Migration and psychosis: the dark side of globalization

Rajiv P. Sharma, M.D.
Professor of Psychiatry, Anatomy and Cell Biology
University of Illinois at Chicago
Overview

1. Definitions and literature
2. Stages, stressors and causes
3. Ethnicity, Culture, technology
4. Non-biological and biological hypotheses
Definitions: Migrants, Psychosis

1. First generation (foreign born-person) vs Second generation (native born offspring) vs third generation (native born offspring$^2$).


3. $\sim$ 120 million migrants worldwide; $\sim$900 million international journeys per year (Gushulak 2006)

4. Psychosis (i.e., presence of delusions, hallucinations, thought disorder, disturbance of reality-perception)
Cantor-Graae metanalysis 2005

Mean RR=2.9
Canto-Graae metanalysis 2005

- Literature review. 18 studies for metanalysis.
  » Skin pigmentation categories
  » UNCTAD developed vs. developing

- Analysis 1: First generation RR=2.7
- Analysis 2: Second Generation RR=4.5
### Canto-Graae metanalysis 2005

| Analysis 3: effect of first- and second-generation migrant status | 50 | 2.9 |
| Analysis 4: effect of United Nations Conference on Trade and Development (UNCTAD) rating | 35 | 3.3 |
| Developing countries | 11 | 2.3 |
| Analysis 4a: effect of UNCTAD rating | 9 | 2.0 |
| Developed market economies | 24 | 3.6 |
| Eastern Europe and developing countries, high or medium income | 11 | 2.8 |
| Developing countries, low income | 16 | 2.2 |
| Analysis 5: skin color* | 16 | 2.3 |
| White | 16 | 4.8 |
| Black | 11 | 2.2 |
| Nonwhite/nonblack | 11 | 2.2 |
| Analysis 5a: skin color* | 11 | 2.3 |
| White | 16 | 4.8 |
| Black | 16 | 2.2 |
| Nonwhite/nonblack | 16 | 2.2 |
| Analysis 6: gender | 21 | 2.5 |
| Male | 21 | 2.4 |
| Female |
Kirkbride Metaanalysis 2012

Metanalysis of all psychosis in the UK general population spanning 60 years (1950-2009)

- Black Caribbean RR=6.6
- Black African = 4.7
- South Asian = 2.4

- First generation RR=3.5
- Second generation RR=2.3
Kirkbride et al 2012

Kirkbride Metaanalysis 2012

[Graph showing estimated incidence rate ratio (95% CI) for various ethnic groups]
Veling Metaanalysis 2013

- Effect sizes from 61 first generations and 28 second generations
- First generation (RR=2.3) = second generation (RR=2.1)?
- Black migration to White host (RR=4.0)
- Nonwhite or White to White host (RR=2.0)
Migration in Early Childhood
Ethnic Density
Both weak or strong ethnic identification
Social adversity
Low neonatal Vitamin D.
Diagnostic Bias (Zandi et al 2010) only for affective psychosis
  RR of 7.9 with standard assessment
  RR of 4.2 with culture sensitive.
Psychosis Risk now extends to THIRD generation

- Unbiased population sample 37,063 in France
- Non-migrants and migrants
- Single Psychotic Episode
  - First generation (OR 1.68)
  - Second generation (OR 1.43)
  - Third generation (OR 1.34)
- Repeat Psychotic episodes
  - First generation (OR 1.57)
  - Second generation (OR 1.43)
  - Third generation (OR 1.78)

Amad et al 2014
Psychosis Risk now extends to THIRD generation

<table>
<thead>
<tr>
<th></th>
<th>Non-migrants (n = 172)</th>
<th>First generation (n = 21)</th>
<th>Second generation (n = 42)</th>
<th>Third generation (n = 36)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean age (SD)</strong></td>
<td>42.77 (17.35)</td>
<td>44.29 (11.63)</td>
<td>34.54 (14.79)</td>
<td>34.80 (15.96)</td>
</tr>
<tr>
<td><strong>Sex (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>50.58</td>
<td>52.38</td>
<td>61.9</td>
<td>50</td>
</tr>
<tr>
<td>Women</td>
<td>49.42</td>
<td>47.62</td>
<td>38.1</td>
<td>50</td>
</tr>
<tr>
<td><strong>Education level (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No education-primary level</td>
<td>25</td>
<td>14.28</td>
<td>9.52</td>
<td>19.45</td>
</tr>
<tr>
<td>Secondary level</td>
<td>51.16</td>
<td>38.09</td>
<td>61.91</td>
<td>47.22</td>
</tr>
<tr>
<td>University level</td>
<td>23.84</td>
<td>47.62</td>
<td>28.57</td>
<td>33.33</td>
</tr>
<tr>
<td><strong>RPD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-migrants (n = 743)</td>
<td>First generation (n = 51)</td>
<td>Second generation (n = 112)</td>
<td>Third generation (n = 128)</td>
</tr>
<tr>
<td><strong>Mean age (SD)</strong></td>
<td>41.49 (16.40)</td>
<td>40.57 (15.46)</td>
<td>36.13 (13.03)</td>
<td>35.17 (13.53)</td>
</tr>
<tr>
<td><strong>Sex (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>47.79</td>
<td>60.78</td>
<td>56.25</td>
<td>63.28</td>
</tr>
<tr>
<td>Women</td>
<td>52.21</td>
<td>39.22</td>
<td>43.75</td>
<td>36.72</td>
</tr>
<tr>
<td><strong>Education level (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No education-primary level</td>
<td>18.58</td>
<td>25.49</td>
<td>18.74</td>
<td>13.28</td>
</tr>
<tr>
<td>Secondary level</td>
<td>55.53</td>
<td>35.3</td>
<td>58.03</td>
<td>58.6</td>
</tr>
<tr>
<td>University level</td>
<td>25.88</td>
<td>39.22</td>
<td>23.21</td>
<td>28.13</td>
</tr>
</tbody>
</table>

Amad et al 2014
**Table 2. Adjusted Relative Risk of Schizophrenia According to Family History, Place of Birth, and Season of Birth.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>First Adjustment</th>
<th>Relative Risk (95% CI)*</th>
<th>Second Adjustment</th>
<th>Third Adjustment (Full Model)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Family history</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Father affected, mother affected</td>
<td>65.49 (24.55–174.73)</td>
<td>59.74 (22.39–159.45)</td>
<td>46.90 (17.56–125.26)</td>
<td></td>
</tr>
<tr>
<td>Father affected, mother not affected</td>
<td>8.34 (5.91–11.76)</td>
<td>7.97 (5.65–11.24)</td>
<td>7.20 (5.40–10.16)</td>
<td></td>
</tr>
<tr>
<td>Father not affected, mother affected</td>
<td>11.33 (8.84–14.53)</td>
<td>10.19 (7.93–13.09)</td>
<td>9.31 (7.24–11.96)</td>
<td></td>
</tr>
<tr>
<td>Father not affected, mother not affected†</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Father unknown, mother affected</td>
<td>20.99 (12.59–36.00)</td>
<td>17.12 (10.24–28.64)</td>
<td>14.18 (8.48–23.70)</td>
<td></td>
</tr>
<tr>
<td>Father unknown, mother not affected</td>
<td>2.48 (2.14–2.88)</td>
<td>2.45 (2.11–2.84)</td>
<td>2.00 (1.72–2.32)</td>
<td></td>
</tr>
<tr>
<td><strong>Sibling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One or more affected siblings</td>
<td>9.04 (6.97–11.72)</td>
<td>7.33 (5.63–9.53)</td>
<td>6.99 (5.38–9.09)</td>
<td></td>
</tr>
<tr>
<td>No affected siblings†</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td><strong>Other factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Place of birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>2.49 (2.21–2.80)</td>
<td>2.49 (2.20–2.80)</td>
<td>2.40 (2.13–2.70)</td>
<td></td>
</tr>
<tr>
<td>Suburb of capital</td>
<td>1.64 (1.40–1.93)</td>
<td>1.04 (1.00–1.93)</td>
<td>1.62 (1.37–1.90)</td>
<td></td>
</tr>
<tr>
<td>Provincial city (&gt;100,000 population)</td>
<td>1.57 (1.36–1.81)</td>
<td>1.57 (1.36–1.81)</td>
<td>1.57 (1.36–1.81)</td>
<td></td>
</tr>
<tr>
<td>Provincial town (&gt;10,000 population)</td>
<td>1.24 (1.10–1.41)</td>
<td>1.24 (1.10–1.41)</td>
<td>1.24 (1.10–1.41)</td>
<td></td>
</tr>
<tr>
<td>Rural area†</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Greenland</td>
<td>3.71 (2.03–6.75)</td>
<td>3.71 (2.04–6.76)</td>
<td>3.71 (2.04–6.76)</td>
<td></td>
</tr>
<tr>
<td>Other countries</td>
<td>3.52 (2.74–4.52)</td>
<td>3.52 (2.73–4.52)</td>
<td>3.45 (2.69–4.44)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>1.28 (0.48–3.42)</td>
<td>1.26 (0.47–3.39)</td>
<td>1.22 (0.46–3.27)</td>
<td></td>
</tr>
<tr>
<td>Season of birth (amplitude of sine function)‡</td>
<td>1.12 (1.06–1.18)</td>
<td>1.11 (1.06–1.18)</td>
<td>1.11 (1.06–1.18)</td>
<td></td>
</tr>
</tbody>
</table>

*The relative risk was adjusted initially for age—sex interaction, calendar year of diagnosis, and ages of the father and mother (first adjustment) and then for family history or, alternatively, other factors as well (second adjustment). The third adjustment (full model) was for all the variables listed. CI denotes confidence interval.
†This was the reference category.
‡For all three adjustments, the estimated peak of the sine function was at March 6 (95 percent confidence interval, February 6 to April 5).
Table 1  Association of migration history, family dysfunction and the presence of psychotic symptoms

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio for psychotic symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crude (95% CI)</td>
</tr>
<tr>
<td>Migration history(^{2})</td>
<td>1.8 (1.1–3.2)</td>
</tr>
<tr>
<td>Migration history and no family dysfunction(^{3})</td>
<td>1.2 (0.5–3.2)</td>
</tr>
<tr>
<td>Family dysfunction and no migration history(^{3})</td>
<td>1.5 (0.9–2.5)</td>
</tr>
<tr>
<td>Migration history and family dysfunction(^{3})</td>
<td>4.0 (2.0–8.2)</td>
</tr>
<tr>
<td>AP interaction(^{4})</td>
<td>0.59 (0.02–0.93)</td>
</tr>
</tbody>
</table>

CI, Confidence interval.
1. Adjusted for age, gender, psychiatric illness of a parent and educational level of breadwinner.
2. Reference category is no migration history.
3. Reference category is no migration history and no family dysfunction.
4. Attributable proportion (AP) of cases owing to the interaction of migration history and family dysfunction.

Retrospective, no ethnicity defined,
Patino et al 2005
Psychosis vs Affective disorders?

- Non affective psychosis > affective psychosis (Veling 2013, Kirkbride 2012)
- Affective symptom masking due to culturally insensitive criteria...stability of criteria...shame vs guilt..(Zandi et al 2010)
- Migration as a ‘grief process’…more so in refugees from war
- Ulysses syndrome…Chronic and multiple stress
Magnitude of Relative Risk in relationship to known Genetic psychosis predictors

- 3rd degree relatives: 12.5%
- 2nd degree relatives: 25%
- 1st degree relatives: 50%
- Identical twins: 100%
- General population: 1%
- First cousins: 2%
- Uncles / Aunts: 2%
- Nephews / Nieces: 4%
- Grandchildren: 5%
- Half siblings: 6%
- Parents: 6%
- Siblings: 9%
- Children: 13%
- Fraternal twins: 17%
- Identical twins: 48%

Fig. 1 Stages of migration

Bhugra and Jones 2001
Stages of Migration

Fig. 2 Factors in migration and psychological distress

Bhugra and Jones 2001
Ødegaard hypothesis – ‘negative selection’

- Hypothesis (paraphrased): psychiatrically vulnerable populations, societal misfits, are prone to migrate. Early studies in white Norwegians migrating to white Minnesota had higher psychosis (~1932)
- Biological offspring of Schizophrenia Spectrum parents less likely to emigrate/migrate (Rosenthal et al. 1974)
- Bipolar spectrum offspring more likely to emigrate/migrate in Denmark nationwide study (Pedersen et al. 2011)
- Active premorbid symptoms may inhibit planning/preparations for migration (Lundberg et al. 2007)
- Previously identified psychosis premorbid risk factors NOT increased in future migrants (Ven et al. 2014) (Low IQ, social adjustment, disturbed behaviour, non-psychotic diagnosis, urban upbringing, cannabis use).
- Increased risk in second generation as well as psychosis 10-12 yrs after migration (Ødegaard et al. 1932)
<table>
<thead>
<tr>
<th>Candidate Explanatory Factors</th>
<th>Number of Studies</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misdiagnosis</td>
<td>3</td>
<td>–, –, –,</td>
</tr>
<tr>
<td>Selective migration</td>
<td>4</td>
<td>–, –,</td>
</tr>
<tr>
<td>Genetic</td>
<td>3</td>
<td>–, –, –,</td>
</tr>
<tr>
<td>Viral infection</td>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>Obstetric complications</td>
<td>2</td>
<td>–, –</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>Neurological markers</td>
<td>1</td>
<td>–,</td>
</tr>
<tr>
<td>Brain structure</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td>Substance use (primarily cannabis)</td>
<td>4</td>
<td>–, –, –, –</td>
</tr>
<tr>
<td>Stressors premigration and during migration</td>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>Childhood separation from parents</td>
<td>2</td>
<td>+, +</td>
</tr>
<tr>
<td>Adult markers of disadvantage</td>
<td>3</td>
<td>+, +</td>
</tr>
<tr>
<td>Discrimination— perceived</td>
<td>1</td>
<td>+, +, +,</td>
</tr>
<tr>
<td>Ethnic identity</td>
<td>2</td>
<td>+, +</td>
</tr>
<tr>
<td>Ethnic density</td>
<td>4</td>
<td>+, +, +, +, +</td>
</tr>
</tbody>
</table>
Viable hypothesis must consider higher RR in both First and Second and Third generation.

- **Virus susceptibility** may explain in first generation, but not in second generation. Impaired intrauterine immunity will not explain incidence in First generation.

- **Climate** not explanatory for migrants to Denmark from Australia and New Zealand.

- **Dark skin color** had almost double RR....but no evidence in native born African Americans.

- **Vitamin D deficiency** in dark skinned migrants may explain in second generation rather than first generation.

- **Urban birth and urban living** very strongly associated with schizophrenia...are migrants more sensitive to the urban effect.

- **Use of cannabis or illicit drugs**...but no increased male incidence.

- **Reproduction**...larger babies through smaller pelvises....could explain rate in second generation.

- **Reduced breast feeding** in the migrant population with reduced immunity...but not found to have an effect.
Six hypotheses for the higher incidence of schizophrenia in migrant group

1. Sending countries have high rates of schizophrenia

2. Schizophrenia predisposition are predisposed to migrate

3. Migration produces stress, which can initiate schizophrenia

4. Migrants are misdiagnosed with schizophrenia

5. Different symptom patterns are presented by migrants

6. Increased population density of ethnic migrant groups

Bhugra and Jones 2001
How early can migration explain mental illness: Autism

- Increased incidence at age of diagnosis 3.5 yrs (cf. US born white mothers RR1.00)
- Foreign born mothers:
  - ↑ 76% black mothers (RR 1.76)
  - ↑ 43% Vietnamese (RR 1.43)
  - ↑ 25% Philippines (RR 1.25)
  - ↑ 26% central/south America (RR 1.26)

** adjusted for maternal age, maternal education
How early can migration explain mental illness: Autism

- Nutritional deficiency secondary to chaotic conditions in sending country (folic acid, vitamin D)
- Infections (e.g., influenza, Filipino mothers in health care)
- Increased prevalence in sending country (increasing in Vietnam)
Population pressure or Pigment pressure

1. Ethnic Density vs Urban Density
2. Who is a visible minority
3. Assimilation/reward vs loss of ethnic identity
4. Second generation vs. First generations...trapped, no return?
White to White migration?

- White to White migration. Previous studies have found twofold increased risks for schizophrenia in Swedish immigrants in New York State (Malzberg, 1962) and in Scandinavian migrants, including Swedes, in Denmark (Cantor-Graae et al. 2003).
Urban Density and Psychosis

469 subjects with FIRST EPISODE PSYCHOSIS...this avoids the syncretizations and residuals from longer term psychosis

Increased Reality Distortion and Depressive symptoms in Urban setting

**Urban Density**
Baseline: Nottinghamshire 30 people per hectacre
Superimposed: Southeast London 95 people per hectacre

Oher et al 2014
Urban Density and Psychosis

35 people
94.1% White
British/Irish/Other
2.5% South Asian
1.5% Afro-Caribbean

95 people
30-40% Afro-Caribbean

Oher et al 2014
Urban Density, Dark Skin and Psychosis

1. Dark skin contains Eumelanin, required for the energetic absorption of high frequency UVR rays to prevent oxidative damage from reactive oxygen species
2. Medium wave UVR or UVB required for production of pre-vitamin D.
3. Much of the migration/psychosis literature is with dark skinned people migrating to low sunlight host countries.
4. Urban dwelling is 80%-90% indoors
5. Vitamin D receptors are ligand nuclear receptors with epigenetic mechanisms
6. Vitamin D receptors found in 36 tissues…including brain
7. Immune function by lymphocyte function
8. Possibly increased risk for multiple sclerosis and type 1 diabetes
Ethnic Density vs Urban

1. The incidence of schizophrenia is greater in ethnic minorities when they comprise a smaller proportion of the local population

2. Incidence risk ration 2.3 in ethnic dense to 4.4 in ethnically sparse populations

3. Caveats: selection bias (paranoia and mobility), economic and social opportunities

Boydell et al 2001
Ethnic Density vs Urban Density

1. The incidence of schizophrenia is greater in ethnic minorities when they comprise a smaller proportion of the local population.

2. Incidence risk ratio 2.3 in ethnic dense to 4.4 in ethnically sparse populations.

3. Caveats: selection bias (paranoia and mobility), economic and social opportunities.

Boydell et al 2001
What is a visible minority?
Ethnic and Cultural Fragmentation

- Negative ethnic identity
- Mixed marriages
- Ethnic diversity
- Family dynamics, parental authority, patriarchy
- Social deprivation
- Divorce and alternate living arrangements
- Socio-economic loss
- Drugs use
- Sexual patterns, interactions
- Social defeat and dopamine in the amygdala
Possible non-biological mechanisms

- Climate of host vs parent country
- Communication styles of host vs parent country
- Sunlight of host vs parent country
- Ethnic density and cultural/religious systems
- Difference in cultural norms
- Language differences (English to English, Spanish to Spanish)
- Unemployment
Possible non-biological mechanisms - Gender roles

- Female gender stressors..dating, sexuality, marriage, suicide, homemaker vs breadwinner?

- Major switch from patriarchal society structure with dominant male role

- Women may initially migrate as a disruption of family ties...later may embrace the associated freedom from family restrictions

- Increased suicide in certain ethnic women such as South Asians

- Psychiatric treatment as a form of ‘control’…a tool of perceived racism
Possible non-biological mechanisms- Gender roles

- Case example:
  - 34 y female, Asian-Indian migrant to the United States, physician, living in Texas (warm, sunlight), married to highly successful Indian industrialist. Arranged marriage.

- Psychotic Episode: Full blown catatonia, mutism, with history of recent bizarre and disorganized behaviours
  - Sanitary napkins hidden for months…with maggot infestation…discovered by husband mother-in-law
  - Conflict with husband (splattering of feces) and mother-in-law (spitting)
  - Paranoia

- Formulation
  - Biological ..
  - Psycho-dynamic interpretations
  - Cultural context..role expectations…become a licensed physician or raise children and family…or both??
Possible socio-political mechanisms

- **Technological Ascendence**: Migrant with dominant technology and economic capability to establish new societal power roles.

- **Technological Dependence**: Migrant with lower technological capacity and dependent societal power roles, ambivalent response of the host, i.e., economic dependence vs. hostility.
Possible Cultural mechanisms

- **Traditional Cultures**: follow traditional norms regarding parenting, child-rearing, education, family roles, sexuality, polysubstance use/abuse, social networks, mental health

- **Transitional Cultures**: Changing definitions of family, marriage, sexual identities, sexuality, use of polysubstances (?marijuana), social networks (facebook etc), mental health
Possible technological mechanisms

- Speed of migration...land routes, ships and jet planes...(licensing, regulations, credit cards etc)
- Permanence vs semi-permanence of separation...European migrants to the new world
- Internet, skype, facebook etc...supportive but also reinforcing the parent identity
- Ambivalence towards cultural re-definition in the migrant community
Possible biological mechanisms…Susceptibilities to other non-psychological illnesses

- Multiple Sclerosis
- Type 1 Diabetes (decreased in immigrant offspring from Asia, America or Europe to Sweden, but increased in immigrant offspring from Africa, Hussen et al 2013)
- Coronary Artery disease
Possible Biological mechanisms

- Viruses (influenza and such)
- Sunlight, vitamin D, dark skin and northern climates
- Diet, processed foods, preservatives
- Drugs of abuse, inexpensive alcohol
- Stress, cortisol, glucocorticoid receptors—Epigenetics
- Meiotic transmission of stressors—Epigenetics
Epigenetics defined

- Reversible modifications made to DNA and/or the surrounding histones, that are ‘heritable’ and can have a long term impact on the next generation
Rat offspring of ‘nurturing’ mothers have altered DNA methylation and histone modification patterns at the glucocorticoid receptor in the hippocampus.

Offspring of ‘negligent’ mothers have poor stress response in later adult life (glucocorticoid measures). This can be reversed by HDAC inhibition.

(Weaver 2014)
Transgenerational effects especially in male-line – Lamarck?

- Axin fused allele in mice (AxinFu). DNA hypermethylation or hypomethylation of AxinFu gene in mature sperm can induce change in frequency of offspring with Kinky tails.

- Early paternal childhood smoking increased the BMI of the son

- If the paternal grandfather had a good food supply during his mid-childhood his grandsons had a higher risk for diabetes and died earlier

- If the paternal grandfather experienced famine during his mid-childhood his grandson was protected from diabetes and lived longer

- Human and rat males who eat betel nuts induce metabolic syndrome in offspring for generations

(Bygren et al., 2001; Kaati et al., 2002; Chen et al., 2006; Pembrey et al., 2006)
Primary migrant is commonly male

Curley et al 2011

Mead and Sarkar 2014
Sperm transmits epigenetic information to multiple subsequent generations

Lim et al 2013
Sharma 2005

Schematic overview of Epigenetic mechanisms

Fig. 1. Epigenetic changes at a gene promoter during activation of transcription. Demethylation of methylated cytosines is effected by MBD2 having demethylase activity. Bound nuclear transcription factors recruit histone acetyltransferases (HATs) resulting in acetylation of histone tails. Chromatin remodeling of cores is effected by recruitment of remodeling proteins such as SWI/SNF, inducing torsion and rotation in the DNA strand making it more accessible to transcription factors. Final outcome is assembly of transcriptional holocomplex.
Open vs Closed chromatin: acetylation and deacetylation

Acetylation

Deacetylation

TF
Nuclear Ligand Receptors

1. Glucocorticoid receptors
2. Vitamin D receptors.
Future Directions

- Because migration is likely to increase
  - Need to move beyond descriptive research (enough of RR and OR)
  - Ethnic density and Religious identity may be protective
  - Parenting styles..level of attention and control
  - Biological perspective
    - Migrant as novelty seeker/adventurer.
    - Migrant as anxious/stressed (glucocorticoids to dopamine)
    - Transgenerational phenomenon