Developmental Risks in Vulnerable Children from a Low-Income South African Community

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Abstract

Objective: To describe the developmental risks, and its influence, in young children from a low-income South African community.

Method: An exploratory, cross-sectional research study design was employed. Developmental screening was conducted during home visits with 126 caregivers and children between 0 and 42 months of age from a low-income South African community. Children who failed the rescreen were referred for diagnostic assessment. A binomial logistic regression was used to determine the effect of developmental risks on developmental outcomes.

Results: Seventy-three percent of children screened were identified with a possible developmental delay (n = 59) according to caregiver-report using the PEDS tools. The regression model was statistically significant (χ^2 (3) = 34.902, $p < 0.001$) with exposure to multiple languages ($p < 0.05$; odds ratio 3.810, CI 1.2–12.4) most indicative of potential developmental delay. Older children (19–42 months) were also more at risk of developmental delay ($p < 0.001$) than younger children (0–18 months).

Conclusions for Practice: Healthcare professionals serving these vulnerable populations should create awareness amongst caregivers about the effect of developmental risks, in particularly multiple language exposure, on development.

Significance Statement: Children in low- and middle-income countries are exposed to risks, which have a cumulative effect on their development. Developmental risks in children from low-income South African communities and its effect on development is, however, unclear. This study aims to describe the developmental risks, and its effect on child development, in young children from a low-income South African community. Developmental screening using the

PEDS tools identified a high prevalence of possible developmental delays. Multiple language exposure and child age are predictive risks of developmental delays.

Keywords; LMIC; Child development; Developmental delay; Low-income; Developmental risks

Significance Statement

Children in low- and middle-income countries are exposed to risks, which have a cumulative effect on their development. Developmental risks in children from low-income South African communities and its effect on development is, however, unclear. This study aims to describe the developmental risks, and its effect on child development, in young children from a low-income South African community. Developmental screening using the PEDS tools identified a high prevalence of possible developmental delays. Multiple language exposure and child age are predictive risks of developmental delays

Introduction

Early childhood experiences, or a lack thereof, affect child development (Black et al. 2017). The first few years of life are foundational to brain development with lifelong consequences (Britto et al. 2017). Children's brain structure and function are directly and indirectly influenced by environmental factors such as poverty and maternal exposure to malnutrition (Fernandes et al. 2014; Karatsoreos and McEwen 2013), which in turn impact children's functional abilities (Panter-Brick and Leckman 2013).

Biological and environmental factors that may influence or exacerbate developmental vulnerability should be identified and monitored continually. Limited family resources in terms of financial constraints and inadequate social support are also considered environmental risks (Guralnick 2013). Forty-three percent of children below the age of 5 years, living in low-income settings, are at an increased risk for developmental delay (Black et al. 2017; Shawar and Shiffman 2017) due to poverty and associated factors, including HIV/AIDS. Currently, in an low- and middle-income country (LMIC) like South Africa, more than half of the population (56%; 30.4 million) live in poverty (Statistics South Africa 2017), many of whom are infected or affected by HIV/AIDS. Children who are affected by HIV/AIDS are at increased risk for developmental delays due to a variety of environmental risks including poverty, anti-retroviral (ARV) drug exposure, family stress and illness (Rajan et al. 2017).

In LMICs such as South Africa, risks include, but are not limited to, poverty and HIV/AIDS. A South African study reported a moderate correlation between maternal age, substance abuse and premature birth (Claassen et al. 2016), which in turn place children at greater risk of developmental delay. Furthermore, many children growing up in households with low socio-economic status (SES) are not ready for the academic and social demands of the school system (Guralnick 2013). Caregiver support and family interaction are also impacted in families exposed to multiple risks. These families and their children tend to be less exposed to community learning activities and childcare is often of lower quality (Guralnick 2013).

Poor childcare and family interaction is due to social, health, education and early intervention services not being in place to support these children (Cloet et al. 2017). Early diagnosis and developmentally supportive therapeutic services play a role in shaping child development (Cloet et al. 2017), but cannot be effective if the child's immediate risks are unknown. Several studies have explored the risks South African children are exposed to (Claassen et al. 2016; Jamieson et al. 2017; Semba and Bloem 2008; van der Linde et al. 2015a, b). Yet, the association between risks identified and its effect on child development remain unexplored. Furthermore, most of these studies are dated (Semba and Bloem 2008; Venetsanou and Kambas 2009) or explore associations between risks and single developmental domains (Pienaar and Kemp 2014; Springer et al. 2018; Stevens et al. 2017; Venetsanou and Kambas 2009; Zysset et al. 2018). Reports also typically only focus on children affected or infected by HIV/AIDS (Betancourt et al. 2013; Munoz et al. 2017; Rajan et al. 2017; Springer et al. 2018; Stevens et al. 2017). Quantifying the risks and considering the cumulative effect of multiple risks on general child development can facilitate informed planning of primary prevention strategies. This study therefore describes the risks present in children from a low-income South African community and its influence on development. Furthermore, it also aims to determine which risks will effect later developmental outcomes.

Method

Study Objective

The primary objectives of this study were to (1) describe the developmental risks, and its influence, in young children from a low-income South African community and (2) determine the effects of risks on developmental outcomes in the sample population.

Study Design

IRB approval was obtained for this study from the Humanities Research Ethics Committee (GW20170401HS). An exploratory, cross-sectional research study design was employed to describe the risks and its influence in children from a low- income community, who were screened in a previous study (van der Merwe et al. 2019).

Setting and Participants

Data was collected in Mamelodi, Gauteng, South Africa. Mamelodi is one of the largest poverty-stricken urban populations in the City of Tshwane, the administrative capital of South Africa (Statistics South Africa 2012). In 2011 Mamelodi had an estimated population of 334,577 individuals, of which 57,212 are children below the age of 9 years (Statistics South Africa 2012). Future Families, a community based non-governmental organization (NGO), supports high risk families with children who are either infected or affected by HIV/AIDS. Future Families has a satellite office located in Mamelodi, where diagnostic assessments were conducted. In May 2017, non-probability purposive sampling were used to invite ten community care workers (CCWs) employed by Future Families to participate, by conducting developmental screening during home visits. Informed consent was obtained from the CCWs prior to training for developmental screening. The CCWs have a minimum education level of Grade 12 and have

been part of various training programmes on healthcare service provision, including hearing (Yousuf Hussein et al. 2015) and developmental screening (Maleka et al. 2016).

Eligibility criteria required caregivers who were part of the Future Families Mission (FFM) program in Mamelodi during 2017, with children between the ages of 0 and 42 months. The caregivers were also required to be proficient in conversational English, in order to complete the background information questionnaire and the caregiver-completed subsections of the diagnostic assessment. In June 2017, data were collected during home visits conducted by CCWs. A total of 2600 children below the age of 15 years were part of the FFM program at the time, of which 150 caregivers had a child in the required age group. Only one child per household were screened. All the caregivers who were at home during the time of home visits, and who met the inclusion criteria, were invited to participate.

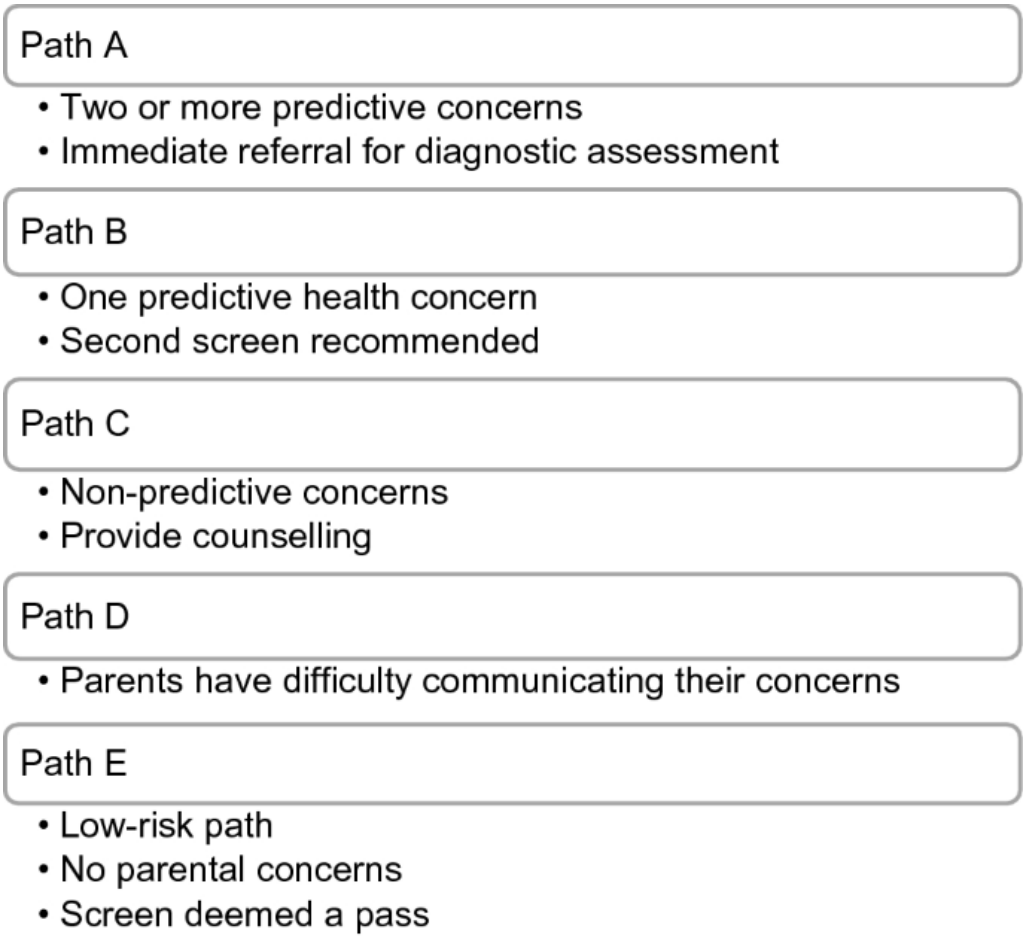

Fig. 1. Evidence-based pathways of the PEDS (Glascoe 2013)

Measures and Outcomes

The PEDS (Glascoe 2013) and PEDS: Developmental Milestones (PEDS:DM) have been combined into a validated developmental screening smartphone application using the same validated referral algorithm as the original paper-based tools (Maleka et al. 2016).

Correspondence between the paper-based and smartphone PEDS tools was 100% (Maleka et al. 2016). The PEDS tools, i.e. the PEDS and PEDS:DM, consist of 16 multiple choice questions and take approximately 15 minutes to complete. The PEDS tools have been implemented within a setting similar to Mamelodi and yielded positive results (van der Linde et al. 2016). The outcome of the PEDS are interpreted using five evidence-based pathways, which determine the pass or fail screening outcome based on type and/or amount of parental concerns (Fig. 1 top). Children receive a fail result on the PEDS:DM when one or more concerns are identified. For the purpose of this study, children failed the PEDS tools developmental screen when they received a Path A result from the PEDS. Children also failed the PEDS tools screen when three or more concerns were identified by the PEDS:DM regardless of the PEDS path, as suggested by the author of the tools (Glascoe 2013). For the purpose of this study, the combined version of the PEDS tools were used.

The Bayley-III was used to assess all children that failed on the PEDS tools two consecutive times. The Bayley Scales of Infant and Toddler Development- Third Edition (Bayley-III) (Bayley 2006) is a tool used to measure the developmental functioning of infants and toddlers to identify developmental delays and to assist professionals in planning appropriate intervention (Albers and Grieve 2007). The Bayley-III is considered a 'gold standard' for evaluating developmental status in children younger than 42 months (Rubio-Codina et al. 2016). It evaluates the five main developmental domains, i.e. cognitive, language, motor, socio-emotional and adaptive behaviour, yielding a comprehensive assessment of a child's true abilities. The Bayley-III was standardised on a population of 1700 children and reported excellent reliability (≥ 0.90) across all five domains (Bayley 2006). Cognitive, language and motor domains are administered by a trained healthcare professional, whereas socio-emotional and adaptive behaviour are assessed by means of a questionnaire given to the caregiver to complete. Children were classified as having a developmental delay when they scored one SD (mean < 85) below the normative composite score mean of 100 (SD 15) of two or more developmental domains. Furthermore, a developmental domain was considered delayed when a child scored one or more SD (mean < 4) below the normative mean of 10 (SD 3) when considering the standard score.

All participants were required to complete a background information questionnaire, in order to obtain their demographic and biographic information for an accurate description of the sample population (Table 1). An existing questionnaire was amended (van der Linde et al. 2015a, b).

Table 1 Risks identified from background information questionnaire in sample population

Category	Developmental risks
Age	Older than 18 months
Gender	Male gender
Prematurity	Preterm birth
HIV status	Infected or affected
Language exposure	Multiple language exposure (≥ 2)
Primary caregiver	Single caregiver
Caregiver qualification	Less than grade 12
Monthly income	Less than €320
Age of mother	Younger than 18, older than 35
Children in household	Three or more
Marital status	Never married
Housing status	Informal housing or staying with others
People in household	More than five
Employment status	Unemployed
Breastfeeding	No breastfeeding or formula feeds

Bias

Selection bias may have occurred. All participants were from a high risk, vulnerable population, due to the source, i.e. the NGO, through which participants were recruited. This NGO supports families that have either been affected or infected by HIV/AIDS.

Procedures

Developmental screening was conducted by CCWs using the PEDS tools. The 46 caregivers whose children were identified, were notified via a phone call and an appointment was scheduled within 4 weeks after developmental screening. Caregivers and their children visited the Future Families satellite office where informed consent was obtained and the assessment took place.

The participants completed the background information questionnaire. The caregivers were asked to complete the two subsections (socio-emotional and adaptive behaviour) of the Bayley-III while the other subsections were administered by a qualified speech-language pathologist, in the form of a play-based assessment.

After the assessment, the caregivers whose children were identified as having a developmental delay in any of the five developmental domains (as per the outcome of the PEDS tools), received a referral via short message service (sms) or a phone call. The sms included the developmental domain(s) of concern, the healthcare professional to be visited and the contact details of the nearest clinic offering the required services.

Data Analysis

The Statistic Package Social Sciences (SPSS) v 24 (Chicago, Illinois) was used for statistical calculations and analysis of quantitative data. Descriptive statistics were employed to analyse the developmental risks. Pass and fail rates of the PEDS tools and Bayley-III were obtained using cross tabulations. A binomial logistic regression was used to predict the effects of various risks on developmental outcomes. The Omnibus Tests of Model Coefficients were used to determine the statistical significance (p-value) of the regression model. A .05 criterion of statistical significance was employed. The variance in developmental outcomes based on the risks were determined by the Nagelkerke R^2 test.

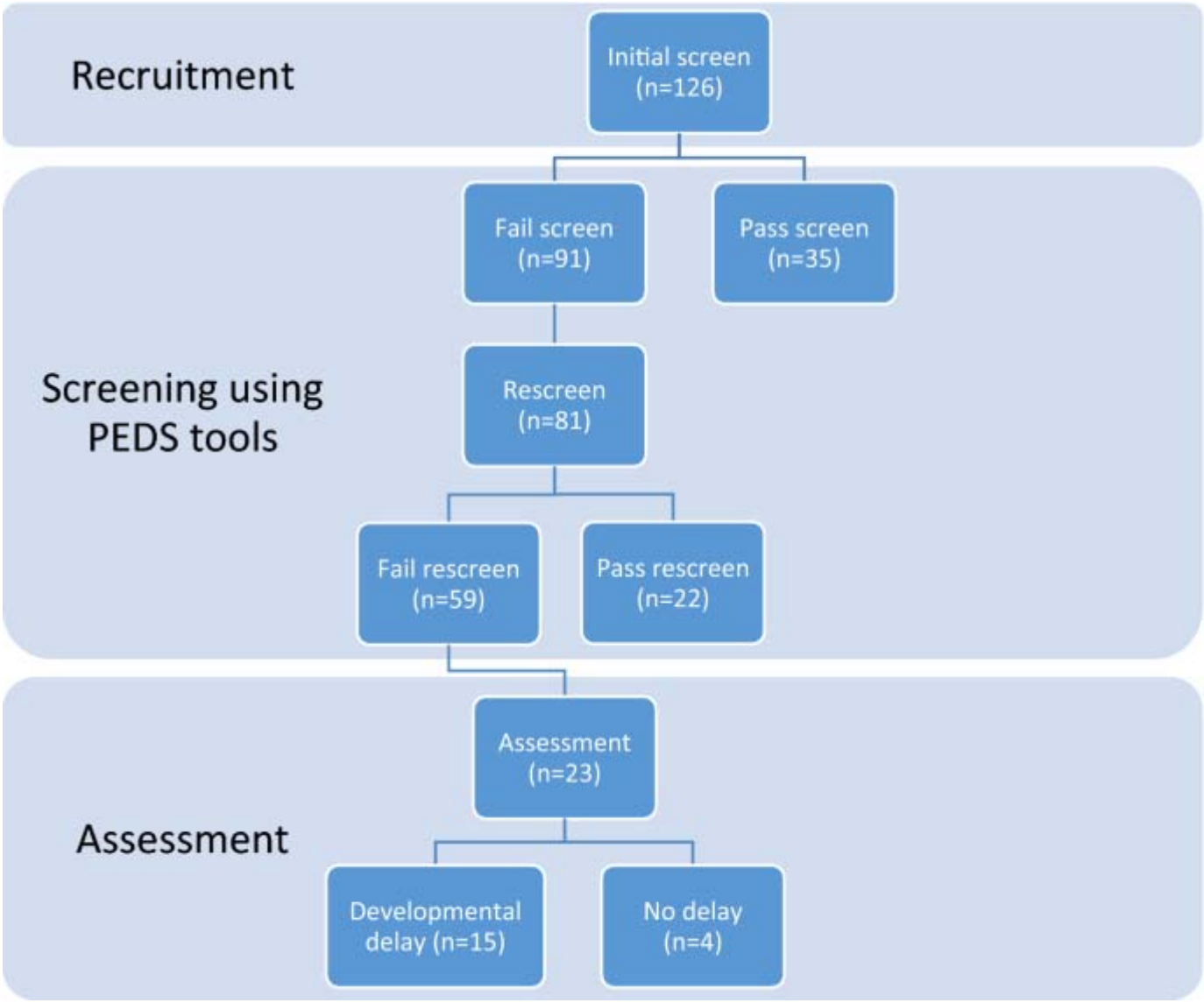

Fig. 2. Recruitment, screening, and assessment flow sheet of the 0–42 month cohort

Results

A total sample of 150 caregivers were invited to participate in the study. Only 24 caregivers and their children were excluded, due to incomplete data. Therefore, the total sample population included 126 children between the ages of 0 and 42 months (mean 19 months, SD 10.9). Gender was equally distributed with 50% male (n = 63) and 50% female (n = 63). 126 vulnerable children were screened for parent-reported developmental concerns using the PEDS tools. Thereafter, 64% (n = 81) of the children that failed the initial screen (n = 91) were rescreened. Of the children that were rescreened, 46 children were referred for a diagnostic assessment using the Bayley-III of which 50% (n = 23) were available. Thirteen children who failed the rescreen did not meet the PEDS tools referral criteria, as they had less than three developmental concerns identified by the PEDS:DM or obtained a Path C or D on the PEDS. These participants will be monitored by means of developmental surveillance (Fig. 2).

Influence of Developmental Risks on Early Childhood Development

All the children who received an initial screen (n = 126) were exposed to at least three developmental risks (Tables 1 and 2) according to the information obtained from the background information questionnaire. Almost all children older than 18 months (97%; 64/66) were exposed to at least five developmental risks compared to 90% of younger children (54/60). According to the outcome of the PEDS tools, children older than 18 months (19 to 42 months; 66/126) were at a significantly higher risk ($p = 0.00$; Omnibus Tests of Model Coefficients) of developmental delay compared to younger children (0–18 months; 60/126). 83% of children assessed diagnostically using the Bayley-III (19/23) had a delay in at least one developmental domain. Of the children rescreened, 73% (59/81) were identified with risk of developmental delay based on the outcome of the PEDS tools. After developmental assessments were conducted, 79% of children (15/23) were diagnosed with a developmental delay.

Half (53%; 8/15) of positively diagnosed children were exposed to more than two languages in their immediate home environment ($p < 0.05$; Omnibus Tests of Model Coefficients). Based on reported monthly income, 96% (98/102) of families lived in extreme poverty, with a monthly household income of less than €320 (Table 2).

Table 2 Population demographics and developmental risks of all children and those with positive screen and diagnoses

Description	Positive diagnosis—Bayley-III n=15		Positive screen—PEDS tools n=91		Total population n=126		Sig. effect (p<0.05; Chi-Square) n=126
Age	0–18 months n=3 (%)	19–42 months n=12 (%)	0–18 months n=31 (%)	19–42 months n=60 (%)	0–18 months n=60 (%)	19–42 months n=66 (%)	0.000
Gender							
Female	2 (67)	7 (58)	19 (61)	29 (48)	30 (50)	32 (49)	0.233
Male	1 (33)	5 (42)	12 (39)	31 (52)	30 (50)	34 (51)	
Prematurity							
Indicated prematurity	0	3 (25)	7 (23)	6 (10)	7 (12)	7 (11)	1.00
HIV status[a]							
Infected	0	0	0	2	0	2 (3)	1.00
Affected	3 (100)	12 (100)	30 (97)	58	59 (100)	64 (97)	
Language exposure[a]							
≥2	2 (67)	6 (50)	18 (62)	31 (55)	40 (71)	36 (59)	0.026
1	1 (33)	6 (50)	11 (38)	25 (45)	20 (29)	30 (41)	
Primary caregiver							
Single caregiver	3 (100)	10 (83)	29 (94)	57 (95)	57 (95)	62 (94)	0.928
Both parents	0	2 (17)	2 (6)	3 (5)	3 (5)	4 (6)	
Caregiver qualification							
Less than grade 12	1 (33)	4 (33)	6 (19)	15 (25)	11 (18)	17 (26)	0.217
Grade 12, diploma/degree	2 (67)	8 (67)	25 (81)	45 (75)	49 (82)	49 (74)	
Income (monthly)[a]							
<€320	2 (100)	8 (100)	21 (91)	49 (96)	43 (96)	55 (97)	0.999
≥€320	0	0	2 (9)	2 (4)	2 (4)	2 (3)	
Age of mother[a]							
Younger than 18,	2 (67)	3 (25)	11 (36)	19 (32)	17 (28)	20 (31)	0.176
Older than 35	1 (33)	9 (75)	20 (64)	40 (68)	43 (72)	45 (69)	
Children in household							
≥3	3 (100)	9 (75)	23 (74)	49 (82)	44 (73)	54 (82)	0.620
≤2	0	3 (25)	8 (26)	11 (18)	16 (27)	12 (18)	
Marital status							
Never married	1 (33)	10 (83)	23 (74)	52 (87)	46 (77)	57 (86)	0.934
Married/living together	2 (67)	2 (17)	8 (26)	8 (13)	14 (23)	9 (14)	
Housing status[a]							
Informal housing/staying with others	2 (67)	10 (83)	23 (74)	53 (88)	41 (68)	58(89)	0.138
Own house	1 (33)	2 (17)	8 (26)	7 (12)	19 (32)	7 (11)	
People in household							
>5	2 (67)	8 (73)	19 (61)	35 (58)	36 (60)	38 (58)	0.478
≤5	1 (33)	3 (27)	12 (39)	25 (42)	24 (40)	28 (42)	
Employment status							
Unemployed	3 (100)	6 (50)	22 (71)	46 (77)	41 (68)	48 (73)	0.101
Employed	0	6 (50)	9 (29)	14 (23)	19 (32)	18 (27)	
Breastfeeding							
No	0	2 (17)	6 (19)	13	11 (18)	15	0.469
Yes	3 (100)	10 (83)	25 (81)	47	49 (82)	51	

Total population: HIV status n=125; income n=102; language exposure n=117; age of mother, housing status n=125. Positive screen: HIV status n=30; language exposure n=85; income n=74; mother age n=90. Positive diagnosis: Language exposure n=13; income n=10

[a]Missing data from population

Effect of Risks on Developmental Outcomes

A binomial logistic regression evaluated the effect of various risks on developmental outcomes of children as detected by the PEDS tools initial screen (n = 126). The child's gender, child age (OR 1.131; 95% CI 1.1–1.2) and multiple language exposure (OR 3.810; 95% CI 1.2–12.4) were included in the regression model (Table 3). Gender was included in the regression model as it is an established risk for developmental delays (Demirci and Kartal 2018; Matheis et al. 2019; Tager-Flusberg, 2016; Valla et al. 2015). The logistic regression model was statistically significant (χ^2 [3] = 34.902; $p < 0.001$; Omnibus Tests of Model Coefficients), indicating a good fit for predicting the relationship between developmental outcomes, child age and the statistically significant risks (Table 3). The regression correctly classified 77% of children with developmental delays when considering multiple language exposure, child gender and age ($R^2 = .37$). Positive predictive value (PPV) was found to be 82%, with a negative predictive value (NPV) of 59%. An increase in child age and multiple language exposure had a significant negative effect on developmental outcome as determined by PEDS tools. Children with exposure to two or more languages were 3.8 times more likely to present with a developmental delay (95% CI 1.2–12.4) than children exposed to only one language.

Table 3 Logistic regression predicting developmental delay from risk factors

Predictor	B	Wald x^2	p-value	Odds ratio (95%CI)
Child age	.123	18.293	.000	1.131 (1.1–1.2)
Child gender	− .591	1.422	.233	.554 (.2–1.5)
Language exposure	1.338	4.925	.026	3.810 (1.2–12.4)

Receptive Language (80%; n = 12) and socio-emotional (67%; n = 10) domains had the highest fail rates when considering positive diagnosis with lowest rates on expressive language (33%; n = 5) and gross motor (20%; n = 3). Fine motor (35%; n = 44) was the developmental domain that parents were most concerned about (Table 4). No associations between domain specific outcomes and risks were found.

Table 4 Developmental concerns according to PEDS tools and Bayley-III

Developmental domain	Initial screen using PEDS tools n = 126 (%)	Positive diagnosis using Bayley-III n = 15 (%)
Expressive language	38 (30)	5 (33)
Receptive language	37 (29)	12 (80)
Fine motor	44 (35)	8 (53)
Gross motor	24 (19)	3 (20)
Social-emotional	30 (24)	10 (67)
Behaviour	32 (25)	7 (47)

Discussion

Multiple language exposure ($p < 0.05$) and child age (older than 18 months; $p < 0.001$) were identified as significant predictors for risk of developmental delay. Children exposed to multiple languages during their first three years of life have been shown to have smaller vocabularies and delayed acquisition of morphosyntactic knowledge (Bialystok et al. 2010). A well-developed first language is fundamental to successful additional language development (Hofer and Jessner 2019) and may benefit children in terms of non-linguistic cognitive functioning (Uljarevic et al. 2016). A systematic review, however, reported no clear link between multiple language exposure and delayed language development (Uljarevic et al. 2016) but this is in the absence of other developmental risks. Language development is influenced by a number of factors including caregiver-child reciprocity, conversational exposure and other environmental aspects (Barnett et al. 2012; Dixon et al. 2012). Furthermore, the age and quality of exposure may also determine whether multiple language exposure is considered a risk or merely slower language acquisition (Singh and Seet 2019). It should still be considered that 38% of the children exposed to more than two languages in the home environment (n = 36), and in the 19–42 month age category (n = 66), were also exposed to at least three additional developmental risks. Due to the cumulative effect of these risks, it is recommended that longitudinal developmental surveillance should be implemented for vulnerable children exposed to multiple risks.

Although most of the developmental risks, such as large family size, low family income and unemployment, were not statistically significant, these risks were prevalent and reflect a population living in extreme poverty (Ali, 2013; Toumbourou et al. 2014). In the current study, 79% (n = 99) of all participants were living in households consisting of extended family members. In South Africa, 36% of all households are three-generation family households living together (Hall et al. 2018). The majority of participants (94%; n = 119) lived in a house headed by either a single caregiver or with neither parent. Twenty-two percent of South African children grow up in single caregiver-headed households (Hall et al. 2018). Child poverty is at its greatest when children live in extended or single caregiver-headed households (Budlender 2018). These factors contribute to fewer opportunities for children to reach developmental milestones, reducing their capacity to develop more complex abilities later in life. When comparing national statistics of household dynamics with results obtained in this study (36% vs 79%), it is apparent that these children may be at increased risk of developmental delay, although no significant association between risk of developmental delays and household dynamics was found. A replication of this study on larger cohorts in similar communities would provide more widely generalizable findings. Evidence regarding associations between risks and developmental domains remain limited and further exploration, especially in low-income communities and on older children, is needed.

This study had several limitations. Firstly, selection bias may have occurred due to the source through which participants were recruited. Therefore, this study's findings are not representative of the sample population. Furthermore, the small sample size, due to unavailable caregivers, may have contributed to the absence of some potential associations between domain specific outcomes and developmental risks.

Conclusion

The majority of vulnerable children presented with a risk of developmental delay according to parent-report using the PEDS tools. This study indicates that multiple language exposure and child age (older than 18 months) are predictive of developmental delays and should be considered when evaluating a child's development. Multiple language exposure needs to be further explored to determine whether a language delay is present or whether the findings suggest later language emergence. Creating awareness amongst caregivers about developmental risks for child development should be prioritised alongside strategies to support children early on. Developmental risks such as socio-economic status, language exposure and the family environment cannot be directly altered or eliminated but it is imperative to encourage and inform caregivers regarding practices to be implemented at home, like language stimulation techniques that can support resilience to the cumulative effect of developmental risks.

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Conflict of interest

The authors declare that they have no conflict of interest.

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