# Detecting developmental delays in infants from a low-income South African community: Comparing the BSID-III and PEDS tools

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*ABSTRACT*

Detecting developmental delays is essential for early intervention, especially in low to middle income countries (LMICs), where prevalence is highest. Detection in infants is challenging; therefore, this study compares the outcome of two measures, the Bayley Scales of Infant and Toddler Development III (BSID-III) and Parents Evaluation of Developmental status (PEDS) tools. A cross-sectional, within-subject, comparative design was employed to determine the overall and domain-specific performance of the PEDS tools smartphone application and the BSID-III to detect developmental delays in 174 young children aged 3-18 months. Data was collected at a primary healthcare (PHC) clinic in Mamelodi, an underserved high-risk community, in South Africa. The PEDS tools identified 56% (n=97), and the BSID-III 35% (n=61) of the 158 children with possible developmental delays, with an overall agreement of 65% between tests. The PEDS tools referral rate was significantly higher (p=0.004) than that of the BSID-III. The high-risk nature and age group (<18 months) may have contributed to the poor agreement across the tools. A combination of tools for the screening and assessment of developmental delay in infants in a South African PHC context may be necessary.

Keywords: Communication delays, developmental delay, primary health care, early intervention, mHealth

## Introduction

Approximately 200 million children in low-and-middle-income countries (LMICs) do not reach their full potential due to developmental delays (Irwin, Siddiqi, & Hertzman, 2007). Exposure to poverty, health problems, violence, malnutrition, compromised care and stimulation, and insufficient opportunities contribute to the increased prevalence of developmental delays (Samuels, Slemming, & Balton, 2012). Developmental delay is defined as delays in speech and language development, motor development, social-emotional development and cognitive development (Demirci & Kartal, 2016). There is an established link between socio economic status (SES) and milder forms of delay, such as language or cognitive delay (Hackman & Farah, 2009; Wise, 2016); whereas an evidential link between SES and severe forms of developmental delay is not well developed (Vrijheid et al., 2000). Severe developmental delays which may have a genetic or congenital link occur across socioeconomic status groups, and irrespective of the financial status of the family (Scherzer, Chhagan, Kauchali, & Susser, 2012). Some of these severe developmental delays due to conditions such as Downs syndrome may be apparent at birth, and some through their latent nature may appear later as the child grows and develops with well-known consequences (Karmiloff-Smith et al., 2016; Hamilton, 2006). Mild delays such as language, cognitive, or motor impairment may be more subtle but also associated with poorer health status, higher rates of school failure, in-grade retention, and special education placement (Hamilton, 2006).

The long-term consequences such as the negative influence on educational achievement and later vocational outcomes, contribute to the substantial global burden of developmental delays.

The prevalence of risk factors emphasizes the importance of preventative strategies to eliminate or reduce the extent of developmental delays (Fischer, Morris, & Martines, 2014). Mild and moderate developmental delays, if not addressed timeously, can progress into developmental disorders, which limit academic and later economic success (Fischer et al., 2014). Thus, prevention, including early detection and intervention for developmental delays, serve to alleviate the burden on the child, family and society. The emphasis has shifted to *early* identification and diagnosis of delays and disabilities to reduce the impact on development, with the current focus especially aimed at infants and children from birth through three years of age (Fischer et al., 2014).

Development is often influenced by parents' expectations, which may be guided by cultural norms (Balton, 2009). Culture has various influences on child development (Yamamoto & Sonnenschein, 2016). Cultural differences in families' attitudes and coping strategies, as well as culture-specific values regarding disability; along with attitudes toward stress, may contribute to parental roles, family structure as well as child-rearing and-care practices (Rivard, Mercier, & Mello, 2016). Development is thus culturally loaded whereas growth and maturation are not, as these processes are physiological in nature.

In LMICs like South Africa, the majority (62%) of children live in rural, poverty-stricken areas, and 61% of the South African population use public health care clinics as a first point of access to medical services (van der Linde & Kritzinger, 2013). Employing screening and surveillance tools at primary healthcare (PHC) settings may facilitate early identification and diagnosis of children with developmental delays, as most infants and young children are taken to PHC facilities for immunization, providing an early opportunity for developmental screening (Brothers, Glascoe, & Robertshaw, 2008). However, the early identification and diagnosis of

developmental delays is difficult as they are not easily recognized in infancy; and because infants and young children are difficult to test (Glascoe, 2000). Despite the difficulty of diagnosing developmental delay, early identification and intervention should be encouraged to maximize critical early developmental periods and reduce long-term disability. Global action to improve early child development as a public health endeavor in the first 5 years of life is necessary (Sabanathan, Wills, & Gladstone, 2015). However, in LMICs, such as South Africa, access to services are often limited as there are an insufficient number of therapists, particularly in rural areas. Therapists are also disproportionately distributed between the public and private healthcare sectors; and are often not representative of the population's cultural and linguistic diversity. These challenges make it difficult to develop and sustain early identification services (Pascoe & Norman, 2011).

Due to the dearth of human resources in rural, underserved areas, there is a need for development and use of novel, cost-effective and culturally acceptable screening and diagnostic methods that could improve timely developmental interventions for improved outcomes (Barker, Gout, & Crowe, 2011; Richter, Daelmans, Lombardi, Heymann, Boo, et al., 2017). There are many forms of developmental assessment to identify delays and initiate early intervention. Screening tools are used to identify infants at risk for developmental delay, while diagnostic assessment tools identify children who need intervention (Fischer, et al., 2014). Screening tools are less expensive, and often not lengthy. However, the results obtained may not be sufficiently detailed to diagnose developmental delay (Aylward, 2018). Screening should be as accurate as possible, to avoid both under-detection as well as over-referrals. The Road to Health Booklet (RTHB) is the only nationally implemented developmental screening tool in South Africa (Van Der Merwe, Mosca, Swanepoel, Glascoe, & Van Der Linde, 2018; van Der Linde, Swanepoel, Glascoe, Louw, & Vinck, 2015). The PEDS tools are currently

being used in research, but not commercially, in South Africa (Van Der Merwe et al., 2018; Maleka, Van Der Linde, Glascoe, & Swanepoel, 2016). The PEDS includes open ended questions to elicit parents' concerns regarding their child's development and behaviors. The PEDS: DM uses more direct, close ended questions to identify whether the child has developed specific skills as per the age-appropriate developmental milestones. The PEDS tools, whilst a screening measure, also identifies areas of difficulties. The use of the PEDS tools in the South African primary health care context was evaluated using the basic algorithm of the test, and it was found that the tool is very sensitive for mild to severe delays, and may thus burden the healthcare system where manpower is limited (Maleka, Linde, Swanepoel, & Glascoe, 2019). This may lead to over-referral of children in these high-risk groups. Limited healthcare resources prevent these high referral rates to be accommodated into the healthcare system (Maleka et al., 2019).

Developmental screening within a PHC setting provides an opportunity for caregivers to receive informational counselling on early development, as well as assist in early detection and intervention of developmental delay, which could take place remotely. However, tools developed in high-income countries may need to be adapted, and their costs, training requirements, and time for application may make them less suitable for use at PHC clinics in LMICs ( Fischer et al., 2012). The PEDS tools is a cost-effective developmental screening solution in PHC contexts, particularly in LMICs (Maleka et al., 2019). Although it is developed from a reliable and credible tool that is well-validated; the PEDS tools has yet to be validated based on its test performance in detecting developmental delays in infants and young children in South Africa (Glascoe, 2000; Glascoe, & Nolensville, 2013; Maleka, Van Der Linde, Glascoe, & Swanepoel, 2016). Previous research on the PEDS tools in South Africa has demonstrated the ability of community care workers to administer the tools (Maleka et al.,

2016), and to thus reduce the demand on healthcare professionals in healthcare settings (Van Der Merwe et al., 2018).

Standardized tools are recommended when assessing high-risk infants, or when a more detailed assessment is needed (Rademeyer & Jacklin, 2013). Yet the current context does not always lend itself to this, as the clinician should administer these assessments. The Bayley Scales of Infant Development (BSID) is a well-established diagnostic tool, which is currently a gold standard in developmental assessment (Rademeyer & Jacklin, 2013). It has concurrent validity with the Differential Abilities Scale and the McCarthy Scales of Children's Abilities. The BSID-III has been reported to be also time-consuming and costly and requires highly trained professionals to administer (Aylward, 2018). Although some concerns have been raised internationally regarding the interpretation of scores; the BSID-III has been deemed a suitable tool to be used on the black urban African population in Gauteng (Rademeyer & Jacklin, 2013). Recent studies have reported that BSID-III assessments significantly underestimate developmental delay in infants; but these findings have not been confirmed in South Africa, where the tool has not been culturally adapted for the context.

The appropriate tools for a decentralized model of detection in low-income communities can be elusive, especially in young infants where concerns have been raised with a reference standard created in high income countries. Furthermore; issues around content validity and contextual relevance of tools from high-income countries applied in low-income countries should be considered. Therefore, this study aimed to compare the BSID-III and PEDS tools in an at-risk infant population from a low-income South African community.

**Method**

A cross-sectional, within-subject comparative research design was employed to compare the detection of developmental delays in young children aged 3-18 months using the PEDS tools and the Bayley Scales of Infant and Toddler Development III. The overall performance of the tools, as well as domain specific performance (language, motor, and social emotional) was determined. Data was collected at the Stanza Bopape primary healthcare (PHC) clinic in Mamelodi, Gauteng, South Africa. Most community residents in Mamelodi rely on government health care facilities such as Stanza Bopape clinic. Mamelodi is a low-income community with high poverty rates; and has been identified as an underserved community with a high risk population (Statistics South Africa, 2011).

***Participants***

A convenience sampling method was utilized to select the one hundred and seventy-four caregivers who participated in this study. Caregivers attending the baby wellness clinic with their children aged between 3-18 months were invited to participate while waiting in the queue. Caregivers who were proficient in English or Afrikaans were included in the study.

A total of 174 caregivers with infants aged between 0-18months were included in this study. 47% (n=82) of the infants were female. Home language distribution was Sepedi (47%), Zulu (15%), Ndebele (13%), Setswana (5%), Tsonga (4%), Shona (3.5%), SiSwati (2.5%), Southern Sotho (2.5%), Venda (2%), English (2%), Xhosa (1.5%), Shangaan (1.5%) and Portuguese (0.5%).

***Material***

The PEDS tools or mHealth version refers to the smartphone application of the combined PEDS and PEDS: DM (Maleka et al., 2016). The PEDS tools is a developmental screening tool, focusing on children's developmental milestones as well as identifying caregiver concerns

by means of parental report. The developmental areas which are addressed by the PEDS include language, motor, self-help, early academic skills, behaviour and social-emotional/mental health. The PEDS consists of ten questions, focused on parental concern such as: “Do you have any concerns about how your child understands what you say?” and “Do you have any concerns about how your child behaves?” The PEDS: DM consists of questions regarding children's abilities across all developmental domains, including expressive language, receptive language, fine motor, gross motor, social-emotional, self-help and academics. The PEDS: DM consist of 6-8 questions per age interval, such as: “Does your baby look at his/her hands?” or “Does your baby put lots of sounds together that sound like talking?” (Glascoe & Robertshaw, 2009). The PEDS tools smartphone application provides automated scoring, where scores were interpreted into five evidence-based different paths which either pass or refer a child based on the degree and nature of parental or caregiver concerns (Glascoe, 2013). Path A indicates a need for a direct referral, while Paths B-D indicate some degree of concern. These were all classified as a “refer”, while Path E was classified as a “pass”, as there are no concerns. When using an adapted referral criteria (ARC) (Maleka et al., 2019), the PEDS and PEDS: DM are combined, with Path A being a refer and Path B-E dependent on the PEDS: DM (two or more domains indicate a refer). Smartphone assessment was conducted using two Samsung Galaxy Pocket Plus S5301 phones running the Parents Evaluation of Developmental Status (PEDS) application.

The Bayley Scales of Infant and Toddler Development III is a widely used standardised assessment tool and is used as a gold standard of infant and toddler assessment (Rademeyer & Jacklin, 2013). It is a valid and reliable tool, used for clinical and research purposes (Rademeyer & Jacklin, 2013). Although designed and normed in the USA, a study to evaluate the performance of black South African urban infants on the Bayley Scales of Infant

Development III found it to be a suitable tool to use on this population (Rademeyer & Jacklin, 2013). Infants were assessed using the current version of The Bayley Scales of Infant and Toddler Development (version-III, BSID-III) as the diagnostic test in this study. This assessment consists of five scales: Cognition, Receptive Language, Expressive Language, Fine Motor and Gross Motor, which are assessed directly; whereas the Social-Emotional and Adaptive Behaviour domains are based on information supplied by the primary caregiver to items contained in a separate questionnaire. Diagnosis of developmental delay was defined, according to the BSID-III manual, as a score of 70-79 indicating a mild delay, and a score of <69 suggesting a severe delay.

***Procedures***

Informed consent was obtained from all participants. Assessments were conducted by the researcher, a qualified speech-language therapist, and final year speech-language pathology students in a quiet room provided at the primary health care clinic. Assessment procedures were conducted in a counterbalanced sequence, between traditional diagnostic or smartphone based assessments alternatively. The BSID-III was used for traditional diagnostic assessment; and developmental screening was conducted by smartphone assessment using the Parents Evaluation of Developmental Status (PEDS) application. Final year Speech-Language Therapy students (registered with HPCSA), who received training to administer the PEDS Tools smartphone application and conduct the diagnostic assessment of the Bayley Scales of Infant & Toddler Development, assisted with the assessments under direct supervision. The researcher and students conducting the assessments did not communicate, have contact with each other or access to each other's assessment results, to ensure that no bias was present.

Scores of the paper-based BSID-III were manually completed and captured; while scores of the PEDS tools were uploaded to the smartphone application server. Caregivers whose children obtained referral results according to the findings of the SLT were issued with referral letters to the relevant health care professionals for follow-up.

### *Data analysis*

Quantitative data analysis was conducted using a commercially available software package, namely the Statistic Package Social Sciences (SPSS) v 23 (Chicago, Illinois). Pearson Chi-Square as well as Fishers Exact tests were used to determine the significance between the results from the PEDS, PEDS: DM, PEDS tools and BSID III. A 5% significance level was used to determine statistical significance.

## Results

The PEDS tools identified 56% (n=97), and the BSID-III 35% (n=61) of the sample for possible developmental delays. When comparing the outcomes of the PEDS tools to the BSID-III, the overall agreement was 65%. The PEDS-DM and PEDS had a referral rate of 55% (n=96) and 19.5% (n=34) respectively. Maleka et al., (2019) suggested considering alternative referral criteria options to tailor the use of the PEDS tools to LMIC contexts with high prevalence of risks, which have shown lower rates of positive identification of more severe developmental delays (24%) only in their study.

Table 1. Pass/Refer distribution of the BSID-III, PEDS Tools, PEDS, PEDS: DM, and PEDS tools with adapted referral criteria (ARC) (n=174)

| | **BSID-III** | **PEDS Tools** | **PEDS** | **PEDS: DM** | **PEDS Tools with ARC*** |
|---|---|---|---|---|---|
| **Pass** | 113 (65%) | 77 (44%) | 140(80%) | 78 (45%) | 130 (75%) |
| **Refer** | 61 (35%) | 97 (56%) | 34 (20%) | 96 (55%) | 44 (25%) |
| *ARC- PEDS and PEDS: DM combined; Path A refer. Path B-E dependent on PEDS: DM (two or more domains refer) | | | | | |

BSID-III, Bayley Scales of Infant & Toddler Development-III; PEDS, Parents' Evaluation of Developmental Status; PEDS-DM, PEDS-Developmental Milestones; PEDS tools, combined PEDS and PEDS: DM smartphone application

The PEDS tools and BSID III corresponded in 70.5% of cases with developmental delay, and 52.2% of cases who did not present with developmental delay (Table 2). Individually, the PEDS: DM and BSID-III corresponded in 70.5% of cases with a delay and 53.1% of cases without a delay; whereas the PEDS corresponded with the BSID III in 24.6% of cases with a delay and 83.2% of cases without developmental delay.

Table 2. Comparison of the referral rates (%) of PEDS, PEDS-DM, PEDS tools, PEDS tools ARC and the BSID-III and BSID-III (very severe only) (n=174).

| | **BSID-III** | | | | **BSID-III (very severe only)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **PEDS Tools** | **PEDS: DM** | **PEDS** | **PEDS Tools (ARC)*** | **PEDS Tools** | **PEDS: DM** | **PEDS** | **PEDS Tools (ARC)*** |
| Delays | 70.5 | 70.5 | 24.6 | 39.3 | 66.7 | 66.7 | 23.8 | 38.1 |
| No delays | 52.2 | 53.1 | 83.2 | 81.4 | 45.8 | 46.4 | 81 | 75.8 |
| *__ARC__: Adapted Referral criteria - PEDS and PEDS: DM combined; Path A refer. Path B-E dependent on PEDS: DM (two or more domains refer) | | | | | | | | |

BSID-III, Bayley Scales of Infant & Toddler Development III; PEDS, Parents' Evaluation of Developmental Status; PEDS-DM, PEDS-Developmental Milestones; PEDS tools, combined PEDS and PEDS: DM smartphone application; ARC, Adapted referral criteria(Maleka, Karabo Boledi ; Van Der Linde, Jeannie; Swanepoel , De Wet and Glascoe, n.d.)

The PEDS tools referral rate was significantly higher (p=0.004) than that of the BSID-III. The referral rate of the PEDS tools dropped by 31% (from 70.5% to 39.3%) when the adapted referral criteria was implemented (Table 1 and Table 2). Participants who scored below the 2-standard deviation ("extremely low") cut-off point on 1 or more domains were identified on the BSID-III as severe failed cases (Veldhuizen, Clinton, Rodriguez, Wade, & Cairney, 2015). This approach was used to differentiate between severe and less severe delays, and then examine its' effect on the overall correspondence of the PEDS tools with the BSID-III. Using this approach, the PEDS tools and BSID-III corresponded in 66.7% of cases with developmental delay and 45.8% of cases with no delay (Table 2).

Table 3. Developmental domain–specific distribution of screening fail results on the BSID III, PEDS Tools, PEDS and PEDS: DM (n=174)

| | Language (receptive & expressive | Motor (fine & gross) | Social-emotional |
|---|---|---|---|
| **BSID-III** | 12% (n=21) | 13% (n=23) | 8% (n=14) |
| **PEDS Tools** | 24% (n=42) | 48% (n=84) | 14% (n=25) |
| **PEDS** | 7% (n=12) | 8% (n=14) | 4% (n=7) |
| **PEDS: DM** | 21% (n=37) | 44% (n=77) | 11% (n=20) |

BSID-III, Bayley Scales of Infant & Toddler Development III; PEDS, Parents' Evaluation of Developmental Status; PEDS-DM, PEDS-Developmental Milestones; PEDS tools, combined PEDS and PEDS:DM smartphone application

Domain specific outcomes (language, motor, and social emotional) of the PEDS tools and BSID-III was compared (Aylward, 2011). Outcomes indicate that twice the number of participants were identified as having developmental delay on the PEDS tools in relation to the BSID-III in all domains (Table 3).

Table 4. Developmental domain–specific comparison of the PEDS tools, PEDS and PEDS-DM in and the BSID-III.

| **Developmental Domain** | **PEDS** | **PEDS-DM** | **PEDS tools** |
|---|---|---|---|
| **Language** | | | |
| Identification of cases with delay | 10% | 52% | 52% |
| Identification of cases without delay | 94% | 83% | 80% |
| **Motor** | | | |
| Identification of cases with delay | 9% | 61% | 61% |
| Identification of cases without delay | 92% | 58% | 54% |
| **Social-emotional** | | | |
| Identification of cases with delay | 0% | 21% | 21% |
| Identification of cases without delay | 96% | 89% | 86% |

BSID-III, Bayley Scales of Infant & Toddler Development III; PEDS, Parents' Evaluation of Developmental Status; PEDS-DM, PEDS-Developmental Milestones; PEDS tools, combined PEDS and PEDS:DM smartphone application

Identification of developmental delay in the language domain was significantly higher for the PEDS tools than the BSID-III ($p=0.001$). No statistically significant difference was noted in the social emotional domains of the PEDS tools compared to the BSID-III.

## Discussion

More than a third (35%; n=61/174) of infants in the current study were identified as having a developmental delay on the BSID-III. This prevalence rate is higher than the 24% identified in Brazil (Ertem, 2012), and in agreement with reports of elevated rates in other LMICs (Ertem, 2012; Samuels et al., 2012; Maleka et al., 2016). This is not unexpected as an at-risk population was used, from a low income setting with high rates of drug and alcohol abuse, crime, HIV and unemployment (Statistics South Africa, 2011; Van Der Linde, Swanepoel, Glascoe, Louw, & Vinck, 2015). In LMIC's, children are often exposed to a combination of risk factors that limit them reaching their developmental potential (Rademeyer & Jacklin, 2013). These factors include poverty, and its associated health and social factors, in addition to various environmental and other risks. Some delays may be more influenced by these factors than others; and some as a primary effect while others as a secondary effect. The presence of risk factors, exacerbated by resource-limited settings, may increase the probability of delayed development (Van Der Linde et al., 2015).

Referral rates on the BSID-III may be elevated in the current study, as researchers have expressed their concerns about its interpretation in infants and young children. Recent studies in the United States, United Kingdom, and Australia have raised concerns that BSID-III assessments may significantly underestimate the rate of developmental delay in preterm and full-term infants (Ahn & Kim, 2017). A further limitation of the BSID-III in this study is that it has not been culturally adapted for the South African population. The BSID-III is a comprehensive test, but may be influenced by the natural uneven course of child development. The large number of test items may increase reliability, but requires a child to concentrate for a long period of time. The long duration of the test may reduce the validity of the test results (Aylward, 2018). Although test items may yield valuable information, some may be difficult to elicit in a clinical situation. As this may not be adequate by itself to determine all the

functions needed, it becomes necessary to identify the right combination of tools that best determines developmental abilities and eligibility for intervention for young children and their families. A combination of screening tools and diagnostic measures has thus been recommended, with phone screening between 3-12 months and detailed developmental assessment at 24-36 months (Aylward, 2018). Therefore, the difference between the outcome of the BSID-III and the PEDS tools smartphone application may be due to the BSID-III's underestimation of developmental delays in infants.

The high referral rate identified by the PEDS tools (56%) was consistent with findings of past research conducted in other LMIC contexts (Maleka et al., 2016; Brothers et al., 2008). Similar referral rates have also been reported with this screening tool in previous studies conducted in comparable South African communities. A referral rate of 51% was found with 142 mothers of infants aged 6-18 months in Mamelodi (Maleka et al., 2016); and of 52% with 102 mothers of young children aged 6-12 months in Olievenhoutbosch and other areas in Tshwane (Van der Linde et al., 2016). As screening isolates a small group of individuals, high referral rates can be expected. However, high referral rates further constrain limited resources to accommodate referrals in underserved communities in LMICs like South Africa. To reduce the referral rates, ongoing surveillance is recommended to initiate formal screening for those at risk for delay (Hirai, Kogan, Kandasamy, Reuland, & Bethell, 2018). Maleka et al. (2019) indicated that altered referral criteria may significantly improve the feasibility of developmental screening and surveillance in underserved PHC contexts. The use of less stringent referral criteria of the PEDS tools decreased the referral rate by 25% in infants aged 5-12 months, and by 29% in young children 13-18 months of age (Maleka et al., 2019). The adapted referral criteria, suggested by Maleka et al. (n.d.) to identify more severe delays first, may result in fewer referrals but may also result in the PEDS tools being less sensitive to mild

delays. However, this type of adaptation must be investigated to avoid overburdening the constrained healthcare system in high-risk populations with limited health resources (Maleka et al., 2019).

Implementing alternative referral criteria could possibly enable referrals to be prioritized based on severity (Maleka et al., 2019), and could improve the performance of the various measures. The adapted referral criteria used to interpret the combined PEDS tools in this study indicated poorer identification of cases with developmental delay (39.3%), but improved identification of infants without delay (81.4 %). These poor results undermine the ability of the tool to correctly identify children at risk of developmental delays whilst correctly excluding those without risks, and are insufficient for the tool to be deemed accurate (Glascoe, & Nolensville, 2013). Elevated rates of false positive results can raise concerns and anxiety for parents of children whose development is within normal range on further assessment (Sices, Drotar, Keilman, Kirchner, Roberts, & Stancin, 2008).

Most studies focusing on the use of developmental screening and surveillance tools exclude young infant age groups that were included in this study (Veldhuizen et al., 2015). Difficulties in social interaction, communication and behavior are not always clearly noticeable in children younger than 3 years (Van der Linde et al., 2016). Parental awareness of their children's development in these domains may also be better when the children are older (Van der Linde et al., 2016). As most developmental disorders are not easily identifiable among young infants, the use of standardized assessments in this age range may need to be reconsidered (Veldhuizen, Clinton, Rodriguez, Wade & Cairney, 2015). Inaccuracies in parental reporting, most often used with young infants, may contribute to the under- or over-referral results on the developmental screening measures, resulting in poorer performance than expected when

compared to older children. The PEDS (in isolation) revealed poor identification of cases with delay (0-10%) for specific domains (language, motor and social-emotional). Utilizing the PEDS in combination with the PEDS: DM could facilitate improved communication with caregivers and increases the likelihood of them attending follow-up visits. The use of the combined PEDS tools is a more accurate approach to developmental screening than using the tools individually. The PEDS tools were effective in identifying communication delays in infants aged 6 months in South Africa (Glascoe, 2013). The current study also found that the combined PEDS tools demonstrated improved domain specific outcomes in language, motor and social-emotional domains.

## Conclusion

Traditional assessment has both advantages and disadvantages in identifying developmental delay in infants and young children. The agreement between developmental assessment outcomes across the tools used in this study was poorer than expected. The high-risk nature and young age cohort (<18 months) may have contributed to these outcomes. Findings raise concerns about the outcomes of the BSID-III or PEDS tools in isolation for screening and assessment of developmental delay in infants from LMICs like South Africa. Future research should evaluate performance of the PEDS tools mHealth version in older preschool children (between 2 and 5 years) to ascertain the influence of age. Further investigations into the validity of the PEDS tools and BSID-III for young infants in LMICs should also be prioritised prior to large scale implementation (Aylward, 2018).

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There are no conflicts of interest declared.

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