Daylighting Legislation and Health

Mohamed Boubekri, PhD

May 18, 2009

Velux Daylighting Symposium, Rotterdam, 2009
Daylighting Legislation and Health
Mohamed Boubekri, PhD
Sick Building Syndrome

Mobile Source Emissions

Indoor Air Quality

Air Quality Program

Eye or Throat Irritation
Headache
Dizziness
Nausea
Feeling Sick
Difficulty in Breathing
Lassitude, Fatigue
Difficulty in Concentration
Dry or Itchy Skin

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Windowlessness and Sleep Disorders

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Windowlessness and Sleep Disorders
Windowlessness and Sleep Disorders
Daylighting Legislation and Health

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Daylight Related Health Problems

- Hormonal Unbalance (Melatonin, Seratonin, Cortisol)
- Vitamin-D Deficiency (Hypovitaminosis-D)
FACTS

- People spend up to 90% of their lifetime indoors.
- Indoor Illumination levels are usually around 300 Lux to 700 Lux
Total daylight hours (DH) per day per month and the daylight hours outside of an 8AM to 5PM work schedule.

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Hormonal Unbalance

- Seasonal Affective Disorder (SAD)
- Sleep Disorder
- Depression
- Cancer
Hormonal Unbalance

Seasonal Affective Disorder (SAD)

- 8.9% of Alaska inhabitants suffer from SAD
- SAD correlates with latitude:
  - US Study (Maryland, New Hampshire, Pennsylvania & Florida)
  - Japan (6 cities)
Hormonal Unbalance

- **Seasonal Affective Disorder (SAD)**

  - 2,500 Lux for 60 - 90 minutes / 3 times a week
  - 10,000 Lux for 30 minutes / 3 times a week
Hormonal Unbalance

Sleep Disorder

⇒ Depression
⇒ Cancer

Melatonin Hypothesis
Hypovitaminosis-D
➢ Vitamin D regulates the absorption of nutrients in the small intestine and their re-absorption in the kidneys.

➢ It helps maintain serum calcium and phosphorous concentrations within the normal range, both are essential for growth and development of bone structure.
We Receive 80% to 100% of our vitamin D needs from sunlight.
Hypovitaminosis-D

- Osteomalacia / Multiple Sclerosis
- Diabetes
- Cardiovascular Problems
- Renal Deficiencies
- Cancer
Sunlight vs. Multiple Sclerosis

Multiple sclerosis in the United States. Case/control ratios (x 100) for white male veterans according to place of residence prior to enlistment.
Diet vs. Sunlight

More than 80% of our vitamin D needs come from sunlight (UV-B radiation)
Diet vs. Sunlight?
Diet vs. Sunlight?

Studies examined whether the latitudinal variation between Turkey and Germany and the wearing of the veil affected vitamin D levels in Turkish migrant populations in Germany (Erkal et al., 2006). Turkish women in Germany experienced lower vitamin D levels than their female counterparts in Turkey where sunlight is more abundant. Turkish women in general, however, exhibited lower levels of vitamin D compared to Turkish men because the veil restricts their exposure to sunlight.
How Much Exposure to Sunlight Do We Need?

- How much depends on the type of skin color and degree angle of incidence (time/season).

- 15 minutes to 3 hours per day of unfiltered exposure 3 or 4 times a week.
Who Is At Risk of Hypovitaminosis-D?
At Risk Populations

- Home bound, institutionalized and geriatric patients
At Risk Populations

Home bound, institutionalized and geriatric patients

Long stay hospital patients
At Risk Populations

• 30% - 50% of Children suffer from vitamin Deficiency (The New England Journal of Medicine, July, 2007)
At Risk Populations

- Windowless Workplaces
At Risk Populations

Women in countries of the Arabian Gulf region who totally cover their bodies, including their face and hands, were found to suffer from a more severe vitamin D deficiency than their western counterparts. Low exposure of the skin to sunlight due to dress code seems to be a major contributing factor to vitamin D deficiency. (El-Sonbaty et al., 1996; Ghannam et al., 1999; Gannage-Yared et al., 2000; Saadi & Dawodu, 2005; Saadi et al., 2006).
At Risk Populations

- Living/Working in Dense Urban Environments
Our Modern life style requires us to spend up to 90% of their lifetime indoors
Solutions?

- Eco/Health-Conscious Legislation
- Life style
- Eco/Health-Friendly Urban Typologies
- Eco/Health-Friendly Building Typologies
Compiled data showing total daylight hours (DH) per day on the 21st of each month and the daylight hours outside of an 8 hour (8A.M.-5P.M.) work schedule with a one-hour lunch break at midday.

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Regulatory Solutions
Urban Scale

- Right for air and sunlight in our streets
NYC Solar Zoning Regulation
1916
Daylighting Legislation and Health

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May 18, 2009
NYC 1961 Solar Zoning Regulation
Eco/Human-Conscious
Urban Design Typologies & Legislation
Regulatory Solutions At The Building Scale

Daylighting Standards

• Window Size Rqts
• Illuminance Rqts
• Daylight Factor Rqts
• Sunlight Penetration Rqts
Daylighting Standards

Window Size Requirements

• US Code requires window size requirements but no minimum visible stipulated

• Europe minimum 50% visible transmission required
Daylighting Standards

Window Size Requirements

• **UK**: BR 8206 recommends (not obligatory) window ≥ 20% of wall for all room measuring less than 8 meters in depth & ≥ 35% of external wall for rooms measuring more than 14 m in depth.

• **Japan**: Article 28 of Bldg Code: Habitable rooms should have window ≥ 14% of total floor area.
Daylighting Standards

Illuminance Requirements

- **Canada:** Department of Public Works suggests a minimum average of 200 lux along the perimeter of the office space at a depth of 3 m for 80% of working hours.
Daylighting Standards

Illuminance Requirements

• In order for illuminance requirements to be feasible, they should stipulate duration.
Daylighting Standards

Daylight Factor Requirements

- **Post War UK**: DF $\geq 2\%$ for schools, then lowered to 1%.

- **France**: 1997 Cahier des Charges recommends DF $\geq 1.5\%$ for educational establishments.

- **Italy**: Ministry of Education requires DF $\geq 3\%$ for educational establishments.

- **Germany**: The German DIN 5034-1 Standard for the daylighting of work rooms requires a mean DF $\geq 0.9\%$ and a minimum of 0.75% at the least-favorable point. (The mean is calculated as the average of the midpoint of the room and the points 1m from the side walls, all at 0.85m elev).
Daylighting Standards

Sunlight Penetration Requirements

• Duration of penetration

• Size of sunlight penetration

\[ SP = \frac{\text{sunlit Area}}{\text{Floor Area}} \times 100 \]
Regulatory Solutions & health Issues
Summary

• Daylight must be sufficient at street levels
Regulatory Solutions & health Issues Summary

- Daylight must be sufficient inside. At what levels?

  - People spend up to 90% of their lifetime indoors.
  - Indoor Illumination levels are usually around 300 Lux to 700 Lux
  - We need: 2,500 Lux for 60 - 90 minutes / 3 times a week, or 10,000 Lux for 30 minutes / 3 times a week
Regulatory Solutions & health Issues
Summary

Building typologies should allow for access to sunlight
Glass filters 95% to 98% of the UV-B
Eco/Human-Conscious Building Typologies
People spend up to 90% of their lifetime indoors.
People spend up to 90% of their lifetime indoors.

With the proper building legislation and human (not money) conscious designs, architecture can heal and provide shelter.