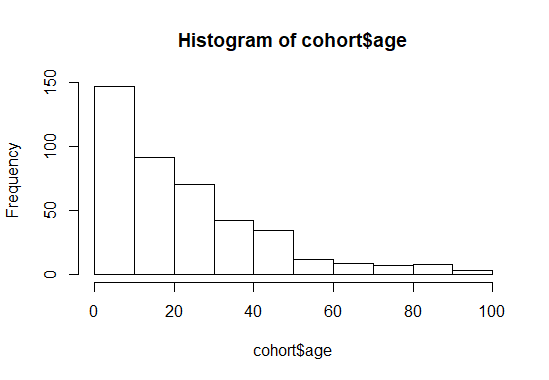
*SCHISTOSOMIASIS TRANSMISSION*

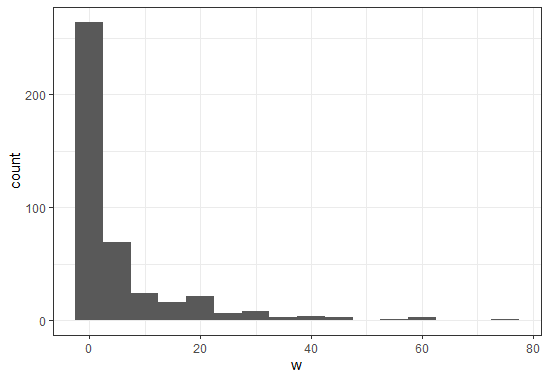
Timestep [1 month] *t*

Human hosts *i = 1, …, N*

**INITIAL POPULATION**

* Initial age distribution
* Initial worm distribution in the population





* Individuals are assigned with sex and individual susceptibility to infection (described below)

All the quantities presented with the subscript *i* refer to the *i-th* individual in the population.

At each timestep *t* the following events occur*:*

**DEMOGRAPHY**

At the beginning of each month, birth and death events happen:

The number of **births** for the current monthis determined by a Poisson drawn with a rate given as:

where

is the crude **annual** birth rate for Sub-Saharan Africa (per **1000** individuals)

is the population size at timestep *t*

The population is updated with *#births* new individuals, assigned with age=0 and worm load=0. Sex and individual susceptibility are also assigned as described in the next section.

Each month, every individual can dye according to an age- and sex- specific **death probability** available from the WHO Demography App for Sub-Saharan Africa.

In case of **death,** the individual is removed from the population.

**Updating age and population quantities:**

After births and deaths occurred, individual age is (monthly) incremented and population size, number of SAC and cumulative exposure accordingly updated.

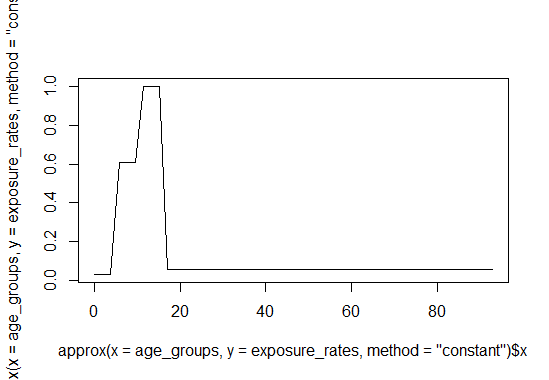
**EXPOSURE to infection**

**Force of infection acting on individual *i* : number of new worms acquired [nw]**

*cloud* = number of larvae in the reservoir

*zeta =* overall exposure rate (it mainly drives transmission --> the level of true prevalence)

= age-specific contact (exposure) rates



: aggregation level of worms, including individual propensities to infection. It has a range in Graham (2021). It drives the abundance of high intensities of infection.

individual susceptibility to infection. It is assigned at birth and lasts lifelong.

New worms are assigned sex. Random portion of new worms are male worms:

**WORMS**

**Mature worms are paired [wp]. Paired worms can produce eggs.**

, number of worm pairs

, expected egg load

: number of male mature worms for human host *i*

: number of female mature worms for human host *i*

: number of detected eggs from human host *i*

: fecundity in eggs/worm pair/slide. Range studied in De Vlas (1992). It has effect on the shape/slope of the bounce backs.

: aggregation parameter for egg counts. It drives the “gap” between true prevalence and egg-based prevalence. Sake takes into account quantity of stool and repeated sample to quantify it.

***N.B.*** *In case the density dependency assumption applies, the individual expected egg load is defined as*

*With : density dependent fecundity. (Temporary assumption.) From Graham (2021).*

**CONTRIBUTION to the reservoir**

**Individual contributions []**

**CONTROL**

*(****MDA* assumptions*: 75% coverage, 80% efficacy, annual to pre-SAC and SAC, 10 years)***

If *t* is the time of MDA:

If age of individual *i* is in the target population:

}

**WORMS are updated for the next month:**

The new acquired worms are added, which will be considered mature the next month. (Assumption that can be improved).

Survival portion of males and females worms from the previous month is included.

*:* 1 - survival probability of worms from the previous month

: lifespan of an adult worm in the human host [years]

**RESERVOIR/CLOUD**

**Temporary assumption: general cloud without snails**

**OUTCOMES**

**Population size over time**

Ten stochastic seeds (grey lines) with the mean (black line) are displayed.

****

**PRIORITIES / DISCUSSION POINTS:**

1. **How to keep constant population size.** The parameters describing the population in South Africa reflect an expanding demography, increasing exponentially over time. We need a mechanisms to keep the population constant.

In WORMSIM this is implemented with a “trimmer” event. This occurs all the times that the population size exceeds a given value, as a consequence the population is reduced of 10%.

In SCHISTOX they assume that a new born is added to the population for each occurring death.

To produce the plot above I am using the trimming mechanism, annually, whenever the population is greater than 700 individuals.

**Prevalence timelines**

1. True prevalence
2. Egg-based prevalence
3. Egg-based prevalence in SAC
4. Prevalence of high intensity of infections

Applying density-dependency assumption for egg production.

The implementation of a dynamic demography has introduced greater stochastic effect during the burn-in, the runs however stabilise afterwards.

With the same assumptions I show below the effect of 10 simulated years of MDA, distributed annually in SAC with a coverage of 75% and an efficacy of 80%.



Assuming NO density-dependency for egg production.

(Polman, de Vlas (2000))

The particles in the reservoir increase linearly without an upper bound. Without any limiting mechanisms it can reach implausible values going to +∞, even though we consider aging, births and deaths of individuals.



**PRIORITIES / DISCUSSION POINTS:**

1. **Limiting mechanisms.** We need limiting mechanisms that can help to stabilise the number of particles in the reservoir, in case we do not assume density-dependency in egg production. Those can be explored:
   1. Death of individuals due to high burden of worms
   2. Saturating effects in the reservoir due to saturation of resources or seasonality

**NEXT STEPS:**

1. Role of intermediate host.
2. Probability of worms’ reproduction (now we are assuming that all worm pairs reproduce).
3. Death of worms: individual lifespans can be generated.