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Wealth-related inequality in early uptake of HIV testing among pregnant women: an analysis of data from a national cross-sectional survey, South Africa

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ABSTRACT

Objectives Wealth-related inequality across the South African antenatal HIV care cascade has not been considered in detail as a potential hindrance to eliminating mother-to-child HIV transmission (EMTCT). We aimed to measure wealth-related inequality in early (before enrolling into antenatal care) uptake of HIV testing and identify the contributing determinants.

Design Cross-sectional survey.

Settings South African primary public health facilities in 2012.

Participants A national-level sample of 8618 pregnant women.

Outcome measures Wealth-related inequality in early uptake of HIV testing was measured using the Erreygers concentration index (CI) further adjusted for inequality introduced by predicted healthcare need (ie, need-standardised). Determinants contributing to the observed inequality were identified using the Erreygers and Wagstaff decomposition methods.

Results Participants were aged 13 to 49 years. Antenatal HIV prevalence was 33.2%, of which 43.7% came from the lowest 40% wealth group. A pro-poor wealth-related inequality in early HIV testing was observed. The need-standardised concentration index was −0.030 (95% confidence interval −0.038 to −0.022). The proportion of early HIV testing was significantly better in the lower 40% wealth group compared with the higher 40% wealth group (p value=0.040). The largest contributions to the observed inequality were from underlying inequalities in province (contribution, 65.27%), age (−44.38%), wealth group (24.73%) and transport means (21.61%).

Conclusions Our results on better early uptake of HIV testing among the poorer subpopulation compared with the richer highlights inequity in uptake of HIV testing in South Africa. This socioeconomic difference could contribute to fast-tracking EMTCT given the high HIV prevalence among the lower wealth group. The high contribution of provinces and age to inequality highlights the need to shift from reliance on national-level estimates alone but identify subregional-specific and age-specific bottlenecks. Future interventions need to be context specific and tailored for specific subpopulations and subregional settings.

Strengths and limitations of the study

- ► Although socioeconomic inequalities are known to exist in South Africa, few studies have used analytical models to accurately measure wealth-related inequalities in early uptake of HIV testing among pregnant women on a large nationally representative sample.
- ► The external validity of the study is restricted to public healthcare users who are in the majority in South Africa, hence, the observed inequalities exclude the minority private healthcare users.
- ► This is a cross-sectional study and causality inferences about the observed results could not be ascertained, but the observed associations were indicative of areas to be investigated in future.

BACKGROUND

In most low-middle income countries, unfair inequalities in healthcare are still a challenge.[1 2] Maternal and child health is one health area that has received increased attention towards improved service coverage but wealth-related disparities remain.[1 3 4] Immunisation, for example, has good coverage even in the poorer countries but wealth-related inequalities such as in immunisation against measles have been reported.[5] High wealth-related inequality in skilled birth attendance is another example common in many low middle-income countries.[3 5] Such disparities in uptake of health services lead to the continuing problem of high child mortality especially among the poorest.[6]

Mathematical models have been developed specifically to give accurate measures of health inequalities due to disparities in wealth. The concentration index (CI) is one of the measures used in the study of socioeconomic inequality in health.[7] This index

provides a measure of the extent of inequalities in health that are systematically associated with socioeconomic status (SES). It reflects the experiences of the entire population (rather than just for example two classes) and it is sensitive to changes in the distribution of the population across socioeconomic groups.[8] A decomposition technique was further developed to enable researchers to unravel the causes of socioeconomic health inequalities.[9] Inequalities in the determinants of a health outcome also contribute to socioeconomic inequalities in the health outcome. The decomposition method allows assessing the relative importance of these different inequalities in generating inequalities in the health outcome.[10]

Data gathered from prevention of mother-to-child transmission of HIV (PMTCT) services demonstrate that SES mostly affects the number of antenatal visits.[3 11 12] However, the effect of background SES on other parameters of the antenatal PMTCT cascade has not been widely studied. A 2011 study on a small South African sample employed the mathematical models of the concentration index and found pro-poor inequalities in infant mortality and HIV transmission to infants.[13] Socioeconomic factors are well known to be driving forces behind health-related disparities in South Africa, but the application of the concentration index to specifically display the extent of the disparities due to wealth has been minimal.[2] It becomes important to evaluate the potential impact of SES across the PMTCT cascade, using the appropriate methodology, at a time when countries have adopted targets to eliminate mother-to-child transmission of HIV (MTCT), to identify key sticking points and population groups for intervention.

Presently, although South Africa has more than 90% coverage of PMTCT services, the annual incidence of early vertical HIV transmission, measured at 6 weeks postpartum in 2013, was 2.5%, which was higher than the 2% target.[14] Maternal HIV prevalence has remained high (approximately 30%) and stagnant in the most recent years[14 15] due to improved uptake of antiretroviral treatment. This stagnant and high HIV exposure rate to unborn, newborn and breastfeeding infants hinder the complete elimination of mother-to-child transmission of HIV (EMTCT).[16] The other challenge is the unequal healthcare system which is dualistically divided into public and private sectors. The majority (~68%) of the population use the public healthcare system which however is serviced by only 30% of the country's doctors and specialists.[17] The public sector has a three-tier service provision system; the primary healthcare clinics and community health centres which serve as the first contact at no cost for basic health and maternity care; these make referrals of complicated cases to the secondary level care—the district hospitals. Academic hospitals form the highest level and mostly serve more complicated healthcare needs. Reports of 2015, indicate a doctor to patient ratio of 1:>4000 in the public sector with still ~4% of the population living at least 5 km away from the nearest health facility.[18] The private sector, smaller, comprises private-practising healthcare professionals and private hospitals whose services are mainly remunerated through the medical aid schemes. Comparatively, the primary level of the public sector is mostly overburdened and does experience substandard service provision while the private sector mainly offers high-quality service. The government and some non-governmental organisations have expanded the number of primary healthcare clinics in an effort to decongest and improve the quality of public healthcare. Improvements for maternal and child healthcare have been at the forefront of attempts to improve public healthcare, such as the recent revisions of the PMTCT consolidated guidelines.[19]

Here, we investigated wealth-related inequality as a potential barrier to eliminating MTCT within the public health system in South Africa. We evaluated the impact that SES background could have on one of the main entry point indicators of the PMTCT cascade, that is, early uptake of HIV testing. We further considered whether certain determinants contributed to the observed wealth-related inequality. Unpacking the SES disparities in PMTCT services could provide additional clues to eliminating MTCT within the public healthcare system.

METHODS

Data

A secondary analysis of data from a national cross-sectional survey conducted in 2012 to evaluate the South African PMTCT programme was conducted.[20] The methods have been explained in detail elsewhere.[21] In summary, the survey was conducted at public primary healthcare clinics and community health centres offering immunisation services countrywide. The primary aim was to measure national and provincial-levels MTCT among infants attending public health facilities for their 6-week immunisation. Infants with known and unknown HIV exposure were eligible for inclusion. The 6-week postpartum point was chosen because it has a 99% infant coverage for immunisation.[22] Antenatal HIV prevalence and presumed PMTCT coverage were used to estimate the sample size needed for each province at precisions of 30% to 50% and a design effect of 2. The national target sample size was 12 200, ranging between 700 and 1800 per province, proportional to provincial 6-week immunisation coverage. A two-stage probability proportional to size sampling approach was used. The first stage was at provincial level. In each province, health facilities were stratified into medium (130–300 immunisations per year) and large (300 immunisations or more per year) facilities. Large facilities were further stratified into two groups—facilities in districts with antenatal HIV prevalence <29% or≥29%, which was the 2009 national average antenatal HIV prevalence. Therefore, facilities were grouped into three strata. The second stage was at health facility level: 580 facilities selected proportional to target facility sample size were needed to achieve the desired provincial and national sample sizes. The target number of infants per facility

was taken as the median number of infants expected in each facility within each stratum over a 3-week data collection period. Finally, caregiver–infant pairs were invited to enrol into the study during the 6-week immunisation visit using either random or consecutive selection depending on facility size. Ultimately, 10 533 infants were screened and 9120 provided both interview and infant blood data to measure MTCT. With respect to the data analysis for the primary outcome (6-week MTCT), sampling weights were calculated as the inverse of the realised sample size, accounting for South African live births, relative to the target sample size for each facility.

Consent to enrol into the study, to be interviewed and to take infant blood for laboratory HIV tests was sought from infant caregivers. Ethics approval was granted by the South African Medical Research Council (MRC) Ethics Committee in 2009 (institutional review board identifier—FWA00002753). Information about sociodemographic characteristics and uptake of antenatal and PMTCT programmes was collected through interviews. Two HIV tests were performed on the infants: (1) an ELISA for passively transferred maternal anti-HIV antibodies to confirm maternal HIV infection and infant HIV exposure and (2) an HIV total nucleic acid PCR to confirm infant HIV infection. The ELISA results for infant HIV exposure were used here as a proxy for antenatal HIV prevalence. Data from 8618 out of 9120 consented caregiver–infant pairs were used for analysis; the rest had missing information to establish SES.

The main outcome variable was binary: early uptake of HIV testing, that is, self-initiated HIV testing before enrolment to antenatal care versus PMTCT programme-influenced testing after enrolling into antenatal care during pregnancy. Independent variables with potential to influence inequality in the outcome were chosen, that is, variables which can influence or be influenced by socioeconomic background and at the same time can influence at least one of the outcomes: education level, dichotomised as primary school and lower or high school and above was selected as education could influence attitudes towards the importance of healthcare; marital status, dichotomised into single women (ie, not married, not in a relationship, widows, divorced) and married (or cohabiting) women, was included as spousal support is likely to encourage uptake of healthcare; transport to health facility categorised into own car, public transport and walking was included as a marker of ease of healthcare access, affecting the frequency and timing of uptake; prior knowledge about PMTCT as either 'yes' or 'no' was included as prior knowledge can influence timing of HIV testing in relation to pregnancy; a categorical variable of the nine South African provinces was included as provincial differences in healthcare management and in cultural behavioural norms has been observed; lastly, source of income with four categories of women namely employed, dependent on extended family, dependent on spouse or partner and fourthly those with irregular sources of income such as government grants. The latter is not a good measure of household income but is a common structural division in South Africa, and it will be important to know whether and how it impacts on the primary outcome variables.

Three healthcare need-based variables included were maternal age, a positive syphilis diagnosis result during pregnancy and a positive tuberculosis (TB) diagnosis result during pregnancy. These were used to predict and adjust for inequality due to differences in need for ill-health-related healthcare, therefore allowing for a better prediction of inequality under equal needs. Age is not ill health itself but different age groups have pre-existing differences in risk of ill health which thus introduces inequity in need for healthcare.

Defining the SES

The wealth scores to measure SES were generated from household living conditions and household assets (ie, house building material, sanitation, water, domestic fuel source and household appliances) using principal component analyses.[23] The wealth scores are only based on household assets because information on actual value of household income was not available. However, these assets in the current South African context do give a good indication of wealth status.

Measuring wealth-related inequality

Wealth-related inequality measures were performed in R Statistical package v3.1.0 and in STATA version SE 2013. Wealth-related inequalities were determined using the concentration index measure which has been described in detail elsewhere.[24 25] Briefly, the concentration index is used to measure wealth-related inequality and ranges from −1 to 1. It is calculated from twice the area under a curve (which is a relative measure of the covariation between the health outcome and the SES ranking, formula shown in equation 1), the concentration curve, which deviates from a line of equality (the diagonal straight line). Along this diagonal line, CI=0, meaning that there is no inequality caused by wealth differences, that is, the distribution of the variable of interest across the SES groups is not influenced by wealth.

$$CI = \frac{2}{\mu}\mathrm{cov}(h, r), \quad (1)$$

in which h is the health outcome of interest, r the SES ranking and μ the mean of the health outcome. In this study, for example, h would be either 'early uptake of HIV testing' or 'infant HIV exposure'. A positive CI (and curve below the diagonal line) indicates that a variable is favourable among the higher wealth groups (the wealthy), otherwise it is more prevalent among the lower wealth groups (the poor, when the curve is above the diagonal line).

Contribution of determinant variables to wealth-related inequality can be calculated using a regression-based decomposition analyses shown in equation 2.

$$RCI = \sum_k \left(\frac{\beta_k \bar{x}_k}{\mu} \right) C_k, \quad (2)$$

where for 1 to k determinant variables, β_k is the coefficient of a determinant variable, $\bar{x}_k$ is the mean of the determinant, μ is the mean of the health outcome and C_k is the concentration index of the determinant. An error term would also be included in equations 1 and 2 for continuous outcomes.[24] In this study, *k* would represent the six independent variables described earlier.

The concentration index formulas were initially designed for continuous variables, therefore are limited in handling the bounded nature of binary variables. Since the outcome variable of this study was binary, we applied the commonly used Erreygers correction[26] on the CI (equation 3) to correct for the linearity assumptions in the above equations.

$$\text{Erreygers correction E of the CI : E (CI)} = \frac{CI \times \mu \times 4}{\text{range(h)}}, \quad (3)$$

where h is the health outcome of interest and μ mean of the health outcome. Therefore in Erreygers correction, the concentration index of the health outcome is multiplied by four times the mean of the outcome, then divided by the range of the outcome. Similarly the wealth-related inequality decomposition by contributing determinant factors was adjusted using the Erreygers method (equation 4).[9]

$$\text{Erreygers decomposition} = E\left(RCI\right) = 4\left[\sum \beta_k C_k \bar{x}\right] \quad (4)$$

The target strata sample sizes for the survey were not all fully attained; hence, all analyses were adjusted using appropriate sampling weights.

To accurately measure horizontal wealth-related inequality under equal needs, we used two approaches to adjust for need-based inequality measure. First, we included the healthcare need-defining variables—age, syphilis diagnosis during pregnancy and TB diagnosis during pregnancy in the decomposition analyses together with non-need variables to generate a need-standardised concentration index.[24 27] Second, we subtracted the concentration index defined by need variables alone (inequality due to need-predicted uptake) from the standard concentration index.

RESULTS

Sample characteristics and distribution of outcome variables

The study sample comprised women aged between 13 and 49 years, with most (44.3%) aged 13–24 years, 43.2% in the 24–34 years age groups and 12.4% being 35 years and older. Many of them (85.6%) completed their primary education. Only 18.4% (95% confidence interval (CInt) 17.5 to 19.3) were employed, similar to 17.8% (16.9 to 18.7) dependent on extended family for income, while the majority (52.9%) depended on their spouses/partner. A quarter of the sample reported to be legally married. Third, 33.2% of the pregnant women were HIV positive, as determined by the ELISA tests for infant HIV exposure done at 6weeks postpartum, of which 49.3% (1345) had early uptake of HIV testing. The distribution of HIV-positive women varied significantly by wealth groups, most (43.7%) were in the lower wealth group, followed by the higher wealth group (33.9%) then the middle wealth group (22.4%), p value<0.0001.

Table 1 shows the distribution of early uptake of HIV testing by determinant variable. A total of 22.4% of the women had their first HIV test before enrolling into antenatal care. This early HIV testing appeared to be higher in the lower 40% wealth group (23.4%) compared with the higher 40% wealth group (20.6%), p=0.040. Compared with high school achievers, mothers with primary school education appeared to be better at testing early for HIV (p=0.0001). There was a significantly different distribution of early uptake of HIV testing between income groups and between provinces. Highest early HIV testing (31.4%) was observed among mothers with unstable income sources, seconded by employed mothers, while extended family dependents had the least.

Wealth-related inequalities and decomposition of determinant variable contributions

The Erreygers' corrected concentration indexes, E(CI), are given in table 2. The need-standardised E(CI) for taking the first HIV test before pregnancy was negative, −0.03, indicating a pro-poor inequality, that is, early HIV testing is unequally common among women of lower SES ranking. Although the inequality adjusted by directly subtracting the need-based E(CI) from the standard E(CI) was slightly stronger, it was also similarly pro-poor.

The concentration index for need-based use was positive (0.027) which indicates that expected healthcare use given healthcare need is higher among those in the higher SES ranking compared with the poorer.

The contributions of secondary determinants to the need-standardised inequality are given in table 3. Each contribution is measured from the underlying wealth-related inequality within the determinant alone (the E(CI) of the determinant) and the direct influence which the determinant has on the outcome (given by the decomposition regression coefficient). These final contributions were obtained from the need-standardised analysis. Even after adjusting for predicted need, E(CI) values for non-need variables were not zero indicating that horizontal inequity exists with respect to these variables. Province (65% contribution) and age (−44% contribution) were the highest contributors to wealth-related inequality in early HIV testing. Provincial results varied widely between provinces with highest contributions from the Limpopo and Gauteng provinces. Gauteng stood out with a very high pro-poor E(CI) of −0.133. The same two provinces as well as North West and Free State also had significant regression coefficients for association with early uptake of HIV testing. Among the age groups, nearly all the contribution to inequality was from the 25–34 years age-group, and being older than 24 in overall

Table 1 Proportion of early HIV testing by sociodemographic and need characteristics

Characteristic	Early HIV testing=yes % (95% CInt)	p Value	N
Total	22.4 (21.4 to 23.4)		8618
Wealth groups		0.040	
Lower 40%	23.4 (21.8 to 25.0)		3411
Middle	24.1 (22.0 to 26.3)		1753
Higher 40%	20.6 (19.2 to 22.1)		3454
Mother's education		0.0001	
Primary school	27.7 (25.1 to 30.5)		1277
High school	21.6 (20.5 to 22.6)		7341
Income source		0.0001	
Employed	25.9 (23.6 to 28.3)		1596
Spouse	21.2 (19.9 to 22.5)		4538
Family member	17.2 (15.3 to 19.4)		1543
Unstable/grant	31.4 (28.2 to 34.7)		941
PMTCT knowledge		0.710	
No	23.3 (19.0 to 28.3)		392
Yes	22.4 (21.4 to 23.4)		8226
Marital status		0.560	
Married/cohabit	21.9 (20.1 to 23.8)		2257
Single/widow/divorced	22.6 (21.5 to 23.8)		6361
Transport		0.060	
Own car	17.8 (14.5 to 21.5)		498
Public transport	23.6 (22.0 to 25.2)		3171
Walked	22.1 (20.9 to 23.4)		4949
Province		0.0001	
WC	25.0 (22.6 to 27.7)		1141
EC	24.8 (22.0 to 27.8)		939
FS	19.3 (16.7 to 22.2)		811
GP	18.3 (16.4 to 20.4)		1595
KZN	28.2 (25.5 to 31.1)		1015
LP	18.6 (16.4 to 20.9)		1144
MP	20.8 (18.2 to 23.7)		822
NC	29.3 (25.0 to 34.0)		396
NW	20.9 (18.2 to 24.0)		755
Age*		0.0001	
13–24 years	13.3 (12.2 to 14.6)		3778
25–34 years	28.6 (27.0 to 30.2)		3761
35+ years	33.6 (30.6 to 36.8)		1079
Syphilis during pregnancy*		0.0001	
No	21.8 (20.8 to 22.8)		8372
Yes	44.8 (38.1 to 51.6)		246
TB during pregnancy*		0.0001	
No	21.8 (20.9 to 22.8)		8396
Yes	46.4 (39.4 to 53.6)		222

The p values are from the χ^2 tests for differences between subgroups of a variable. Significant values at p<0.05 are in bold.
*Need variables.
EC, Eastern Cape; FS, Free State; GP, Gauteng Province; KZN, KwaZulu Natal; LP, Limpopo Province; MP, Mpumalanga; NC, Northern Cape; NW, North West; TB, tuberculosis; WC, Western Cape.

Table 2 E(CI) for early uptake of HIV testing

	E(CI)	95% CI
Actual concentration index	-0.030	−0.053 to −0.007
Need-predicted CI	0.027	0.015 to 0.039
Actual minus need-predicted CI	−0.057	−0.068 to −0.046
Need-standardised CI	−0.030	−0.038 to −0.022

E(CI), Erreygers' corrected concentration indexes.

significantly increased the chances of early uptake of HIV testing compared with being 24 years old and younger. The E(CI)s for age groups >24 years were both pro-rich. Age was the only high negative contributor implying that it effected a decrease in the E(CI)s of the outcome variable.

The next high contributors were wealth group (25%) and means of transport (22%). The highest wealth groups had a large effect on the contribution with a pro-poor E(CI) but the regression coefficients were not significant. Within means of transport, the strongest effect was from public transport users from which a high pro-poor E(CI) but non-significant positive regression coefficient were seen. PMTCT knowledge had a very low contribution. Although source of income and marital status had low contributions to the observed inequality in uptake of HIV testing, being a grant recipient and being single significantly increased the chances of early uptake of HIV testing by a factor of 0.25 and 0.27, respectively. In addition, both had pro-poor E(CI)s.

In addition to age, syphilis and TB were the need variables. Both syphilis and TB had extremely low contributions to horizontal inequality in uptake of HIV testing. The E(CI) for TB was negligible and that for syphilis was very low and pro-poor. However, both had significant associations with uptake of HIV testing as shown by positive regression coefficients.

DISCUSSION

This work shows that early uptake of HIV testing was affected by wealth-related inequality within the public health system in South Africa during the 2012–2013 period. There is improved uptake of self-initiated early HIV testing among mothers of relatively lower wealth groups, but a higher burden of infant HIV exposure among them. HIV testing services are now benefiting the poor in the country. This differs from countries like Burkina Faso, Kenya, Malawi and Uganda where self-initiated testing appeared more prevalent among higher wealth groups.[28] The reasons why uptake of HIV testing has become disproportionately lower among women in higher SES are unknown and need investigation. Overall, the wealth-related inequality scores are not very high, both from the two methods of adjusting for need-introduced inequality are less than 0.1, likely due to data being limited to public healthcare users alone. The wealthiest 20% in South Africa largely use private health facilities. However, obtaining significant inequality score within the public health facility users alone is of concern as it indicates that disparities exist even within the public health service. The majority of the population in the country uses these public health facilities, hence, efforts are needed to ensure that there is no inequity in PMTCT programmes.

In decomposing determinant contributions, with adjustment for healthcare need factors, the non-need variables showed influence towards wealth-related inequality in early uptake of HIV testing. Two of the three need variables, syphilis and TB had negligible inequality scores and contributions to overall inequality but were significantly associated with increased early uptake of HIV testing. These women probably already knew they were at high risk of HIV infection leading them to test for HIV prior to antenatal enrolment. However, age was the only need variable with high contribution to the overall inequality and the only determinant whose underlying inequalities contributed to lowering the overall wealth-related inequality. This makes sense considering that the E(CI) scores for age alone were pro-rich, thus if age had no effect on uptake of HIV testing, then uptake of HIV testing among the poor would increase by 44%. The polarised uptake of healthcare in general between the adolescent or young mothers and women older than 24 years is currently a challenging problem in South Africa for various HIV and healthcare activities, and requires urgent attention.[29 30]

For non-need variables, being single or being a grant recipient showed significant associations with uptake of HIV testing which led to pro-poor inequality scores even though their contribution to overall inequality of HIV testing were small. Not much detailed work has been reported regarding disparities between different income sources, and the cross-sectional nature of this study limits our explanation for this observation. Even though women who reached high school had a pro-poor inequality score, there was no significant association with the study outcome nor a high contribution to its inequality. The insignificant regression result for association of education with HIV testing is contrary to observations reported in other low-income countries.[31 32] In the South African general population, evidence from data in the period around the start of this survey showed poor uptake of HIV testing among the less educated.[33] We see the similar difference here from the χ^2 test but our findings further confirm that this difference among antenatal women is not associated with wealth-related inequality. Knowledge about MTCT was also not significantly associated with wealth-related inequality for HIV testing implying that national efforts on HIV education have not prioritised certain socioeconomic groups over others.

Transport contributed to increased wealth-related inequality with largest effect from public transport users. The E(CI) scores indicate that public transport users were largely from lower SES groups while those who walked were mostly from higher SES groups. This could indirectly reflect the distance from facilities which need

Table 3 Summary of need-standardised decomposition showing variable contributions to wealth-related inequality in early uptake of HIV testing

Determinant	Regression-decomposition coefficient	E(CI)	% contribution to wealth-related inequality
Wealth group (ref: lower 40%)			Total=24.73
Middle	0.09	0.002	−1.14
Higher 40%	−0.05	−0.045	25.87
Mother's education			
(ref: primary school)			11.08
High school	−0.12	0.019	
Income source (ref: employed)			Total=−8.10
Spouse	−0.09	0.001	−0.49
Family member	−0.14	0.010	−5.61
Unstable/grant	0.25*	−0.025	14.20
PMTCT knowledge (ref: no)			
Yes	−0.08	−0.001	0.52
Marital status (ref: married/cohabit)			
Single/widow/divorced	0.27*	−0.016	9.39
Transport (ref: own car)			Total=21.61
Public transport	0.26	−0.048	27.16
Walked	0.25	0.010	−5.55
Province (ref: WC)			Total=65.27
EC	0.04	−0.005	2.96
FS	−0.39*	−0.009	4.99
GP	0.46*	−0.133	75.52
KZN	0.15	−0.030	17.08
LP	−0.45*	0.056	−31.75
MP	−0.27	0.002	−1.40
NC	0.18	0.005	−3.02
NW	−0.34*	−0.002	0.89
Need variables			
Age (ref: 13–24 years)			Total=−44.38
25–34 years	1.02*	0.077	−44.03
35+ years	1.25*	0.001	−0.35
Had syphilis in pregnancy (ref: no)			
Yes	0.91*	−0.006	3.68
Had TB in pregnancy (ref: no)			
Yes	0.86*	0.000†	−0.01

*Significant regression coefficient.
†No wealth-related inequality —95% CI includes 0.
EC, Eastern Cape; E(CI), Erreygers' corrected concentration indexes; FS, Free State; GP, Gauteng Province; KZN, KwaZulu Natal; LP, Limpopo Province; MP, Mpumalanga; NC, Northern Cape; NW, North West; PMTCT, prevention of mother-to-child transmission of HIV services; TB, tuberculosis; WC, Western Cape.

to be travelled, wherein poorer communities live further away from health facilities while the least poor live closer to health facilities with walkable distances or choose to live far from services if they can afford private transport. The insignificant regression coefficients for HIV testing are due to a weak difference between those who walked and the rest. There was a clear difference in uptake of HIV testing between those who owned cars and those who used public transport, leading to a high contribution to inequality. This result is impressive in that even though the poor rely on public transport and largely live further from health facilities,[34] uptake of HIV testing is better

among them. This is a progress worth to note as other countries battle with accessibility to healthcare for their populations.[35 36]

There were clear differences between wealth groups. Being in the highest wealth group was associated with reduced early uptake of HIV testing. Although this was not significant, it supports its pro-poor inequality index and the positive contribution percentage. That is, the wealthier have comparatively lower uptake and there is disproportionate inequality of uptake in favour of the poor; but if wealth group had no influence, then the observed unequal uptake among the poor would decrease by 26%. There were also evident differences in regression coefficients, inequality indexes and individual contributions between provinces, hence, the very high overall contribution to overall inequality in uptake of HIV testing. In a large country like South Africa, aggregated national-level estimates can conceal hotspot geographical areas by averaging across high-risk and low-risk areas, yet policy-makers using subgeographical approaches could find better clues to eliminating health problems.[37] Within-country disparities in health indicators have also been observed elsewhere,[6 11] and indeed show the need to begin shifting focus from average national targets alone to spatial subregional focus. In regard to wealth-related inequality in uptake of healthcare, future work would need rural–urban disaggregation to identify the specific geospatial areas needing attention, as there is already evidence for rural–urban disparities in healthcare delivery and uptake.[38 39]

We have used a need-standardised concentration index to present a better estimate of actual inequality in early uptake of HIV testing, by accounting for predicted inequality due to healthcare need. This approach is widely preferred in reporting horizontal inequity.[40–42] In addition we used E(CI) which attempts to improve the fit of the original concentration index algorithm meant for continuous outcomes on a binary outcome. This Erreygers correction was suggested in the recent decade, and not all studies with binary outcomes use this correction. Different methods to serve the same purpose have been discussed and none has been shown to be superior over the other.[43] Here, we chose to adopt the Erreygers because it is strongly biased for country-level estimates and our survey was designed to report national-level estimates.

Limitations

One limitation of this study is that its findings are only valid for the South African population using public health facilities. Although inequalities are evident just within this population alone, inclusion of private healthcare users would give a clearer indication of the true inequality gap between the richest and the poorest in the country. An all-inclusive national demographic health survey would be needed for such information. Another limitation is the lack of qualitative data to explain why the lower SES group preferred a test for HIV earlier than the higher SES group for example. The nature of a cross-sectional study also limits any causality inferences like the possibility that low uptake of HIV testing among wealthier is due to low infant HIV exposure. Future studies will require time series and inclusion of qualitative data to answer these questions. There are clearly differences at subregional level but our data lack rural–urban location information which could have been useful in disentangling wealth-related geographical differences more accurately. Lastly, the study was facility based, but enrolled a nationally representative sample across all nine provinces of South Africa; we did not include mother and infants who were too poor to access health facility care. Thus, we could have underestimated the impact of poor SES among the poorest group. However, given that routine data estimate that 99% of live births attend health facilities for their 6-week immunisation, we do not believe that this underestimation significantly changes our overall estimate.

Conclusion

Low self-initiated early HIV testing prevalence (22%) and high infant HIV exposure (33%) in the sample are both a concern. However, self-initiated uptake of HIV testing among the lower SES group before pregnancy indicates good awareness of HIV among the economically disadvantaged and at the same time reveals inequity between the rich and the poor. Taking from the observed distribution of infant HIV exposure in the sample, higher uptake of HIV testing among the poorer could be what was needed and could contribute to fast-tracking progress towards the EMTCT targets. Wealth group, age, transport and province were the largest contributors to wealth-related inequality in early uptake of HIV testing. The wealth group and transport results simply reflect the overall pro-poor biased uptake of testing, while the results seen for age and province raise a need for interventions targeted at high-risk age groups and high-risk geographical settings. Therefore, inequity along the PMTCT cascade needs to be evaluated at lower geographical levels followed by context-specific and targeted interventions to eliminate MTCT.

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Contributors NKN conceptualised the manuscript aims, carried out the analyses and wrote the manuscript. CVM and NS trained and supervised the analyses methods, assisted with interpretation of the results and reviewed the manuscript drafts. AG contributed to conceptualising the manuscript aims and in writing and reviewing the manuscript drafts.

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Competing interests None declared.

Patient consent Obtained from participating mother/caregivers.

Ethics approval The South African Medical Research Council Ethics Committee and the Centers for Disease Controland Prevention approved the final protocol for the PMTCT survey.

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Data sharing statement The data are bound by ethical and legal restrictions. To access the data of the South Africa's Prevention of Mother to Child Transmission Effective study, investigators who are not part of the study team should submit a concept proposal to AG (South Africa Medical Research Council (MRC), principal investigator), Debra Jackson (University of the Western Cape/UNICEF, principal investigator) and Thu-Ha Dinh, MD, MS (US Centers for Disease Control and Prevention (CDC), principal investigator) for approval. Investigators with an approved concept proposal must apply for guest researcher status to obtain access to a workstation and the data. Additionally, they will need to complete data security and confidentiality training, and to sign data use and non-disclosure agreements. The data are not yet available in a stable public repository. Researchers who meet criteria to access the data should contact the author AG at Ameena.Goga@mrc.ac.za.

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