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A randomized controlled trial of home visits by neighborhood mentor mothers to improve children's nutrition in South Africa

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Malnourished children and babies with birth weights under 2500 g are at high risk for negative outcomes over their lifespans. Philani, a paraprofessional home visiting program, was developed to improve nutritional outcomes for young children in South Africa. One "mentor mother" was recruited from each of 37 neighborhoods in Cape Town, South Africa. Mentor mothers were trained to conduct home visits to weigh children under six years old and to support mothers to problem-solve life challenges, especially around nutrition. Households with underweight children were assigned randomly on a 2:1 ratio to the Philani program ($n = 500$) or to a standard care condition ($n = 179$); selection effects occurred and children in the intervention households weighed less at recruitment. Children were evaluated over a one-year period ($n = 679$ at recruitment and $n = 638$ with at least one follow-up; 94%). Longitudinal random effects models indicated that, over 12 months, the children in the intervention condition gained significantly more weight than children in the control condition. Mentor mothers who are positive peer deviants may be a viable strategy that is efficacious and can build community, and the use of mentor mothers for other problems in South Africa is discussed.

Keywords: mentoring; motherhood; nutrition; positive deviant; South Africa

Introduction

Malnutrition is a significant and growing global problem and is the leading factor in more than one-third of deaths worldwide among young children (Black et al., 2008). Among South African children less than five years old, the national prevalence of stunting (low height for age) is 27%, and at least 12% of babies are underweight (UNICEF, n.d.). About 7% of South African children die before their fifth birthday (UNICEF, n.d.), and more than half of South African households experience hunger (Labadarios et al., 2005). In the longer term, poor nutrition results in shorter adult height, reduced economic productivity and lifelong impairments in neurocognitive and socioemotional development (Grantham-McGregor et al., 2007; Mason et al., 2005; Stanfield, 1993). Nutritional challenges at birth and during childhood result in successive generations of unhealthy adults who, in turn, place their children at risk (Horta, Gigante, Osmond, Barros, & Victora, 2009). The Philani

Project was established in the outskirts of Cape Town, South Africa in 1979 to combat these odds by providing basic child health and nutrition services. The goal of this article is to evaluate the effectiveness of this community-developed service model in improving nutritional outcomes and child health.

The Philani program contains elements found in several successful international models that have been shown to improve healthy development of children in resource-poor settings. The first is the Positive Deviance/Hearth model to target childhood malnutrition (Marsh & Schroeder, 2002; Sternin, Sternin, & Marsh, 1998; Wollinka, Keeley, Burkhalter, & Bashir, 1997) developed in Haiti in the 1980s (Berggren, Alvarez, Genece, Amadee-Gedeon, & Henry, 1984) and replicated worldwide (Sternin et al., 1998; Wollinka et al., 1997). Using this approach, "positive deviant" (PD) mothers, who are raising healthy and well-nourished children despite living in the same poor conditions as their peers, are recruited to lead gatherings in their homes attended by small groups of local malnourished children and their mothers. The PD/Hearth method has been demonstrated to improve health behaviors, increase nutrition knowledge and rehabilitate undernourished children (Berggren et al., 1984; Marsh & Schroeder, 2002; Marsh, Schroeder, Dearden, Sternin, & Sternin, 2004; Sternin et al., 1998; Wollinka et al., 1997).

Peer education programs have also been shown to improve nutritional outcomes. The US Department of Agriculture's Expanded Food and Nutrition Education Program (EFNEP) enrolls more than 500,000 new participants annually to receive personal nutrition education, delivered by trained peer educators, who usually live in the communities where they work. EFNEP increases consumption of fruits and vegetables, knowledge of nutrition basics, food storage and preparation safety and nutrition per dollar spent on food (Arnold & Sobal, 2000; Burney & Haughton, 2002; National Institute of Food and Agriculture, n.d.). The peer nutrition education model has also been successful in small-scale programs, such as La Cocina Saludable in Colorado (Taylor, Serrano, Anderson, & Kendall, 2000) or the Peer Nutrition Program of the Toronto Public Health Department (Moscovitch, n.d.).

Philani also incorporates elements of nurse home visiting for infants and young children, which has been highly beneficial for children in the United States (Olds et al., 2002, 2004a, b). Such programs provide social support, health education and practical assistance during an important period of early childhood, and result in significant improvements in developmental and psychosocial outcomes (Gomby, Culross, & Behrman, 1999).

By pulling together elements from these models of child health and nutrition interventions – PD mothers, nutrition education provided by local peers and home visits during children's early years – the Philani program aims to build community relationships and encourage mothers to engage in healthy practices each day to improve nutrition and health outcomes. The arrival of a child creates unique opportunities for behavior change. Verplanken and Wood (2006) have demonstrated that it is far easier to shift behaviors during periods of life transition compared to periods of stable living. Early childhood opens a window of opportunity to instill positive health behaviors into the daily life of the family. In all cultures, rewarding daily routines that promote consistent care for children's health and encouraging parents' bonds with their children are associated with healthy developmental outcomes (Weisner, 1998, 2002). In this article we evaluate whether the Philani program was successful in one specific outcome: rehabilitating underweight children to recommended weights within one year of enrollment into the program.

Methods

In the Xhosa townships surrounding Cape Town, 37 neighborhoods of about 500 households each were identified to participate in the project. The neighborhoods contain

a variety of housing, including formal settlements (government housing with onsite water and sewage connections), site-and-service plots (plots of land where residents can build a home, with some access to water and sanitation facilities) and informal settlements (shacks or temporary structures that rarely have water on the premises and are not on a specified plot of land). For each neighborhood, a Mentor Mother (MM) was screened, recruited and trained. Recruitment and training of MMs is described below.

MMs canvassed their neighborhoods, entering each household and inquiring if there were any children under six years of age living in the home. When children were present, the MM weighed each child and plotted the weight on a growth chart that was shown and explained to the parent(s). If the MM identified a child whose weight indicated malnourishment, the household was eligible to participate in the study. Malnourishment was defined as having a weight more than two standard deviations below the World Health Organization (WHO) normative mean weight for the child's age. Children in this range are in the bottom 2% in weight for age.

From November 2002 to July 2004, the 37 MMs recruited 684 mothers with malnourished children under the age of six years; if there was more than one malnourished child, only one was selected to be followed for this study. The mother–child unit in each household is referred to as a dyad. Dyads recruited into the study were scheduled for a baseline assessment, after which they were randomized to either the intervention or control arm of the study. Figure 1 displays the flow of participants through the study. Assignment to the treatment condition was based on a random sequence decided a priori for every three households enrolled into the study. MMs were provided with randomly sequenced numbered folders containing the randomization assignments. Once a dyad was enrolled the MM selected the next folder in her possession, and assigned the dyad accordingly. Two out of each three households were assigned to the Philani intervention condition ($n = 500$).
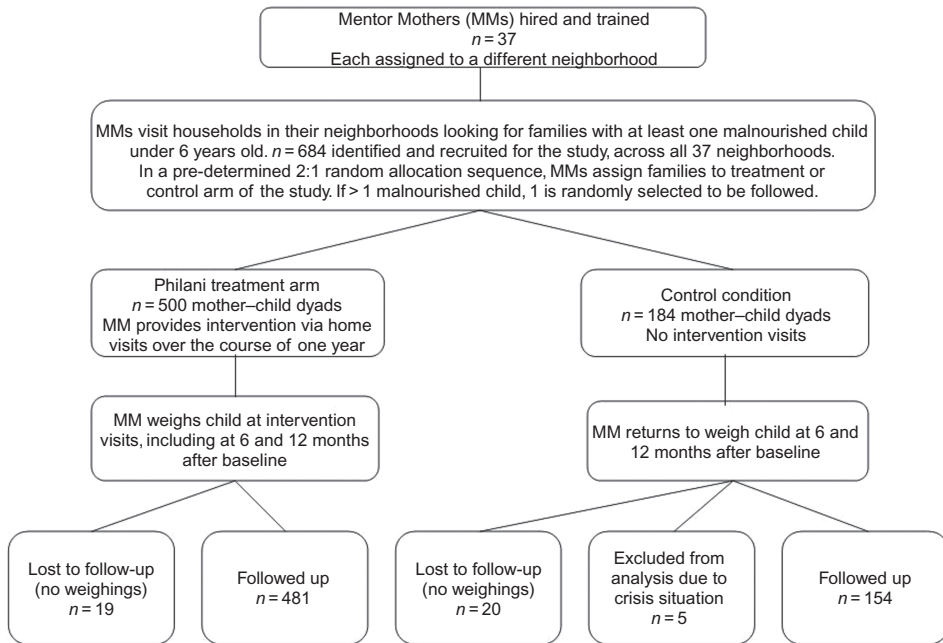

Figure 1.   Outline of flow of participants in the study.

The third household became a control case ($n = 184$). Five dyads were assigned initially to the control condition but were removed from the analysis and were provided services for ethical reasons because the child's life was endangered; the final sample size in the control condition was thus $n = 179$.

During the year following recruitment, MMs provided the intervention home visits with growth monitoring to those dyads randomized to receive it. Dyads in the control arm of the study did not receive these visits. In addition, MMs conducted follow-ups with control dyads approximately every six months, at which time they weighed the children. After their final weighing, dyads in the control condition were given the option to receive the Philani nutrition intervention program. The follow-up period ended in September 2005. The study was approved by the Institutional Review Board at UCLA and was registered with ClinicalTrials.gov (NCT00995592).

Intervention description

Mentor Mothers were nominated initially by local community leaders or by open application. Criteria included having thriving babies, demonstrating good communication and strong interpersonal skills, being committed to community service and showing a disciplined personal and professional lifestyle. The nominees were interviewed and trained by the Philani outreach supervisors and received home visits to observe routines and confirm that the households met the criterion of "thriving" (i.e. the home was organized, children were monitored, healthy food was available). Only about 50% of potential MMs remained after this process; these MMs were engaged to recruit participants and deliver the home-based interventions. They received a stipend of $US 130/month and were expected to work for four hours per day.

Mentor Mothers received four phases of training: (1) watching experienced MMs implement the intervention in an inspiring manner; (2) attending training sessions covering nutrition, basic child health, weighing babies and completion of growth charts, how to recognize danger signs and crisis situations and how to encourage depressed mothers to be more active and engaged with their children; (3) learning how to build trust with mothers and use the relationship to improve the consistency of healthy daily routines; and (4) implementing the first round of home visits independently in their neighborhoods. The intervention supervisor visited at least one day per month on a random schedule to ensure that the implementation was proceeding as planned. The supervisor collaborated with the MM in problem-solving and generating action plans when problems occurred in the field. The quality of implementation was monitored by reviewing the forms completed at each home visit, monitoring visitation patterns, collecting observations by outreach supervisors and brief ratings of home visits by the outreach supervisors.

The frequency of MM visits was based upon need. For example, if there was a very small low-birth weight baby, the family might be visited two to three times a week for a week or two until the MM was confident that the child's mother was coping well. If a child was improving and gaining weight that dyad could be visited every two–three weeks. When the child was almost fully rehabilitated visits might occur once a month. Typical MM home visits lasted from 20 minutes to one hour. During the visits, the MM weighed the child and discussed developmental progress with the mother. The MM also ensured that the mother had applied for appropriate social grants and understood proper nutrition and hygiene. MMs stressed the importance of breastfeeding, the proper time to introduce solid food, frequent feeding and a mixed diet that includes fruits and vegetables. The MMs checked that immunizations were up to date and that the child had been dewormed. Among the families

in each MM's caseload there was likely to be one emergency per week; for example, a child with a high fever, difficulty breathing or appearance of severe dehydration. These cases were brought to the Philani health clinic or the local public health clinic to receive immediate attention. As part of the intervention program, MMs established neighborhood meetings where mothers gathered to discuss child health and nutrition issues.

Measures

The following measures were assessed:

- *Maternal and household characteristics*. At recruitment, mothers reported their age, number of years they had been in Cape Town, number of living children, marital status and housing conditions (classified as formal, site and service or informal). Interviewers reported two subjective assessments of the mothers' living conditions: overall smell (classified as pleasant, neutral or poor) and hygiene (classified as good, average or poor).
- *Children's characteristics*. At recruitment, mothers reported on several characteristics of the child enrolled in the study, including: age, gender, birth weight, whether the child's meals had been reduced in size or skipped in the past year due to lack of money and whether or not the child was already enrolled in a nutrition program. At recruitment and follow-ups, child weight was measured in kilograms. In addition, a weight-for-age Z-score (WAZ) was calculated and standardized according to reference weights from the Centers for Disease Control and Prevention growth charts (Kuczmarski, Ogden, & Grummer-Strawn, 2000).

Statistical methods

We compared demographic and household characteristics of the dyads across intervention conditions at recruitment. We also compared dyads followed over time versus those lost to follow-up; χ^2 tests and *t*-tests were conducted for categorical and continuous measures, respectively. Where appropriate, Fisher's exact test was conducted on categorical measures with sparse cell counts and the Wilcoxon two-sample test was conducted on continuous measures with skewed distributions.

Mixed-effect linear regression models were fitted in SAS software version 9.1 (SAS Institute Inc., Cary, NC, USA) using the PROC MIXED procedure to evaluate the impact of the intervention on the child's weight (in kilograms and weight-for-age Z-score) over the year following recruitment. Random intercepts were included for each MM and each child to account for the hierarchical structure of the data. We also modeled an autoregressive (AR) covariance structure to account for variability between repeated evaluations not accounted for by the random intercepts. The longitudinal model estimates separate baseline means and trajectories for each intervention condition. In doing so, the model allows baseline and trajectory differences across intervention conditions to be disentangled and estimated separately.

Models included covariates for relevant background characteristics (i.e. characteristics anticipated to be associated with child weight or found to differ across intervention conditions); an intervention condition indicator to control for baseline differences in child weight across intervention conditions; time from recruitment; and a time × intervention condition two-way interaction to model both separate mean weights at recruitment and weight trajectories over time for the intervention and control conditions. Based upon the

curved trajectories found in infant growth charts, we anticipated that weight would change in a non-linear manner over the course of the year. Therefore, we also tested covariates for a quadratic time trend to model non-linear weight changes in the overall sample and a three-way interaction between quadratic time and intervention condition to model additional non-linear weight changes in the intervention condition; quadratic covariates were retained if significant. The model for weight in kilograms also included age of the child at recruitment as a covariate; weight-for-age incorporates age into the outcome measure.

Results

Table 1 shows the demographic and background characteristics of mother–child dyads at recruitment. Most mothers were married (70%); the average age was 29.4 years old for mothers and 26.2 months for children. Half the dyads lived in informal housing (48%). A majority of interviewers reported living conditions of the dyads to have a pleasant or neutral smell (87%) and to have at least average hygiene (78%). Slightly fewer than a quarter of the children were supported by a nutrition program (24%) and 41% of children were of low birth weight, defined as less than 2500g at birth. None of the demographic and background characteristics differed significantly across intervention conditions, although two characteristics exhibited trends towards significance. A higher percentage of children in the intervention condition were likely to be in a nutrition program at recruitment compared to children in the control condition (26% vs. 19%; $\chi^2 = 3.54$, df $= 1$, $p = 0.06$). On average, children in the intervention condition weighed less at recruitment (mean=8.6 vs. 9.0 kg; $t = 1.88$, df $= 677$, $p = 0.06$.). WAZ was also significantly lower in the intervention group (mean $= -3.49$ vs. -3.21, $t = 3.07$, df $= 677$, $p = 0.002$). These potential differences across intervention conditions were accounted for in regression analyses by the inclusion of appropriate adjustment covariates.

Table 1. Demographic and background characteristics of mothers and their children at recruitment by intervention condition.

	Control (n = 179)		Intervention (n = 500)		Total (n = 679)		p^e
Maternal characteristics							
	Mean (SD)		Mean (SD)		Mean (SD)		
Mean age of caregiver mothers[a]	29.9	(7.2)	29.1	(7.2)	29.4	(7.2)	0.37
Mean years of residence in Cape Town[b]	10.3	(7.6)	10.0	(7.2)	10.1	(7.3)	0.73
Mean number of living children[c]	2.7	(1.7)	2.6	(1.6)	2.6	(1.6)	0.29
	n	(%)	*n*	(%)	*n*	(%)	
Married vs. single	120	(70.6)	330	(70.4)	450	(70.4)	0.96
Presence of father[c]							0.50
Present	80	(60.6)	230	(56.9)	310	(57.8)	
Maintaining	6	(4.6)	13	(3.2)	19	(3.5)	
Absent	46	(34.9)	161	(39.9)	207	(38.6)	

(*Continued*)

Table 1.   (Continued).

	Control (n = 179)		Intervention (n = 500)		Total (n = 679)		p^e
Child characteristics							
	Mean (SD)		Mean (SD)		Mean (SD)		
Mean birth weight in grams[c]	2574.5	(619)	2494.9	(641)	2514.1	(636)	0.22
Mean weight at recruitment in kg[d]	9.0	(2.5)	8.6	(2.4)	8.7	(2.4)	0.06
Mean age at recruitment in months[d]	27.0	(15.2)	26.0	(15.2)	26.2	(15.2)	0.45
Mean weight-for-age Z-score (WAZ)	−3.21	(0.87)	−3.49	(1.09)	−3.41	(1.04)	<0.01
	n	(%)	*n*	(%)	*n*	(%)	
Male gender	87	(48.6)	253	(50.6)	340	(50.1)	0.65
Low birth weight, <2500 grams[c]	46	(35.9)	173	(43.0)	219	(41.3)	0.16
Supported by a nutrition program	32	(18.6)	120	(25.8)	152	(23.8)	0.06
Cut size of child's meal in past 12 months	71	(41.8)	213	(44.6)	284	(43.8)	0.53
School attended							0.41
Preschool	4	(2.4)	17	(3.6)	21	(3.3)	
Creche	11	(6.7)	18	(3.8)	29	(4.6)	
Informal playgroup	13	(7.9)	48	(10.2)	61	(9.6)	
Not attending	136	(82.4)	386	(82.1)	522	(82.2)	
Unknown	1	(0.6)	1	(0.2)	2	(0.3)	
Household characteristics							
	n	(%)	*n*	(%)	*n*	(%)	
Housing							0.75
Formal	42	(24.3)	125	(25.5)	167	(25.2)	
Site and service	49	(28.3)	120	(24.5)	169	(25.5)	
Informal	81	(46.8)	240	(49.0)	321	(48.4)	
Other	1	(0.6)	5	(1.0)	6	(0.9)	
Access to water							0.57
Tap on site	94	(55.0)	251	(51.8)	345	(52.6)	
Communal tap	72	(42.1)	224	(46.2)	296	(45.1)	
Other source	5	(2.9)	10	(2.1)	15	(2.3)	
Sewage							0.66
Flush toilet	100	(58.8)	270	(56.5)	370	(57.1)	
Bucket	28	(16.5)	94	(19.7)	122	(18.8)	
None	42	(24.7)	114	(23.9)	156	(24.1)	
Overall smell							0.67
Pleasant	39	(23.1)	94	(20.0)	133	(20.8)	
Neutral	109	(64.5)	312	(66.2)	421	(65.8)	
Poor	21	(12.4)	65	(13.8)	86	(13.4)	
Hygiene							0.40
Good	48	(28.1)	111	(23.5)	159	(24.7)	
Average	90	(52.6)	254	(53.7)	344	(53.4)	
Poor	33	(19.3)	108	(22.8)	141	(21.9)	

Notes: [a]*n* = 325 (48% of possible responses).
[b]*n* = 417 (61% of possible responses).
[c]*n* = at least 530 (at least 78% of possible responses).
[d]*n* = 679 (full sample).
For remaining measures, total *n* = 635 or greater (at least 93% of responses).
[e]*t*-Test or Wilcoxon test for means; χ^2 test or Fisher's exact test for percentages.

We compared characteristics from Table 1 between mothers we were unable to follow after recruitment (6%; 39 of 679) and mothers with at least one follow-up assessment. Mothers in the control condition were more likely to be lost to follow-up compared to those in the intervention (11% vs. 4%; $\chi^2 = 13.24$, df $= 1$, $p < 0.01$). Mothers lost to follow-up were also likely to have lived in Cape Town for fewer years compared to mothers who were followed successfully (mean $= 6.1$ vs. 10.3; $t = -2.46$, df $= 415$, $p = 0.01$). None of the other demographic or background characteristics differed significantly by whether or not mothers were lost to follow-up. All observations were included in regression analyses; dyads lost to follow-up contributed only to weight estimation at the recruitment timepoint.

Regression analyses

Analyses on weight in kilograms and WAZ led to the same conclusions; therefore, we present results on WAZ only. We included children's gender and a dichotomous indicator for enrollment in a nutrition program at recruitment as covariates; both were significant predictors of WAZ (both $p < 0.01$). Children in a nutrition program weighed less at baseline. Males also weighed less, consistent with research indicating that male infants thrive less successfully than females (Khoury, Marks, McCarthy, & Zaro, 1985; Naeye, Burt, Wright, Blanc, & Tatter, 1971; VanDenBosch, Huygen, VanDenHoogen, & VanWeel, 1992; Waldron, 1983; Wells, 2000). The quadratic time trend was significant and retained in the model; the quadratic time × intervention condition interaction was not. WAZ trajectories for each intervention condition as estimated by the regression model are shown in Figure 2. Across both conditions, WAZ increased over the one-year follow-up period, initially at a faster rate (linear time slope $= 0.11$ and quadratic time slope $= -0.0040$, $t = 10.95$ and -7.63, df $= 5176$, both $p < 0.01$). At recruitment, WAZ was estimated to be 0.22 points lower in the intervention condition compared to the control condition ($t = 2.11$, df $= 5176$, $p = 0.04$). In the intervention condition, WAZ increased linearly over one year compared to the control condition (slope difference $= 0.018$, $t = 2.25$, df $= 5176$, $p = 0.02$).

Discussion

The Philani program resulted in significantly greater weight gain among malnourished children enrolled in the intervention program, compared to controls, in 37 neighborhoods in South African townships in the vicinity of Cape Town. Poor nutrition is one of the major determinants of child health and survival and is linked consistently to poor cognitive and developmental outcomes over the lifespan (Grantham-McGregor, Powell, Walker, & Himes, 1991; Mason et al., 2005; Stanfield, 1993). As demonstrated by programs such as EFNEP and PD/Hearth, and now by Philani, peer educators and role models can be used successfully to improve nutrition practices in low-resource communities.

These results also support the potential utility of paraprofessional MMs to deliver in-home programs for households at high risk of other negative outcomes for their children. The WHO has advocated successfully for the integrated management of childhood disorders (World Health Organization [WHO], 1997) and has demonstrated that paraprofessionals can be consistently good deliverers of effective programs (World Health Organization [WHO], 2003). The work of Grantham-McGregor and colleagues in Jamaica, for example, shows the effectiveness of home visits by community health aides to improve the cognitive development of malnourished children (Grantham-McGregor et al., 1991; Powell, Baker-Henningham, Walker, Gernay, & Grangham-McGregor, 2004). An evaluation of the mothers2mothers program in KwaZulu-Natal, South Africa (Beck et al.,
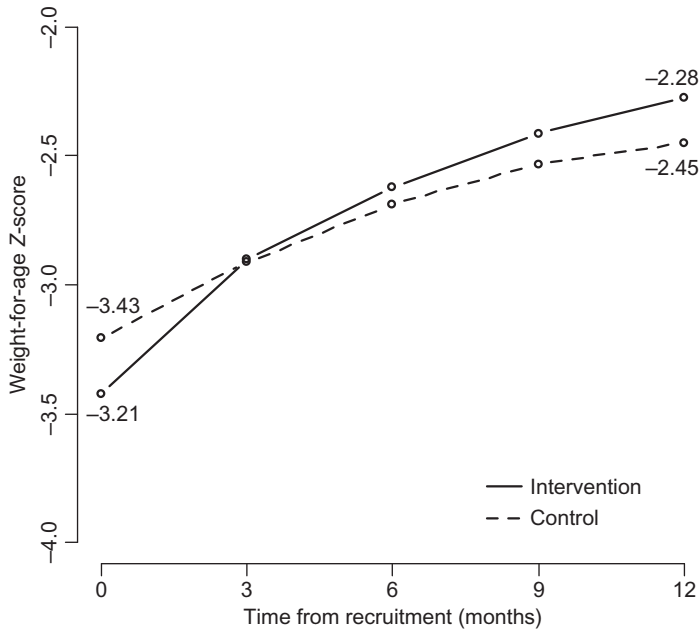
Figure 2.   Plots of model-fitted weight-for-age *Z*-scores (WAZ) over time for initially malnourished children in the intervention and control conditions.

2007) demonstrated the ability of MMs to improve psychosocial wellbeing, increase use of clinical services to prevent mother-to-child human immunodeficiency virus (HIV) transmission and continued utilization of the health-care system, among HIV$^+$ pregnant women. Across geographical contexts and maternal and child health outcomes, peer mentors are an efficacious model for health behavior and structural interventions.

Limitations

It is important to recognize that these are preliminary findings. MMs implemented assignment of families to the treatment condition; the nearly significant difference in child weight at baseline between the intervention and control groups indicates that reassignment of needier families into the intervention probably took place, and prevents this from being a truly randomized study. The loss to follow-up was significantly greater in the control condition compared to the intervention condition, suggesting that there may have been bias as mothers in need of support and intervention dropped out of the study. In addition, because MMs conducted the intervention as well as collected data, assessments were not blinded as to study arm. Finally, because randomization took place within each neighborhood, with the possibility of close neighbors being assigned to different arms of the study, it is possible that contamination could have occurred in which women receiving the intervention shared information and support with women in the control arm. Given these preliminary findings, we are currently conducting a randomized controlled trial with neighborhoods assigned to intervention and control conditions, that is, randomization occurs at the neighborhood level rather than the individual level. Assessments are conducted by an independent team, not

MMs. This will prevent the possibility of MM bias during the condition assignment process or during data collection, as well as preventing contamination of intervention effects from mothers in the same neighborhood.

Conclusion

In the United States, home visiting programs such as that of Olds et al. have been effective and broadly diffused (Gomby & Culross, 1999; Olds, Hill, & Rumsey, 1998; Olds, Sadler, & Kitzman, 2007; Olds et al., 2002, 2004a, b; Sweet & Applebaum, 2004). These programs target multiple child development and parenting outcomes, not just nutrition. Although the US experience has shown the greatest effectiveness when home visitors are professional nurses, paraprofessional visitors have also provided significant improvements (Olds et al., 2002, 2004b). The huge differential in costs and the shortage of trained medical personnel in South Africa favor implementation with paraprofessionals, especially those who are chosen on the basis of the theory of positive peer deviants (Berggren et al., 1984; Marsh et al., 2004; Marsh & Schroeder, 2002; Rogers, 1983; Sternin et al., 1998; Wollinka et al., 1997). The MM model could become a vehicle for addressing a variety of conditions, relating to nutrition, alcohol, mental health and HIV, that confront families in South Africa. This is a significant shift from existing prevention models that do not integrate prevention efforts vertically to target simultaneously the health behaviors that lead to major diseases affecting African women, children and families.

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