Global Scientific and Social Evidence on Asbestos Hazard

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International Asbestos Conference

24-25 Nov 2014,
Bangkok, Thailand

Objective

“Expedite Asia to be Free from Asbestos Hazard”
International Asbestos Conference, BKK, Thailand

What should be recognized as scientific & social evidences

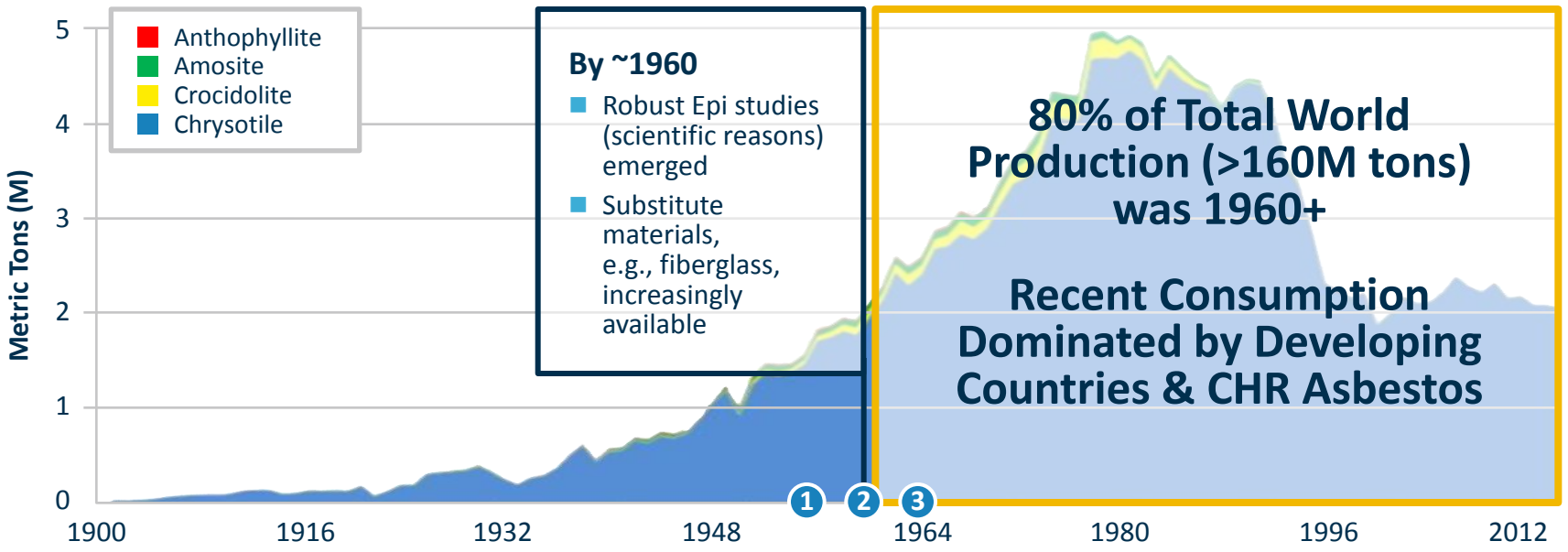
which may contribute to conference aim?

What is important in the epidemiology and trends of ARDs

from a global perspective?

Epidemiology vs. Economy

World Asbestos Production by Type: 1900-2012 Total 200M tons*



Landmark EPI Studies

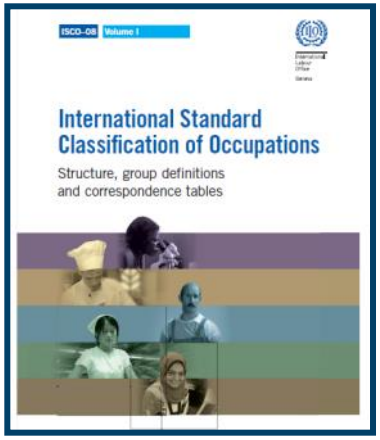
1. **1955 Richard Doll (*BJIM*)**
   1st epidemiologic study on UK ASB factory workers on LC risk (O/E = 11/0.8)
2. **1960 Wagner JC (*BJIM*)**
   33 cases of mesothelioma working/living near S African crocidolite mine
3. **1964 Selikoff (*JAMA*)**
   American insulation workers at very high mortality risk for cancer of lung, GI tract and mesothelioma

 * Virta, USGS

Usage vs. Asbestos-Specific-JEM

Developed Countries		Developing Countries
Remaining *(in situ)*	**Construction Material** i.e., Asbestos-Cement	**Thriving**
Mostly Phased Out (Historically Yes)	**Anti-friction / Heat Material** i.e., Insulation, etc.	**Continuing** (Variable Degrees)
Early Detection & Compensation	**Diversity of Industries, Occupations & Products** Must Be Considered	**Roadmap to Ban & Control Measures During Transition**

Countries vs. Asbestos Situations



(Findings for occupations and industries were similar)

Code	Major Occupations	Sub-major	Minor	Unit
1	Managers	4	11	31
2	Professionals	6	27	92
3	Technicians and Associate Professionals	5	20	84
4	Clerical Support Workers	4	8	29
5	Services and Sales Workers	4	13	40
6	Skilled Agricultural, Forestry and Fishery Workers	3	9	18
7	Craft and Related Trades Workers	5	14	66
8	Plant and Machine Operators and Assemblers	3	14	40
9	Elementary Occupations	6	11	33
0	Armed Forces Occupations	3	3	3
Totals	**10**	**43**	**130**	**436**

Asbestos-related		Korea		Total
		Yes	No	
Japan	Yes	60	99	159
	No	35	241	276
Total		95	340	435

Percentage agreement between 2 countries is:

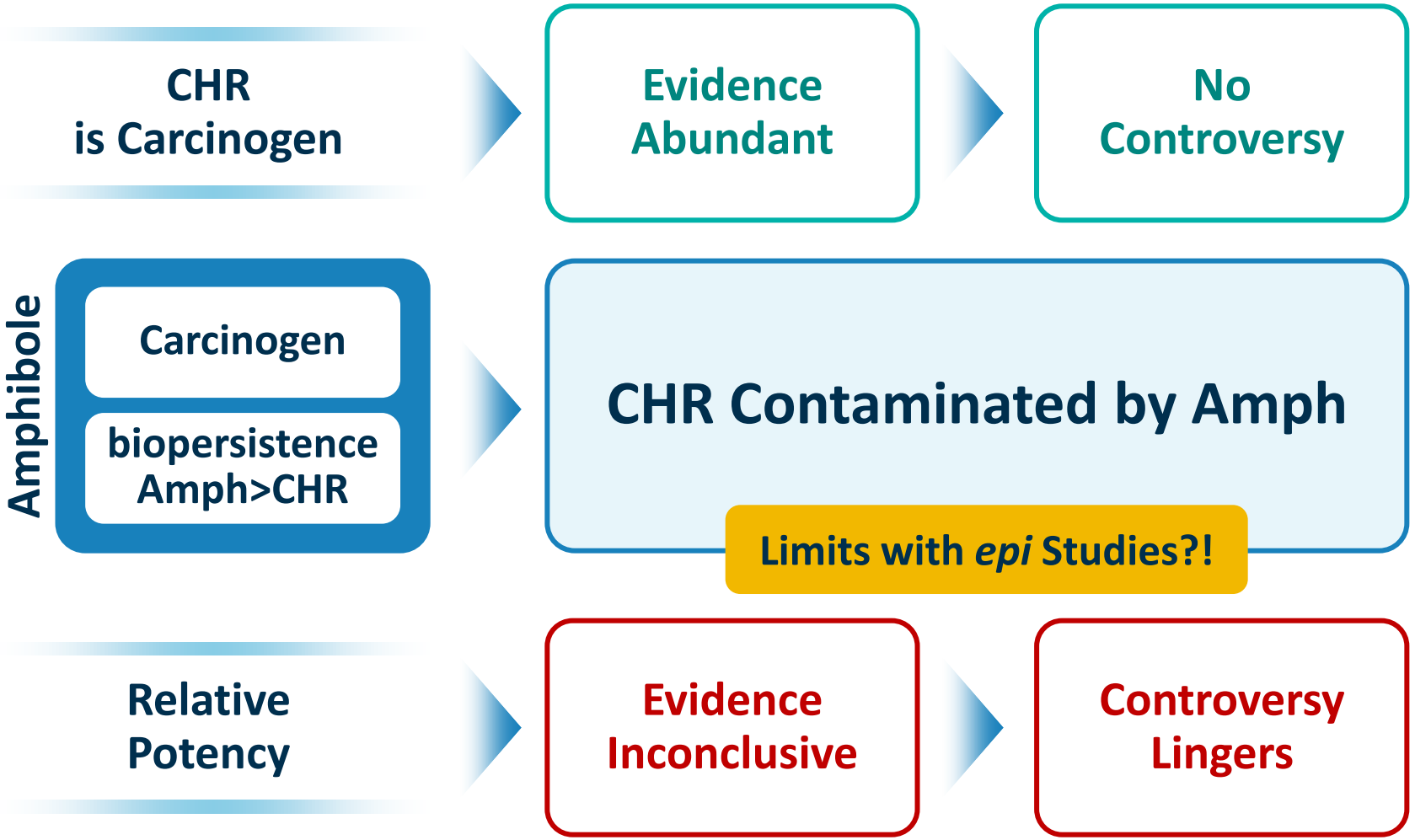
Pr(a) = (**60** + **241**) / 435 = **69.2%**

Percentage inconsistencies where

Japan (Y) and Korea (N) = **99**/435 = **22.8%**

Korea (Y) and Japan (N) = **35**/435 = **7.6%**

Chrysotile vs. Amphiboles



Chrysotile as Cause of Mesothelioma: Hill's Criteria*

9 Items of Hill's Criteria (Sir Bradford Hill, 1965)

1. Strength of Association
2. Temporality
3. Biologic Gradient
4. Consistency
5. Specificity
6. Biologic Plausibility
7. Coherence
8. Experimental Evidence
9. Analogy

Global Consensus

Culminated in:

1. **IARC** Monographs from 1977 onwards
2. **Helsinki** Criteria (1997)
3. **IPCS** Environ Health Criteria by WHO (1998)

Supported by governmental agencies:
EPA, OSHA, CDC, NIOSH, DHHS, PHS and FDA

- CHR ***per se*** **can induce MESO** when TREM or other amph are not detected
- As there is no 100% pure CHR, (arguing) meso carcinogencity of CHR is ***academic*** **at best**

*Lemen: *IJOEH*, 2004

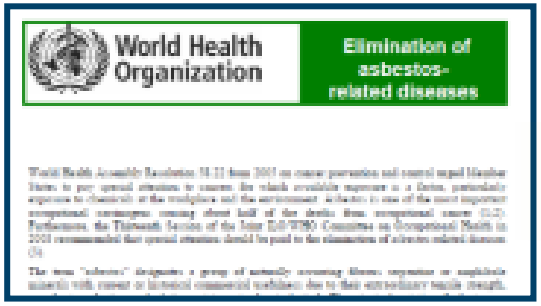
Relative Potency: CHR vs. Amph

Mesothelioma

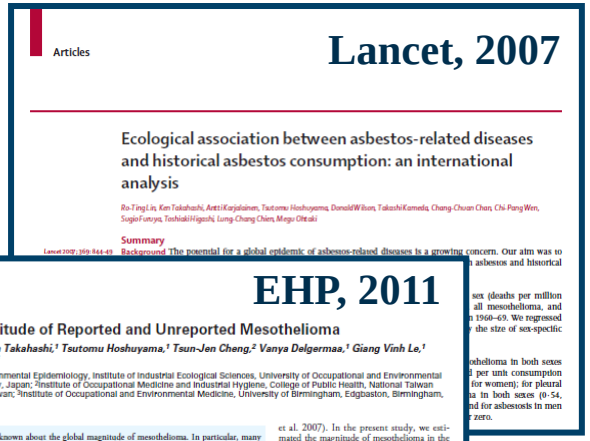
> "It is prudent & in the public interest to consider all fiber types as having comparable carcinogenic potency in its qualitative assessment of meso risk. Engagement in argument has prevented timely and appropriate health protective actions."
>
> – EPA, 1989

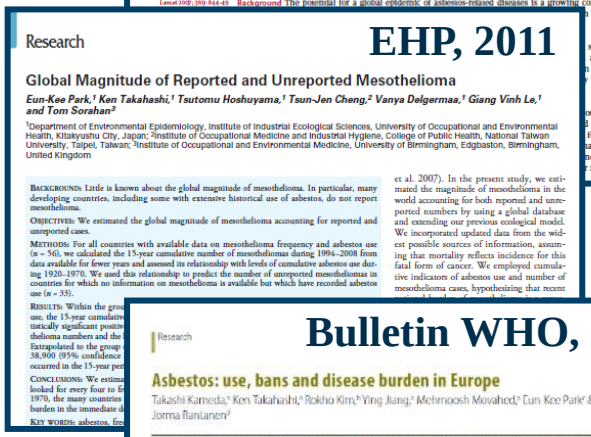
It is prudent & in the interest *of developing countries*… Argument *will* only prevent timely and appropriate protective actions !

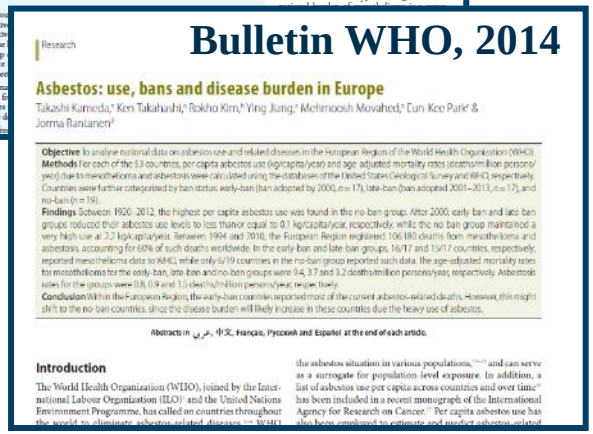
Research Papers
in Support of WHO Position



"The most efficient way to eliminate ARD is to stop using all types of asbestos (WHO, 2006)"







Recently Acknowledged by WHO

"Evidence continues to show that national burdens of ARD are directly proportional to national consumption of asbestos"

Our Update: Global Trend of ARDs

Methods*

- Source: WHO Mortality Database, 1994–2010
- Target: Mesothelioma (C45), Asbestosis (J61)
- **Countries with total <10 cases or <3 reported years precluded from analysis**
- Gender combined; mortality rates are age adjusted to the WHO world population of 2000
- PYLL = potential years of life lost; APYLL = average potential years of life lost

 **Bull of WHO* (2011); *Environ Health Perspect* (2011); *AJIM* (2013); paper in preparation

Annual N* of Deaths: Mesothelioma

(Persons; 1994–2010)

Rank	Country [years]	N*	%
1	**United States [10]**	**2,448**	**20.6**
2	**United Kingdom [11]**	**1,827**	**15.4**
3	**Italy [5]**	**1,282**	**10.8**
4	**Germany [13]**	**1,133**	**9.5**
5	**France [10]**	**853**	**7.2**
6	Japan [16]	849	7.1
7	Australia [8]	468	3.9
8	Netherlands [15]	406	3.4
9	Canada [10]	357	3.0
10	Spain [12]	294	2.5
Subtotal		**9,917**	**83.4**
World Total (61 Countries)		**11,897**	**100.0**

*Averaged over reported N of years

 Other ranks: **20**. Finland [15] 75

Adjusted Mortality Rates*: Mesothelioma

(Person per Million Population; 1994–2010)

Rank	Country [years]	Rate*
1	**Iceland [13]**	**24.6**
2	**Malta [15]**	**21.3**
3	**Bahrain [7]**	**20.5**
4	**United Kingdom [11]**	**18.4**
5	**Australia [8]**	**16.6**
6	Netherlands [15]	15.9
7	New Zealand [9]	13.9
8	Luxembourg [12]	13.6
9	Italy [5]	10.4
10	Belgium [5]	9.3
World Average (60 Countries)		**5.2**

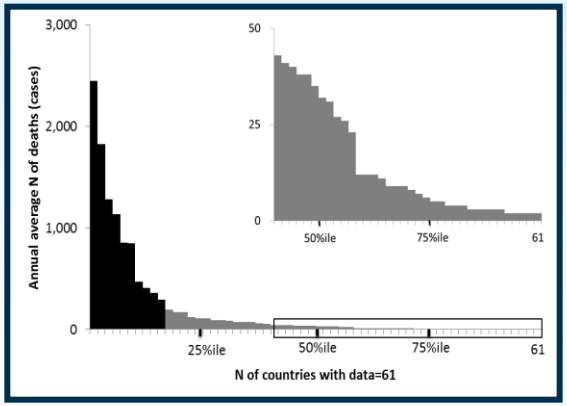
*Age-adjusted to the world population

 Other ranks: **12**. Finland [15] 9.0; **27**. USA [10] 5.6; **34**. Japan [16] 3.2

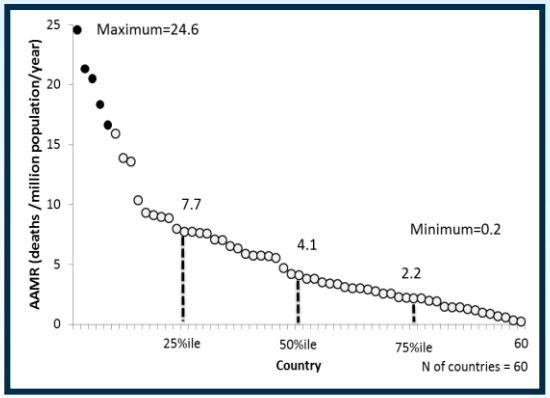
Global Deaths Due to Mesothelioma

Statistical Distribution of Data by Country, 1994-2010

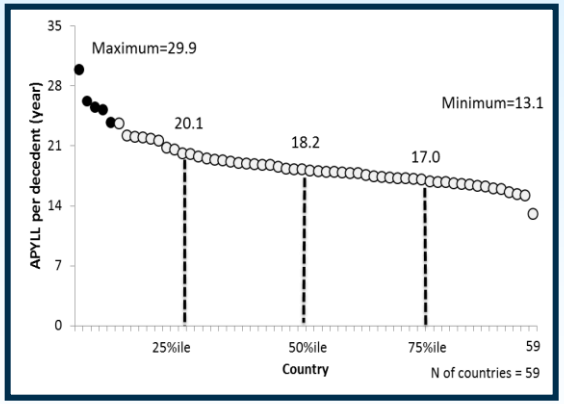
Annual N of Deaths



Age-adjusted Mortality Rate



Years Life Lost (APYLL)



- Skewed distribution likely reflects historical pattern of ASB use
- Rationality despite obscure validity of data from developing countries

Global Trends in ARDs

Preliminary Observations

1

Descriptive Statistics Depicted Both Accumulation and Spread of ARD Burden

2

Present Dependence on Asbestos Use Likely to Correlate with Future ARD Burden

3

Plausible Data Emerging from a Wide Range of Countries including Developing Ones

From Research to Practice

The Asian Asbestos Initiative

What is AAI?

The Asian Asbestos Initiative (AAI) is the international collaborative effort aimed at the prevention & elimination of ARDs with primary focus on Asian countries but aspiring to provide model for the world

Ultimate goal is consistent with existing efforts of the WHO, ILO and UNEP to globally eliminate ARDs

Development of AAI

	Year	Host / Venue	National Funds	International Organizations
AAI-1	2008	Initiated by IIES-UOEH	JSPS/IIES-UOEH	WHO-WPRO, ILO
AAI-2	2009	Co-organized by MPH, Thailand and IIES-UOEH	JSPS/IIES-UOEH and MPH, Thailand	WHO (HQ, WPRO, SEARO), ILO
AAI-3	2010	Organized by IIES-UOEH	JSPS/IIES-UOEH	WHO (HQ, WPRO, SEARO), ILO, UNU-IIGH
AAI-4	2011	Organized by PNU	MOE-Korea	WHO-WPRO
AAI-5	2012	Co-organized by PNU and IIES-UOEH	MOE-Korea and JSPS/IIES-UOEH	WHO (WPRO, SEARO), UNU-IIGH
AAI-6	2013	Co-organized by Gov of Philippines and IIES-UOEH	Gov of Philippines and JSPS/IIES-UOEH	WHO (HQ, WPRO, SEARO), IARC, ILO, UNU-IIGH
AAI-7	2014	Co-organized by RCS-UNEP and IIES-UOEH	RCS-UNEP and JSPS/IIES-UOEH	RCS-UNEP, ILO, IARC

Sep 29 – Oct 1, 2014

AAI-7, Jakarta

IIES-UOEH, Under a Grant by JSPS, Supported Attendance of 25 Delegates from 9 Countries

10:04 15 November 2014

FEATURE: Japanese doctors helping stop-asbestos campaign in Asia

By Tatsuya Tsujimura
JAKARTA, Nov. 15, Kyodo

Japanese doctors are stepping up efforts to help Asia's developing economies stop using asbestos, sharing knowledge bitterly learned in Japan about the serious and fatal illnesses caused by the material after it was used in abundance during the post-war economic boom through the 1970s.

Emerging economies continue using the affordable but hazardous silicate minerals "because they are still in the process of development and because the 30- to 50-year latent period of mesothelioma has prevented widespread recognition of future costs," said Ken Takahashi, a professor at Japan's University of Occupational and Environmental Health.

In October, Takahashi led an Asia-Pacific workshop in Jakarta on the sound management of industrial chemicals. The workshop was organized by the Asia Asbestos Initiative, a program Takahashi launched in 2008, in collaboration with the U.N. Environmental Program.

Conclusion

“Expedite Asia to be Free from Asbestos Hazard”
International Asbestos Conference, BKK

Global ARD trends warrant attention

Epidemiology prompted at all levels of prevention

Experience of banned countries should be better studied and utilized to

Expedite Asia to become Asbestos-Free

Selected Bibliography

- Kameda T, Takahashi K* et al. *Bull World Health Organ* 2014, 92:790-7.
- Diandini R, Takahashi K* et al. *Am J Ind Med* 2013, 56:993-1000.
- Pham VH, Le VG et al. *Safety Health Work* 2013, 4:117-21.
- Park EK, Takahashi K* et al. *Cancer Sci* 2012, 103: 1751-5.
- David AM, Ogawa H and Takahashi K. *Int J Occup Environ Health* 2012, 18:22-8.
- Lim JW, Koh D et al. *Safety Health Work* 2011, 2:201-209.
- Vanya D, Takahashi K* et al. *Bull World Health Organ* 2011, 89: 716-24.
- Le GV, Takahashi K* et al. *Respirology* 2011, 16:767-75.
- Park EK, Takahashi K* et al. *Environ Health Perspect* 2011, 119: 514-8.
- Takahashi K and Kang S-K. *Safety Health Work* 2010, 1:103-6.
- Le GV, Takahashi K* et al. *Environ Health Perspect* 2010, 118:116-9.
- Takahashi K (editorial). *Occup Med (London)* 2008, 58:384-385.
- Nishikawa K, Takahashi K* et al. *Environ Health Perspect* 2008, 116:1675-1680.
- Lin R-T, Takahashi K* et al. *Lancet* 2007, 369: 844-849.
- Murayama T, Takahashi K et al. *Am J Ind Med* 2006, 49: 1-7.

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What is important in the epidemiology and trends of ARDs

which may contribute to conference aim?

What is important in the epidemiology and trends of ARDs

from a global & social perspective?

IARC Monograph
Vol. 100C, September 2012

Long-standing vs. Added Endpoints

“ potency of differences with respect to lung cancer or mesothelioma for fibres of various types and dimensions are debated, (but) the fundamental conclusion is that **all forms of asbestos are ‘carcinogenic to humans’** ”

Table 1.2 Historical trend in asbestos use per capita and status of national ban *

	Use of asbestos[a] (kg per capita/year)						
Country	**1950s**	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**National ban[b]**
Asia							
Israel	3.13	2.87	1.23	0.78	0.44	0.02	No ban
Japan	0.56	2.02	2.92	2.66	1.81	0.46	2004
Others[c] (n = 39)	0.06	0.15	0.25	0.27	0.30	0.31	3/39
Eastern Europe and Southern Europe							
Croatia	0.39	1.13	2.56	2.36	0.95	0.65	No ban
Czech Republic	1.62	2.36	2.91	2.73	1.30	0.14	2005
Hungary	0.76	1.23	2.87	3.29	1.50	0.16	2005
Poland	0.36	1.24	2.36	2.09	1.05	0.01	1997
Romania	ND	ND	1.08	0.19	0.52	0.55	2007
Spain	0.32	1.37	2.23	1.26	0.80	0.18	2002
Others[c] (n = 15)	0.79	1.57	2.35	2.05	2.35	1.72	5/15
Northern Europe and Western Europe							
Austria	1.16	3.19	3.92	2.08	0.36	0.00	1990
Denmark	3.07	4.80	4.42	1.62	0.09	NA	1986
Finland	2.16	2.26	1.89	0.78	ND	0	1992
France	1.38	2.41	2.64	1.53	0.73	0.00	1996
Germany	1.84	2.60	4.44	2.43	0.10	0.00	1993
Iceland	0.21	2.62	1.70	0.02	0	0.00	1983
Lithuania	ND	ND	ND	ND	0.54	0.06	2005
Luxembourg	4.02	5.54	5.30	3.23	1.61	0.00	2002
Netherlands	1.29	1.70	1.82	0.72	0.21	0.00	1994
Norway	1.38	2.00	1.16	0.03	0	0.00	1984
Sweden	1.85	2.30	1.44	0.11	0.04	NA	1986
United Kingdom	2.62	2.90	2.27	0.87	0.18	0.00	1999
Others[c] (n = 5)	3.05	4.32	4.05	2.40	0.93	0.05	5/5

NEW!

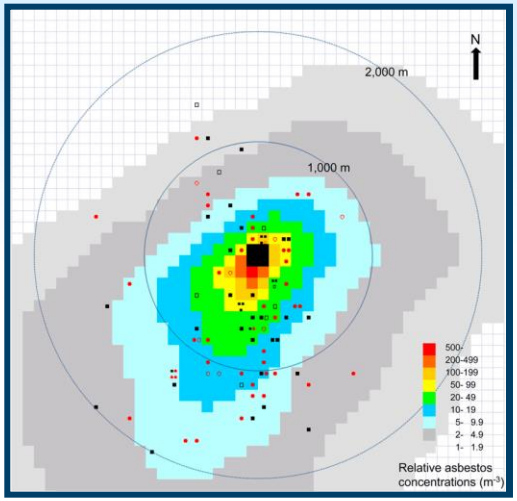
- Larynx & ovary
- Colorectum, stomach & pharynx

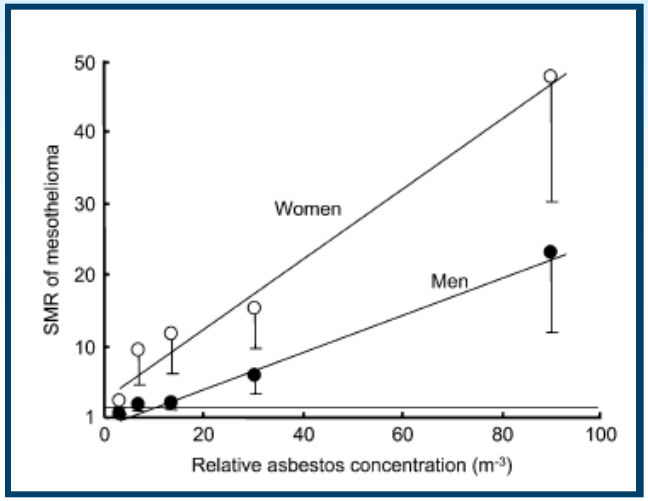
 * *Nishikawa, Takahashi et al. Environ Health Perspect* 2008

ARDs vs. Environmental Exposure

Conventional Knowledge

- Primary route of exposure is occupational
- Para-occupational, household and environmental exposure can cause ARDs





RECENT

In Japan / Korea

- Environmentally induced MM legally compensated ("Relief" Law)
- Epi studies reporting environmentally induced lung cancer

 Kurumatani & Kumagai. *Am J Respir Crit Care Med*, 2008

Estimating ARLC Burden from MESO Mortality (Based on 68 Risk Estimates from 55 Studies)

Ratio: ARLC-to-MESO to 1		
CRO	**0.7** (0.5 to 1.0) to 1 [n=6]	■ Except for CRO, ARLC is larger than MESO ■ For CRO, MESO risk is high & ARLC is just slightly lower
CHR	**6.1** (3.6 to 10.5) to 1 [n=16]	■ For CHR, MESO risk is *"due to amph exposure"* – Based Quebec study and relies on bio-persistence theory
AMO	**4.0** (2.8 to 5.9) to 1 [n=4]	
Mixed	**1.9** (1.4 to 2.6) to 1 [n=31]	

1. Ratios show the low potential of CHR to produce MESO
2. MESO cannot be used (too low, too unstable) to estimate EXP
3. Major effect of CHR is LC (ARLC)

 BJC 2012, McCormack et al

Lemen vs. McCormack (*BJC*)

Omits Newer Data, Relies on Incomplete a/o Outdated Data

- Relies on IARC (1987) not IARC (2012)
- Refers to Hodgson (2000) not Hodgson (2010): narrower fiber-type differences

Uses Heterogeneous Datasets

- Not adequately controlled for latency a/o exposure

None of Raised Concerns Are Substantiated

- Minimized CHR risk > misinterpretation
- Emphasized:
  - Lung cancer risk by CHR
  - Benefits of smoking cessation for formerly exposed workers

Shortcomings Undermine Conclusions and Recommendations

Underestimates CHR Potency!

Original vs. Updated Study
Hodgson & Darnton

AOH 2000 Original Study		OEM 2010 Updated Study
■ Systematic Review (AOH, 2000) ■ Cohort: Textile workers in N. Carolina + Quebec Miners	**Study Details**	■ Included Loomis study (OEM, 2009) – *"meso risk by CHR is higher by a factor of 10"*
1:100:500	**Meso Risk for CHR:AMO:CRO**	**1:10:50**
Risk (ratio) for LC "less clear cut"	**Results**	**Significant # revision*** **"Risk by CHR exposure (N. Carolina textile) is much higher than (Quebec) mines"**

 * Criticisms emerged for omitting this revision

Developing Countries vs. CHR Asbestos

Public Health Argument Losing Against Economic Argument	Reasons	Relative Potency Argument Used to Justify "Controlled Use"
■ Middle of high growth ■ Own burden not evident ■ Failure to learn lessons		■ Lobbied by exporters ■ Used by industry ■ Believed by administrators
Empower Public Health Argument	Solutions	Demythologize Controlled Use Argument
+++	Role of Epi	+++

Global Estimates of Mesothelioma

Driscoll (*AJIM*, 2005)	**43,000** estimated deaths annually (world)	**564,000 DALY (World)**
Delgermaa* (*Bull WHO*, 2011)	92,253 **reported** deaths in 83 countries, 1994–2008	**Crude Death Rate = 6.2 per Million†**
Park* (*EHP*, 2011)	38,900 estimated deaths in 33 unreported countries, 1994–2008	**From Ecological Relation**
Lim (*Lancet*, 2012)	33,610 asbestos-related cancer deaths estimated annually	**Meso Mortality Used as Marker of Exposure**
Diandini* (*AJIM*, 2013)	11,884 **reported** deaths in 82 countries, 1994–2010	**215,000 DALY (Reported Countries)**

†Cross Verification

This equates to **38,000 estimated deaths annually** (world). We joined GBD 2014 Team

 *Speaker is corresponding author

Conclusion

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Epidemiology prompted at all levels of prevention

Experience of developed countries should be better utilized to

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Asian Asbestos Initiative

AAI-1 – Kitakyushu 2008

AAI-6 – Manila 2013

8 countries	**22** countries
40-50 participants	**224** participants
WHO-WPRO, ILO	**WHO** (HQ, WPRO, SEARO); **ILO**; **IARC**; **UNU-IIGH**

+ Concurrent Regional WHO-CC Meeting

Distribution to Countries of ARD Toolkit

- Commissioned by UNEP via WHO/ILO
- Distributed to administrators and academia in 30 countries
- 2 Volume Books, 1 CD-ROM, dedicated website: http://envepi.med.uoeh-u.ac.jp/toolkit/index.html

平成25年6月14日（金）　産経新聞　朝刊　23面（九州・山口面）

途上国アスベスト被害防げ

産業医大がマニュアル作成

産業医科大学（北九州市八幡西区）産業生態科学研究所の高橋謙教授らのグループが、国連の委託に応じ、発展途上国でのアスベスト（石綿）被害を防ぐ対策マニュアルを作成した。発がん性物質として先進国で規制が進むアスベストだが、途上国では野放し状態。アジアを中心に25カ国の政府や医療機関にマニュアルを配布する。

（大森貴弘）

マニュアルは198ページで、アスベストの特性とリスク、関連法律や規制の中、世界保健機関（WHO）の診断方法、一般労働者への啓発―などを記載しうえで、被害防止の施策や設備、医療行為の参考情報を盛り込んだ。

高橋氏はアスベスト対策の第一人者だ。アスベスト

平成25年6月6日（木）毎日新聞　朝刊　27面（社会面）

産業医科大が対策マニュアル

世界の石綿被害根絶を

国連が委託 20カ国に300部

Sankei Newspaper (2013.6.14)

Mainichi Newspaper (2013.6.6)

Years Life Lost (APYLL)*: Mesothelioma

(Years per Person; 1994–2010)

Rank	Country [years]	Rate*
1	**Egypt [9]**	**29.9**
2	**Cuba [10]**	**26.2**
3	**Philippines [6]**	**25.6**
4	**Colombia [13]**	**25.2**
5	**Ecuador [12]**	**23.8**
6	Moldova [15]	23.6
7	Mexico [13]	22.2
8	Venezuela [12]	22.1
9	Chile [13]	22.0
10	Brazil [15]	21.8
World Average (59 Countries)		**17.1**

*Diandini, Takahashi *et al*. Am J Indust Med 2013.

 Other ranks: **18**. Japan [16] 19.4; **37**. Finland [15] 17.6; **55**. UK [11] 16.0; **56**. USA [10] 15.4