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An introduction to the natural history of helminth infections

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What is a parasite?

An organism that lives in or on another organism (its host) and benefits by deriving nutrients at the host's expense.

Macro parasite – eukaryotic, dioecious, multiple life-stages

Helminths (worms), protozoans

Micro parasite – monocellular, directly-transmitted, monoecious

Bacteria, viruses

Hookworm

Trichomonas in *T. rex*

Ewan Wolff, University of Wisconsin

Evolution of parasitism

Many parasites have a free living stage. One possible route to parasitism is:

1. Free-living larval stage of organism feeds on surface of another organism

2. Larva penetrates skin, feeds below in tissue

3. Larva works its way further into biomass, eventually becomes enveloped

4. Once inside, reproductive stages need to exit or auto-infect

W.H.O. list of NTDs

Bacteria

Buruli Ulcer
Dengue/Severe dengue
Leprosy
Trachoma
Yaws

Helminths

Chagas disease(American trypanosomiasis)
Cysticercosis
Dracunculiasis (guinea-worm disease)
Echinococcosis
Fascioliasis
Lymphatic filariasis
Onchocerciasis
Schistosomiasis
Soil transmitted helminthiasis (geohelminths)

Protozoans

Human African trypanosomiasis
Leishmaniasis

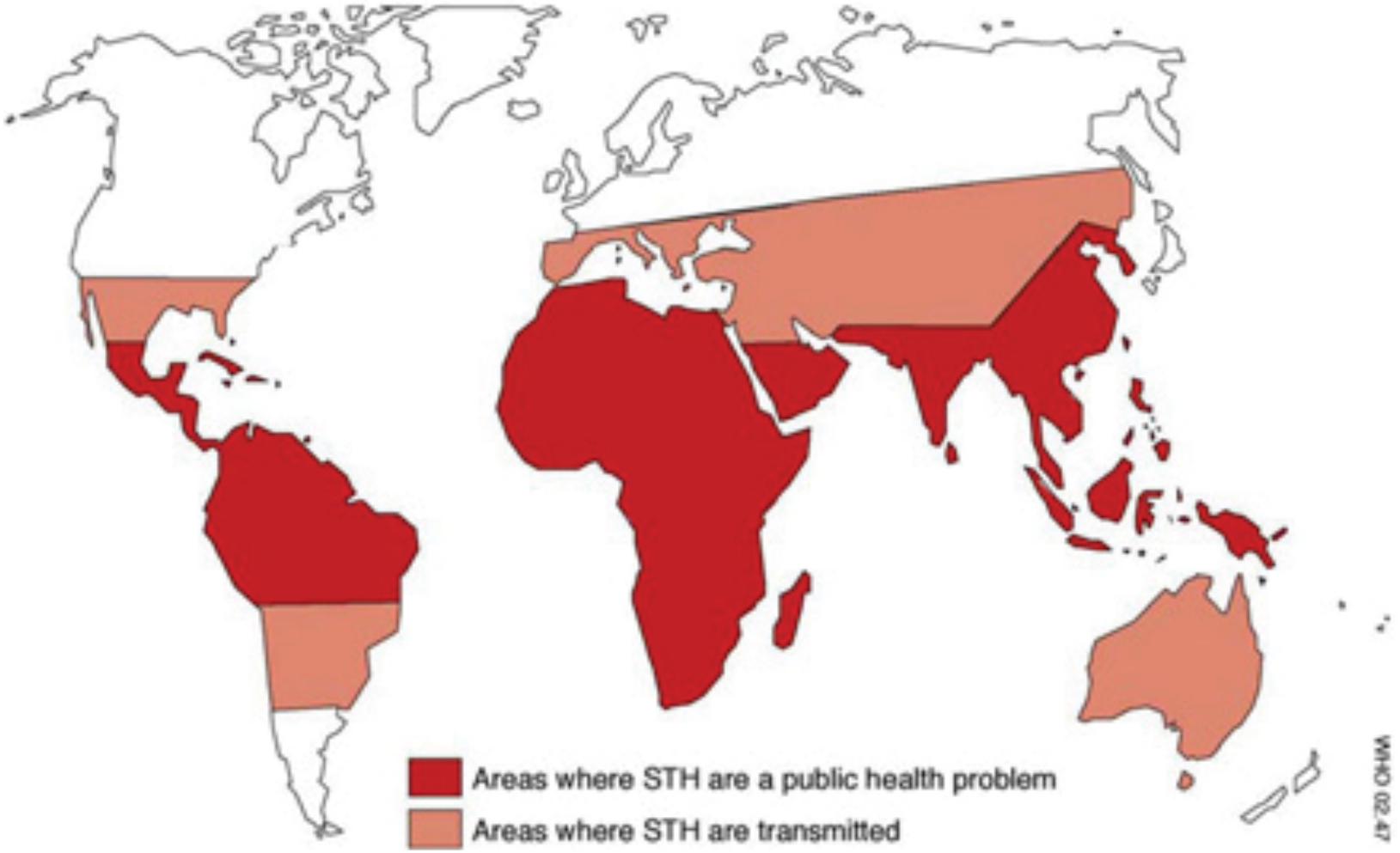
Viruses

Rabies

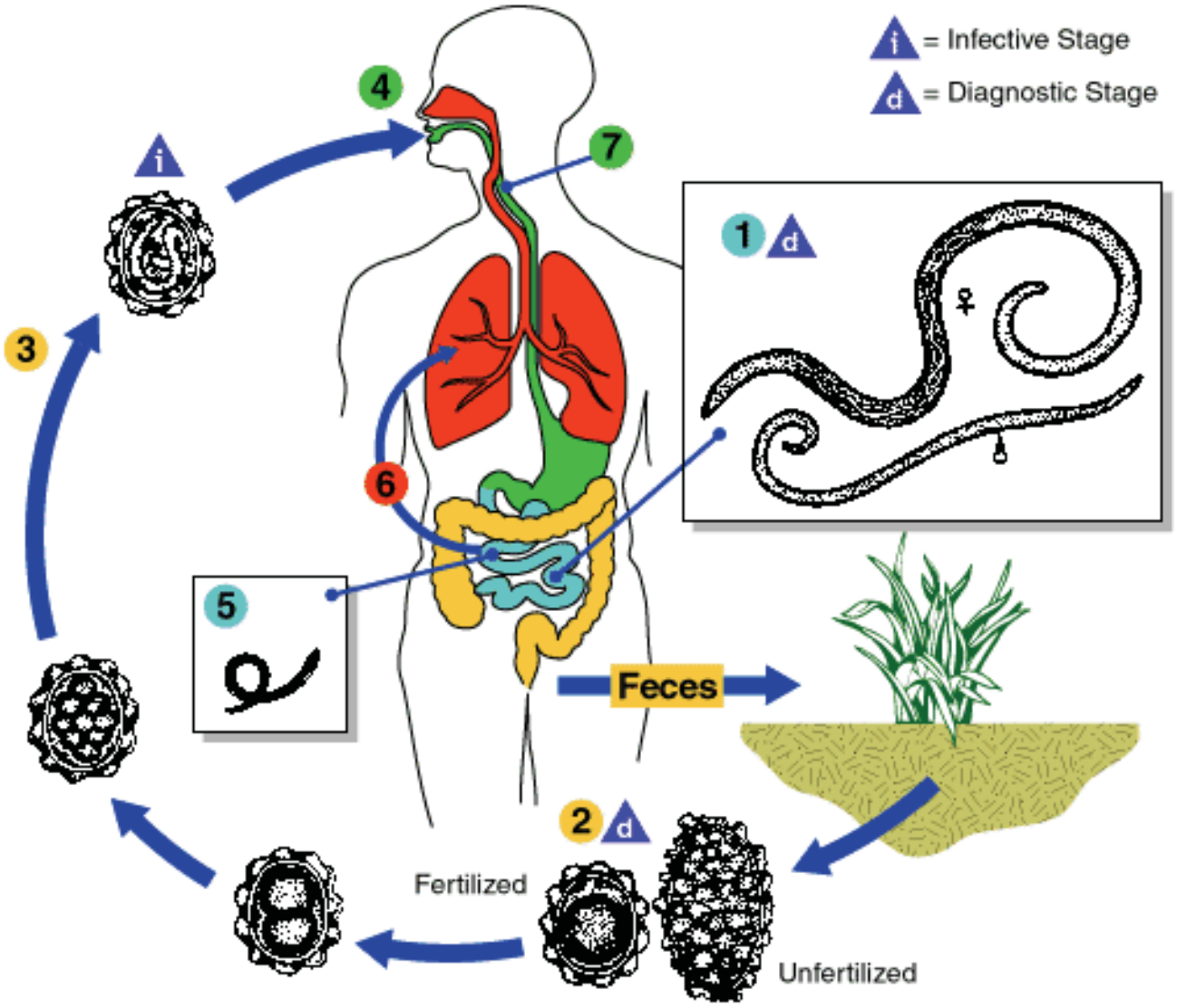
Geohelminth Mortality estimates

Parasite	**Infected (m)**	**Deaths/yr**
Ascaris lumbricoides	>1000m	60,000
Hookworm	>800m	65,000
Trichuris trichiura	>500m	10,000

Global Map of geohelminth distribution



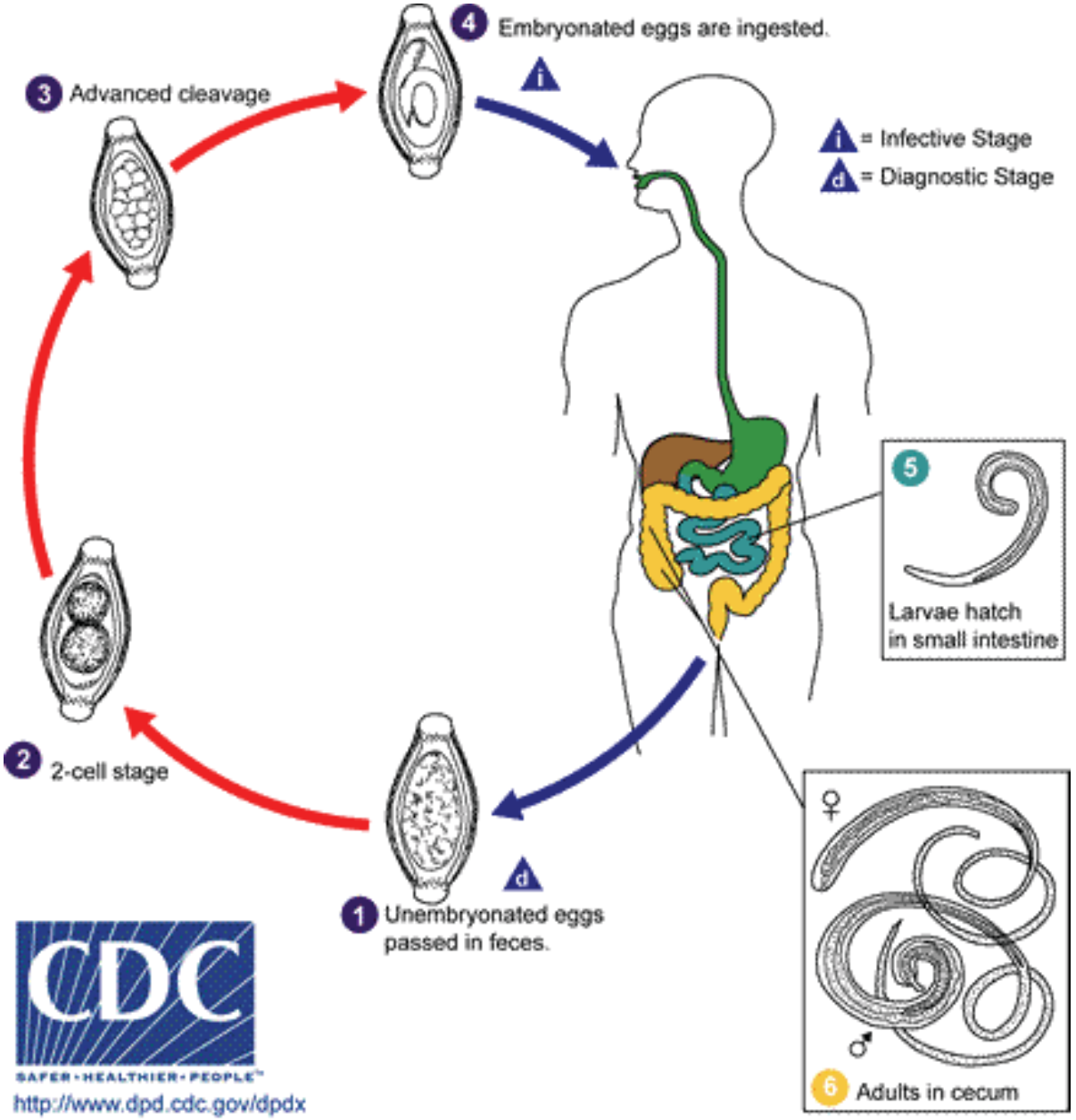
Ascaris lumbricoides lifecycle



Clinical features of A. lumbricoides

- Lung-stage:
  - Coughing, eosinophilia,wheezing
- Adult worms in the gut
  - mechanical obstruction leading to malabsorbtion.
  - Vitamin A deficiency
- Migratory worms
  - Obstructive jaundice
  - Pancreatitis
  - Peritonitis

Trichuris trichiura

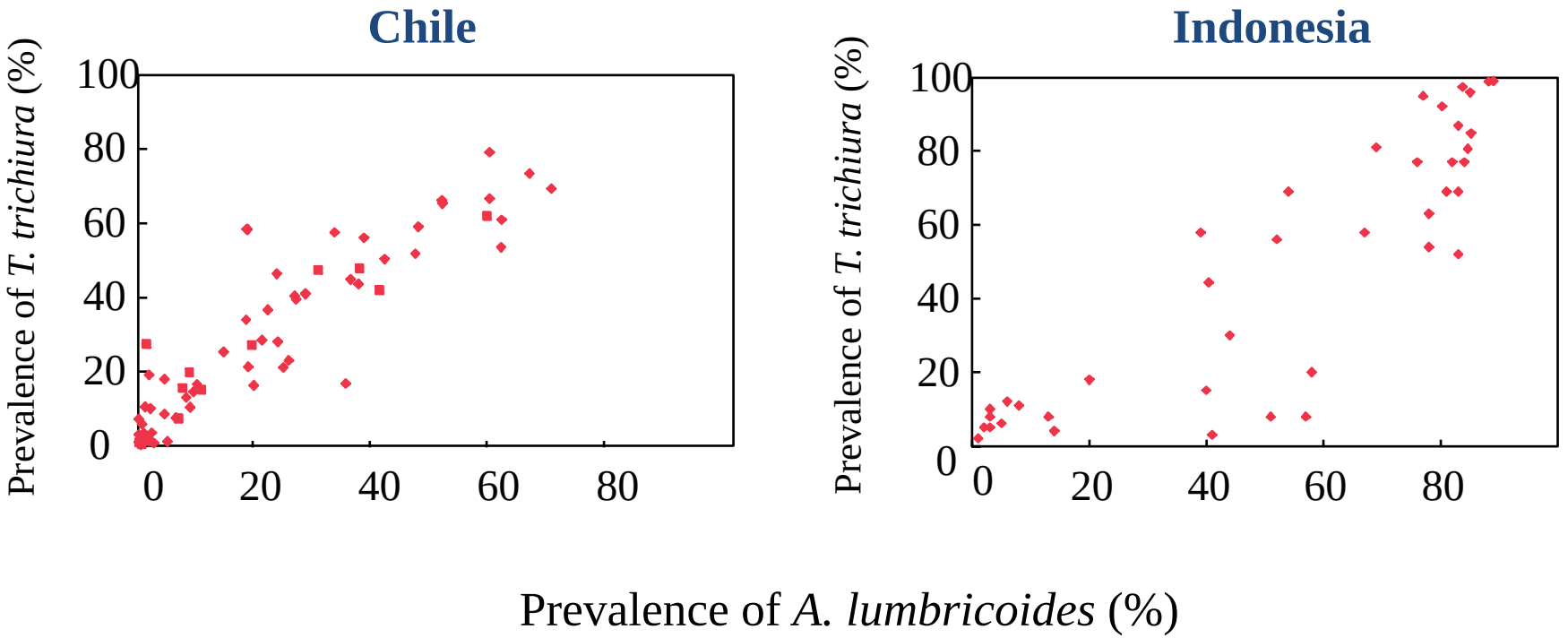


Clinical features of *T. trichiura* infection

- Adult stages
  - Mucoid stools
  - Rectal prolapse
  - Stunting
  - Finger clubbing

- Insidious effects include cognitive impairment and reduced educational attainment

Joint geographical distribution of geohelminth infections



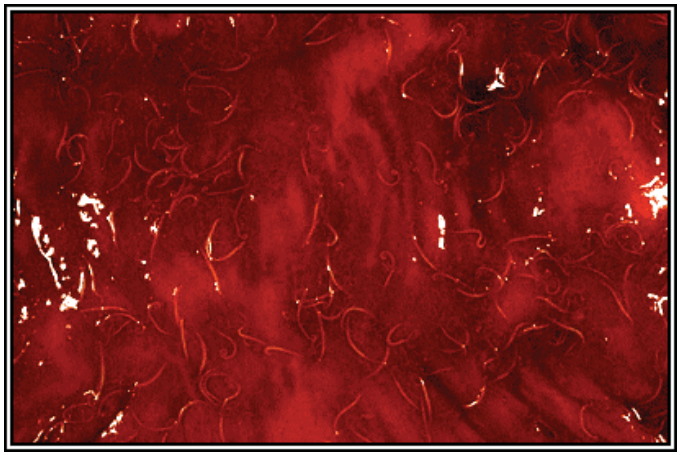
Shared characteristics of geohelminth species

- *A. lumbricoides* + *T. trichiura*
  - Similar transmission routes
  - Similar environmental requirements
  - Similar resting position of adults

A. lumbroicoides

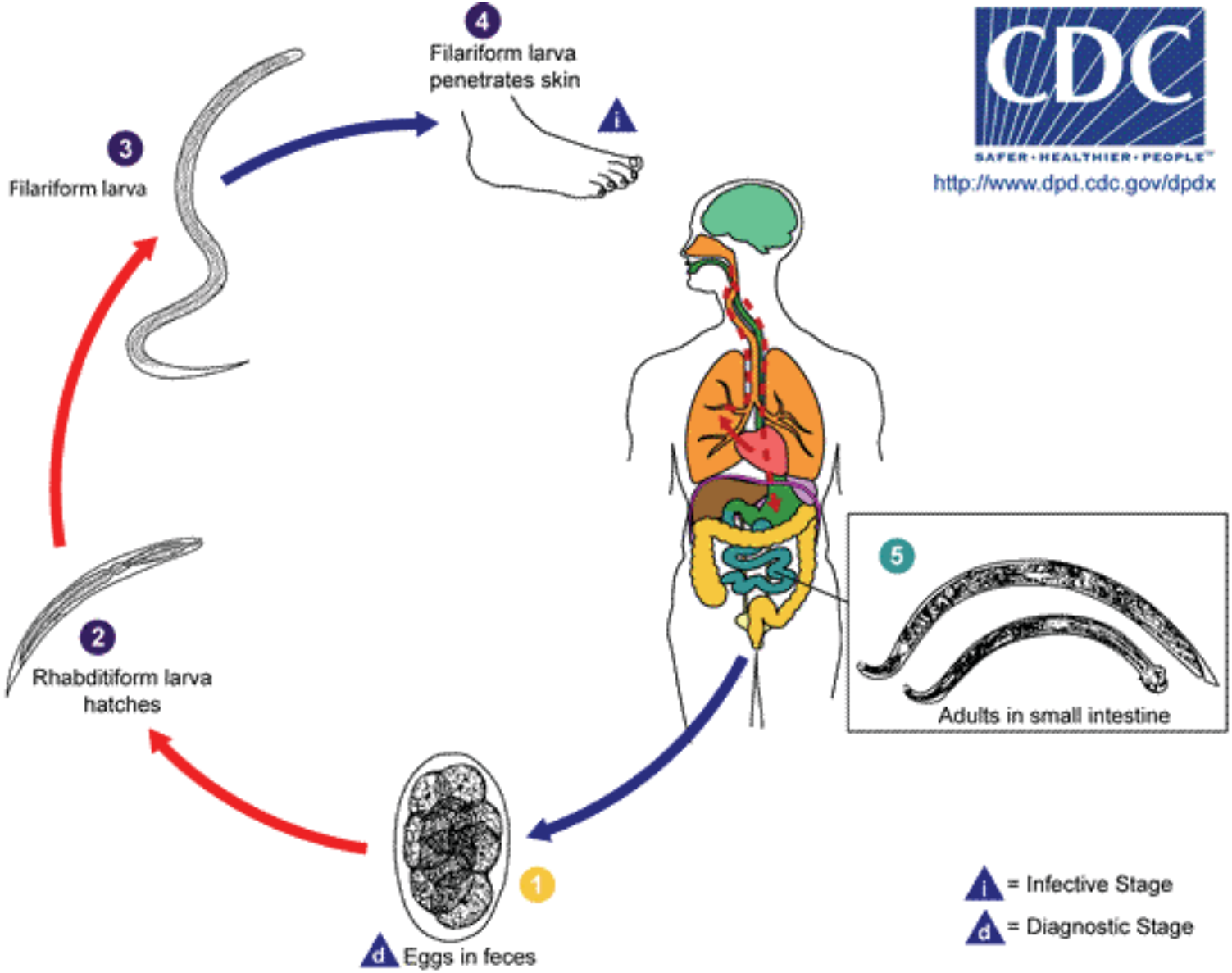
jejunum

T. trichiura



caecum

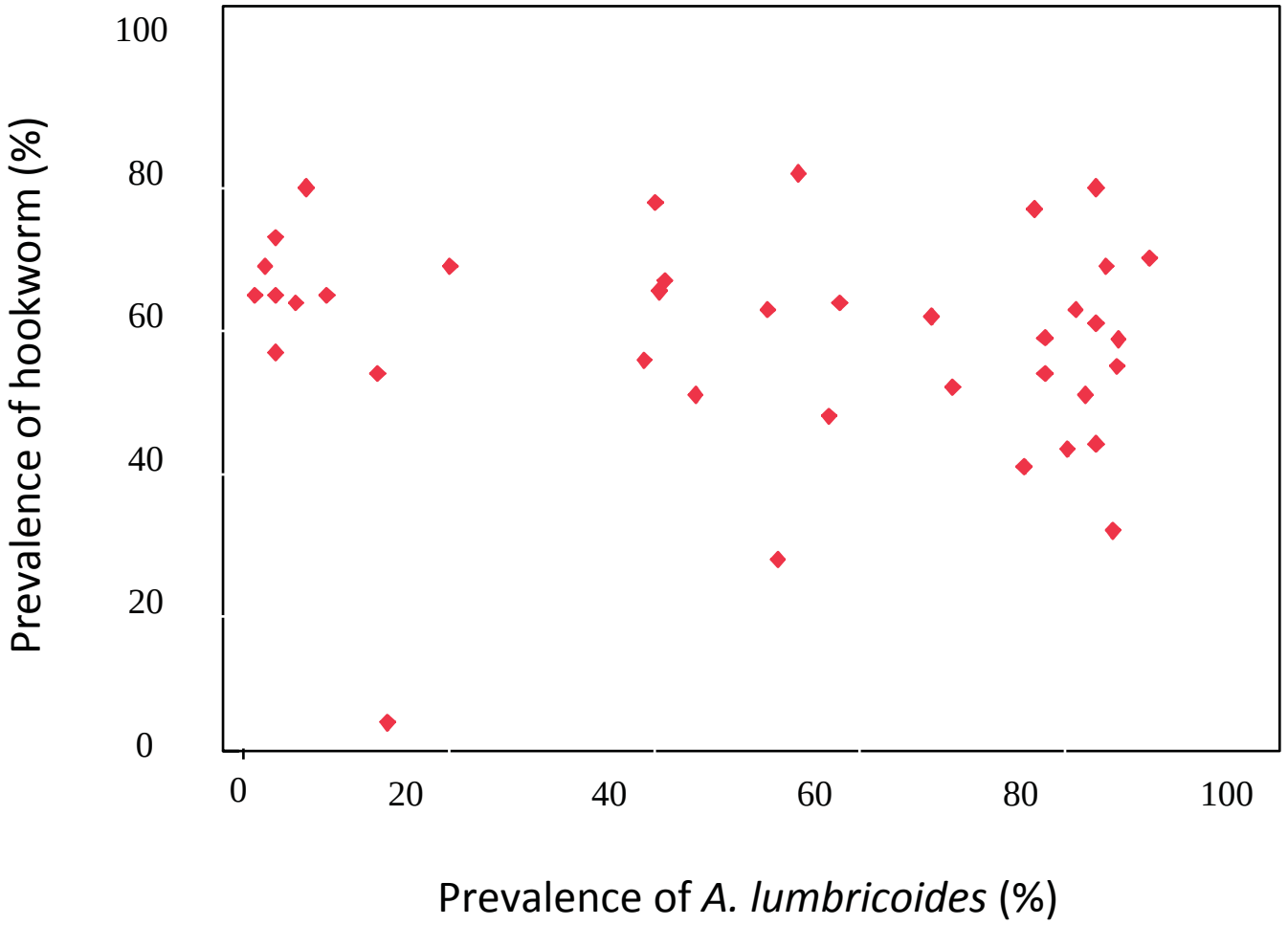
Hookworm life cycle



Hookworm clinical features

- Skin stage
  - Local dermatitis (ground itch)
- Lung stage
  - Cough
- Adult worms
  - Anaemia
  - Folate deficiency
  - Vitamin A deficiency

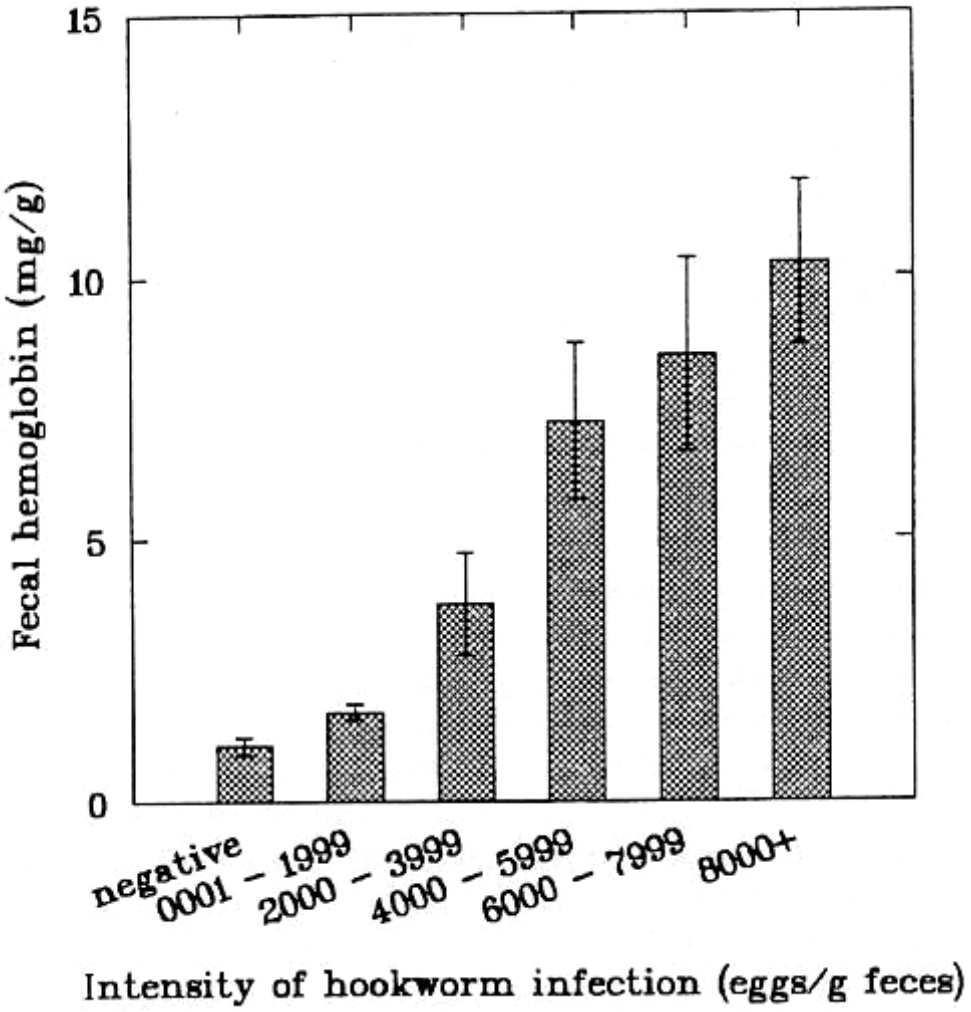
Geohelminth infections in Indonesia



Geohelminth life history parameters

	A. lumbricoides	*T. trichiura*	Hookworm
Infective stage	Ova	Ova	Larvae
Egg production (eggs/female worm/day)[a]	10 000–200 000	2000–20 000	3000–20 000
Life expectancy of free-living infective stages[a]	28–84 days	10–30 days	3–10 days
Adult life span[b]	1–2 years	1–2 years	3–4 years
Pre-patency (adult development to sexual maturity)[b]	50–80 days	50–84 days	28–50 days
Larvae development time to infective stage[c]	8–37 days	20–100 days	2–14 days
Max. temp. of viable development[c]	35–39°C	37–39°C	40°C
Basic reproductive number[b]	1–5	4–6	2–3

Infection intensity and morbidity



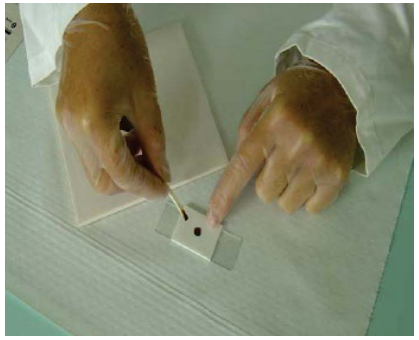
Higher worm burdens lead to greater risk of morbidity across all species

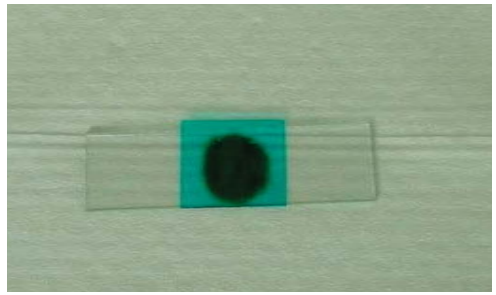
Risk factors for geohelminth infection

- Geophagia
- Eating unwashed vegetables
- Going barefoot (esp. hookworms)
- Poor sanitation / hygiene
- Immuno-compromisation (e.g. HIV)

Diagnosis with the Kato-Katz Technique

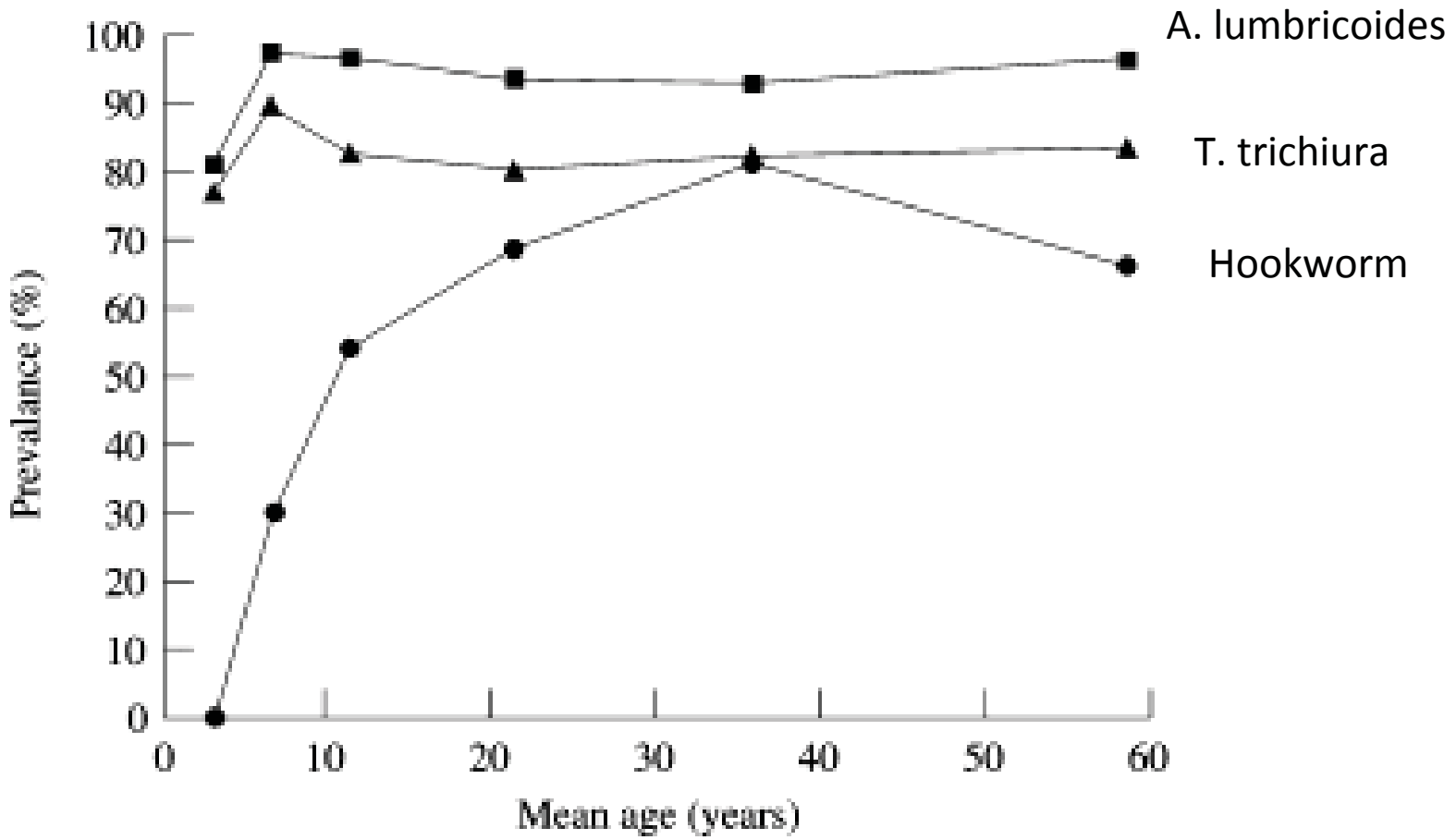




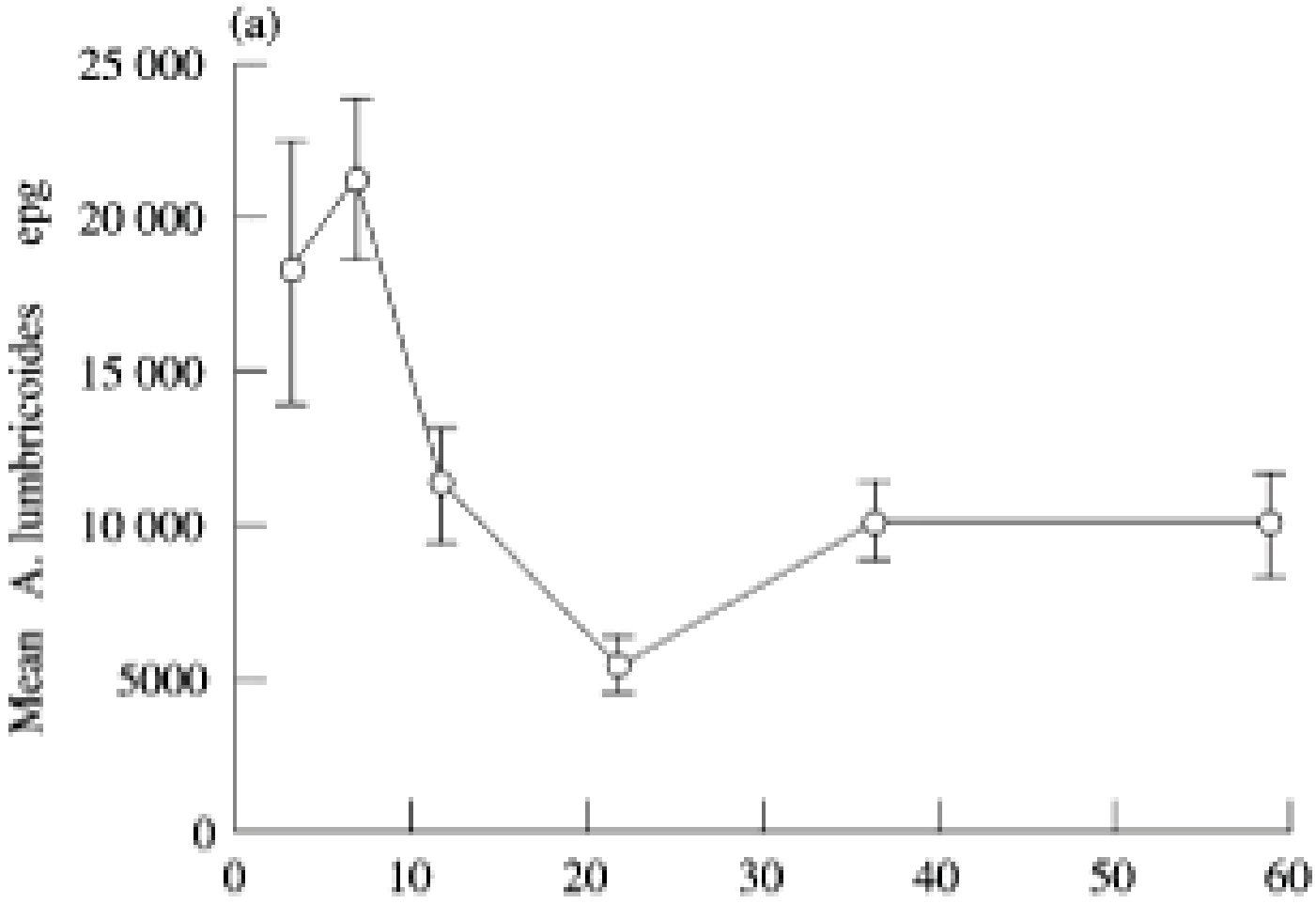
- Highly insensitive technique requires multiple smears
- Cheap and re-usable
- Easy to train and use in the field

Age-Prevalence curves

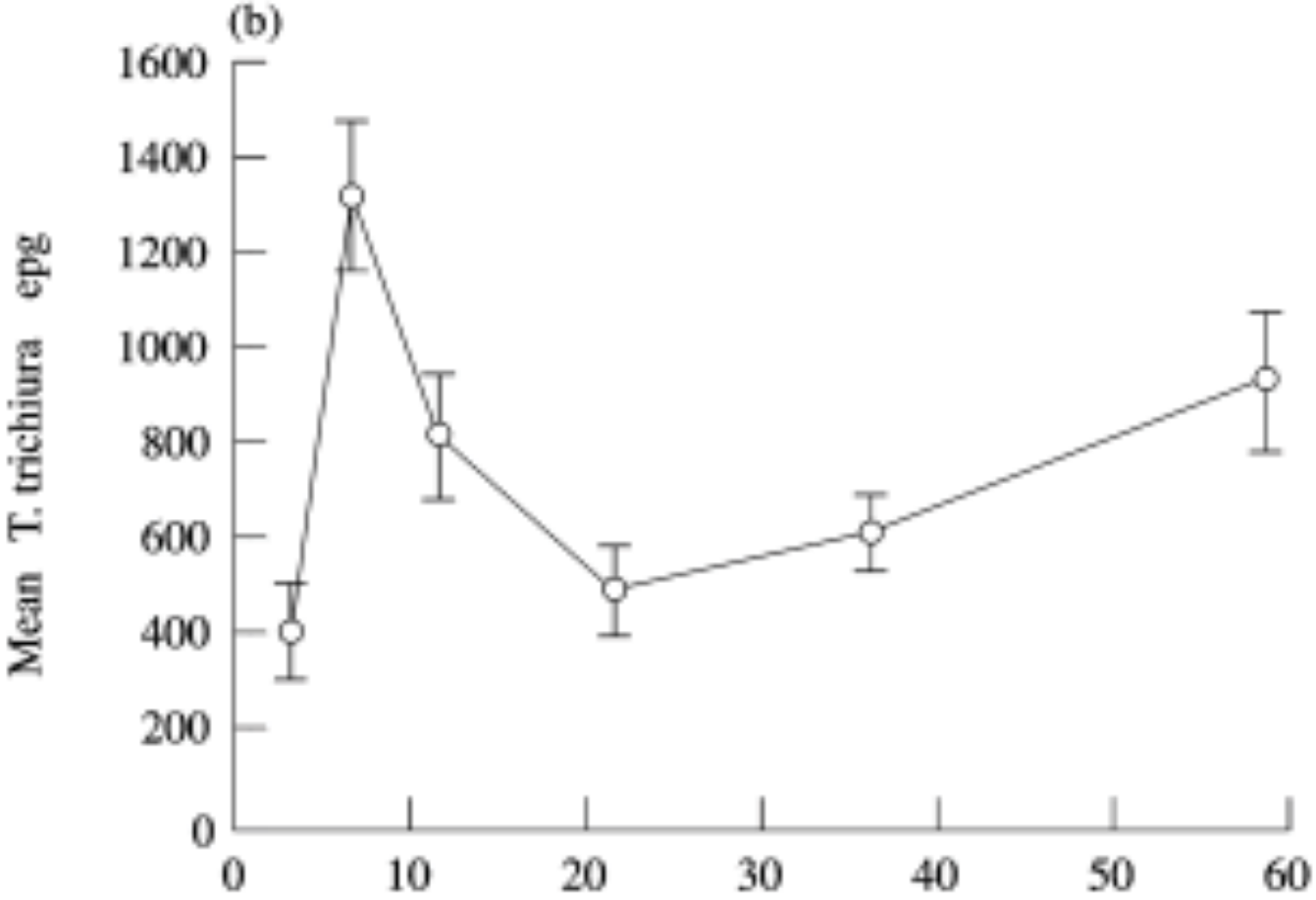


Needham *et al* Trop Med Int Health. 1998 Nov;3(11):904-12

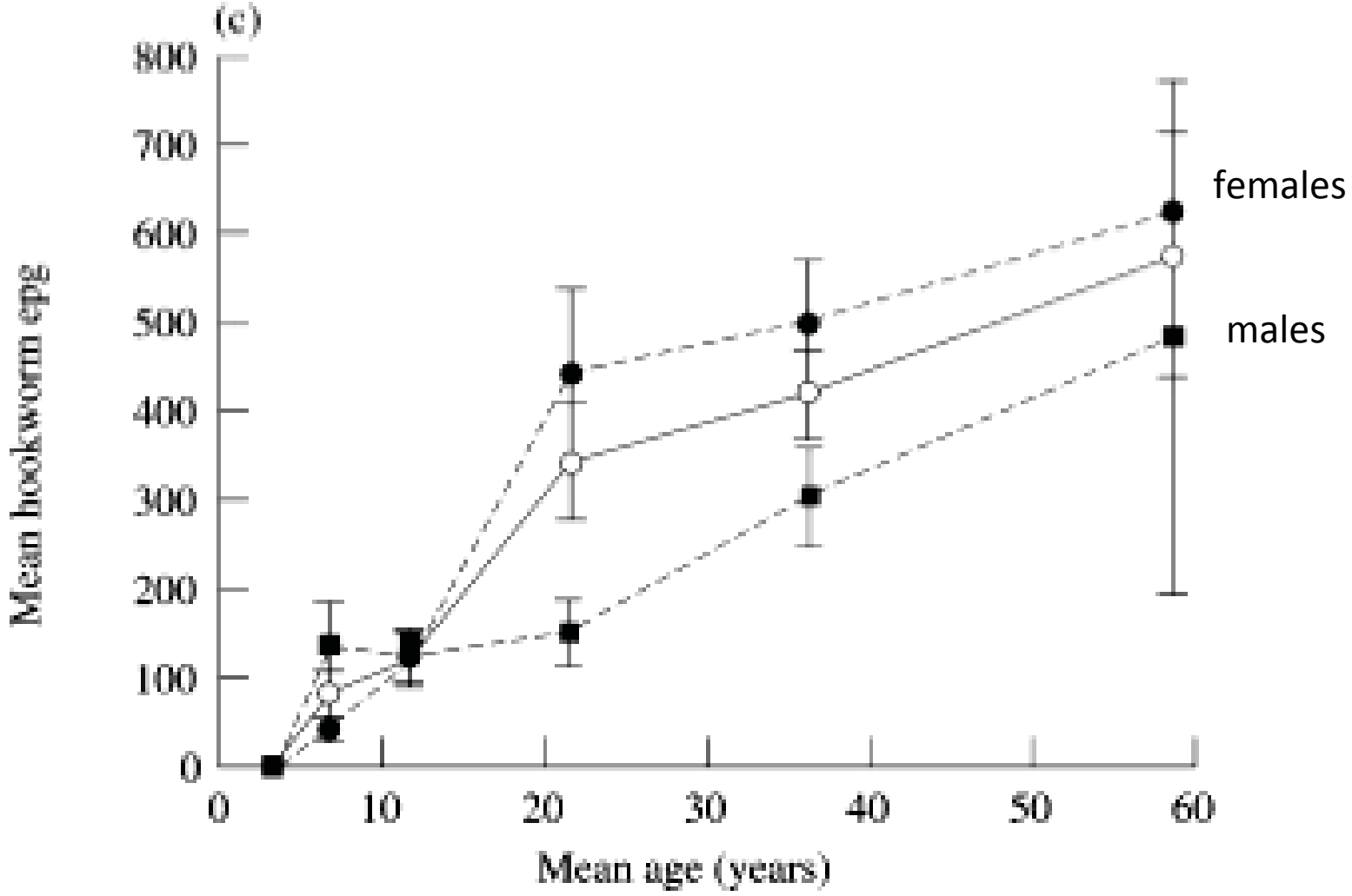
Age-intensity curve (A. lumbricoides)



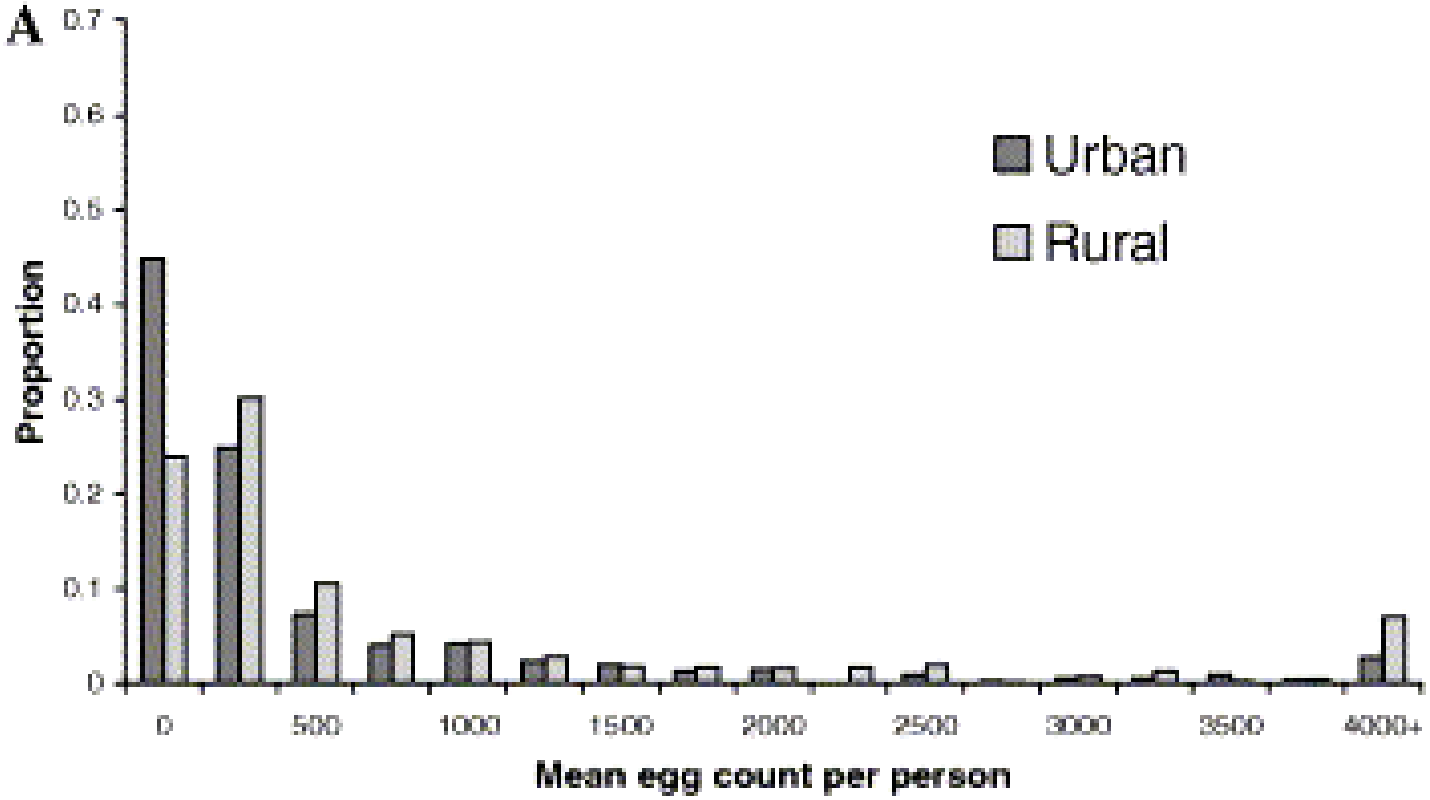
Age-intensity curve (T. trichiura)



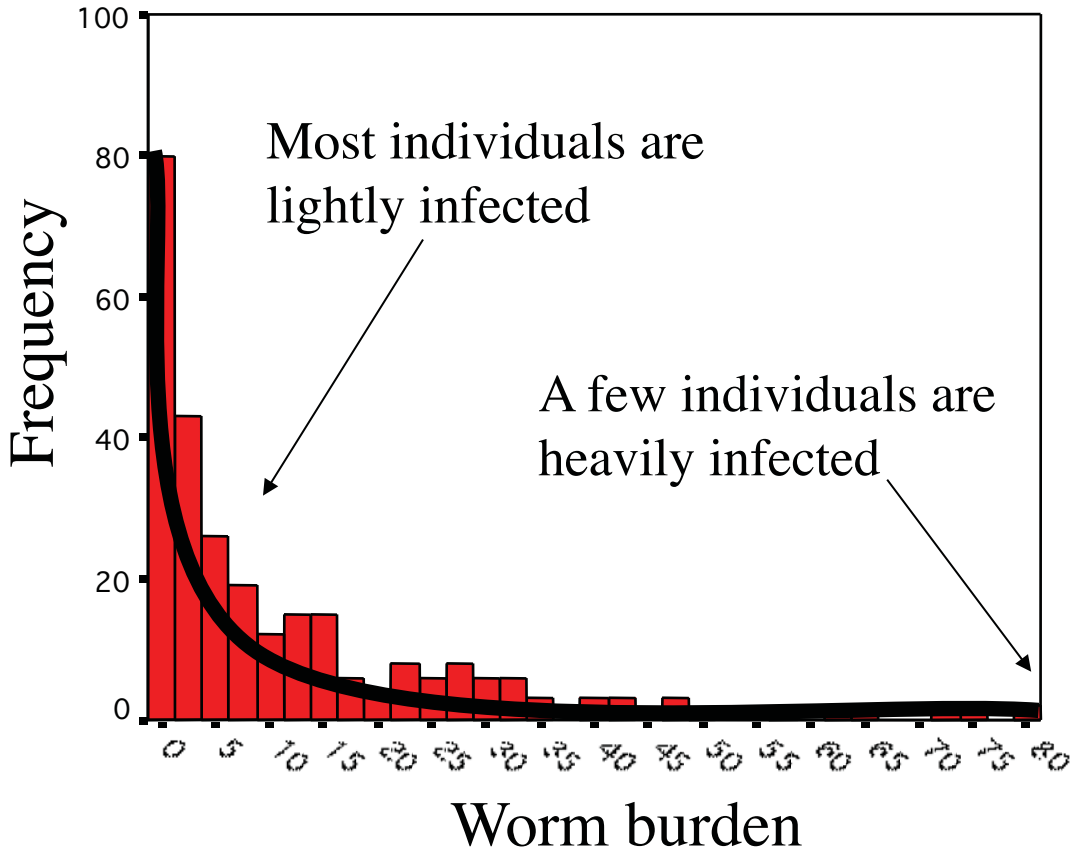
Age-intensity curve (hookworms)



Hookworm egg count frequency distribution



Geohelminth frequency distribution



Worm distributions within a community often have an over-dispersed distribution

The majority of infected individuals carry few worms

A minority of individuals carry heavy worm burdens (80:20 rule)

WHO recommends……

category		prevalence
I	high prevalence	≥ 50%
II	moderate prevalence	≥20% < 50%
III	low prevalence	< 20%

Chemotherapy options are based on prevalence estimates.

For communities in **category I,** universal treatment is recommended. The whole community is treated irrespective of age, sex, infection status, or other social characteristics. Treatment campaigns must be conducted once a year. The efficacy of the measure is higher if the whole population is treated simultaneously.

Mass treatment every year in high transmission areas….

In areas where the prevalence of high intensity infection (visible haematuria for *S. haematobium*) is over 15% schoolchildren may be given treatment twice a year for added benefit.

…twice *p.a.* in high morbidity areas

For communities in **category II,** targeted treatment is recommended. The groups identified for treatment are school-age children, and the treatment can be organized every 1-2 years.

For communities in **category III,** screening schoolchildren is the recommended measure, and positive cases must be selected for treatment by haematuria or urine filtration. The treatment can be organized every two years.

Children take priority in low transmission areas.

In all categories, information, education and communication (IEC) strategies and improving sanitation have a great impact and should be extensively applied.

Use other strategies concurrently.

Other interventions

•Boreholes/wells/taps

•Latrines

• Health Education

Environmental modifications