Impact of Prenatal HIV and Congenital Cytomegalovirus on Child Neurodevelopment: The Role of Caregiving and Early Environment in Malawi

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BACKGROUND

- Congenital cytomegalovirus (cCMV) is an important cause of neurodevelopmental impairment in children.
- Prenatal HIV exposure may increase cCMV susceptibility and affect neurodevelopment through biological, psychosocial, and environmental pathways.
- **Knowledge gap:** Limited data exist on these relationships in sub-Saharan Africa, where HIV and cCMV prevalence are high
- **Study aims:**
  1. Determine impact of prenatal HIV exposure on cCMV risk
  2. Identify biological (prenatal HIV, cCMV), psychosocial and environmental predictors of neurodevelopment

METHODS

- **Study design:** Prospective cohort study (0-42 months)
- **Setting:** Blantyre and Thyolo, Malawi
- **Study population:**
  - CHUU: children of HIV-uninfected mothers
  - CHEU-all: children of mothers living with HIV
    - CHEU-lo: low pregnancy viral load (≤400 copies/mL)
    - CHEU-hi: high pregnancy viral load (≥10,000 copies/mL)
- **Primary exposure:** cCMV (Urine GeneProof PCR <2 weeks)
- **Psychosocial and environmental measures:**
  - Childhood adversity (CPAS)
  - Maternal mental distress (SRQ)
  - Mother–child interaction quality (OMCI)
  - Child access to learning materials (FCI)
  - Child school attendance (School)
- **Outcome assessment:**
  - Neurodevelopment at 24 and 42 months using Malawi developmental assessment tool (MDAT)
    - Gross motor development for age Z score (GM-Z)
    - Fine motor development for age Z score (FM-Z)
    - Language development for age Z score (LA-Z)
    - Social development for age Z score (SO-Z)

RESULTS

Aim 1: Prenatal HIV exposure and cCMV risk

- Overall cCMV prevalence: 3.3% (34/1045 infants)
- CHEU-hi had a 3-fold higher risk of cCMV compared with CHUU
- CHEU-lo had a similar risk of cCMV as CHUU

Association between prenatal HIV exposure and cCMV using log-binomial regression

	cCMV-	cCMV+	Crude Risk Ratio	p	Adjusted Risk	p
	N= 1011	N= 34	(95% CI)		Ratio (95% CI)	
CHUU	507 (97.5)	13 (2.5)	Ref.		Ref.	
CHEU-all	504 (96.0)	21 (4.0)	1.60 (0.82, 3.25)	0.18	**2.06 (1.01, 4.35)**	**0.05**
CHEU-lo	412 (96.7)	14 (3.3)	1.32 (0.62, 2.80)	0.47	1.69 (0.75, 3.79)	0.19
CHEU-hi	92 (92.9)	7 (7.1)	**2.83 (1.09, 6.73)**	**0.02**	**3.09 (1.12, 7.33)**	**0.01**

Data are n (row%). Adjusted for maternal age, education, and gravidity.

Aim 2: Predictors of neurodevelopment at 24 and 42 months

Findings at 24m

- Positive predictors: Mother-child interaction, school attendance
- Negative predictors: Male sex, low birthweight
- No association: cCMV, prenatal HIV

Findings at 42 months:

- Positive predictors: Neurodevelopment at 24 months, school attendance
- Negative predictors: Male sex
- No association: cCMV

DISCUSSION

Key findings:

- High maternal viral load triples cCMV risk
- Viral suppression reduces excess risk
- cCMV did not affect neurodevelopment at 24 or 42 months
- Early caregiving quality, school attendance, birthweight, and child sex predict development at 24 months
- Development at 24 months strongly predicts 42 month outcomes
- Interventions in the first 24 months are critical

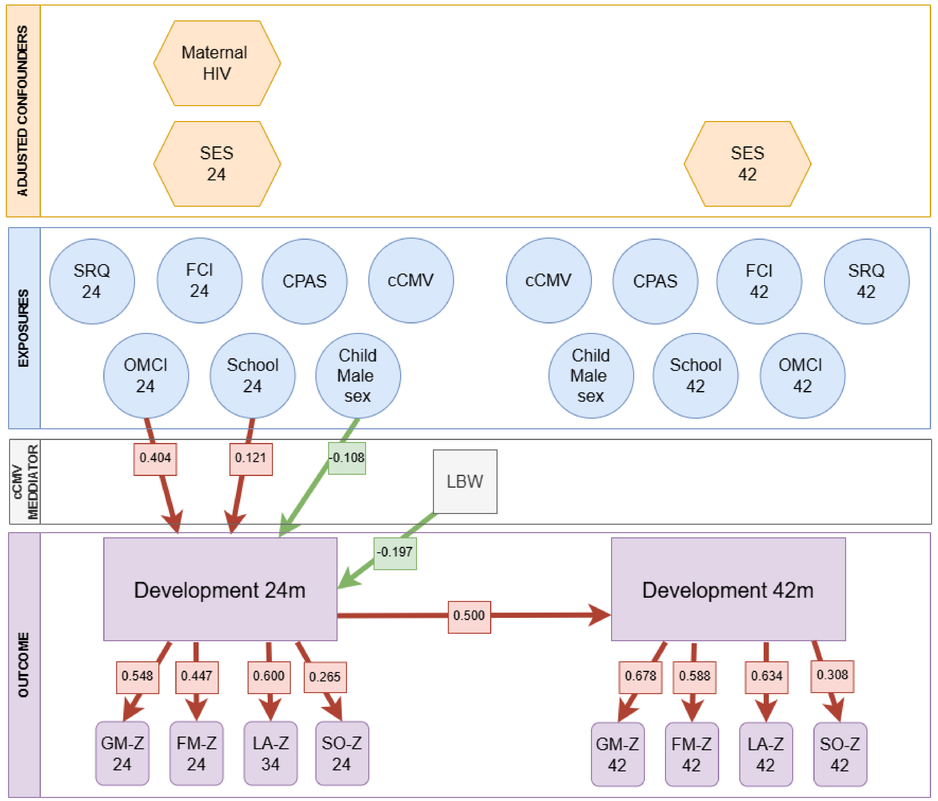


Figure 1: Longitudinal Structural Equation Model. Significant (p<0.05) standardized positive and negative association path coefficients shown. N=749 (cCMV- 726, cCMV+ 23).



Data collection team and study participants

Conclusion

The following represent actionable targets for intervention to promote optimal neurodevelopmental in children: maternal pregnancy viral suppression, optimization of birthweight, early parenting interventions before age 2, access to early childhood education

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