	8	It was found that children who were older, male, of low birth weight, non-Hispanic Black or Hispanic in a non-English-speaking household, poor, or receiving more than 10 h/week of care at someone else's home were at most risk of a probable developmental delay.
Comparison of the ASQ and PEDS in screening for developmental delay in children presenting for primary care	M Limbos and D Joyce	2011	Cross-sectional study	4	Children who presented to their primary care provider for routine care	12–60 months	334	Canada	PEDS; paper-based	Parents	8	The findings support the guidelines of the American Academy of Pediatrics, demonstrating that both the ASQ and, to a lesser extent, the PEDS have reasonable test characteristics for developmental screening in primary care settings.
Prevalence of developmental and behavioral disorders in a pediatric hospital	M Petersen, D Kube, T Whitaker, JC Graff, and F Palmer	2008	Cross-sectional study	4	Primary caregivers of children admitted to a general pediatric service	16 months–17 years	325	United States	PEDS; paper-based	Parents/ caregivers	9	This higher prevalence of developmental and behavioral disorders in hospitalized children emphasizes the need to screen for developmental disabilities at every opportunity. Strategies to implement systematic screening of hospitalized children should be examined.
Parents' concerns about their children's development at school entry	G Restall and B Borton	2009	Mixed method	4	Parents and guardians of children who entered kindergarten in one school division	36–60 months	290	Canada	PEDS; paper-based	Parents	7	Eliciting parent perspectives can assist to build trust and to contribute meaningfully to the identification of children at risk for poor developmental outcomes. Providers need strategies to overcome potential barriers to early identification and referral.
Detecting developmental delays in infants from a low-income South African community: Comparing the BSID-III and PEDS tools	S Abdoola, DW Swanepoel, J Van Der Linde, and FP Glascoe	2019	Cross-sectional study	4	Caregivers attending the baby wellness clinic in a primary healthcare setting	3–18 months	174	South Africa	PEDS tools; app-based	SLP	7	A combination of tools for screening and assessment in infants in a South African PHC context may be necessary.

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Study	Author(s)	Year of publication	Study Design	Level of evidence	Target population	Population age range	Total sample size	Location	Test platform used	Individual who completed the tool/s	Risk of bias	Study outcomes
Early developmental screening for children in foster care	K Hodges, M Landin, M Nugent, and P Simpson	2016	Cross-sectional study	4	Children entering foster care	0–6 years	167	United States	PEDS; paper-based	Parents	7	These results support the use of a developmental screen for children in foster care and suggest that screening be performed as early as possible to expedite necessary evaluations and referrals. Use of a developmental screening tool at foster care entry increased detection of potential DD, and the results remained consistent with screening 1 month later.
Parental perception of developmental vulnerability after inter-country adoption: A 10-year follow-up study: Longitudinal study after inter-country adoption	G Diamond, Y Seneckya, HR Reichman, D Inbar, and G Chodick	2015	Prospective cohort study	4	Parents of adopted children	1–12 years	191	Israel	PEDS; paper-based	Parents	6	Parents perceive international adoption as being associated with a substantial risk for developmental problems. Even meticulous pre-adoption screening cannot preclude developmental problems that may appear in later childhood.
Longitudinal analysis of developmental delays in children with neurofibromatosis type 1.	L Wessel, F Gao, D Gutmann, and C Dunn	2012	Prospective cohort study	4	Children with neurofibromatosis type 1	0–8 years	124	United States	PEDS: DM; paper-based	Clinician	6	Based on the study's findings, early developmental screening and intervention for this at-risk pediatric population was advocated, especially in the area of gross motor function. School-age children exhibited significantly more areas of delay than infants or preschool-age children.
Evaluation of a Zulu translation of the Parents' Evaluation of Developmental Status	M van der Merwe, M Cilliers, C Mare, J van der Linde, and M le Roux	2017	Cross-sectional study	4	Caregivers of children fluent in English and Zulu	18–71 months	99	South Africa	PEDS; paper-based	Caregivers	8	The Zulu PEDS displayed high positive and negative correspondences, representative of an accurate translation of the English PEDS. It is recommended that the study be repeated in a community where the majority are Zulu home language speakers
Routine developmental screening implemented in urban primary care settings: more evidence of feasibility and effectiveness	A Schonwald, N Huntington, E Chan, W Risko, and C Bridgemohan	2009	Prospective cohort study	4	Patients attending well-child care visits	6 months–8 years	616	United States	PEDS; paper-based	Parents	6	Implementation of validated screening by using the PEDS was feasible in large, urban settings. Effectiveness was demonstrated via chart review documenting an increased rate of identification of developmental and behavioral concerns.

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Appendix. (Continued)

Study	Author(s)	Year of publication	Study Design	Level of evidence	Target population	Population age range	Total sample size	Location	Test platform used	Individual who completed the tool/s	Risk of bias	Study outcomes
PEDS and ASQ developmental screening tests may not identify the same children	L Sices, T Stancin, L Kirchner, and H Bauchner	2009	Cross-sectional study	4	Pediatricians and parents with children attending well-child care visits	9–31 months	60	United States	PEDS; paper-based	Parents	6	There was substantial discordance between PEDS and ASQ developmental screens. Clinicians need to be aware that in implementing revised AAP guidelines, the choice of screening instrument may affect which children are likely to be identified for additional evaluation.
Parents' Evaluation of Developmental Status in the Australian day-care setting: Developmental concerns of parents and carers	D Coghlan, JSH Kiing, and M Wake	2003	Cross-sectional study	4	Children from day-care centers and kindergartens	18–36 months	26	Australia	PEDS; paper-based	Parents	7	The PEDS is acceptable to parents of Australian preschool children, with a prevalence of significant concerns that is similar to those in the United States. Further research is needed to assess what factors differentially influence whether a concern is felt in a particular domain for a particular child.
Does Parents' Evaluation of Developmental Status at school entry predict language, achievement, and quality of life 2 years later?	M Wake	2005	Prospective cohort study	4	Children with significant parental developmental concerns	5.3–7.5. years	173	Australia	PEDS; paper-based	Parents	9	Although individual developmental concerns at school entry variably predict later academic and language scores, sensitivity and specificity values would not support the use of the PEDS as a stand-alone screen to detect later problems.

Note. PEDS = Parents Evaluation of Developmental Status; PEDS: DM = Parents Evaluation of Developmental Status: Developmental Milestones; ASQ = Ages & Stages Questionnaire; PEDS: NS = Parents Evaluation of Developmental Status: Northern Sotho; CHW = Community health worker; SLP = Speech Language Pathologist; CCW = Community care worker; BSID-III = Bayley Scales of Infant Toddler Development III; PHC = Primary Healthcare; DD = Developmental delay; AAP = American Academy of Pediatrics.

Authors' Note

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