Early detection of developmental delays in vulnerable children by community care workers using an mHealth tool

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   Maria obtained her degree in Speech-Language Pathology in 2015 at the University of Pretoria. In 2016 she completed her community service year in Barberton, Mpumalanga. In 2017, she obtained her masters degree in Speech-Language Pathology, focusing on training and empowering community health workers to conduct developmental screening, using mHealth, in their community. While completing her masters, she also provided school-based speech therapy services in Pretoria. In 2018 she started with her PhD, continuing and building on the research done for her master study. She is currently also appointed as a clinical lecturer at the University of Pretoria.

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   Ms Renata Mosca forms part of the early intervention team at the Department of Speech-Language Pathology and Audiology, University of Pretoria. The early intervention team trains students in the assessment and treatment of early communication disorders in the Clinic for High-Risk Babies (CHRIB) using a family based approach. Ms Mosca is a Hanen certified speech-language therapist and is involved in encouraging Early Intervention in a variety of South African contexts and communities. She is currently conducting her PhD studies relating to the relationships between music instruction, phonological awareness and early literacy skills in young learners.

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   Prof De Wet Swanepoel is professor in the Department of Speech-Language Pathology and Audiology, University of Pretoria with adjunct positions at the University of Western Australia, and is a senior research fellow at the Ear Science Institute Australia. Prof Swanepoel's research capitalises on the growth in information and communication technologies to explore, develop and evaluate innovative service delivery models and applied solutions to improve access to early development and health services, particularly in ear and hearing care. He has published more than 140 peer-reviewed articles, books and book chapters and has received numerous national and international awards in recognition of his work. Prof Swanepoel serves as president of the *International Society of Audiology* and as deputy editor-in-chief of the *International Journal of Audiology*.

4. Dr Frances Page Glascoe

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Developmental delays are increasing worldwide, as a result of exposure to environmental risk factors. Early detection services are often inaccessible in low- and middle income countries (LMIC). An mHealth developmental screening programme with community care workers (CCWs) was investigated. CCWs administered a smartphone application to vulnerable families during home-based services. 138 children were screened and those who failed were rescreened. CCWs completed a questionnaire regarding their perceptions of community-based mHealth-assisted screening. The overall referral rate was 69%. Older children (19-38 months old) had a significantly higher ($p<0.05$; Chi-Square) referral rate (84%; n=39) compared to those aged 0-18 months (52%; n=24). CCWs perceived mHealth screening as valuable in terms of utility, outcomes and contribution to developmental knowledge for community members and CCWs. Community-based services are a promising platform to implement mHealth-assisted early developmental screening programmes. CCWs and mHealth-assisted developmental screening can facilitate better access to early detection and developmental surveillance for vulnerable populations.

Keywords: Development, screening, community health workers, mHealth

Introduction

Worldwide developmental delays are increasing (Schonhaut, Armijo, Schonstedt, Alvarez, & Cordero, 2013). Poverty and exposure to environmental risk factors contribute to the increase, especially in vulnerable populations (Donald, Hall, & Dawes, 2012). Developmental screening from birth through childhood is essential for the early identification of developmental delays in vulnerable children. However, these services are often inaccessible in primary healthcare (PHC) and community-based contexts, due to limited facilities and resources (Preston, Waugh, Larkins, & Taylor, 2010; Samuels, Slemming, & Balton, 2012).

The use of developmental screening tools has received attention in recent literature in response to the global rise in developmental disorders (Donald et al., 2012). Prioritisation of developmental screening, especially in low- and middle income countries (LMICs) such as South Africa (Smith, 2016), is challenged by the global burden of disease, including HIV/AIDS, tuberculosis, and high child mortality rates (Mayosi & Benatar, 2014). Additionally, culturally and linguistically applicable standardised developmental screening tools are lacking (van der Linde, Kritzinger, & Redelinghuys, 2009). In a country such as South Africa, the only national developmental screening tool that has been implemented, the Road to Health Booklet (RTHB), has not yet been validated (van der Linde, Swanepoel, Glascoe, Louw, & Vinck, 2015). A recent study reported that the RTHB failed to identify the majority of infants at risk for a developmental delay due to its low sensitivity as developmental domains are not evaluated consistently across all age ranges (van der Linde, Swanepoel, Glascoe, Louw, & Vinck, 2015). Furthermore, the referral framework of the RTHB screen is insufficient, since no indication is given to whom children should be referred to and for which services (Maleka, van der Linde, Glascoe, & Swanepoel, 2016).

PHC personnel tasked with conducting developmental screening as part of well-baby clinics, regularly lack the knowledge to correctly identify and refer children with developmental delays (van der Linde et al., 2009). This can be ascribed to, amongst other factors, limited knowledge regarding the scope of practice of allied healthcare professionals and as a result may hamper referrals for the services necessary (van der Linde et al., 2009). Furthermore, PHC personnel lack knowledge regarding eligibility criteria for early intervention services for children identified with a developmental delay and, therefore, follow-up of entry into early intervention services are poor (Marshall, Kirby, & Gorski, 2016). PHC personnel are overburdened with high caseloads resulting in less hands-on care available to children (Donald et al., 2012). When children are identified with developmental delays, availability of early intervention services are often limited in resource-poor settings (Kyarkanaye, Dada, & Samuels, 2017).

Community health workers (CHWs) potentially serve as the missing link between healthcare systems and underserved, culturally and linguistically diverse communities. CHWs provide alternative access to vital healthcare, particularly for vulnerable populations (Johnson & Gunn, 2015). Internationally, CHWs are defined as community workers who ‘promote health within a community by assisting individuals to adopt healthy behaviours…who may deliver health related preventative services such as hearing screenings’ (United States Bureau of Labor Statistics, 2017). In many South African studies, they are also referred to as community care workers (CCWs) (Friedman et al., 2007; Moshabela, Sips, & Barten, 2015; Okeyo & Dowse, 2016; Sips et al., 2014). CCWs play an unprecedented role in the social welfare of community members, in addition to focusing on health needs (Pratt & Mbaligontsi, 2014). No clear distinctions between these terms (CHWs vs CCWs) exist across current literature, mainly due to tasks that are formally or informally added to their job description (Olaniran et al., 2017).

Since 2010, the community oriented primary care (COPC) initiative, an example of CHWs’ inclusion in healthcare service delivery, has been implemented in Gauteng, South Africa to help alleviate the burden on PHC professionals in underserved communities (Bam, Marcus, Hugo, & Kinkel, 2013). CHWs can provide direct health services that are culturally and linguistically appropriate, such as developmental screening, and increase caregiver awareness of early developmental milestones (Brownstein, Hirsch, Rosenthal, & Rush, 2011). Despite these benefits, CHWs face many challenges, including funding, printing and processing paper-based instruments, and timely manual analysis of collated information (Liu, Sullivan, Khan, Sachs, & Singh, 2011; Neupane et al., 2014).

Recently, CHWs have been using mHealth tools to deliver healthcare services (Agarwal, Perry, long, & Labrique, 2015). Costs associated with paper-based instruments can be reduced and data can be digitised through mHealth technology. The universal use of mHealth in healthcare is rapidly expanding (Free et al., 2010). Despite initial concerns regarding the feasibility of mHealth in LMICs, a few studies have proven its effectiveness (DeRenzi et al., 2011). In India and Zambia, mHealth is currently used to screen and diagnose cancer patients (DeRenzi et al., 2011). mHealth is accessible in most low-income settings due to the growing availability of mobile phone technology (Surka et al., 2014). A study conducted in 2015 reviewed cell phone ownership across 40 countries and reported that almost all (90%) South African adults have a cellphone (Poushter, 2016). mHealth may be a viable approach to expand community-based developmental screening. A developmental screening tool using mHealth technology administered by CCWs is a low-cost option for decentralised access to early detection.

The Parents’ Evaluation of Developmental Status (PEDS) (Glascoe, 2013b) and the Parents’ Evaluation of Developmental Status: Developmental Milestones (PEDS: DM) (Brothers, Glascoe, & Robertshaw, 2008) are parent-administered screening tools that have recently been adapted for use as mHealth tools (Maleka et al., 2016). The PEDS used in combination with the PEDS: DM is proven to be an accurate approach to developmental screening (Glascoe, 2013a). Currently there is limited evidence regarding the role of CCWs in the developmental screening of children, especially using mHealth technology such as the PEDS tools..

Method

Study objective

To describe the clinical utility and perceived value of a CCW-administered mHealth screening programme for early detection of developmental delays in vulnerable populations. Clinical utility will be examined in terms of referral rate, test duration and early detection.

Research design

An exploratory, mixed method research design was employed. Exploratory research is used when research is in a preliminary stage and conclusive information arising from it is rare (Maxwell & Satake, 2006). Quantitative data was used to describe the clinical utility of the smartphone developmental screening conducted by CCWs. Both quantitative and qualitative data were used to describe the perception of the CCWs regarding the use of an mHealth screening programme.

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, 2011).Ten accredited CCWs from the Mamelodi division of Future Families were invited to participate in the study. Future Families, a community based non-governmental organization (NGO), supports families with children who are either infected or affected by HIV/AIDS. The CCWs are employed to provide healthcare and welfare services to these families within their communities. Their primary role is to create awareness, promote prevention and address issues pertaining to HIV/AIDS and anti-retroviral (ARV) treatment, nutrition, immunisation and parenting skills. The CCWs' ages ranged from 32 to 64 years (mean 43.9; SD 10.6). One hundred and thirty eight initial screens and 85 rescreens were conducted. Each CCW administered between 11 and 18 (mean=13.8; SD=2.1) initial screens and between four and 13 (mean=8.5; SD=2.8) rescreens.

All the families connected to Future Families with children between the ages of one and 38 months were invited to participate in the study. There were 138 families selected to participate and who were interviewed by the CCWs. The average age of the children (Table 1) was 19.2 months (SD 11.1). Of the families that indicated their monthly income (n=114), 78% (n=89) received a nett income of less than $155 per month. The number of occupants per household ranged from two (4%) to more than 10 (17%), whereas most of the households (76%; n=105) had more than three children per household (Table 1).

Table 1: Demographic information of participants

	Percentage
Children age (n=138)	
0-18 months	46% (n=64)
19-38 months	54% (n=74)
Children Gender (n=138)	
Male	51% (n=70)
Female	49% (n=68)
Primary caregivers (n=138)	
Mother	79% (n=109)
Father	1% (n=2)
Family members	20% (n=27)
Caregiver age (n=135)*	
Younger than 30 years	47% (n=63)
31-40 years	33% (n=44)
41 and older years	20% (n=28)
Home languages (n=138)	
Sepedi	38% (n=53)

isiZulu	19% (n=26)
Tsonga	15% (n=20)
SiSwati	9% (n=12)
isiNdebele	7% (n=9)
Other	12% (n=18)
Caregiver employment (n=137)*	
Employed	29% (n=40)
Unemployed	71% (n=97)
Monthly income (n=114)*	
Below $ 155	78% (n=89)
$ 155 - $ 232	11% (n=13)
Above $ 232	11% (n=12)
Education level (n=138)	
Grade 10 or less	23% (n=32)
Grade 12	69% (n=95)
Diploma/ Degree	8% (n=11)
People per household (n=133)*	
Less than 5	25% (n=34)
5-9	58% (n=77)
10 or more	17% (n=22)
Children per household (n=138)	
One	7% (n=9)
Two	17% (n=24)
Three or more	76% (n=105)
Housing status (n=137)*	
House owner	23% (n=31)
Living with others	77% (n=106)

** Missing data due to nondisclosure of information.*

Materials and apparatus

The PEDS tools, i.e. PEDS (Glascoe, 2013b) and the PEDS: DM (Brothers et al., 2008), consist of 16 multiple choice questions and take approximately 10-15 minutes to complete. These tools were recently developed into a smartphone application by the University of Pretoria using the same algorithm as the original paper-based tool (Maleka et al., 2016). Almost perfect agreement (99%) was found between the screening outcome, administered by a CCW, and the paper-based version, administered by a speech-language therapist (Maleka et al., 2016). It was written as a native Android application in Java making use of the Android Software Development Kit (SDK). The PEDS application was installed on ten Vodacom Smart mini 7 smartphones (Android OS 6.0). Data automatically save to the phone and can be downloaded as an MS Excel file.

The PEDS tools have validated referral algorithms. The outcome of the PEDS tools are interpreted using five evidence-based pathways, which either pass or refer a child based on the type and/or amount of parental concerns (Figure 1) (Glascoe, 2013a).

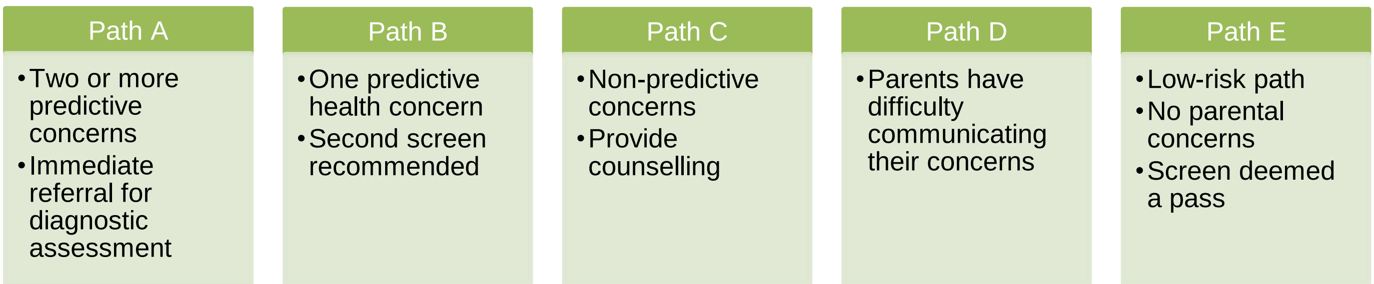

Figure 1: Evidence-based pathways of the PEDS (Glascoe, 2013a)

The combination of the PEDS and PEDS:DM is used to prevent false negatives, especially in high risk populations such as Mamelodi (Glascoe, 2013a). Using this referral criteria reduced false negatives by 12% in a previous study conducted within a high risk population (Glascoe, 2013a). For the purpose of this study, all children failed the screen when they received a Path A result from the PEDS. Children were referred when three or more concerns were identified by the

Table 2. CCW questionnaire regarding their perceptions of the mHealth screening programme

1.	Instructions for using the PEDS smartphone application were clear and easy to understand.	1	2	3	4	5
2.	The training I received was adequate for using the PEDS smartphone application.	1	2	3	4	5
3.	The PEDS smartphone screening was easy to administer.	1	2	3	4	5
4.	The PEDS application was easy to administer in the home setting.	1	2	3	4	5
5.	The smartphone screening was quick to administer.	1	2	3	4	5
6.	According to me, the caregivers understood the questions that were asked.	1	2	3	4	5
7.	I trust that the results gotten are true.	1	2	3	4	5
8.	The caregivers agreed with results of the PEDS screening.	1	2	3	4	5
9.	The screening can have a positive impact in the community.	1	2	3	4	5
10.	Additional comments:					

PEDS:DM, regardless of the path identified by their PEDS result, as was suggested by the author of the tools (Glascoe, 2013a).

Additionally, caregivers completed background information questionnaires to gather demographic and biographic information. A five point rating scale, ranging from strongly agree to strongly disagree, of nine questions was used to determine CCWs' perceptions of the mHealth screening programme (van der Linde, Swanepoel, Glascoe, Louw, & Vinck, 2015). Question 10 provided space where additional comments or recommendations were made (Table 2).

Procedures

IRB approval was obtained. Once informed consent was obtained, the CCWs were trained to administer the PEDS tools. CCWs then approached the caregivers of the children within the specified age range (0-38 months). After informed consent was obtained from the caregivers, background information questionnaires and developmental screening were completed in the caregiver's preferred language (Figure 2). Screening was conducted in the form of a caregiver interview, where CCWs recorded parents' responses.

Children who failed the initial screen were rescreened by the same CCW within 14 days. The children who failed the rescreen were then referred for a comprehensive diagnostic evaluation. The evaluations took place at the Future Families Satellite office and were conducted by a registered healthcare professional. Upon completion of rescreening, the CCWs completed the five point rating scale questionnaire regarding their perceptions of the mHealth screening programme. .

Data analysis

Descriptive and inferential statistics were employed to describe and analyse quantitative data (Irwin, Pannbacker, & Lass, 2008). The Statistic Package Social Sciences (SPSS) v 23 (Chicago, Illinois) was used for statistical calculations and analysis. Data were extracted from the PEDS cloud-based server to an MS Excel sheet. Cross-tabulations were used to compare the combined outcomes of the PEDS tools. Results were divided into two age categories (0-18 months and 19-38 months). Pearson Chi-Square tests were used to evaluate the differences between outcomes of initial screens and rescreens. Thematic analysis (deVos, Strydom, Fouche, & Delport, 2002) was employed to analyse qualitative data describing the perceptions of the CCWs, obtained from the questionnaire. This method involves the management of data by meaningfully organising the responses, thereafter comments are identified and coded. Data is then interpreted by categorising them into salient themes (deVos et al., 2002). Responses were divided into the following three themes: the programme's benefit for children in the community, knowledge regarding development and the CCWs' perceived value of the mHealth-assisted screening programme

Results

A total of 138 children were screened by the CCWs using the mHealth PEDS tools. Figure 2 illustrates the process from the initial screen to the rescreen and further referral for diagnostic assessment.

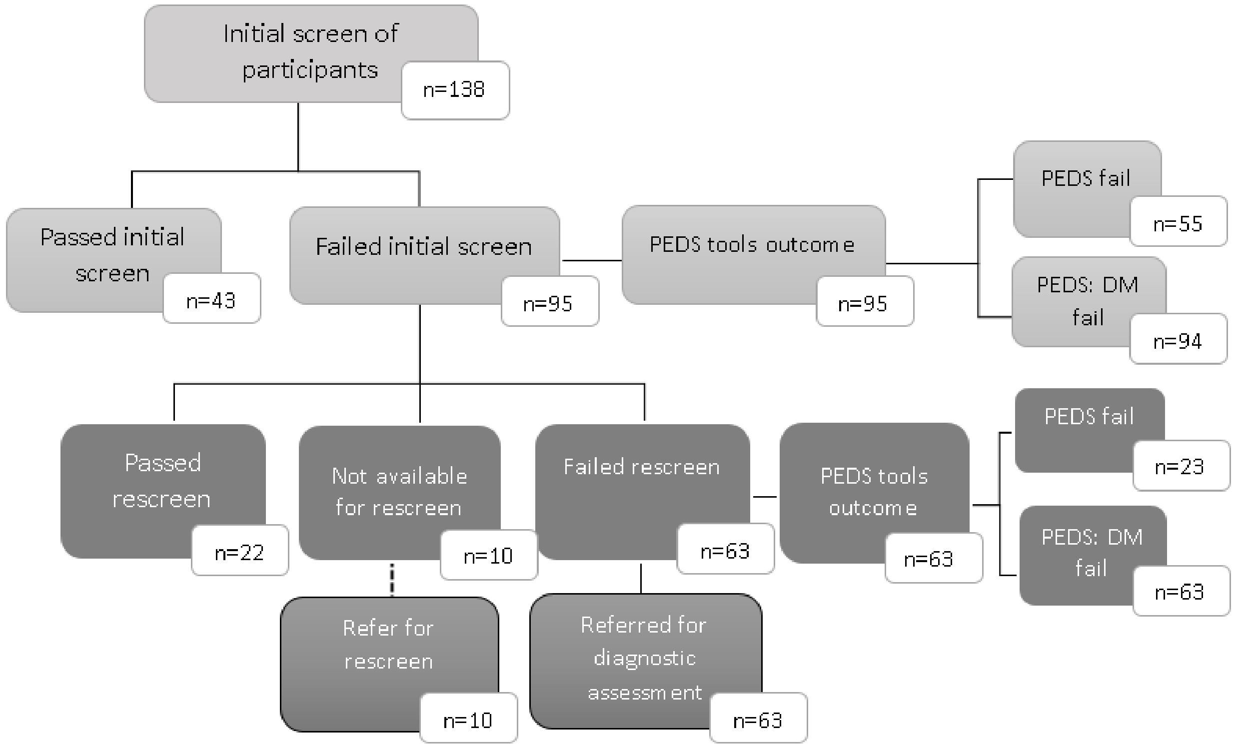

Figure 2: Stages of the screen and rescreen process facilitated by CCWs.

The overall referral rate (Table 3) of the PEDS tools was 69% (n=95). The overall referral rate of the PEDS tools was significantly higher ($p<0.05$; Chi-Square) for the older age group (84%; n=62) when compared to the younger age group (52%; n=33). The referral rate of the PEDS:DM (68%; n=94) compared to the PEDS (40%; n=55) was higher (Table 3), although not significantly ($p>0.05$; Chi-Square).

Table 3: Overall referral rate across PEDS tools, PEDS:DM and PEDS and two age groups

Age group	PEDS tools referral rate	PEDS:DM referral rate	PEDS referral rate
0-18 months (n=64)	52% (n=33)	52% (n=33)	28% (n=18)
19-38 months (n=74)	84% (n=62)	82% (n=61)	50% (n=37)
TOTAL REFERRED (n=138)	69% (n=95)	68% (n=94)	40% (n=55)

Of the referred participants (n=95), 89% (n=85) were available at the time of rescreen. Results of children unavailable for rescreening (11%; n=10) were disregarded when comparing the initial screen and rescreen results (Table 4). The PEDS rescreen referral rate (27%; n=23) was significantly lower ($p<0.05$) compared to the PEDS initial screen referral rate (35%; n=45).

Table 4: Distribution of referral rates across initial screen (IS) and rescreen (RS) within age categories

Age group	PEDS tools IS (n=128*)	PEDS tools RS (n=85)	PEDS:DM IS (n=128)	PEDS:DM RS (n=85)	PEDS IS (n=128)	PEDS RS (n=85)
0 – 18 months (IS n=60; RS n=30)	48% (n=29)	80% (n=24)	48% (n=29)	80% (n=24)	23% (n=14)	23% (n=7)
19-38 months IS n=68; RS n=55)	82% (n=56)	71% (n=39)	81% (n=55)	71% (n=39)	46% (n=31)	29% (n=16)
TOTAL REFERRED	66% (n=85)	74% (n=63)	66% (n=84)	74% (n=63)	35% (n=45)	27% (n=23)

** Results of ten participants disregarded*

Mean test duration recorded for the initial screen was 12.5 minutes (SD 3.1 minutes) and 13.9 minutes (SD 4.5 minutes) for rescreen. The CCWs that were older than 40 years (50%; n=5) took significantly longer ($p<0.05$; Chi-Square) to rescreen with an average of 15.4 minutes (SD 4.4 minutes) compared to younger CCWs (50%; n=5), with an average rescreen time of 12.5 minutes (SD 3.7 minutes). Over a period of 14 days, CCWs screened an average of ten children per day (SD 7.02). CCWs completed the mHealth screening process within one month.

All CCWs (100%; n=10) indicated on the questionnaire that developmental screening can have a positive impact in the community (Table 5) as it was easy to use in the home environment (90%; n=9) and caregivers understood the questions asked (100%, n=10). No responses were reported in the categories ‘disagree’ and ‘strongly disagree’ on the questionnaire completed by the CCWs regarding their perceived value of an mHealth supported screening programme (Table 5).

Table 5: CCWs’ perceptions regarding value of an mHealth screening programme (n=10)

Questions	1- Strongly agree	2- Agree	3- Neutral
1. App instructions clear	90% (n=9)		10% (n=1)
2. Adequate training	60% (n=6)	40% (n=4)	
3. Easy to administer	70% (n=7)	10% (n=1)	20% (n=2)
4. Easy to administer in homes	60% (n=6)	30% (n=3)	10% (n=1)
5. Quick to administer	80% (n=8)	20% (n=2)	
6. Caregivers understood questions	50% (n=5)	50% (n=5)	
7. Accurate results	80% (n=8)	20% (n=2)	
8. Caregivers agree with final results?	70% (n=7)	20% (n=2)	10% (n=1)
9. Positive impact on community?	100% (n=10)		

Thematic analysis of the CCWs' comments on the open ended questions of the questionnaire identified three main themes (Table 6). The reported benefits of the mHealth tools included early referral, the positive impact on the community and the importance of developmental screening and surveillance. The CCWs reported increased knowledge regarding typical development and the importance of developmental surveillance. The perceived value of the screening programme was highlighted including aspects such as time-efficiency, convenience, practicality and overall enjoyable experience.

Table 6: Thematic analysis of CCW's comments regarding screening programme

Themes	Comments
Benefit for children in community (n=11)	- 'positive impact to our community' - 'they want to do even older children from 4-6 years before they start school' - 'if the child need help he will be refer early' - 'so that we can know how the child is growing'
Knowledge regarding development (n=8)	- 'I learned so much about development' - 'I did not know that each and every stage is very important to the child and mother' - 'I have learnt a lot myself. Thank you UP'
Perceived value of mHealth-assisted screening programme (n=10)	- 'I think the screening was easy' - 'I have enjoyed a lot to assist' - 'I did enjoy it was fast'

Discussion

The elevated overall referral rate of the PEDS tools (53%) is likely attributable to this underserved populations' exposure to a range of environmental risk factors (Maleka et al., 2016; van der Linde, Swanepoel, Glascoe, Louw, Hugo et al., 2015). Environmental risk factors for developmental delay that were identified include low household income, caregiver unemployment and households with more than three children (Chung et al., 2011; Currie, 2009; Duncan, Brooks-Gunn, & Klebanov, 2017; Glascoe, 2005; Walker et al., 2011). Similar referral rates have been reported in other studies conducted in underserved communities (Maleka et al., 2016; van der Linde, Swanepoel, Glascoe, Louw, Hugo et al., 2015). Yet, the global referral rate reported in a recent systematic review, was lower (34%) (Hackman & Farah, 2009) than the rate in the current study. It should be taken into account that most of these studies were conducted in high-income countries. Risk exposure and its cumulative effect in vulnerable populations advocates the need for developmental screening to improve early detection of developmental delays (Glascoe, 2005). This may narrow the gap in children being unidentified at a younger age (Scherzer, Chhagan, Kauchali, & Susser, 2012).

Although not significant ($p>0.05$; Chi-Square), the PEDS:DM overall referral rate (68%) was higher than the PEDS overall referral rate (40%). Parental lack of knowledge regarding different developmental domains may result in parents being unconcerned about possible developmental risks (Glascoe, 2013a). Several studies found similar results (Glascoe, 2013a; Woolfenden et al., 2014), indicating the necessity of including a milestone-focused measure as part of a screening protocol, so as to discern delays that caregivers may not have identified (Glascoe, 2013a). This supports the approach of using both the PEDS and PEDS:DM in combination when screening children from a high-risk population.

Test times, for both the initial screen and rescreen (mean 12.5 minutes), agree with the reported administration time of the paper-based PEDS tool (Chung et al., 2011). No previous studies have reported on the screening duration when using the PEDS application. Older CCWs took significantly longer ($p<0.05$) to conduct the screening than their younger counterparts. This is likely partly a function of younger CCWs being more accustomed to smartphone technology. Screenings using mHealth may thus be implemented quicker by younger CCWs. Older CCWs may need more training to become more accustomed to smartphone technology. Another study conducted in primary healthcare settings reported screening times using paper-based instruments completed by CCWs that took an average of five minutes longer than in the current study (Hunter et al., 2015; Squires & Bricker, 2009). This suggests that the mHealth tool was time-efficient and effectively implemented by the trained CCWs in the current study.

CCWs completed the mHealth screening process within a period of one month (average of ten children per day). Most children (89%) identified with concerns were rescreened within 14 days. Developmental screening administered by CCWs in the home setting has shown to have a positive impact on follow-up adherence. No transportation costs could impede their attendance at a PHC facility and only the caregiver were relied upon being present for the screening. Studies reported poor follow-up adherence in PHC settings of high risk families primarily due to logistical reasons and employment responsibilities (Giannoni & Kass, 2010; Schoeman, Swanepoel, & van der Linde, 2017). For this reason, mHealth screening in the home-setting may be an adequate model for service delivery in terms of early detection and close developmental surveillance.

CCWs (100%) reported that the training to screen children was adequate and the application was easy to comprehend (90%). Almost all CCWs (90%) reported that caregivers agreed with the screening results. Over a third of the CCWs highlighted the need to educate the community regarding the importance of developmental screening (38%) and this may be considered for future research.

CCWs indicated that they were motivated to promote increased developmental surveillance. A study reporting on the challenges perceived by healthcare professionals offering PHC services indicated limited time for training and service delivery (Chew-Graham et al., 2014), limited funds, lack of allocated space for services and shortages of nurses and PHC staff to conduct these services, leading to a lack in continuity of care (Xaba, Peu, & Phiri, 2012). PHC personnel felt demotivated due to these unrealistic workloads which compromise the quality of care they provide (Xaba et al., 2012). CCWs using mHealth supported screening and developmental surveillance may reduce the burden on PHC personnel. It also appears to contribute to the knowledge of community members, which includes CCWs (Braun, Catalani, Wimbush, & Israelski, 2013; Tulenko et al., 2013), by increasing awareness whilst developmental screening takes place.

Developmental screening for children older than 38 months was a future need identified by CCWs and caregivers in order to ensure early referral and improve future academic success. Future research should also be conducted to compare rescreen outcomes to comprehensive and diagnostic assessment results. Since the screening outcome was not confirmed with a diagnostic assessment at the time, it is recommended that future research should be conducted to compare rescreen outcomes to diagnostic assessment results. Also, the small sample of CCWs (n=10) that participated in the study limited the sample size of the families, thus restricting the amount of screens done per day. Therefore it is recommended that the study should be replicated within a larger cohort.

Conclusion

Several studies have reported the effectiveness of CHWs in conducting mHealth screening programmes (Abrahams-Gessel et al., 2015; Agarwal et al., 2015; Hussein et al., 2015; Maleka et al., 2016; Squires & Bricker, 2009; Surka et al., 2014). This study demonstrated the potential of CCWs to use mHealth tools to reduce the demand on overburdened health professionals in typical healthcare settings. Findings indicate that many children can be screened in a short period of time, resulting in early and accurate referral to the appropriate healthcare professionals. mHealth screening programmes can improve universal access to developmental screening and surveillance by bringing services into the homes of vulnerable populations through minimally trained persons.

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