



Effects of a preschool intervention on cognitive development among East-African preschool children: A flexibly time-coded growth model

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ABSTRACT

The aim of the study is to investigate the effects of the Madrasa Resource Center (MRC), a child-centered intervention program, on East-African (Kenya, Zanzibar, and Uganda) preschool children's cognitive development. Altogether 321 children (153 non-intervention and 168 intervention) participated in a cross-sequential study over three time-points during preschool (mean ages 4.3, 6.0, and 7.1 years). A multilevel model (MLM; time-points nested within children nested within schools), in which time was coded flexibly (i.e., child's age operationalized as months from start of the intervention), showed a beneficial curvilinear effect of the intervention program on children's cognitive gains. A moderation analysis suggested that the effect of observed preschool quality (ECERS) was stronger in the intervention program. The findings are discussed within the context of East-African preschool policy.

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Education in developing countries, and in East (sub-Saharan) Africa in particular, faces several challenges, such as insufficiently trained teachers, overcrowded classrooms, low levels of cognitive stimulation and, as a consequence, deteriorating educational outcomes, and a high level of dropout due to the lack of both material and human resources (Kholowa & Rose, 2007; King, 2007). As in industrialized countries, the introduction of preschool is seen as a way of improving educational equity and, when in parallel with other measures, is a way of combating poverty and societal exclusion, promoting health care, and advancing societal inclusion. As preschool is a relatively recent phenomenon in East (sub-Saharan) Africa, it is important to know more about its potential benefits on children's cognitive development. As a region, sub-Saharan Africa is among the most disadvantaged areas in the world, with poverty, malnutrition, short life-expectancy, high prevalence of diseases, high child mortality, and stunted child development (Alderman & Engle, 2008; Grantham-McGregor et al., 2007; Iglesias & Shalala, 2002; Liddell & Rae, 2001).

In a previous study, we reported on the effects of the Madrasa Resource Center (MRC) child-centered intervention on cognitive development of preschool children in disadvantaged Muslim communities in Kenya, Zanzibar, and Uganda (Mwaura, Sylva, & Malmberg, 2008). To discern the intervention effect between onset and half-way through preschool, multiple regression models were

carried out, using raw scores of school readiness outcomes, and controlling the effects of age and a range of covariates between the start of preschool and halfway through the program (Mwaura et al., 2008). The findings show that children in the MRC intervention had larger verbal, non-verbal, and mathematical gains than the comparison group, and both groups outperform children who stayed at home. In the present study, we go beyond that study in three ways. First, the intervention effects up to the end of preschool are investigated. Second, in order to increase precision of the cognitive measures, age-residualized scores are used in conjunction with a flexibly coded time-variable (coded as time elapsed from the first measurement). Third, we use a three-level multilevel model (MLM; time-points nested within children, nested within preschools) to account for differences in classroom practices across preschools.

1. Stimulation of children's cognitive development in preschool

Following models of Bronfenbrenner (1979; Bronfenbrenner & Morris, 1998), development is viewed as an interactive process between the individual and the environment. The influences vary as a function of the individual, the proximal environmental context (here the classroom in a preschool setting), the more distal environmental context (here the policy context), and time (longitudinal follow-up from beginning to end of preschool). In order to extrapolate how a preschool intervention might be successful in stimulating children's cognitive development in the East African context, we draw on a range of literatures: those on effects of health interventions, preschool attendance, and quality

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of preschool on shorter- and longer-term academic outcomes (e.g., school readiness, literacy, and numeracy), and equivalent studies in industrialized countries.

It is estimated that more than 200 million children in developing countries do not reach their potential of cognitive development, due to lack of nutrition, early stimulation, or resources. While there is consistent evidence for the impact of health-intervention programs in raising children's health status in developing countries (Grantham-McGregor et al., 2007), there is now a growing body of evidence regarding success of preschool interventions on cognitive outcomes related to school readiness (Engle et al., 2007; Moore, Akhter, & Aboud, 2008). Health interventions, which include child nutrition supplement, regular maternal health care checks, support, and inoculations, have been successful in reducing child mortality and diseases (Grantham-McGregor et al., 2007). These have indirect effects on child cognitive development through promotion of physical growth and brain development (Engle et al., 2007).

Results from preschool interventions are in line with those from health interventions in developing countries, however effect sizes are smaller (Engle et al., 2007; Grantham-McGregor et al., 2007). Some observational studies of preschool quality have been carried out in developing countries. For example, a study in Bangladesh (Moore et al., 2008) found that higher levels of observed preschool quality predict higher school readiness. In South Africa (Liddell & Rae, 2001) school readiness increased school performance, and decreased dropout rates, grade retention, and absence once in primary school. Mwaura et al. (2008) found that children who had attended 18 months of preschool had higher levels of school readiness in verbal, non-verbal, and numeric aspects of cognition, than children who had not attended preschool, and those children who attended a child-centered intervention had higher levels of school readiness than those who attended state or Non-Government-Organization-run preschools.

When effects of preschool are found in developing countries, they are in line with studies conducted in Western countries, where both childcare and preschool quality are predictive of children's short-term or concurrent developmental outcomes (National Institute of Child Health and Development, Early Child Care Research Network, [NICHD ECCRN], 2003a; Sammons et al., 2004), and longer term cognitive and social development reaching in to the primary school years (Belsky et al., 2007; Duncan et al., 2007; NICHD ECCRN, 2003b). Studies in developed countries show consistent effects of preschool structure and processes on cognitive and social developmental outcomes. Structural aspects such as the educational level or specialization of the staff (Arnett, 1989; Dowsett, Huston, Imes, & Gennetian, 2008), adult-to-child ratio (Pianta et al., 2005), type of preschool (Sammons et al., 2003), and children's access to and use of appropriate learning materials (Pianta, La Paro, Payne, Cox, & Bradley, 2002), have been found to promote children's academic and social school readiness. In line with studies of the beneficial effects of parental sensitivity for child development (Ainsworth, 1973; Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004), educational processes such as emotional support, warm and appropriate teacher-child interactions (Marjanović Umek, Kranjc, Fekonja, & Bajk, 2007; Pianta et al., 2005), and the use of cognitive stimulation and sustained language interactions in the classroom (La Paro, Pianta, & Stuhlman, 2004; Pianta et al., 2002), have also been shown to be beneficial for children's developmental outcomes.

Such process variables, usually termed *global classroom quality*, show stronger effects than structural variables (Howes et al., 2008). School readiness in preschool is related to outcome assessments in kindergarten and first grade in primary school, with a meta-analysis showing average cross-time relations of $r = .43$ in the cognitive domain and $r = .32$ in the social domain (La Paro & Pianta, 2000). There is also some evidence that higher quality is more ben-

eficial for disadvantaged than advantaged children (Burchinal & Cryer, 2003), but there are also studies suggesting that all children, both those experiencing social risk and those who were not, benefit from higher quality child care (Burchinal, Peisner-Feinberg, Bryant, & Clifford, 2000).

Taken together, there is some evidence, in both developing and developed countries, that attending preschool itself relates to concurrent and later academic outcomes, that a higher classroom quality relates to higher concurrent and later academic outcomes, and that high-quality preschool can have stronger effects on concurrent and later academic outcomes for more disadvantaged children. Given the severe challenges facing East African countries: poverty, ill health, and exclusion (Engle et al., 2007; Kholowa & Rose, 2007; King, 2007; United Nations Educational, Scientific and Cultural Organization, Government of Kenya [UNESCO, 2005; United Nations International Children's Emergency Fund [UNICEF], 2005), it is important to investigate whether higher quality preschool can contribute to alleviating these challenges in such settings.

1.1. The Madrasa Early Childhood Development Program

The Madrasa Early Childhood Development Program started with a request, made by Muslim communities in Mombasa, Kenya to His Highness the Aga Khan, to assist in improving educational standards by providing opportunities for Muslim children in the area. The program took the traditional institution of education in Muslim societies, the Madrasa, and sought to revitalize it to provide appropriate and community-based preschool education of high quality for Muslim children who were at the time among the most educationally disadvantaged and under-performing students in the country. In the traditional Muslim education system, children were taught in a teacher-centered manner and the curriculum did not focus on secular knowledge and skills. As a result, children from the traditional Madrasa were rarely admitted to high-performing primary schools. The Madrasa Resource Center (MRC) then developed a comprehensive approach to Early Childhood Education and Development (ECD), that created a high-quality early learning environment, and a curriculum in which religious and secular content were integrated with cultural and religious values, in keeping with practices of the local communities.

In all three countries, preschool teachers need a minimum of eight years of schooling plus a one-year teacher training. Most preschool teachers are of secondary school level though some may not have completed all four years. Above this, MRC teachers have their own initial training in the centers lasting six months leading to an ECD certificate. After graduation, they continue to get post-graduation support as a form of professional development. In particular, the MRC staff are trained to use locally available low-cost materials for children to select, explore and experiment with, and to use appropriate language to stimulate children's curiosity in a sensitive and supportive way (Aga Khan Development Network [AKDN], 2008). This teaching approach goes under the acronym MAMACHOLASU (MA: material; MA: manipulation; CHO: choice; LA: language and SU: support). The basic elements of the approach are in line with constructivist theory about child development (Piaget, 1963; Vygotsky, 1978), and the active participatory learning curriculum of the High/Scope program (Schweinhart & Weikart, 1993). It is also in tune with research demonstrating beneficial effects of both material aspects (i.e., choice of materials to explore and manipulate) and process aspects (i.e., use of elaborate language and provision of support) of early years education, which are crucial parts of the promotion of preschool children's cognitive development (La Paro & Pianta, 2000; Tonyan & Howes, 2003).

The intervention was initiated among disadvantaged, mainly but not exclusively Muslim families in East Africa, in order to

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