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Effects of a 3-year integrated maternal and child unconditional cash transfer intervention on early childhood development in Malawi: a cluster-randomized controlled trial (MAZIKO-IE).

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Abstract

Background: 1.4 billion children live in poverty and at risk of not reaching their developmental potential. Multi-sectoral programs addressing the underlying determinants of development can reach children at scale. Evidence gaps exist on the effectiveness of programs embedded in government systems.

Objective: The MAZIKO trial examined effects of nutrition-sensitive social behavior change (SBC) integrated with two cash transfers (CTs) levels on child development outcomes in communities receiving a standard of care (SoC) government program in Malawi.

Methods: A cluster-randomized controlled trial was conducted in 156 village clusters randomly assigned to (1) SoC, (2) SBC, (3) SBC+lower CT (USD17/month), or (4) SBC+higher CT (USD43/month). The trial included (index) women 15-49y who were pregnant or mothers/female caregivers of children <2y at baseline, and (index) children. The primary outcome was child development age adjusted z-score (DAZ), assessed using Malawi Development Assessment Tool (MDAT). Effects were by intent to treat, estimated using mixed effects regression at population-level and in prespecified subgroups, including sex, intervention timing, and wealth quintiles.

Results: Index women (n=2,677) were surveyed at baseline (June 2022) and endline (n=2,430, June 2025). There were no substantive differences between arms at baseline. At endline, index children were aged 3.3y (n=2,096). Positive effects of the SBC+CT were found on children's diets and caregiving environment. SBC+CT interventions increased the proportion of children with adequate energy

consumption, and mean probability of adequacy of micronutrient intake (MD 5.9% (CI 1.0, 10.7) SBC+lower CT, MD 8.6% (CI 3.5, 13.7) SBC + higher CT). No effects were found on MDAT DAZ score. Sub-group analysis found that SBC+higher CT increased MDAT DAZ scores in girls (MD 0.26 (95% CI 0.02, 0.49)), including fine motor development DAZ.

Conclusions: Integrating SBC with CTs in Malawi can improve children's diets and caregiving practices, and ECD in girls, though only higher value CTs were effective.

Registration: The trial was prospectively registered with ISRCTN, number ISRCTN53055824.

Keywords: Cash transfers, behavior change, early childhood development, nutrition, trial.

1. Introduction

Recent estimates suggest that 1.4 billion children live in poverty[1]. Poverty during early life contributes to sub-optimal child development [2], and poverty-related risks to child development can be most salient in food insecure households, lacking basic infrastructure and where children are more vulnerable to infections[3]. Multi-sectoral programs addressing the broader drivers of child nutrition and development can provide platforms for implementing interventions at scale[4,5]. These programs include interventions which support ECD, social protection and integrated agriculture and nutrition interventions.

Interventions in ECD can improve young children's cognitive, motor and socio-emotional development [3,6–8], and are among the most cost-effective investments in human capital [9–11]. Examples of interventions include programs that combine parent training on responsive caregiving and nutrition, to improve young children's cognitive, motor, and socio-emotional development[3,6,7]. However, there is limited evidence of long-term impacts and the extent to which programs address the underlying causes of developmental difficulties[12]. More recent combined programs, including nutrition interventions integrated with responsive caregiving, social protection and agriculture, are thought to provide effective scale-up platforms. However, evidence on combined program effectiveness is mostly from small-scale studies, with less evidence available on interventions integrated into government systems [13]. In practice, coverage and quality of implementation of ECD programs in low- and middle-income countries (LMICs) is also low [14].

A systematic review of cash transfer (CT) interventions on ECD in LMICs found that CTs had positive effects on children's cognitive, language, and gross-motor development, with conditional CTs also showing effects on socio-emotional outcomes [15]. Effects were strongest in conditional CT interventions, or in "Cash+" interventions integrating health, nutrition, and parenting activities. Systematic reviews of CTs on maternal and child nutrition outcomes similarly show consistent positive effects on dietary intake, and less consistent evidence on micronutrient status and anthropometric outcomes[16,17]. Emerging evidence from Cash+ programs shows some success in improving linear growth in children [18]. In parallel, evidence from well-implemented, nutrition-sensitive agricultural social-behavior change (SBC) interventions suggests consistent impacts on diets, mixed evidence on children's nutritional status, and limited evidence on ECD outcomes [4,19]. The literature is also suggestive of synergies from coupling nutrition-sensitive SBC with CTs, as in Cash+ interventions, particularly in food insecure contexts[20]. Theory suggests that relaxing budget constraints through CTs may reduce vulnerability to economic shocks, allowing households to fully realize the benefits of SBC [15]. Few Cash+ evaluations, however, have attempted to understand what level of cash is necessary to improve ECD, alongside SBC or other interventions [15].

The MAZIKO trial assessed the effects of a nutrition-sensitive SBC intervention alone or integrated with one of two levels of CTs on the adequacy of micronutrient intake in mothers of young children, and on ECD outcomes, in communities already receiving a standard of care government program [21]. This study reports the effects of the MAZIKO program on ECD, the child-level primary

outcome of the trial, and on a set of pre-specified child- and childcare-related secondary outcomes on the program impact pathways (PIPs), including children's dietary adequacy, and parenting and stimulation practices.

Country context

Malawi has one of the highest rates of child malnutrition in the world, with over one third (38%) of children aged 6–59 months moderately or severely stunted and 63% anemic[22]. Over 5 million people face moderate or severe chronic food insecurity due to poverty and recurrent shocks, including extreme weather events and economic crises[22]. Chronic poverty persists, with over 70% of the population living below the international poverty line of $1.90/day. Recent analyses estimate that 40% of children aged between 3 and 4 years of age were "not developmentally on track", with only 17% developmentally "on track" in literacy and numeracy[23]. Government investment includes sacling-up the "Investing in Early Years for Growth and Productivity Project" (IEYP) that has been improving coverage and utilization of ECD services, including strengthening Community-Based Childcare Centers (CBCCs)[24]. The IEYP design drew on evidence from a cluster-randomized control trial (RCT) which showed that a nutrition-sensitive agricultural intervention implemented through CBCCs had large, positive effects on diets in preschoolers (3-6 years) and their younger siblings (6-24 months), and on linear growth and stunting prevalence in 6-24-month old children, though no effects were found on ECD outcomes in preschoolers [25]. In parallel, a RCT of the Social Cash Transfer Program, an unconditional CT program targeted to ultra-poor, labor constrained households, found positive effects on household food consumption but no impact

on child anthropometry outcomes [26]. The scale-up of government programs provide an opportunity to assess the effectiveness of complementary approaches to improve maternal and child nutrition and development, including potential integration with the Social Cash Transfer Program.

2. Methodology

2.1 Study design and participants

The design and methods for the MAZIKO trial have been published elsewhere[21]. Briefly, a 3-year cluster-RCT was implemented in two districts of Malawi, including 156 communities randomized to one of four arms: (1) standard of care (SoC) arm: receiving standard government program; (2) SBC arm: receiving SoC intervention with additional nutrition- and gender-sensitive SBC activities to improve nutritious food production, diets, and care practices for young children; (3) SBC+ lower CT arm: SoC plus SBC plus a maternal and child cash transfer of ~17 USD per month at baseline; and (4) SBC+ higher CT arm: SoC plus SBC plus a maternal and child CT of ~43 USD per month at baseline. Outcome measurements were undertaken at baseline and endline (3 years post baseline). All analyses presented in this paper were pre-specified. The trial was prospectively registered with ISRCTN, number ISRCTN53055824.

The study area comprised two contiguous districts of Balaka and Ntcheu, targeted due to high levels of malnutrition, service delivery gaps, the presence of implementing partners, and government priorities[27]. Targeted areas were divided into 156 clusters (communities in CBCCs catchment areas). The MAZIKO trial included pregnant women aged 15-49 years and mothers/female caregivers (aged

15-49 years of age) of children <2 years of age at baseline. At cluster level, all women who met inclusion criteria were eligible to participate. A household census was conducted in each cluster to construct a list of eligible households. Index mothers were randomly selected from the listing for survey inclusion, with sample selection stratified by pregnancy status.

2.2 Randomization and masking

Clusters were randomly allocated to intervention arms using a restricted randomization procedure including district level stratification[21]. Treatment allocation was modelled using baseline village-level characteristics to maximize balance. The algorithm assessed 5,000 random allocations and the permutation that minimized the R^2 was selected. Masking of participants and implementers was not possible due to obvious interventions differences. Data collection teams were blinded to intervention allocation. Results were unblinded by a non-study researcher upon completion of data analyses.

2.3 Procedures

Intervention and evaluation design was guided by the "All Children Surviving and Thriving" framework, incorporating the Nurturing Care Framework and UNICEF models on the causes of malnutrition[3]. This framework includes five proximal components necessary for children to thrive: nutrition, health, opportunities for early learning, responsive caregiving, and security and safety. These components are supported by the enabling environment extending from households to communities, programs, and policies, which are influenced by distal factors including political, socio-economic, and climate change processes [3].

Ethical approval was received from institutional review boards at the University of Malawi (# 02/22/128) and International Food Policy Research Institute (# PHND-22-0214).

Standard of care (SoC)

Details on intervention activities have been published elsewhere and are also provided in (**Annex 1**). The SoC intervention reflected national policy, centering on Care Groups- volunteer-based platforms to maternal, infant, and child nutrition care practices, including Infant and Young Child Feeding (IYCF), health and hygiene, ECD and promotion of essential health services through regular home visits and counselling sessions. Other existing volunteer-based outreach reach platforms included CBCCs and Village Savings and Loans (VSLAs). The CBCC component relied on implementation of the government policy and IEYP initiative to strengthen ECD services [24]. The SoC intervention was the same across study arms.

Nutrition sensitive SBC intervention

The nutrition-sensitive SBC comprised agriculture and livelihoods, Male Champions, and Caring for the Caregiver activities [27]. The agriculture and livelihoods activities provided agricultural inputs (e.g. seeds) and training using CBCCs and community gardens as demonstration plots, while also strengthening VSLAs. Three agricultural trainings were conducted at baseline, with yearly refreshers. The curriculum included: (1) nutrition-sensitive agriculture, integrated farming, production and dietary diversification, food processing, food safety, and hygiene; (2) post-harvest losses; and (3) climate-smart and conservation

198 agriculture. VSLA support included a one-off cascade training of community-based
199 trainers by Save the Children using government materials, with the volunteer
200 trainers subsequently providing training on enterprise development and business
201 skills for VSLA members. The Male Champions approach involved fathers and
202 husbands in biweekly group and couple sessions to improve intra-household
203 relationships, sharing of decision-making, resources, and chores, and reduce
204 gender-based violence. Save the Children staff identified and trained Male
205 Champions, who in-turn trained father leads. Father leads facilitated group sessions
206 where men discussed their roles as fathers and husbands. This component
207 targeted fathers of children <5 years and husbands of women enrolled in the trial[27].
208 Couple sessions involved biweekly home visits with women and their husbands,
209 conducted by lead fathers. The Caring for the Caregiver activities aimed to improve
210 capacity of Care Group leaders and Male Champions to support and promote
211 women's mental health and wellbeing. All interventions were delivered at the same
212 frequency in the three SBC intervention arms.

213 *Cash transfers (CTs)*

214 Monthly CTs were provided by Give Directly to index women through mobile
215 phones linked to bank accounts, independent of participation in SBC activities.
216 Transfers were set at monthly Malawian Kwacha equivalent of USD17 (lower CT)
217 or USD43 (higher CT), at exchange rates at baseline in June 2022. These values
218 were determined through analysis of household consumption and cost of diet[27].
219 Transfer values were readjusted after a midline process evaluation to reflect
220 baseline USD values using official exchange rates.

Timeline

The baseline survey was completed in June 2022 and randomization was completed in August 2022. Staggered implementation of SBC components was by design: The Care Group and VSLA interventions began in October 2022; CTs in November 2022; distribution of agricultural inputs and agricultural trainings were completed in November 2023; Caring for the Caregiver and Male Champions activities began in September 2023. The endline survey was completed in June 2025.

Data collection

Data collection was undertaken through structured questionnaires using Android tablets running SurveyCTO software. Enumerators were trained for three-weeks prior to data collection. The Malawi Developmental Assessment Tool (MDAT) was used to assess ECD in children aged <5y at endline, including gross motor, fine motor, language, and socio-emotional development assessments, with cognitive function assessed in items within fine motor and language developmental domains [28]. As pre-specified in the protocol, cognitive and fine motor items were added at endline to mitigate aging-out of MDAT target age for children >5y and included as part of the robustness analyses [21]. Items were extracted from the International Development and Early Learning Assessment (IDELA) tool appropriate for children aged >3.5y, including three emergent numeracy items (sorting and classification; number identification; one to one correspondence), two emergent literacy items (letter identification; first letter sounds), and one fine motor (drawing a person) item [29]. Child development assessments were administered by

enumerators in children's homes. Enumerators were trained using standard operating procedures, including practicing measurements through standardization exercises. Inter- and intra-observer variation of measurement error was documented and corrections to procedures were made prior to data collection.

Dietary assessment was undertaken using the interactive multiple-pass 24-hour recalls with index mothers and children[30]. Quantification methods for portion sizes included weighing of a replica, volume measurement, a picture atlas, modelling food size with salted replicas for commonly consumed foods like "nsima" (porridge), household measures, or market prices. Household recipes were collected for mixed dishes. A second recall was undertaken in 20% of the sample on a non-consecutive day to allow for estimation of usual intake (**supplemental materials section A2**)[31]. Data on parenting practices and home stimulation environment were collected using tools adapted from studies in Malawi based on the Support for Learning and Positive Parenting module from UNICEF Multi-Indicator Cluster Surveys[32–35]. Stimulation was assessed through 14 items measuring frequency of stimulating caregiver-child interactions (by caregiver) in the three days preceding assessment (e.g. reading/looking at picture books, telling stories, singing songs etc.). Parenting practices were assessed using six items examining behavioral management strategies during the previous month including three items on positive and three on negative parenting practices. Data on self-reported participation in MAZIKO interventions were collected at endline. A range of other household-, and caregiver-level indicators were also collected, including

food and non-food consumption expenditures[36], food security status, women's empowerment[37] and mental health[21].

2.4 Outcomes

The ECD indicator (MDAT development age z-score (DAZ)) reported is the prespecified child-level primary outcome of the MAZIKO trial. Domain-specific and aggregate MDAT scores were calculated using standard procedures[28]. The MDAT tool includes norms for Malawian children that were used to convert raw scores to age adjusted development z-scores (DAZ) for children aged <5y. Children with severe developmental delays at endline (i.e. MDAT DAZ <-2) were excluded from analyses[21,38]. As part of the robustness analyses, additional items from IDELA for children aged >3.5y were scored individually, and item scores were also summed to generate emergent numeracy, literacy, and fine motor scores. Other pre-specified intermediate outcomes on the program impact pathways **(Figure 1)** were measured. A maternal knowledge score of nutrition practices (range 0-9) was constructed summing correct responses to questions on infant and young child feeding practices. For parenting practices, following [35], data from these items were analyzed individually and also summed to create scores on caregiver practices, including number of stimulation activities by caregiver in the past 3 days (range 0-14), and number of positive and negative parenting practices (each with range 0-3). Children's diet quality was assessed using three constructs, including 1) individual dietary diversity score, defined as the number of food groups consumed the previous day out of 10 food groups, a score validated against nutrient adequacy in this age group[39,40]; 2) probability of adequate intakes of 11 key micronutrients[41];

and 3) mean probability of adequacy, defined as the mean of 11 micronutrient probabilities of adequacy. Gram quantities of foods children had consumed over the previous 24 hours were converted into nutrients using a food composition table adapted for Malawi [42], including adjustments for nutrient retention of cooked foods[43].

2.5 Statistical analysis

The primary outcomes of the trial were ECD and women's mean probability of adequacy of micronutrient intake (reported elsewhere)[21]. Cluster and resource availability suggested ~40 clusters per arm and 20 mother-child dyads per cluster. Power calculations conducted for primary outcomes suggested a minimum detectable effect size of 0.26 standard deviations (SDs) for MDAT DAZ and 0.31 SDs for mean probability of adequacy. The analysis was by intent-to-treat using linear mixed effects regression models to estimate impact of the interventions using fixed effects for intervention assignment and cluster (randomization unit) as a random effect. All estimates were mean differences (MD) with 95% confidence intervals (CI). Primary analyses were unadjusted for baseline covariates. Robustness analyses included estimating effects on emergent literacy and numeracy in children aged >3.5y; adjusting estimates controlling for district and a-priori selected baseline covariates, including women's age (<18 vs ≥18 y), education (primary/lower vs secondary/higher), marital status (married vs unmarried), household head status (self vs other), household head sex (female vs male), and household wealth (lower vs higher quintiles of household expenditures); and lastly, exploring treatment-on-the-treated effects accounting for receipt of the CTs (based on monitoring data) and at least one SBC intervention (based on self-

report). Missing data were not imputed. Effect modification was assessed in pre-specified sub-groups, including child sex (male vs female), mother's baseline pregnancy status (pregnant vs child <2 years of age), and baseline household wealth (lowest two vs highest three quintiles of household expenditures)[21]. Post-hoc contrast estimation was used to generate effect estimates for each subgroup. Missing data for effect modifiers were imputed using cluster-level means. Interactions were considered statistically significant at $p<0.10$. All analyses were conducted in Stata (Version 18).

3. Results

3.1 Baseline characteristics and loss to follow-up

The trial enrolled 2,677 households (**Figure 2**). At baseline, approximately 50% of women were pregnant (at 22 weeks' gestation on average), were on average 25 years old, 78% were married, and 22% had some secondary or higher education (**Table 1**). Households had four members on average, and 32% were headed by women. Household, maternal, and child characteristics were comparable across intervention arms at baseline, though a higher proportion of households in the SoC arm were in the lowest expenditure quintile relative to other arms; a higher proportion of household heads were female in the SBC arm compared to other arms; and a lower proportion of women were married in the SBC arm compared to other arms. On average, CTs represented 22% (lower CT) and 38% (higher CT) of baseline monthly expenditures. The endline survey included 2,163 households, leading to a 19% loss-to-follow-up which is within expectations from a 3-year longitudinal study. The analytical sample for the primary MDAT analyses included

2,096 index children aged <5y: 537 in the SoC arm, 519 in the SBC arm, 520 in the SBC + lower CT arm, and 520 in the SBC + higher CT arm.

3.2 Program uptake

All program activities had been implemented at endline, though self-reported coverage varied by component (**Table 2**). Participation was below 60% for Care Group-related activities; coverage of couple sessions was below 25% and father participation in male engagement activities was below 40% in all intervention arms. VSLA membership ranged between 46% (SoC) and 61% (SBC+lower CT). Coverage of the seed provision ranged between 85% (SBC) and 89%(SBC+lower CT), and maternal CTs coverage ranged between 72% (SBC+lower CT) and 81% (SBC+higher CT). In addition, less than 30% of mothers were involved in CBCC activities. Participation levels were generally similar across SBC intervention arms, except for participation in VSLAs, where levels in the SBC+CT arms was ~15pp greater than in the SBC arm alone.

3.3 Caregiver related knowledge and practices

No effects of the interventions were found on mother's infant and young child feeding knowledge score. In the SBC+higher CT arm, a range of positive effects were found on the caregiving environment (any children's or picture books available, index child plays with toys from a shop or manufactured toys), and on involvement of mother and father in interactions and stimulation activities with index child (positive effects in 16 out of 46 relevant indicators), including on mothers engaged in more than 4 stimulation activities **(Annex table 1**). Some positive effects were also found in the SBC arm, though these were limited to a smaller set of interactions between caregiver and index child (5/46 relevant indicators). There

was evidence of limited effects of the SBC+lower CT intervention on these outcomes (positive effects on 2/46 relevant indicators). There was no evidence to suggest effect modifiers in the pre-specified subgroups.

3.3 Children's diets

Analysis of usual intake suggested that the SBC+CT interventions increased the proportion of children with adequate energy consumption (MD 8.7% (CI 3.6, 13.8) in SBC+lower CT; MD 10.5% (CI 5.7, 15.3) in SBC+higher CT), and the mean probability of adequacy of micronutrient intake in children (MD 5.9% (CI 1.0, 10.7) in SBC+lower CT, MD 8.6% (CI 3.5, 13.7) in SBC+higher CT) **(Annex table 2**). These effects were driven by improvements in the probabilities of adequacy of vitamin A and vitamin B6 in SBC+CTs, with SBC+higher CT also increasing adequacy of intake of thiamine and zinc. There was no evidence of effects of the SBC intervention alone on any of these indicators. Similarly, analysis of usual intakes found that the SBC+CT interventions increased intakes of macronutrients (kilocalories, protein, fiber, carbohydrates, fat) and micronutrients (vitamin A and vitamin B6), with SBC+higher CT also increasing intake of riboflavin and vitamin C, while the SBC intervention increased intake of folate and iron. The SBC+CT interventions improved dietary diversity and the prevalence of children consuming 5 or more food groups **(Annex table 3**), driven by the higher likelihood of consumption of nutrient dense foods, including eggs (SBC+CTs) meat, poultry and fish (SBC+lower CT), nuts and seeds (SBC+higher CT), and other vegetables (SBC+higher CT). There was no evidence of effect modifiers in the pre-specified subgroups.

3.4 Child development

At the population level, there was no evidence of intervention effects on MDAT DAZ score or the 4 MDAT sub-domains in index children aged <5y at endline. Similarly, no effects were found on the IDELA emerging literacy and numeracy sub-items in children aged >3.5y. However, the results of the pre-specified sub-group analysis found that the SBC+higher CT improved the MDAT DAZ scores in girl index children aged <5y MD 0.26 (95% CI 0.02, 0.49), and fine motor development DAZ by MD 0.15 (95% CI -0.04, 0.34) (**Figure 3, Table 4**). Point estimates for DAZ in boys were negative but not significant MD -0.17 (95% CI -0.4, 0.06). No evidence of subgroup effects was found in the IDELA emerging literacy and numeracy sub-items in children aged >3.5y. The results of the robustness analyses, including adjusted and treatment on the treated analyses were consistent with primary analyses presented.

4. Discussion

This study assessed the impact of a nutrition-sensitive SBC intervention delivered alone or in combination with two levels of CTs on ECD. The analysis also explored intervention effects on pre-specified secondary trial outcomes on pathways linking nutrition-sensitive interventions to ECD, including children's diets, and parenting and stimulation practices. The interventions did not improve the primary ECD outcome in the study population. However, prespecified subgroup analyses provided evidence that the SBC+higher CT improved overall ECD and fine motor/cognitive development among girls with no corresponding benefit observed in boys. Although it is not clear as to why girls alone benefitted from the intervention, the plausibility of improvements in ECD is supported by corresponding

improvements in diet quality and parenting practices in index children, two key components necessary for children to thrive[3]. Parallel studies from the MAZIKO trial found that SBC+higher CT improved maternal mental health [44], suggesting a third mechanism through which SBC+higher CT may have influenced ECD. In contrast, effects of SBC+lower CT on intermediate outcomes were more modest than those observed for SBC+higher CT, in terms of the range of outcomes affected and magnitude of effects. The SBC only intervention showed mostly null results. Previous studies in Malawi have shown that SBC approaches can be effective to improve ECD[35], diets and nutrition[45], at least in the short-term, however none focused on implementation through Government health systems. Process data suggests that though the SBC was comprehensive in terms of content, coverage and uptake was sub-optimal, particularly for components relating to Caring for the Caregiver, Male Champions and CBCC linkages, reflecting challenges of integration with government systems.

With regards to CTs, findings suggest that higher value CTs, when combined with SBC, were more effective in generating measurable changes along pathways relevant to ECD, although evidence of an effect on ECD itself was limited to girls. While the SBC+lower CT intervention improved children's diets and some parenting practices, they were not sufficient to improve ECD. These findings underscore that the value of CTs may be critical in ensuring that social protection and nutrition investments can translate into ECD. The cost-effectiveness and financial implications of scaling-up the SBC+higher CT are important areas for future investigation.

Evidence from a recent systematic review suggests that CTs can benefit cognition, language, gross motor and socio-emotional outcomes[15]. However, most of the evidence is from programs where only cash was provided, with more limited evidence on combining cash with parenting programs[46]. Effectiveness varied by CT design, with strongest effects for conditional CTs and for Cash+ programs. In Mexico, parenting support provided in addition to CTs improved cognition, memory, and language development relative to CTs alone [47]. In Tanzania, parenting and nutrition support integrated with small CTs supporting antenatal and growth monitoring visits improved cognitive, language, and motor development relative to control, whereas parenting and nutrition support alone improved only cognitive development[48]. The effects on ECD observed in our study in girls were approximately three times larger than those reported on cognition in the systematic review[15]. Though there is some evidence that there are gender differences in development test scores and testing behaviors[51], and that nutrition interventions have been more effective in influencing cognition in girls [49,50], to our knowledge effectiveness evidence is limited to primary school-age children receiving school meals. Understanding whether the mechanisms underpinning these effect remains an important area for future investigation to support program design and implementation improvements.

The evidence on the effects of the SBC+CTs on children's diets, including improvements in the adequacy of micronutrient intake and diet diversity, two important outcomes in the context of food insecure households in Malawi, is largely consistent with the evidence on nutrition sensitive social protection[51]. Evidence on

451 the effects of parenting SBC interventions alone, including a systematic review and
452 meta-analysis of 18 studies in LMICs, show benefits in ECD and stimulation at
453 home in a majority of studies[8]. In our study, the null effects of the SBC alone on
454 ECD and intermediate outcomes suggests that economic conditions may have
455 been binding constraints for caregivers in the current Malawian context. Lower-
456 than-intended uptake of some SBC components may also have attenuated
457 intervention effects, particularly given the relatively low participation in Care Group,
458 couple, male engagement, and CBCC activities. In addition to chronic food
459 insecurity, the MAZIKO study population experienced a number of extreme climate
460 events during the study period that, coupled with recent economic crises linked to
461 the Malawian Kwacha devaluation and inflation, will likely have limited caregiver's
462 ability to invest in ECD without additional financial support[52].

463 **4.1 Limitations**

464 The main strengths of this study involve the randomized design and the use of
465 program impact pathways to understand the plausibility of program effects.
466 Improvements in diet quality and parenting practices provide evidence of changes
467 along two hypothesized pathways through which the intervention could influence
468 ECD. In terms of external validity of the study, the trial involved a relatively large
469 number of clusters across two districts, results are also likely generalizable to the
470 rest of Malawi and similar rural, food insecure contexts in the region. Several
471 limitations also require attention: firstly, the trial did not include a "naïve" control
472 group or cash only arm. As the government SoC program is being scaled up,
473 including a pure control group was not relevant in the Malawian context. A second

limitation involves intervention assignment that could not be blinded, which may have introduced participant bias. The 3-year study duration and differential timing of intervention components may have limited the potential to observe the full range of intervention effects. Some components, including Caring for the Caregiver and Male Champions activities, were introduced later in the intervention period, providing less time for changes in caregiving and other intermediate outcomes to translate into improvements in child development. Furthermore, some hypothesized effects may need more time to manifest, including gains in human capital and other household investments observed in parallel studies, that will require longer-term follow-up.

4.2 Conclusion

Integrating SBC with CTs in rural, food insecure settings in Malawi can improve children's diets and caregiving practices, as well as ECD in girls, though only higher value CT interventions were effective in improving ECD. These findings highlight that bringing together SBC interventions with CTs targeted on the basis of nutritional risk can improve developmental outcomes during a critical life course period, and should be a central element in reforms to national social protection programs if the human capital of Malawi's increasing and youthful population is to be nurtured. Important questions, however, remain on cost-effectiveness and sustainability of the interventions at scale.

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Data sharing

Data described in the manuscript, code book, and analytic code will be made available by the corresponding author upon request.

Contributors

AG was the principal investigator on the trial and led the trial design and analysis. AG, LB, MG, MK, and KM wrote the trial protocol. BP and EGM supervised intervention implementation. PM, AM, VN, and MK implemented the surveys and supervised data collection. LB, ON, and AG oversaw the survey training and data collection. ON, LB, LD and AG performed data cleaning, curation, and analysis. AG and MG drafted the manuscript. All authors contributed to, reviewed, and approved this article.

Declaration of interests

We declare no competing interests.

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Table 1: Household, maternal and child level characteristics at baseline, MAZIKO trial study population.

	SOC		SBC		SBC + Low cash		SBC + High cash	
	N	Mean ± SD or proportion	N	Mean ± SD or proportion	N	Mean ± SD or proportion	N	Mean ± SD or proportion
Household characteristics								
Household size	613	4.45 ± 1.93	608	4.5 ± 1.92	606	4.27 ± 1.89	594	4.32 ± 1.79
Number of children under 5 yrs	613	0.89 ± 0.7	608	1.06 ± 0.72	606	0.95 ± 0.73	594	0.92 ± 0.67
Household in the lowest consumption quintile	610	20.16	606	19.64	602	18.44	590	21.19
Household head characteristics								
Head age (yrs)	613	33.63 ± 11.83	608	32.31 ± 11.09	606	33.32 ± 11.74	594	32.64 ± 11.3
Head is female	613	0.32	608	0.36	606	0.36	594	0.33
Secondary or higher education	613	0.3	608	0.29	606	0.27	594	0.29
Maternal characteristics								
Index woman age (years)	612	25.57 ± 7.27	608	25.82 ± 7.3	606	25.31 ± 7.17	594	25.16 ± 6.73
Woman is under 18 yrs	613	0.11	608	0.09	606	0.09	594	0.1
Pregnant at baseline	611	0.52	606	0.41	606	0.53	593	0.49
Woman is married	613	0.77	608	0.76	606	0.72	594	0.75
Secondary or higher education	613	0.24	608	0.21	606	0.21	594	0.23
Woman is head of household	613	0.24	608	0.28	606	0.26	594	0.23
Child characteristics								
Child is a boy	293	0.54	353	0.5	284	0.5	303	0.52
Index child age (years)	293	0.43 ± 0.51	353	0.46 ± 0.53	284	0.42 ± 0.52	303	0.4 ± 0.52

Notes: This table summarises baseline characteristics in the analytical sample. SBC, Social Behaviour Change; SOC, Standard of Care; VSLA, Village Savings and Loans.

Table 2: MAZIKO intervention uptake at endline.

	SOC		SBC		SBC + Low cash		SBC + High cash	
	N	Mean ± SD or %	N	Mean ± SD or %	N	Mean ± SD or %	N	Mean ± SD or %
Received seeds/vines/inputs in the past 24 months	582	4.12	575	85.39	566	89.4	572	86.36
Ever attended a group session on child care, health, nutrition, or development?	576	39.58	573	53.05	563	54.88	569	56.77
Ever received a home visit	587	37.14	576	56.94	568	56.51	572	52.8
Discussed at home visit: breastfeeding	218	16.06	328	19.82	321	13.08	302	19.21
Discussed at home visit: complementary feeding	218	60.55	328	63.72	321	58.57	302	59.93
Discussed at home visit: early childhood development	218	52.29	328	49.70	321	53.89	302	56.95
Discussed at home visit: hygiene	218	79.36	328	76.52	321	85.05	302	83.77
Discussed at home visit: maternal and child nutrition	218	49.08	328	49.70	321	44.55	302	52.32
Involved in CBCC related activities	587	14.82	576	25.17	568	28.7	572	25
CBCC activities: Childcare	87	40.23	145	28.28	163	26.38	143	25.17
CBCC activities: Meal preparation	87	40.23	145	42.07	163	50.92	143	48.95
CBCC activities: Training	87	33.33	145	36.55	163	29.45	143	32.17
CBCC activities: VSLA	87	3.45	145	5.52	163	3.68	143	5.59
CBCC activities: Agriculture production	87	14.94	145	26.21	163	28.22	143	32.87
CBCC activities: Other	87	5.75	145	2.07	163	1.84	143	2.1
Member of a VSLA	587	46.00	576	47.92	568	60.92	572	60.14
Father attended a group session	246	18.29	271	33.95	228	35.09	281	36.3
Father attended a couple's session	252	12.30	279	30.11	236	22.88	287	26.83
Received CT in the past 12 months	584	7.02	576	5.03	568	71.83	572	81.29

Notes: This table summarises participation in different MAZIKO intervention activities for the analytic sample. CBCC, Community Based Childcare Centers; CT, cash transfers; SBC, Social Behaviour Change; SOC, Standard of Care; VSLA, Village Savings and Loans.

Table 3: Effects of MAZIKO interventions on child development outcomes.

	Endline				Treatment effects					
	SOC	SBC	SBC + Low cash	SBC + High cash	SBC vs SOC	SBC + Low cash vs SOC	SBC + High cash vs SOC	SBC + Low cash vs SBC	SBC + High cash vs SBC	SBC + High cash vs SBC + Low cash
	Mean ± SD or %	Mean ± SD or %	Mean ± SD or %	Mean ± SD or %	Mean Difference (95% CI)	Mean Difference (95% CI)	Mean Difference (95% CI)	Mean Difference (95% CI)	Mean Difference (95% CI)	Mean Difference (95% CI)
Child development, children <5y										
MDAT (DAZ)	1.3 ± 1.19	1.3 ± 1.07	1.29 ± 1.17	1.35 ± 1.1	-0.01 (-0.2, 0.17)	-0.02 (-0.21, 0.17)	0.04 (-0.15, 0.23)	-0.01 (-0.19, 0.18)	0.05 (-0.14, 0.24)	0.06 (-0.13, 0.25)
MDAT fine motor (DAZ)	0.81 ± 1.04	0.73 ± 0.83	0.79 ± 0.93	0.82 ± 0.94	-0.08 (-0.24, 0.08)	-0.02 (-0.17, 0.14)	0 (-0.16, 0.16)	0.07 (-0.09, 0.22)	0.08 (-0.08, 0.24)	0.01 (-0.14, 0.17)
MDAT gross motor (DAZ)	1.24 ± 0.98	1.22 ± 1	1.3 ± 0.99	1.32 ± 1	-0.03 (-0.21, 0.14)	0.06 (-0.12, 0.23)	0.08 (-0.09, 0.25)	0.09 (-0.08, 0.26)	0.11 (-0.06, 0.28)	0.02 (-0.15, 0.19)
MDAT language (DAZ)	0.7 ± 1.03	0.68 ± 0.98	0.68 ± 1.12	0.73 ± 0.95	-0.02 (-0.18, 0.15)	-0.02 (-0.18, 0.15)	0.03 (-0.14, 0.19)	0.00 (-0.17, 0.17)	0.04 (-0.13, 0.21)	0.04 (-0.13, 0.21)
MDAT social (DAZ)	0.72 ± 1.38	0.72 ± 1.4	0.57 ± 1.29	0.59 ± 1.29	-0.05 (-0.28, 0.19)	-0.18 (-0.41, 0.06)	-0.15 (-0.38, 0.08)	-0.13 (-0.37, 0.1)	-0.1 (-0.34, 0.13)	0.03 (-0.21, 0.26)
N	537	519	520	520	2096	2096	2096	2096	2096	2096
Emergent numeracy & literacy, children >3.5y										
IDELA emergent numeracy items score	1.29 ± 1.74	1.39 ± 1.7	1.58 ± 1.62	1.64 ± 2.38	0.11 (-0.33, 0.55)	0.27 (-0.19, 0.73)	0.41 (-0.05, 0.87)	0.16 (-0.28, 0.6)	0.3 (-0.14, 0.74)	0.14 (-0.32, 0.6)
IDELA emergent literacy items score	0.51 ± 1.3	0.46 ± 1.05	0.52 ± 0.88	0.42 ± 1	-0.07 (-0.31, 0.18)	-0.02 (-0.28, 0.23)	-0.09 (-0.35, 0.17)	0.04 (-0.2, 0.29)	-0.02 (-0.27, 0.22)	-0.07 (-0.32, 0.19)
IDELA fine motor item score	1.69 ± 2.25	1.59 ± 2.05	1.63 ± 2.1	1.7 ± 2.05	-0.12 (-0.66, 0.41)	-0.15 (-0.71, 0.4)	0.02 (-0.53, 0.58)	-0.03 (-0.56, 0.5)	0.15 (-0.38, 0.68)	0.18 (-0.38, 0.73)
IDELA concentration related items score	1.24 ± 0.88	0.91 ± 0.87	1.21 ± 0.87	1.07 ± 0.9	-0.23 (-0.49, 0.03)	-0.02 (-0.29, 0.25)	-0.13 (-0.4, 0.14)	0.21 (-0.05, 0.47)	0.1 (-0.16, 0.36)	-0.11 (-0.38, 0.16)
IDELA motivation related items score	0.88 ± 0.89	0.69 ± 0.84	0.72 ± 0.86	0.72 ± 0.87	-0.13 (-0.35, 0.1)	-0.12 (-0.35, 0.12)	-0.14 (-0.38, 0.09)	0.01 (-0.22, 0.23)	-0.02 (-0.24, 0.21)	-0.03 (-0.26, 0.21)
IDELA motivation and concentration related items score	2.11 ± 1.61	1.6 ± 1.56	1.94 ± 1.53	1.8 ± 1.62	-0.35 (-0.8, 0.1)	-0.13 (-0.59, 0.34)	-0.27 (-0.73, 0.19)	0.22 (-0.22, 0.67)	0.08 (-0.36, 0.52)	-0.14 (-0.6, 0.32)
IDELA emergent literacy and numeracy related items score	1.8 ± 2.78	1.85 ± 2.47	2.1 ± 2.25	2.06 ± 3.08	0.04 (-0.6, 0.69)	0.24 (-0.44, 0.91)	0.33 (-0.34, 1)	0.19 (-0.45, 0.83)	0.29 (-0.35, 0.93)	0.09 (-0.58, 0.76)
N	185	226	177	177	765	765	765	765	765	765

Notes: This table presents intention-to-treat (ITT) unadjusted effects on MDAT child development scores and IDELA emergent numeracy and literacy scores. CT, Cash Transfer; DAZ, Development for age z-score; IDELA, International Development and Early Learning Assessment; MDAT, Malawi Development Assessment Tool; SBC, Social Behaviour Change; SoC, Standard of Care.

Table 4: Effects of MAZIKO interventions vs. Standard of Care on child development outcome (MDAT DAZ) in pre-specified sub-groups.

	MDAT DAZ		
	SBC vs. SOC Mean Difference (95% CI)	**Low cash vs. SOC Mean Difference (95% CI)**	**High cash vs. SOC Mean Difference (95% CI)**
Child is a girl	0.15 (-0.09, 0.38)	0.02 (-0.22, 0.25)	0.26 (0.02, 0.49)
Child is a boy	-0.16 (-0.39, 0.07)	-0.05 (-0.28, 0.18)	-0.17 (-0.4, 0.06)
p-value	0.03	0.63	<0.001
Household is in highest 3 expenditure quintiles	-0.04 (-0.26, 0.18)	0.02 (-0.2, 0.24)	-0.02 (-0.24, 0.2)
Household is in lowest 2 expenditure quintile	0 (-0.25, 0.26)	-0.1 (-0.36, 0.15)	0.11 (-0.15, 0.36)
p-value	0.77	0.39	0.38
Not pregnant at baseline	-0.05 (-0.28, 0.17)	-0.1 (-0.33, 0.14)	-0.01 (-0.24, 0.23)
Pregnant at baseline	-0.01 (-0.27, 0.24)	0.07 (-0.17, 0.31)	0.07 (-0.17, 0.31)
p-value	0.79	0.24	0.61

Notes: This table presents intention-to-treat (ITT) unadjusted effects on MDAT child development scores and the corresponding p-values for the Wald test on the significance for the specific interaction term. CT, Cash Transfer; DAZ, Development for age z-score;; MDAT, Malawi Development Assessment Tool; SBC, Social Behaviour Change; SoC, Standard of Care.

Figure 1: High-level program impact pathways and level at which measurement was undertaken, (adapted from [21]).



Notes: CT, Cash Transfers; SBC, Social behaviour change. Outline colour reflect survey assessment level, including households (black), mothers (green), fathers (red), children (blue). Dashed lines highlight where assessment was not undertaken.

Figure 2: Trial profile.

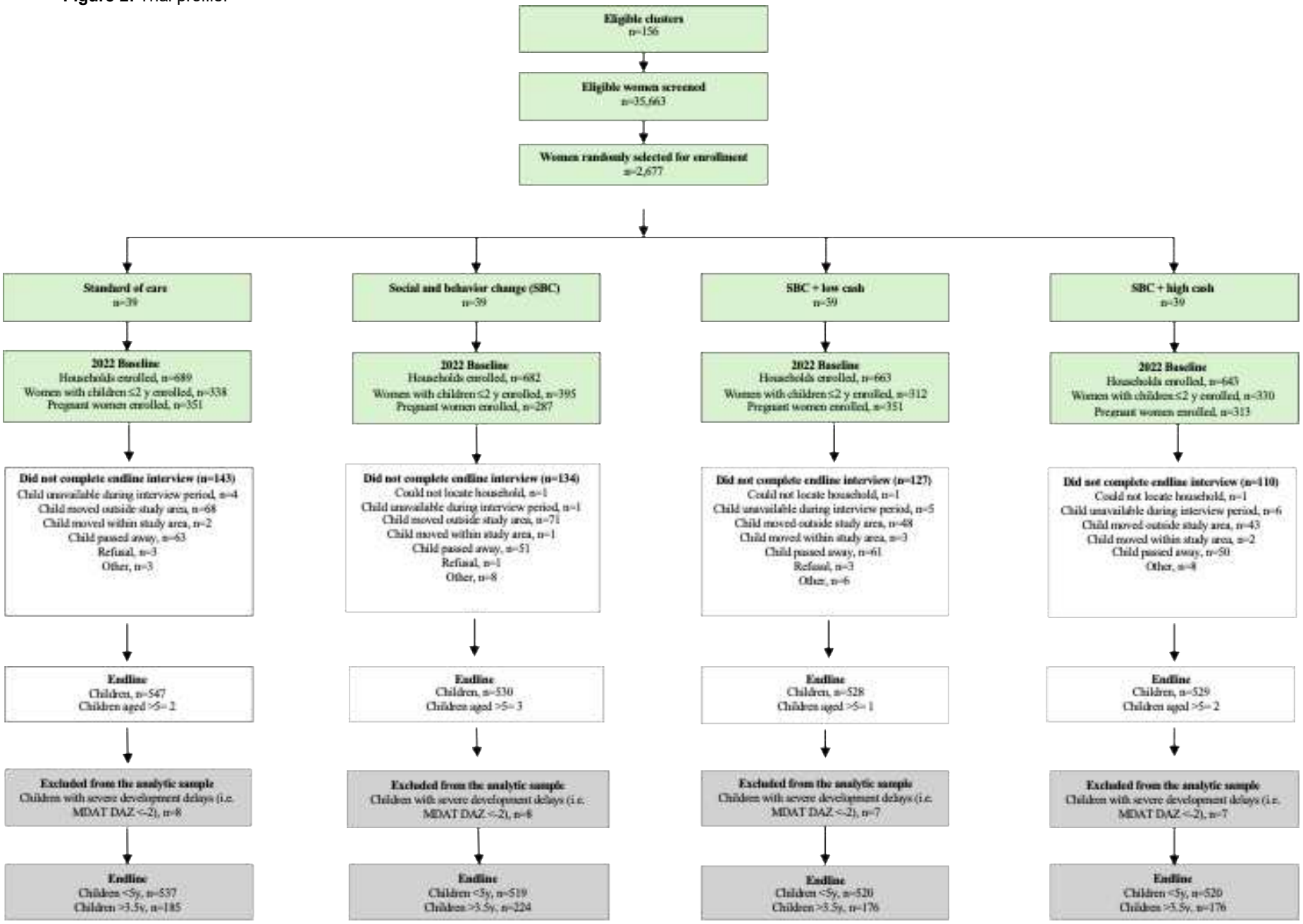
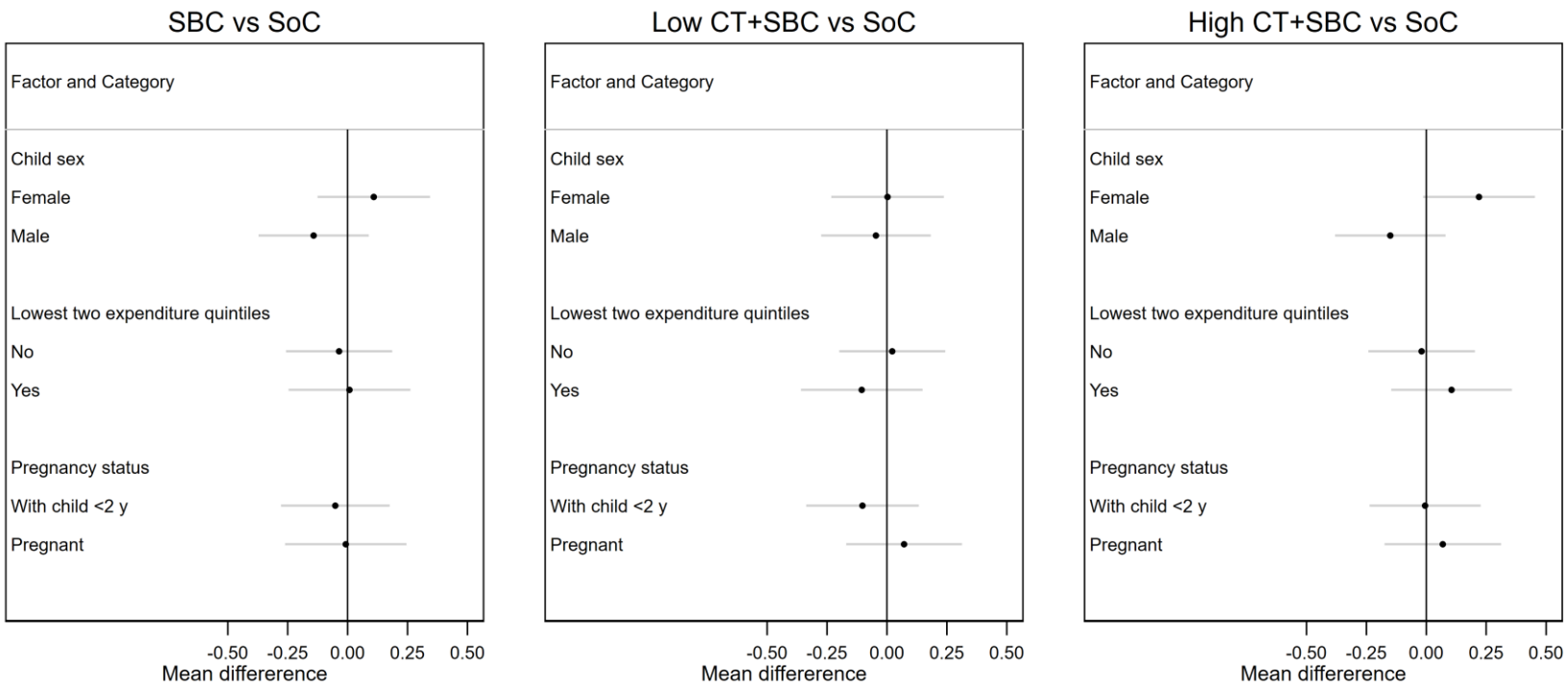


Figure 3: Coefficient plots of effect modifiers for child development MDAT DAZ.



Notes: CT, Cash Transfer; DAZ, Development for age z-score;; MDAT, Malawi Development Assessment Tool; SBC, Social Behaviour Change; SoC, Standard of Care.

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