Allergy and different socioeconomic backgrounds
Dept of Parasitology, Leiden University Medical Center, The Netherlands
(M.Yazdanbakhsh@lumc.nl)
The increasing incidence of immunoregulatory disorders


Figure 1. Inverse Relation between the Incidence of Prototypical Infectious Diseases (Panel A) and the Incidence of Immune Disorders (Panel B) from 1950 to 2000.

In Panel A, data concerning infectious diseases are derived from reports of the Centers for Disease Control and Prevention, except for the data on hepatitis A, which are derived from Joussemet et al. In Panel B, data on immune disorders are derived from Swarbrick et al., Dubois et al., Tuomilehto et al., and Pugliatti et al.
Disease pattern differences between high and low income countries

Hyperinflammatory disease incidence
Including allergies

Personal communication from Dr. Joel Weinstock
Disease pattern differences between Rural and Urban areas

Note: rural areas are changing rapidly in character
Disease pattern differences not only between Rural and Urban areas 
but also within urban areas where socioeconomic status can be very different
Different tools to study allergy in population studies

IgE CAP or ISAC chip

Skin Prick Test (SPT)

Questionnaire reported symptoms

IgE → SPT → Symptoms

mast cell → degranulation
Total IgE Levels in Allergic Diseases

- Normal
- Rural areas of developing world
- Rhinitis
- Asthma
- Atopic dermatitis

Total IgE (IU/ml)

proportion

0

10

100

1000

10000
High levels of total IgE in rural areas: Helminth infections are highly endemic and strong inducers of IgE.

Total IgE (IU/ml)
In urban centers there are also high levels of IgE in those with low SES.
Helminths skew responses to Th2 and induce IgE
Atopy is mediated by Th2

- IL-4
- IL-5
- IL-13

IgE

Eosinophil

?? Allergies
Differences in Skin Prick Test reactivity to allergens

Ghana

% SPT Positivity HDM

Urban

Meyera Accra

Low SES High SES

Rural areas in developing countries, families with low socioeconomic status are often infected with helminths and have less allergies.

**Ghana**

- **% SPT Positivity HDM**
- **Meyera**
- **Accra**

**Indonesia**

- **Helminth infections**
- **Low SES**
- **High SES**
Negative association between helminths and skin reactivity to allergens

Indonesia

Gabon

Ghana

Cockroach SPT

Mite SPT

Filariasis

Schistosomiasis

Hookworm & Trichiuris
High levels of IgE seen to allergens do not translate into skin prick test (SPT) positivity.

% positive

IgE
(cut off 0.35)

SPT
(cut off 3 mm)
The high level of IgE in those with a high socioeconomic background translates into SPT and is associated with allergic symptoms—different for those with low socioeconomic background.
In those with a high socioeconomic background
In those with a low socioeconomic background.
High IgE responses from birth in rural areas of developing countries (helminth infections often only after 2-3 years of age -other environmental inducers of IgE?)

Total IgE

Djuardi et al Allergy Asthma Clin Immunol 2013
Characterization of the IgE in developing countries
Peanut allergy in Ghana – large amounts of peanut specific IgE is seen but little SPT or symptoms
Reactivity to peanut allergens Arah1, 2 and 3 in Ghana

N-glycan found in plants/invertebrates

Mean Specific IgE kU/L (log)
Peanut rAra h 1 rAra h 2 rAra h 3 Bromelain
0.01
0.1
1
10
100
1000

Reactivity to peanut allergens Arah1, 2 and 3 in Ghana

Amoah et al JACI 2013
Peanut Specific IgE in Ghana is:

primarily to cross reactive carbohydrate epitopes present in parasites

$r = 0.89$, $p<0.0001$

Peanut Specific IgE in Ghana is:

cercariae
cercariae
adult
adult
eggs
eggs

Core
Core $\alpha_3$-Fuc
Core $\alpha_6$-Fuc

Amoah et al JACI 2013
Inhibition assay with Bromelain and with *Schistosoma mansoni* Soluble Egg Antigen (SEA)

- Bromelain
- SEA

**Graphs:**
- **Bromelain**
  - IgE to Peanut
  - IgE to Cockroach
  - IgE to House Dust Mite

- **SEA**
  - IgE to Peanut
  - IgE to Cockroach
  - IgE to House Dust Mite
Glycan array
The Glycan arrays
Printing: 127 50μM N-glycans

Ron Hokke and Angela van Diepen
Sera from schoolchildren residing in rural and urban areas in Ghana

Legend:
- **GR** – School in Urban Rich
- **NB** – School in Urban Poor
- **TP** – School in Rural

From: Obeng et al. (2013)
IgE response on the glycan array

![Graph showing IgE response for Rural, Urban Low SES, and Urban High SES populations.](image)
IgE to alpha-gal in Africa

Urban - Rural

Urban Rich

Urban Poor

Rural

IgE

IU/mL

<0.01

(0-0.06)

28%

(0 – 14.4)

57%

(0.1 - 74.5)
Different IgEs with different biological activity: depending on environmental exposures

High SES
Little biodiversity in
- vegetation
- animals
- microbiome
- foods

Rural
Large biodiversity in
- vegetation
- animals
- microbiome
- foods

IgE

degranulation

Poor
degranulation

Amoah et al PAI 2014
A different immunological set point as a result of early and persistent exposure to IgE inducing carbohydrates/cross reactive moieties?
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