Imperial College London

Estimating the male circumcision rates for the evaluation of public health programmes in South Africa

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UNAIDS Reference Group Meeting

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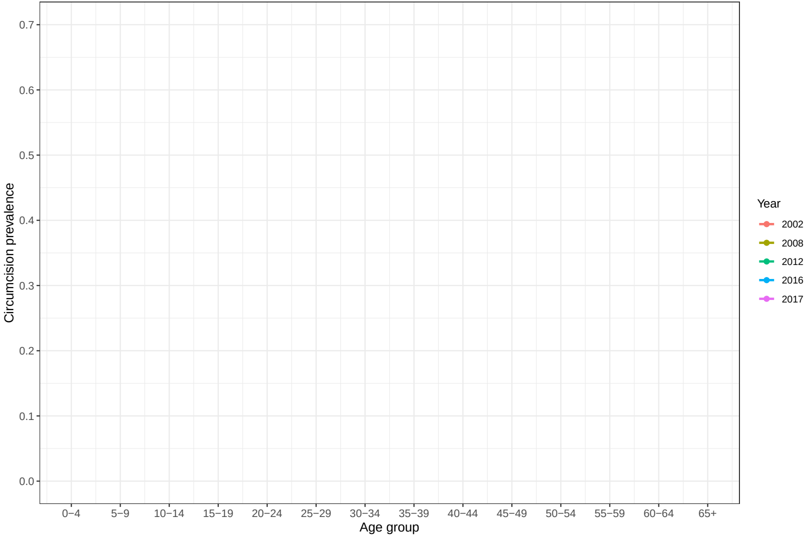
Estimating Circumcision Rates

- Objective: Produce estimates of MC rates and coverage in South Africa
  - District level
  - By age
  - Over time
- Overall MC prevalence combines not only VMMC but also traditional circumcision (TMC)
  - Survey data on the type of circumcisions performed
  - Program data on number of VMMCs

Estimating Circumcision Rates



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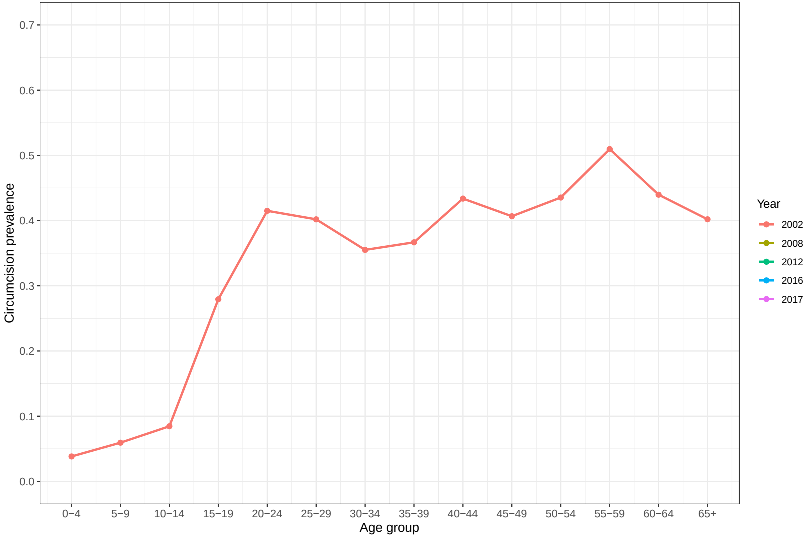
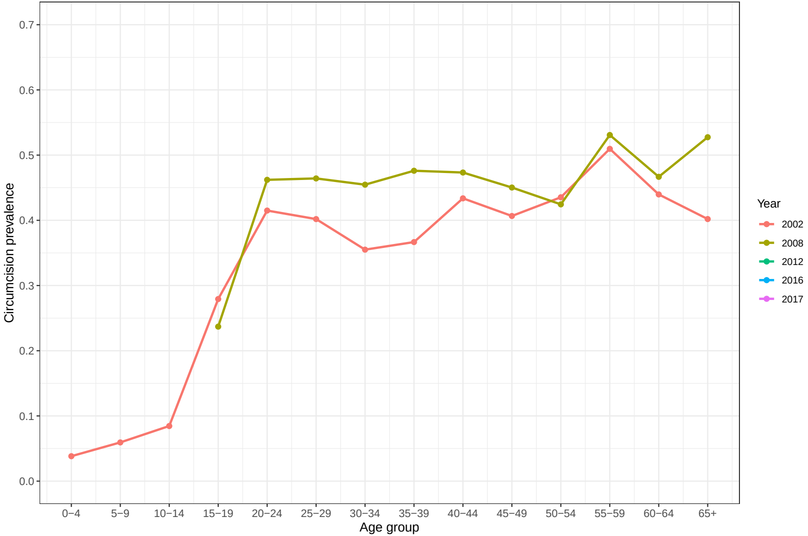


ESTIMATING CIRCUMCISION RATES



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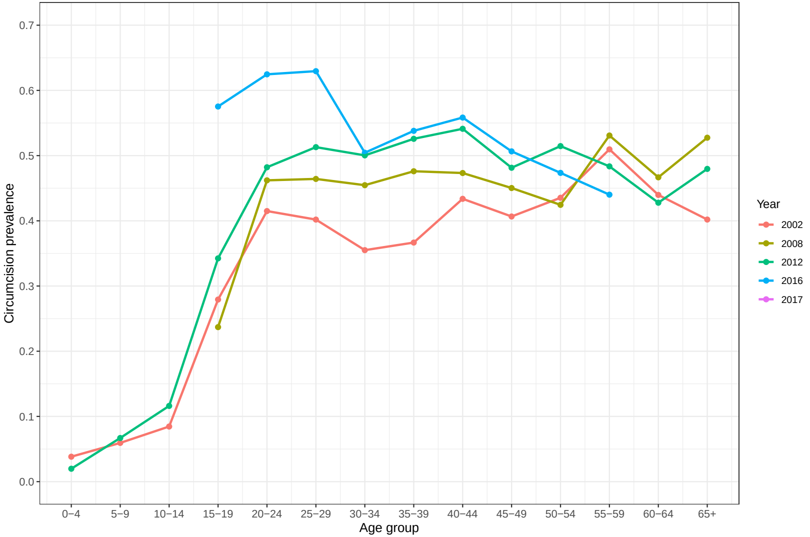

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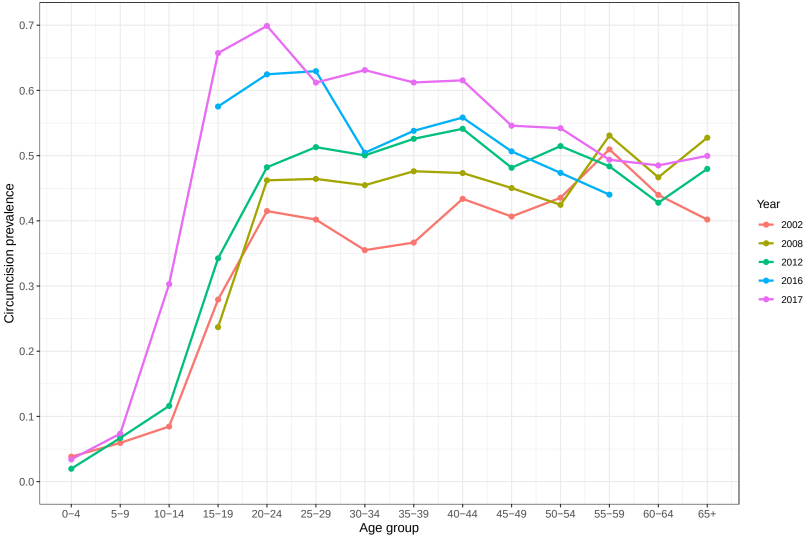

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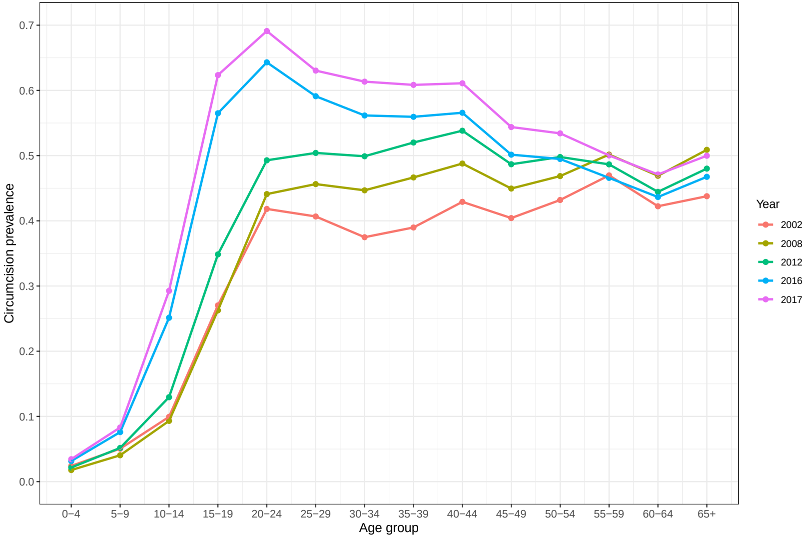

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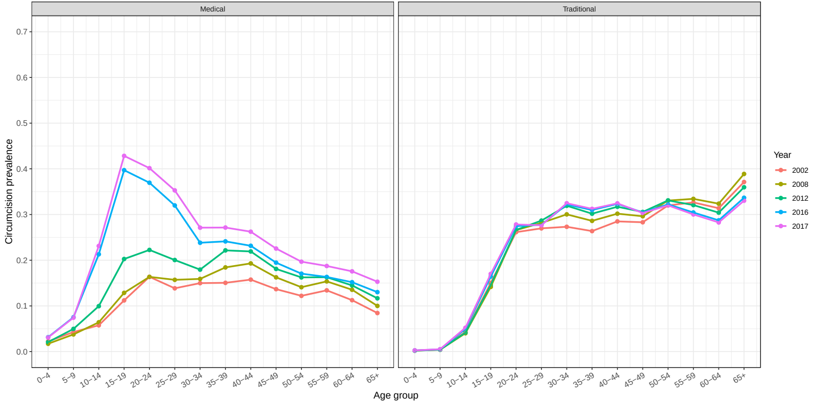

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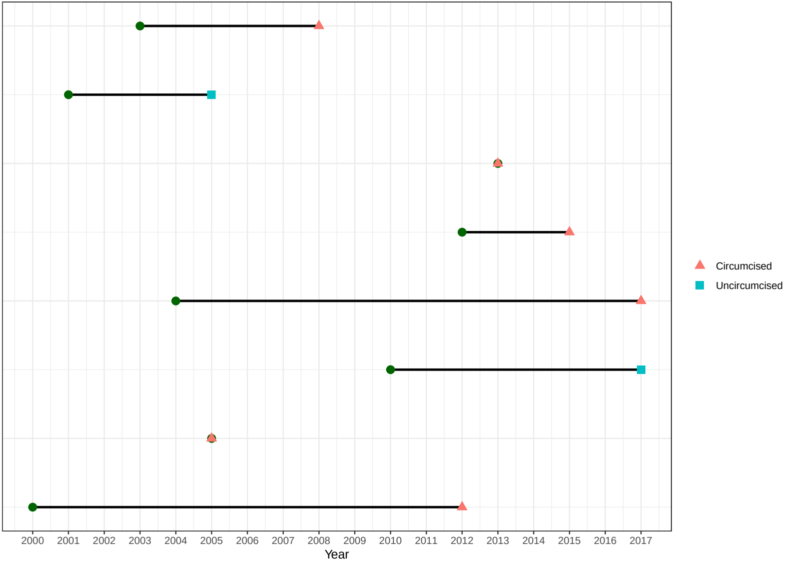

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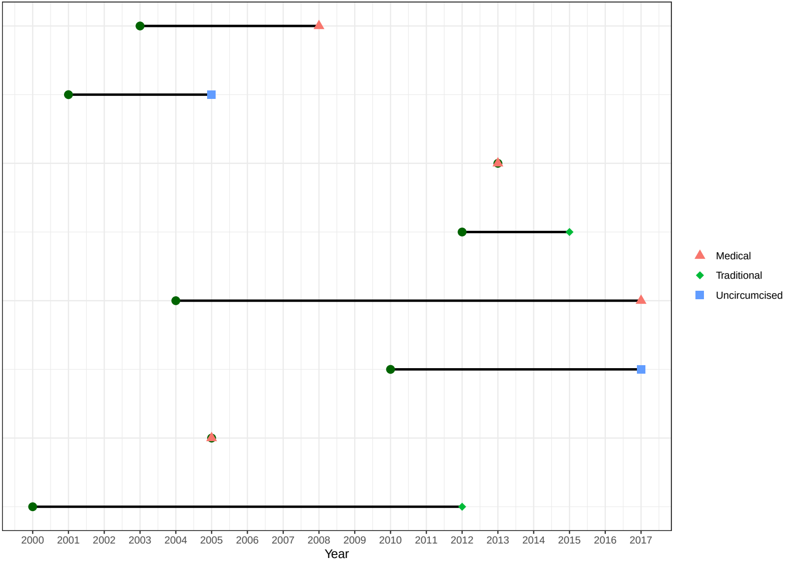


Estimating Circumcision Rates

- Five surveys
  - SABSSM 2002, 2008, 2012, 2017
  - DHS 2016
- Variables extracted
  - Demographics: Age and residence
  - Circumcision: Status, age at circumcision, where and who circumcised
- Program data
  - Number of circumcisions reported
- How do we put these things together to get a coherent answer?

Modelling Circumcision Coverage

- Region-age-time specific circumcision rates
- Survival analysis
- Baseline component
  - Assumed constant over time
  - Represents an underlying rate of circumcision
- Excess component
  - Assumed zero before to 2008
  - Represents circumcisions observed through VMMC programs
- Models fit using Template Model Builder (TMB)

$$\lambda_{iat} = \begin{cases} \lambda_{ia}^{base} & \text{t} < 2008 \\ \lambda_{ia}^{base} + \lambda_{iat}^{VMMC} & \text{t} \geq 2008 \end{cases}$$

Modelling Circumcision Coverage

Baseline rate

$$\lambda_{ia}^{base} = \alpha + \psi_i + \phi_a + \gamma_{ia}$$

- Region random effect - ψ_i (ICAR prior)
- Age random effect - ϕ_a (RW2 prior)
- Interactions -
  - Region-age: γ_{ia} (ICAR $\otimes$ RW2 prior)

Modelling Circumcision Coverage

Excess rate

$$\lambda_{iat}^{VMMC} = \alpha + \psi_i + \phi_a + \theta_t + \gamma_{ia} + \delta_{at} + \zeta_{it}$$

- Region random effect - ψ_i (ICAR prior)
- Age random effect - ϕ_a (RW2 prior)
- Time random effect - θ_t (RW2 prior)
- Interactions -
  - Region-age: γ_{ia} (ICAR $\otimes$ RW2 prior)
  - Age-time: δ_{at} (RW2 $\otimes$ RW2 prior)
  - Region-time: ζ_{it} (ICAR $\otimes$ RW2 prior)

NATIONAL RESULTS

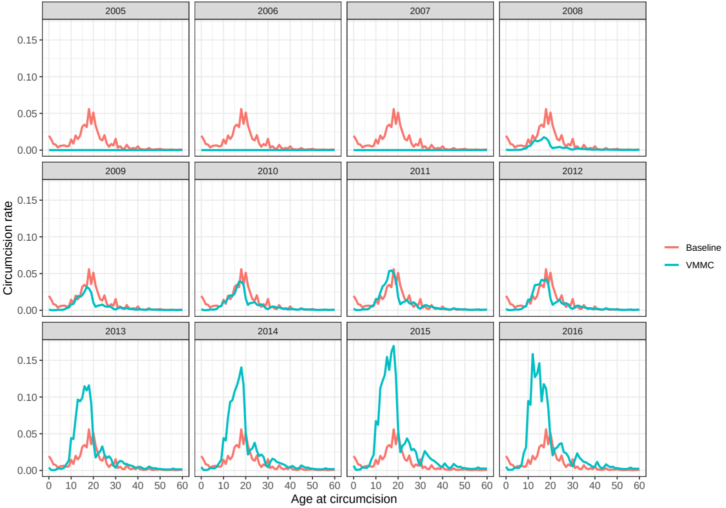


Figure: Estimated circumcision rates by age between 2005 and 2016 in South Africa. Lines denotes the median and the shaded region denotes the 95% CI.

National results

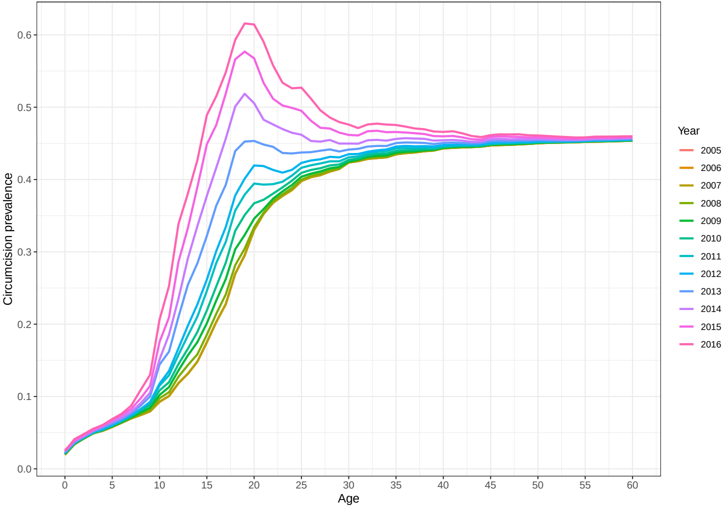


Figure: Estimated circumcision prevalence by age between 2005 and 2016 in South Africa.

Provincial results

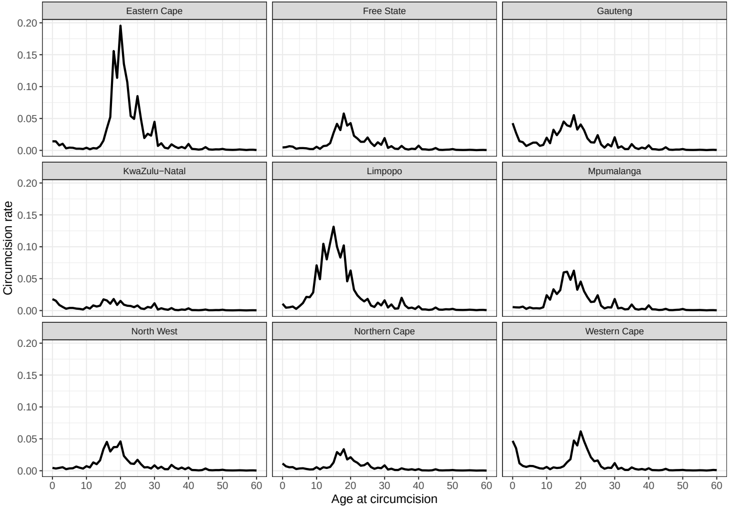


Figure: Estimated baseline circumcision rate by age (fixed over time) in each province of South Africa.

PROVINCIAL RESULTS

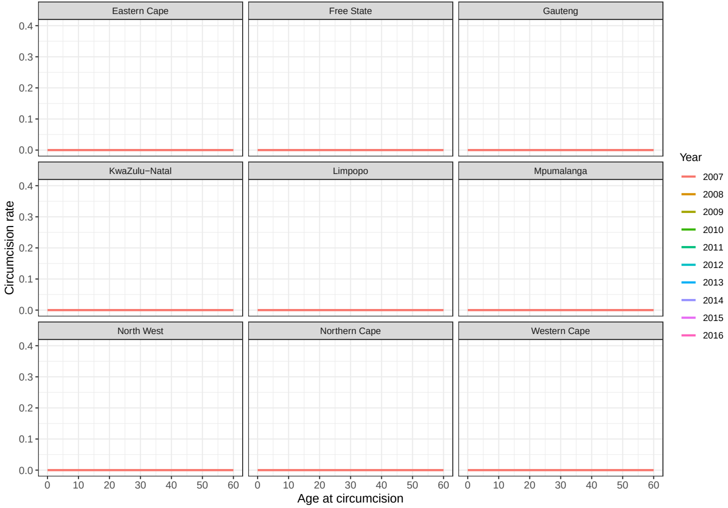
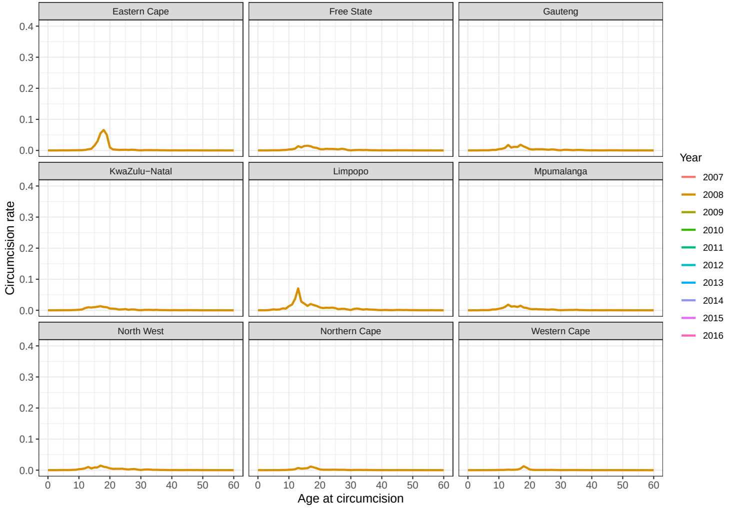


Figure: Estimated VMMC circumcision rates by age between 2007 and 2016 in each province of South Africa.

Provincial results



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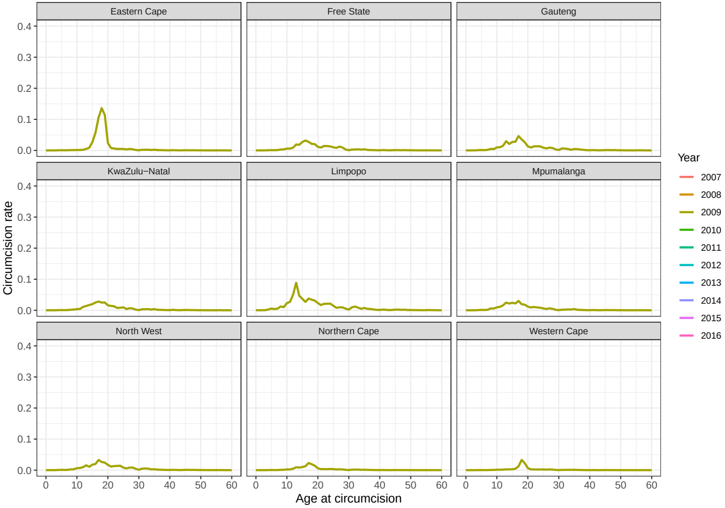

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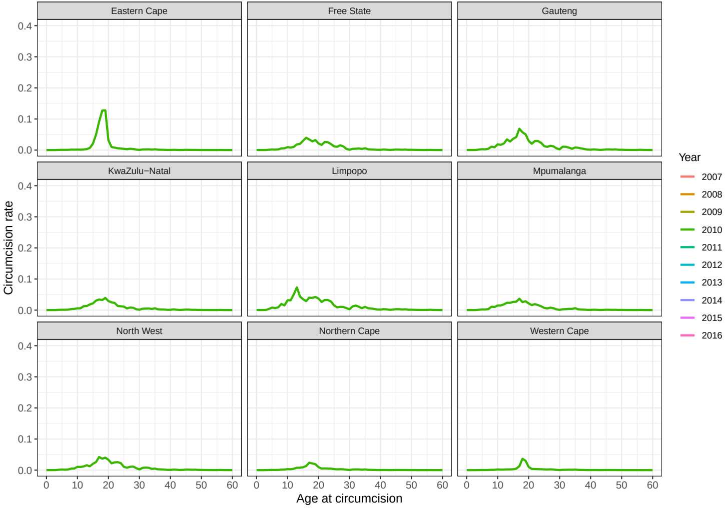

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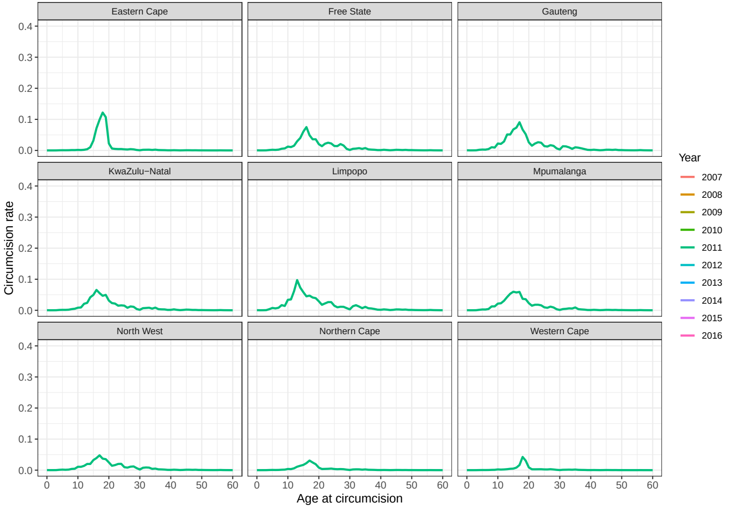

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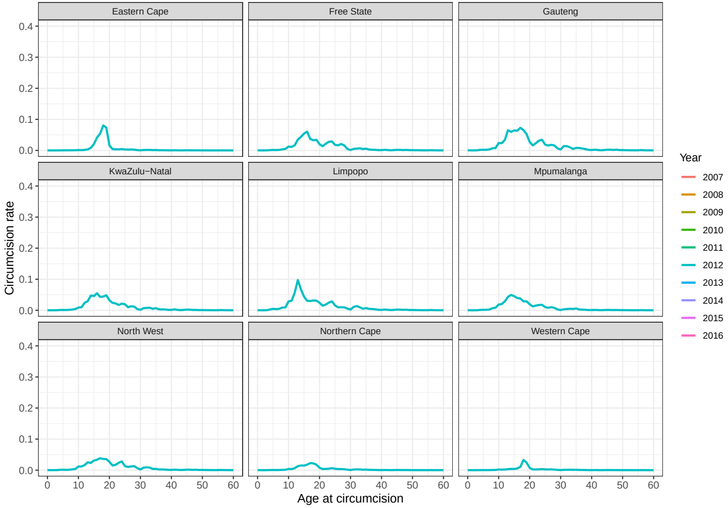

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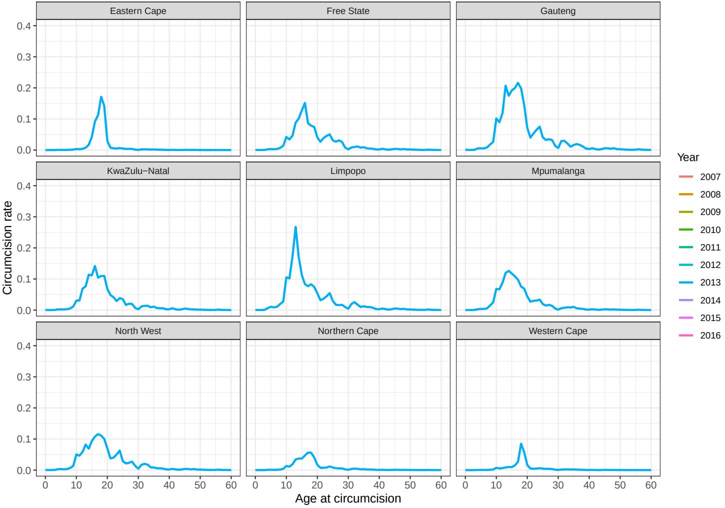

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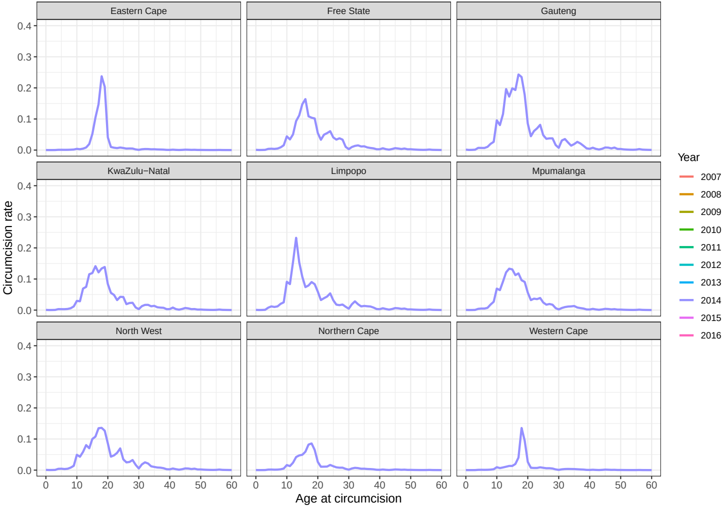

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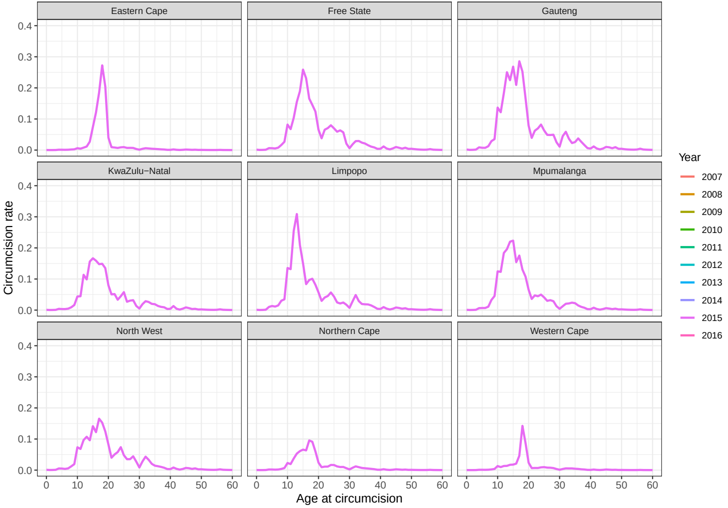

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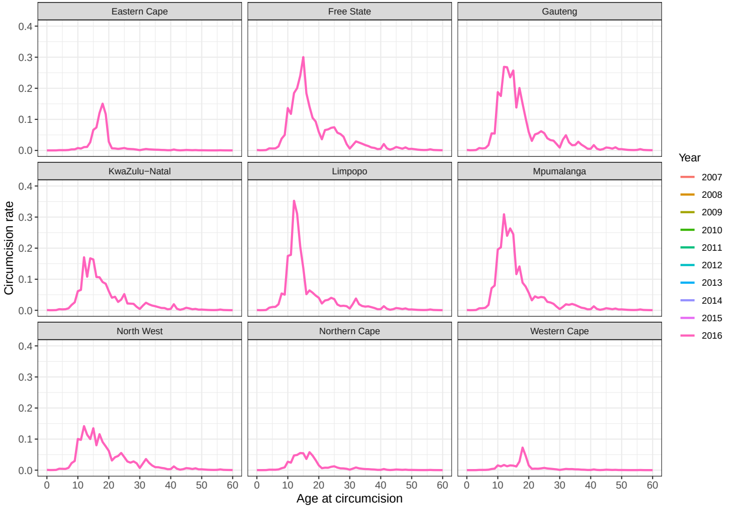

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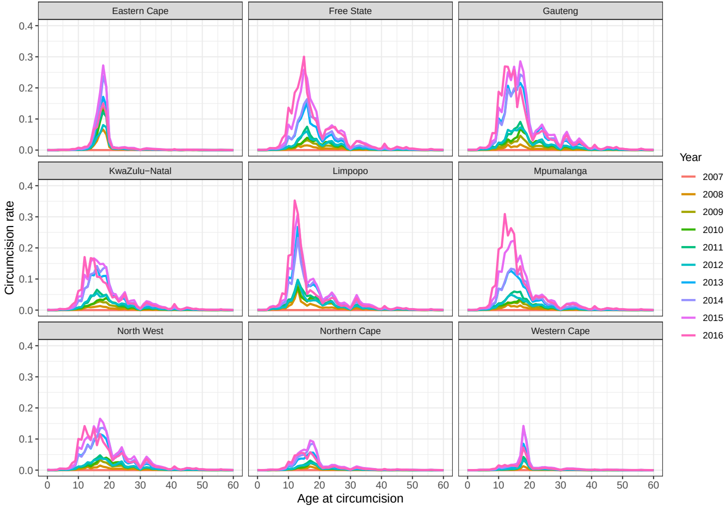

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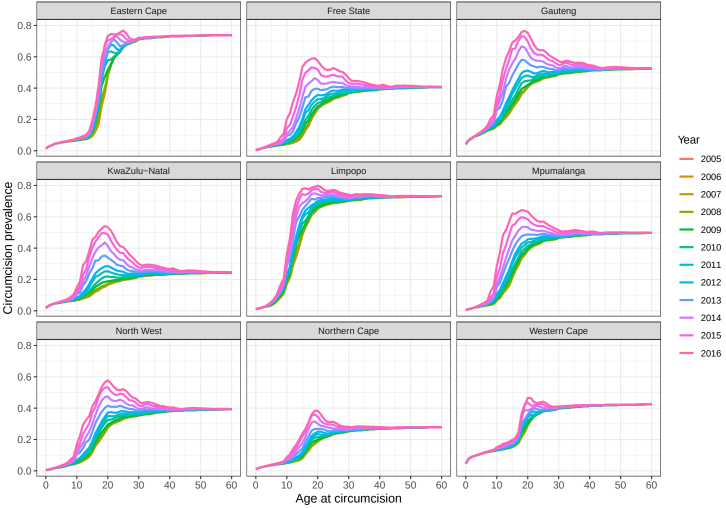


Figure: Estimated VMMC circumcision prevalence between 2005 and 2016 in each province of South Africa.

DISTRICT RESULTS

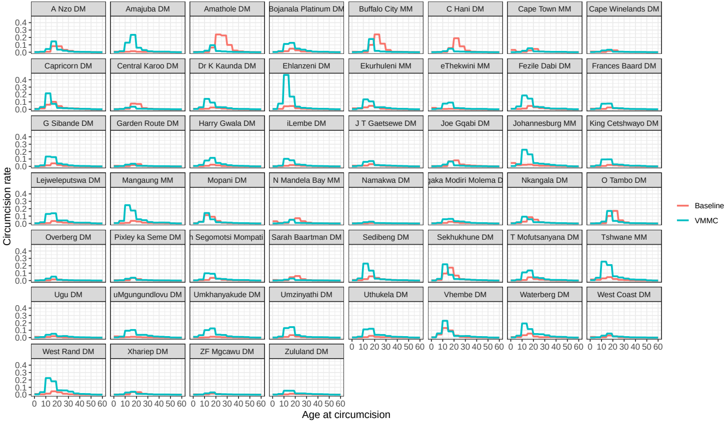


Figure: Estimated baseline circumcision rate by age in 2016 in each district of South Africa.

District results

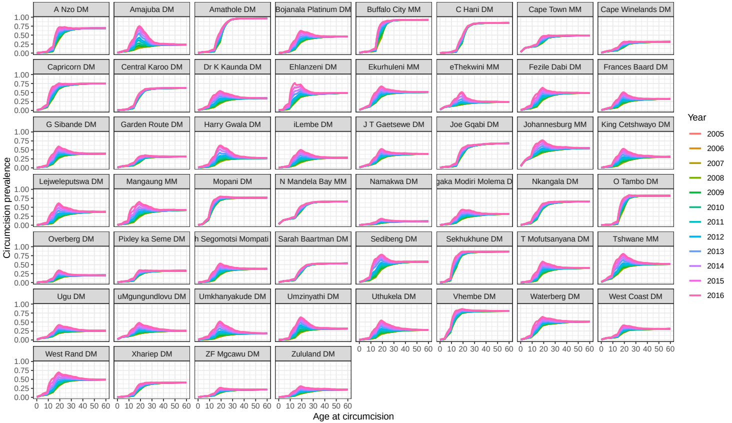


Figure: Estimated VMMC circumcision prevalence between 2005 and 2016 in each district of South Africa.

Adding Program Data

- Estimate an expected number of circumcisions performed

$$N_{iat} = P_{iat} \times \lambda_{iat}^{VMMC} \times \exp(-\Lambda_{iat})$$

  - P_{iat} - Male population aged a, in time t and region i
  - λ_{iat}^{VMMC} - VMMC circumcision rate for age a, time t and region i
  - Λ_{iat} - Cumulative hazard (total rate) from $(0, t-a)$ to (a, t) in region i
- Compare to the number of circumcisions performed

ADDING PROGRAM DATA

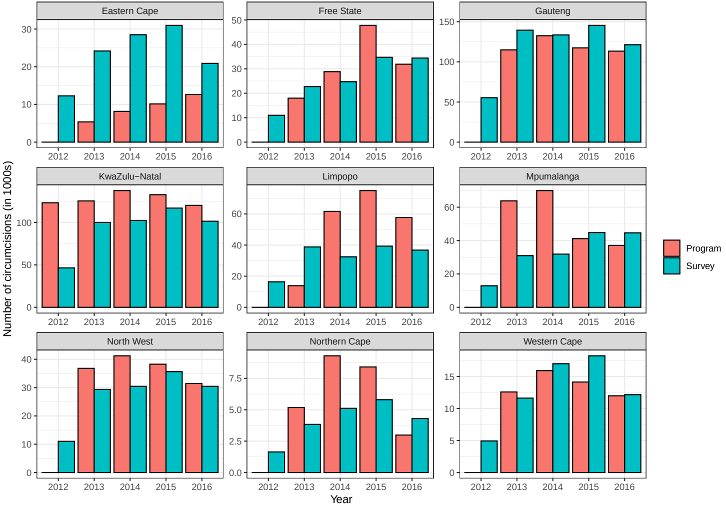


Figure: Estimated number of circumcision between 2012 and 2016 in each province of South Africa, along with the number of circumcisions reported through circumcision programs.

Adding Program Data

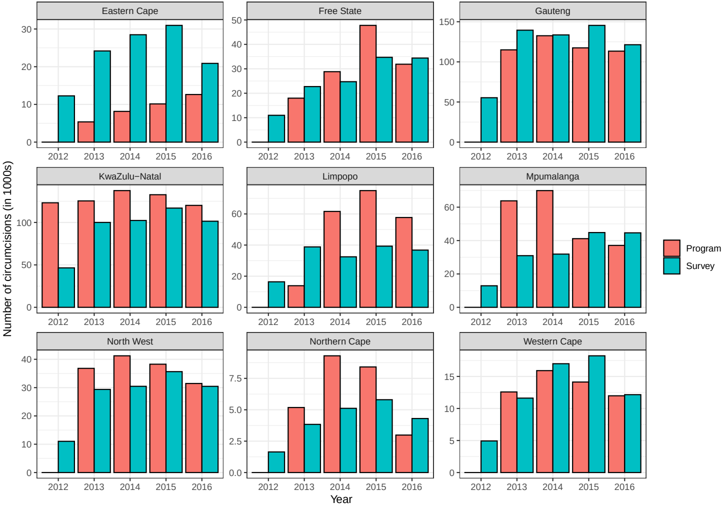
- Expected number of circumcisions performed

$$N_{iat} = P_{iat} \times \lambda_{iat}^{VMMC} \times \exp(-\Lambda_{iat})$$

- Have the number of circumcisions performed in region i and time t, C_{it}
- Add into the model through a Poisson likelihood

$$C_{it} \sim Poisson\left(\sum_{a} N_{iat}\right)$$

Adding Program Data



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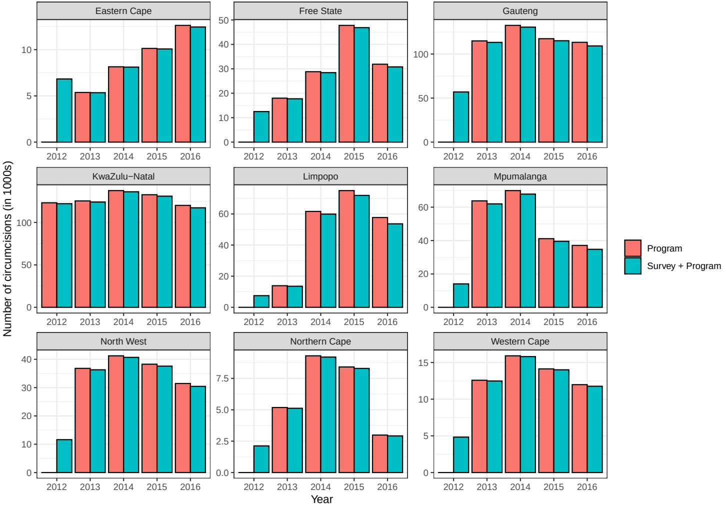

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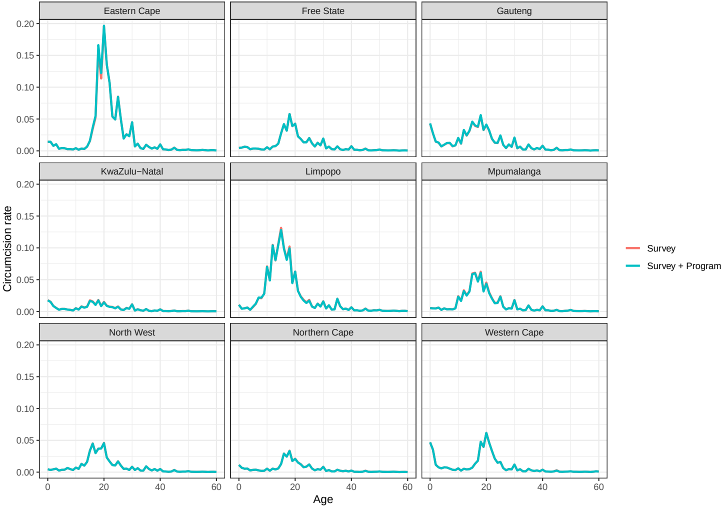

Figure: Estimated baseline circumcision rates by age in 2016 in each province of South Africa.

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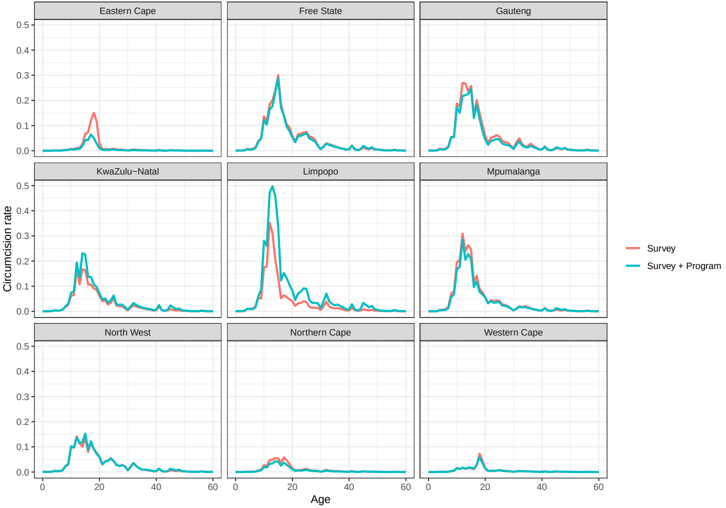

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Summary and Future Work

- Produced a model that estimates circumcision rates in South Africa
  - National/province level
  - By age
  - Over time
- Future work
  - District level estimates
  - Short-term projections
  - Age disaggregates of number of circumcisions performed
  - Movement (between districts) for circumcisions
  - Medical vs. traditional circumcision

ANY QUESTIONS?