2014 EAAC IN TAIPEI TAIWAN

18TH EAST ASIAN ACTUARIAL CONFERENCE

12-15 October 2014

Taipei International Convention Center in Taipei Taiwan

Cancer – a look into the future

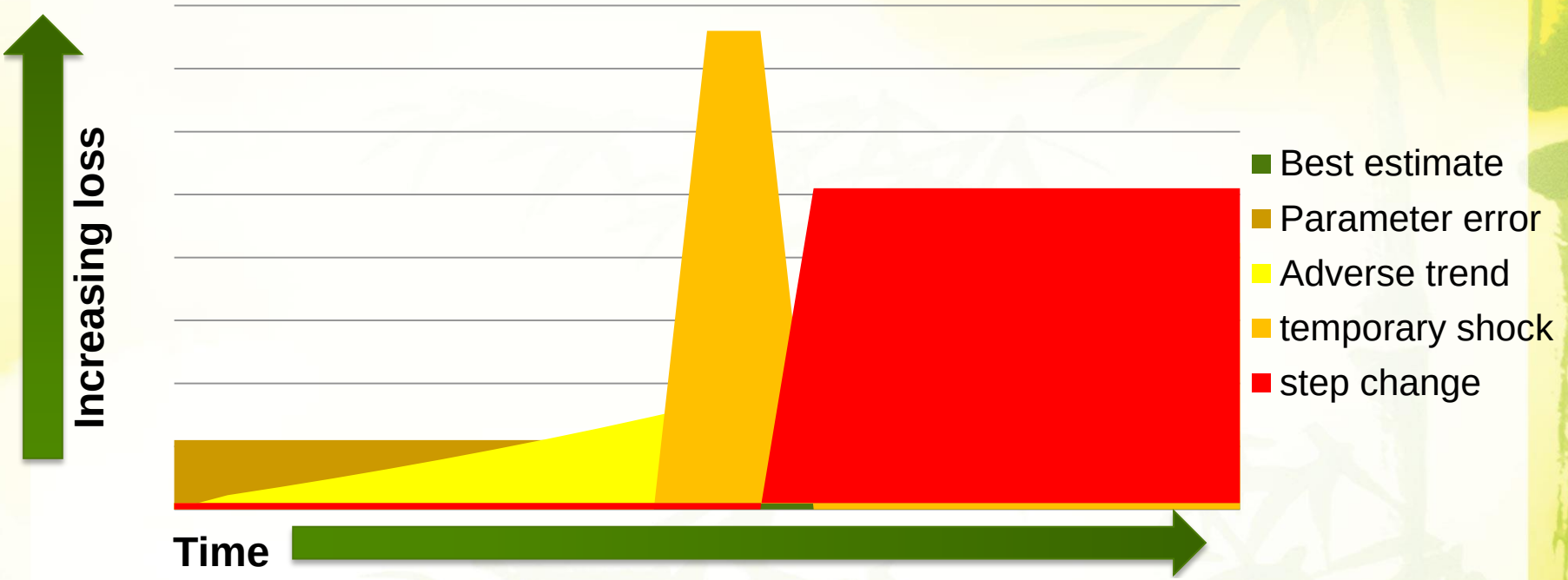
Philip Bundy, FIA

Swiss Re

Good news (and more risk?)

- Growing popularity of cancer and critical illness products across Asia
- Increasing desire for rates to be guaranteed, creating an additional challenge for insurers
  - certainty required not only of the initial incidence, but also future trends
  - how do we estimate changes in incidence over time
  - does it matter?

Uncertain claims



Loss of reviewability means pricing error cannot be rectified

- many ways to lose money!

Can we be accurate today, and tomorrow?

Future cancer incidence

Methods to estimate future incidence rates can be broadly grouped into 4 categories

- ignore
- benchmark
  - compare with other markets, particularly if data is sparse
- retrospective projection
  - extrapolate past trends
- prospective projection
  - analysis of future drivers

What is appropriate in Asian markets?

Retrospective projection

- Derive a trend mainly from the numeric incidence rates in the past; and
- Apply this trend for the future for a period of time with/without a cap.

Features	
Simple & easy to explain	✓
Better than nothing?	✓
Requires credible, relevant data	✗
Projection period/ultimate cap are subjective	✗
Relevance of past to future?	✗
Sensitive to data period used	✗

Cancer specific considerations

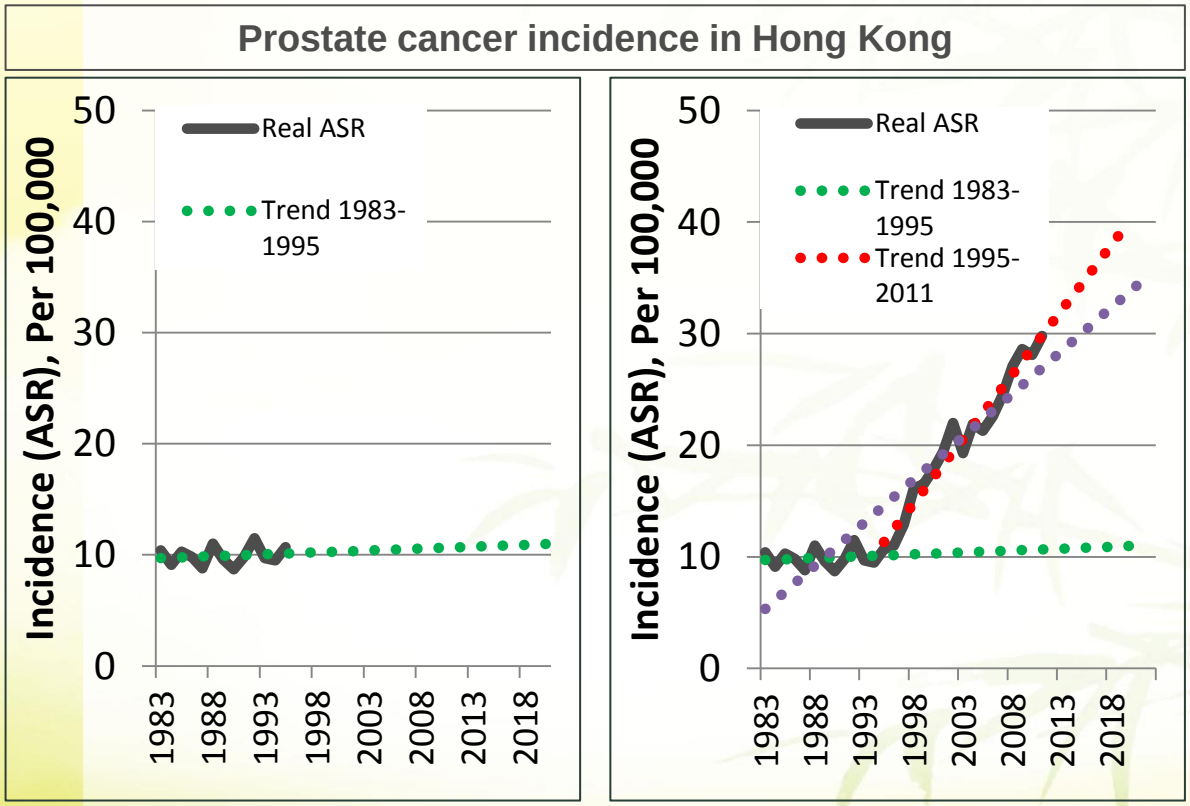
- A group of conditions
- Heterogeneous risk factors (modifiable and non-modifiable)
- Non-natural factors (screening), behaviour driven

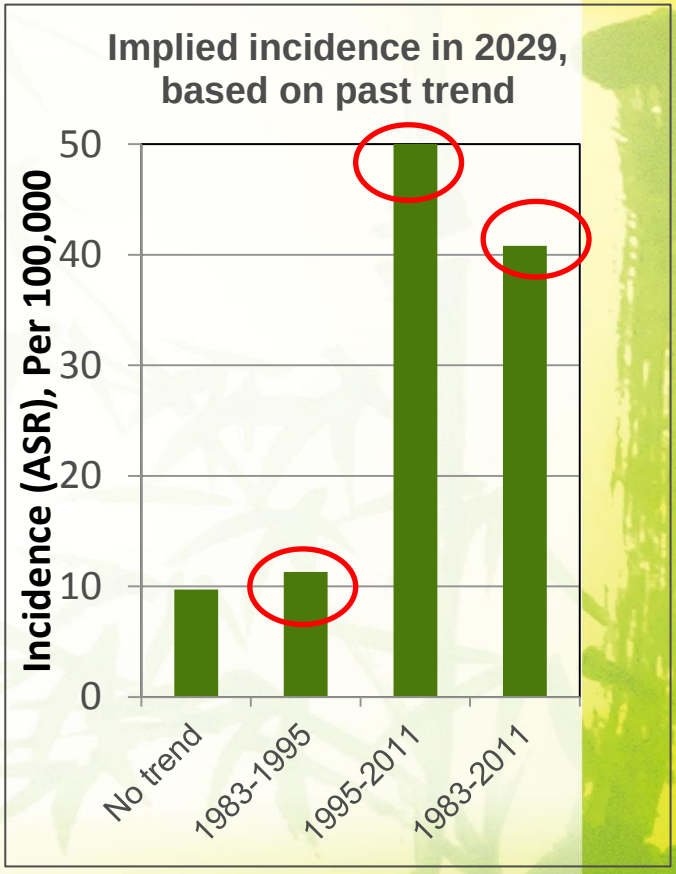
Proposition

- the limitations of a retrospective approach to trend => better to use other method…
- need to understand what caused the past experience to estimate into the future

Trend Approaches

Past data can give a very different answer, depending on the period considered

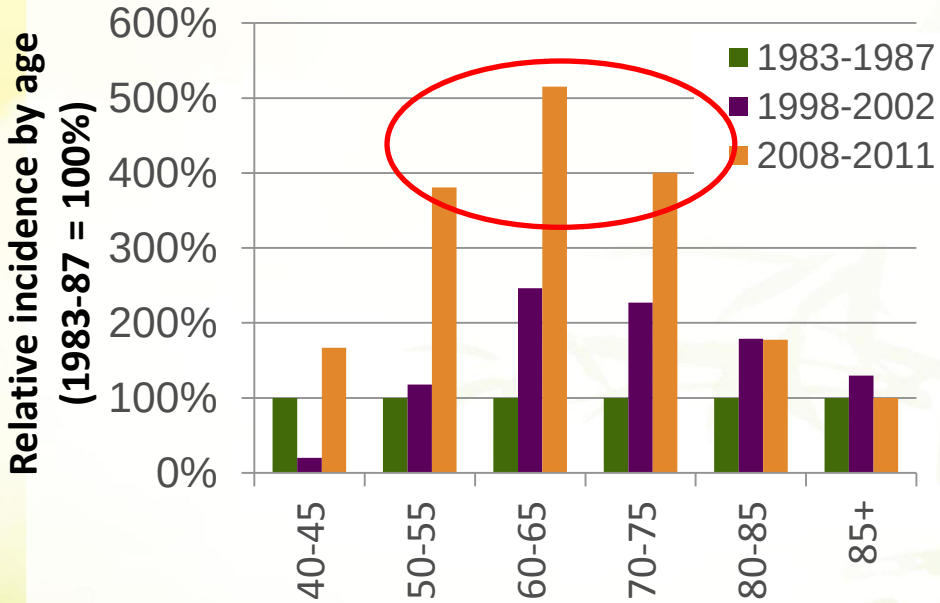




Source:
Hong Kong cancer registry online query system

Drilling deeper

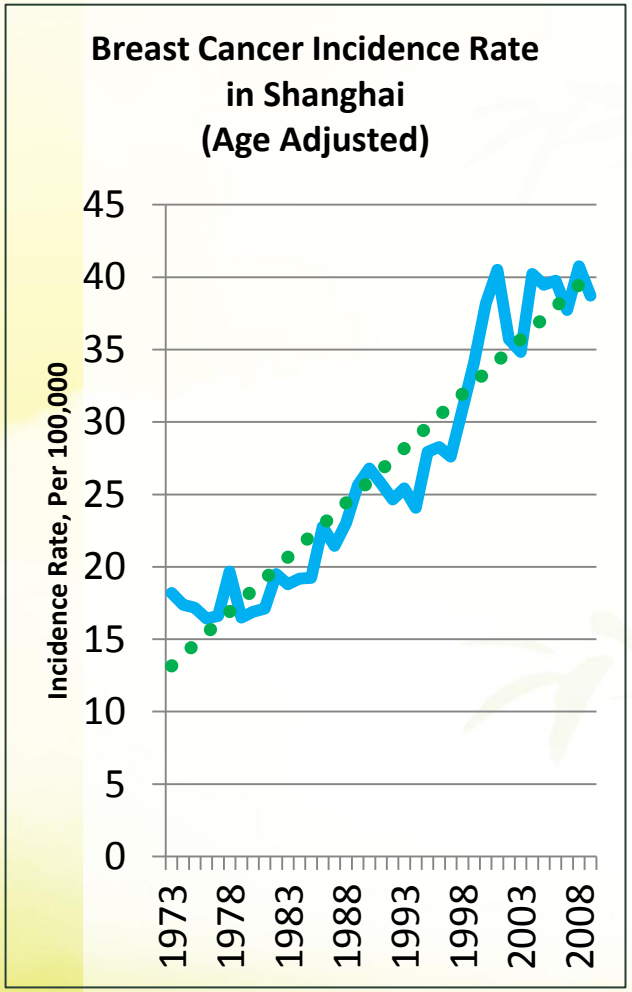
- Before making assumptions for the future, it is necessary to understand the circumstances that drove current and past experience



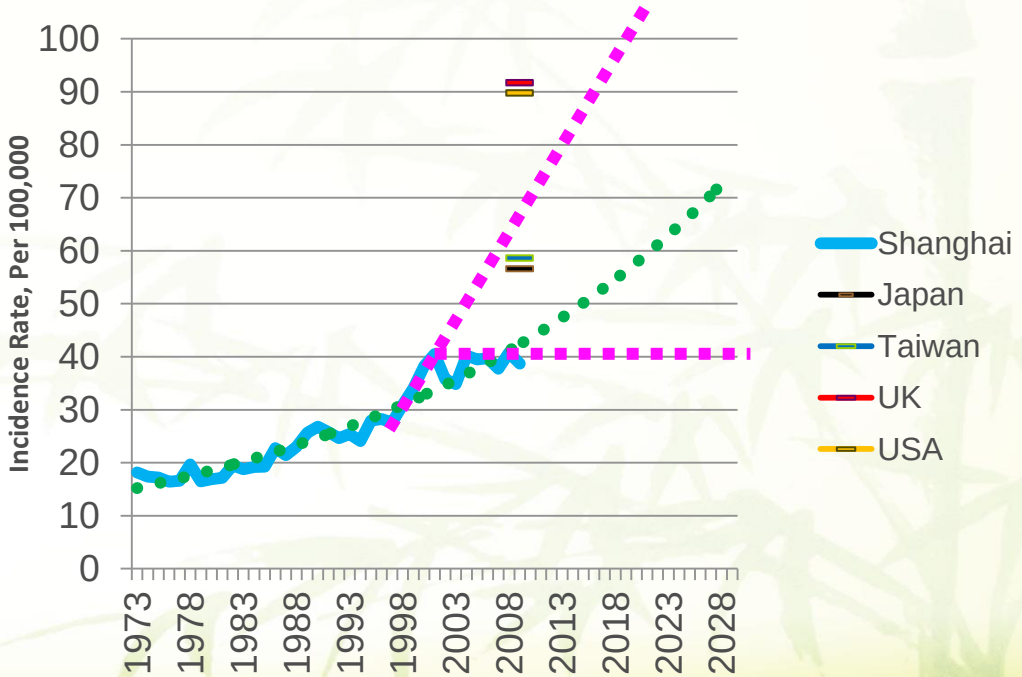
Spike in ASR is driven by specific ages and coincides with the key screening age group

Retrospective method does not allow for this

Breast cancer



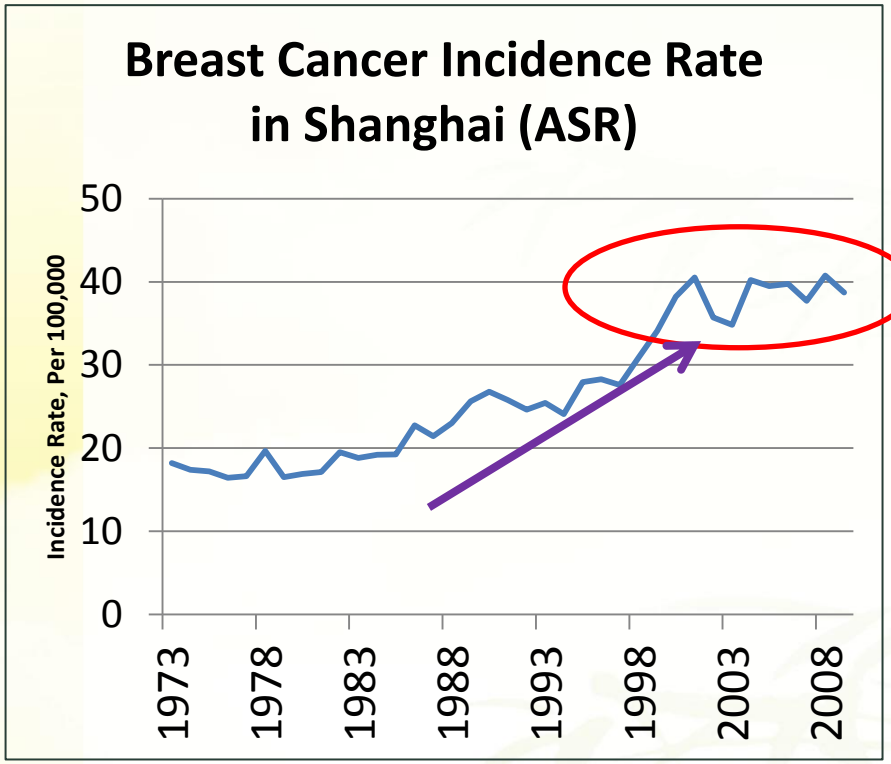
- How to project forward breast cancer incidence rates in Shanghai?
  - extrapolation?
  - external benchmarks? which one?

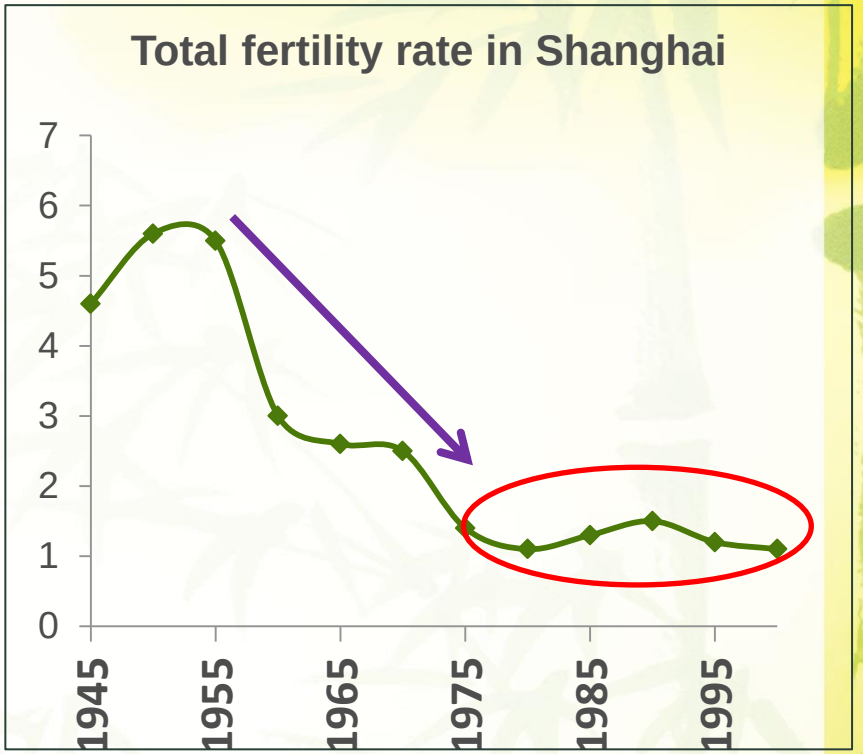


What else do we know?

- Breast cancer risk factors:
  - obesity & lack of exercise
  - alcohol intake
  - occupation
  - hormone levels
- Can underlying risk factors help explain part of the trend?

Fertility rate & breast cancer





- Link between breast cancer risk and hormone status during reproductive ages
  - Did we have a 20-30 year advance notice?

Fertility rate & breast cancer

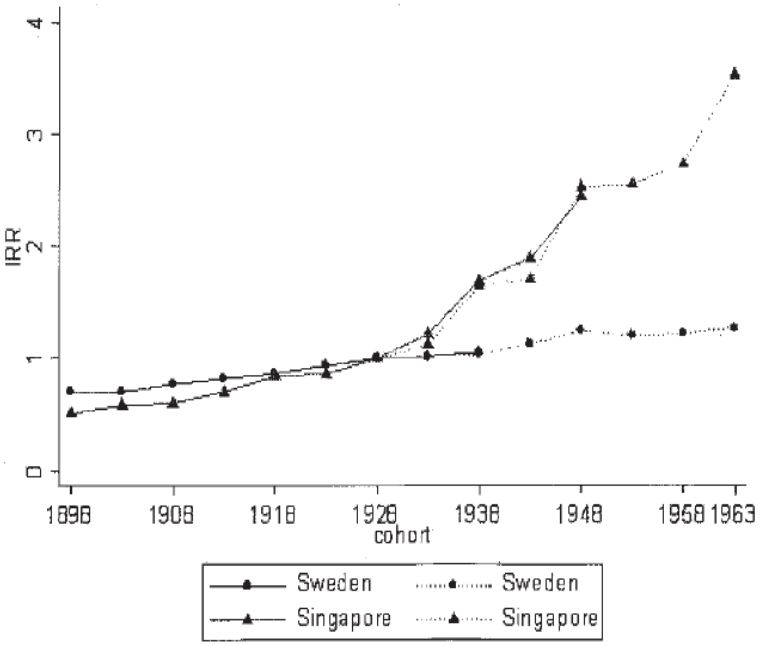


FIGURE 4 – IRRs of breast cancer diagnosed 1968–1997 by birth cohort, with the 1928 birth cohort as reference group. Estimates derived from age-cohort models fitted to younger (< 45) and older (≥ 45) women. Dotted lines, premenopausal women; solid lines, postmenopausal women.

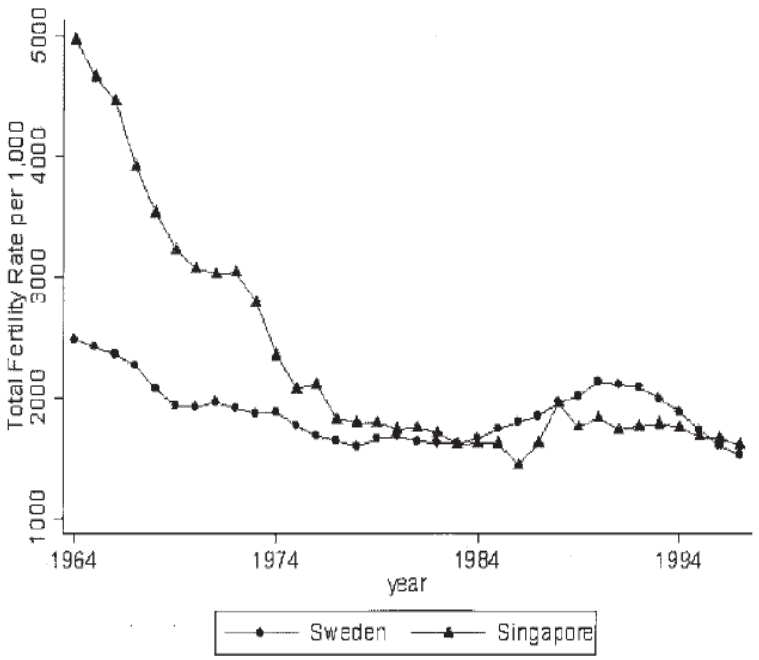


FIGURE 5 – Total fertility rates (age 15–44) for Sweden and Singapore from 1964 to 1997. Source: Registrar-General of Births and Deaths, Republic of Singapore (1978–1997). Total Population Register, Statistics Sweden (1964–1997).

- Similar patterns observed in other countries

Source:
Profound Changes In Breast Cancer Incidence May Reflect Changes into a westernized lifestyle

Causes of cancers

To estimate future cancer incidence, it is necessary to estimate the changes in the underlying causal factors

- Breast cancer (c30%)
  - Obesity, alcohol intake, hormones, occupation, diet, …
- Lung Cancer (c90%)
  - Smoking, Occupational hazards, Low fruit & veg, Radiation, …
- Stomach cancer (c80%)
  - Low fruit & veg, infection, salt intake, tobacco, …
- Bowel cancer (c60%)
  - Red meat, obesity, low fibre, alcohol, tobacco, infection, inactivity, …
- Malignant melanoma (>90%)
  - sunlight/sunbeds, …

cancer research, UK

Prospective projection

- Emphasis of understanding of risk factors, with focus on key and modifiable ones
- Evaluate the relative importance (e.g. attributable fraction) of risk factors
- Project the change of these risk factors and measure the impact on cancer incidence rate

Features	
Less reliance on past experience data	✓
Allows for known changes	✓
Theoretically more sound	✓
More complex	✗
Intensive research required	✗
Not all risk factors have been identified	✗

Two interesting examples

	Liver Cancer	Thyroid Cancer
Main risk factors identified	✓	✗
Recent Trend	↓	↑
Screening	✗	✓
Asian incidence vs West	**High**	**Comparable (exc-KR)**

2014 EAAC IN TAIPEI TAIWAN

18TH EAST ASIAN ACTUARIAL CONFERENCE

12-15 October 2014

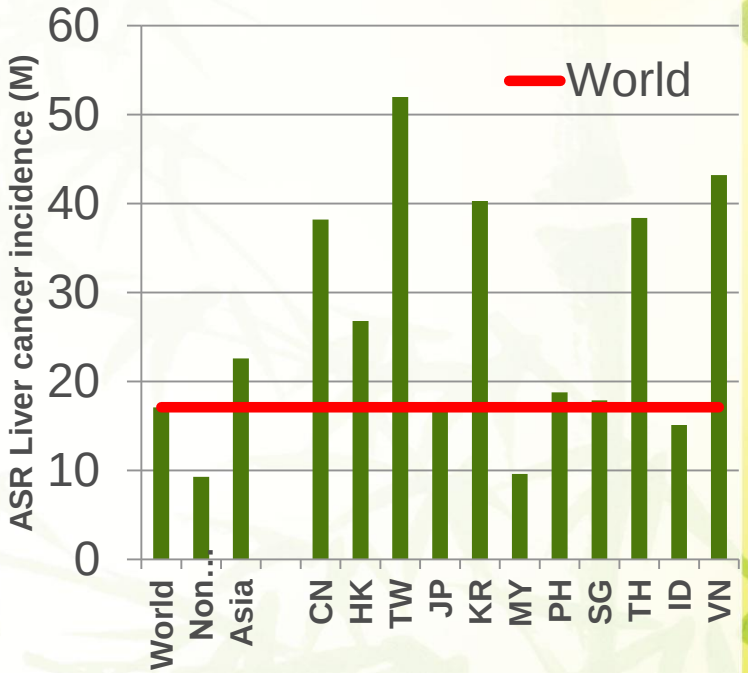
Taipei International Convention Center in Taipei Taiwan

CASE 1: LIVER CANCER

EAAC

Liver cancer – key facts

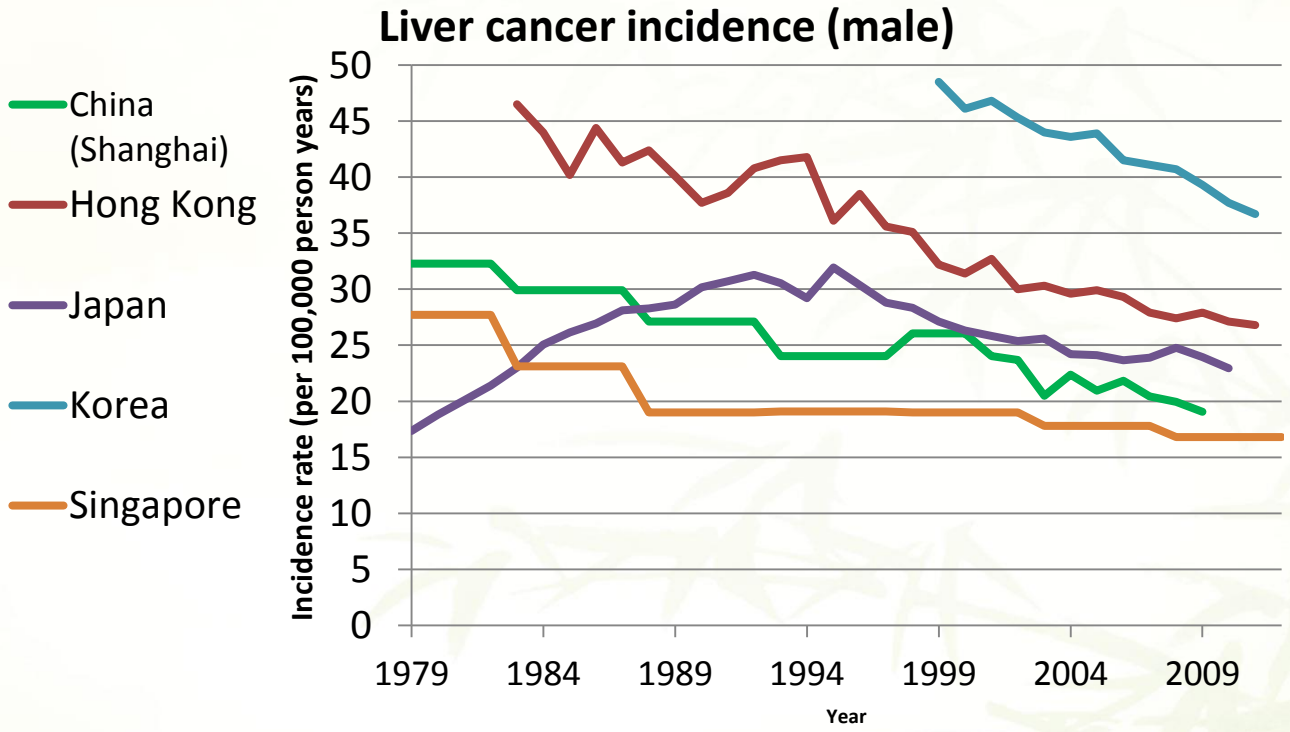
- Liver cancer was the 6th most commonly diagnosed cancer worldwide in 2012
  - 780,000 new cases, 750,000 deaths
- More common in Asia. For males:
  - 5th most common worldwide
  - 2nd most common diagnosis in
    - China,
    - Taiwan,
    - Southeast Asia



- Understanding Liver cancer will be an important component of estimating future cancer risk in Asia

Current trends in Asia

- Incidence has generally reduced over last 30 years

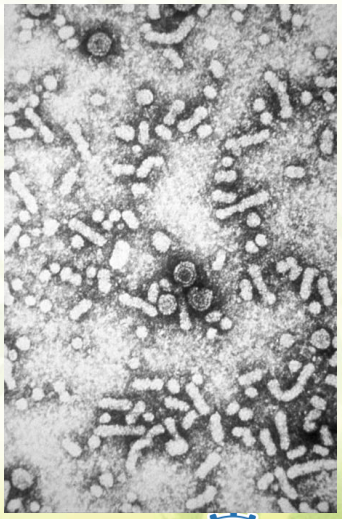


- Why a reduction, and will it continue? How long?
- Why is Japanese shape so different?

Source:
From cancer registries of each market

Risk factors

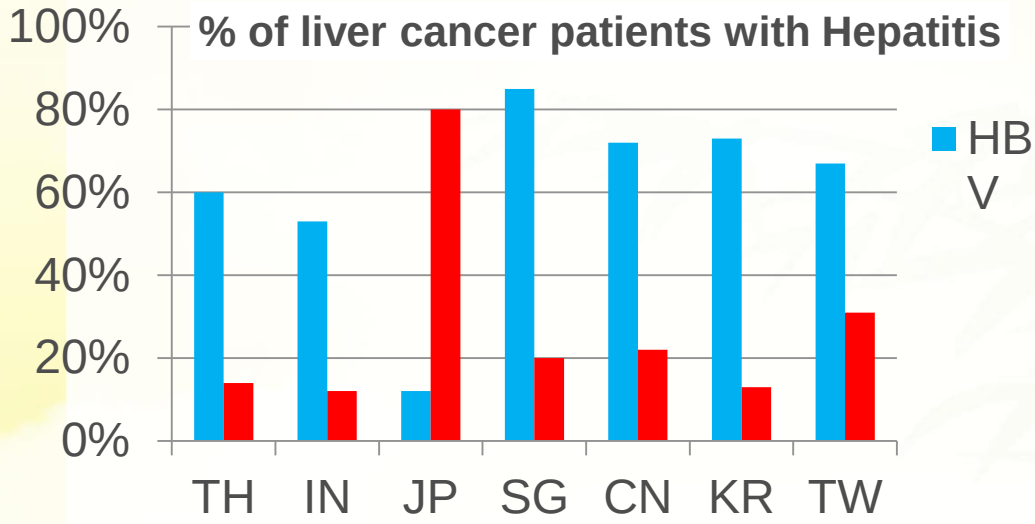
	Risk (95% CI)
Hepatitis B Virus (HBV)	**- Pooled RR: 11.6 (8.3-16.3)** **- Higher in HBV genotype C**
Hepatitis C Virus (HCV)	**- Pooled RR: 7.4 (4.3-12.8)** **- Higher in HCV genotype 1b**
Aflatoxin B1	**- Pooled OR: 6.4 (3.7-10.9)** **- Higher in HCV genotype 1b**
Alcohol Intake	- Pooled RR: 1.6 (1.4-1.7) for intake of 60g/d, 11.8 (7.5-18.6) for intake of 140g/d
Smoking	- Pooled RR: 1.51 (1.37-1.67) for current smokers and 1.12 (0.78-1.60) for former smokers
Overweight/ Obesity	- Pooled RR: 1.17 (1.02-1.34) for overweight, 1.89 (1.51-2.36) for obesity
Diabetes	- Pooled RR: 2.5 (1.9-3.2)



RR: relative risk
OR: odds ratio

Source:
From various research articles

Hepatitis as a risk factor



- *Clear link between hepatitis infection & liver cancer*
  - *HBV in particular*
- *Again Japan appears out of step*

- Hepatitis prevalence has been reducing

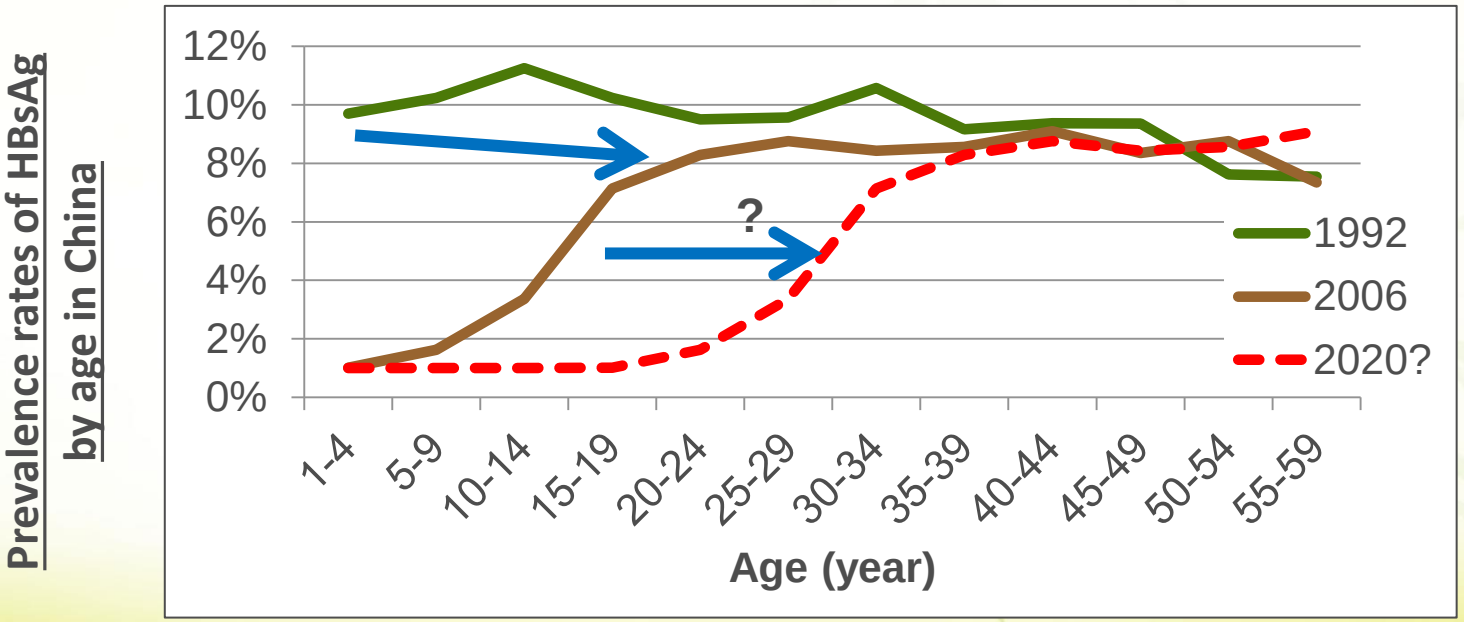
	HBV prevalence rate	Change	Notes
CN	9.8% in 1992, 7.2% in 2006	**-27%**	National serosurvey of HBV, age 1–59
HK	11.3% in 1990, 7.4% in 2011	**-35%**	Hepatitis surveillance, antenatal women
TW	14.3% in 1995, 1.1% in 2009	**-92%**	University freshmen
JP	1.1%	**n/a**	National health screening for HbsAg, age 40+
KR	4.5% in 1998, 3.7% in 2005	**-18%**	National health & nutrition survey in Korea, 10+
SG	4.0% in 1999, 2.8% in 2005	**-30%**	National health survey, age 18–69

Intervention methods

- HBV
  - universal childhood vaccination programmes (>95% in most major countries)
  - Vaccination for high risk individuals
  - Reduce vertical transmission (mother to baby) using HBIG & vaccination (c90% effective)
  - Control of blood contamination
- HCV
  - Improved treatment (including some recent success – ref Sofosbuvir)
  - Still no effective vaccination
- Aflatoxin
  - Improved food storage conditions
  - Regular monitoring of food supply/storage systems

Results of intervention

- Aflatoxin has improved in the past and now generally under control. Unlikely to bounce back
- Transmission of HBV/HCV via blood products well reduced in most countries
- Treatment becoming more effective:
  - Control of HBV (although not a cure) can reduce liver cancer risk by 40-50%.
- Success in treatment for HCV may compensate for lack of vaccination,
- Vaccination for HBV well established in many countries over last 10-30 years
  - Reduction in prevalence will be observed as vaccinated population ages



Source:
Epidemiological sero-survey of Hepatitis B in China--declining HBV prevalence due to Hepatitis B vaccination

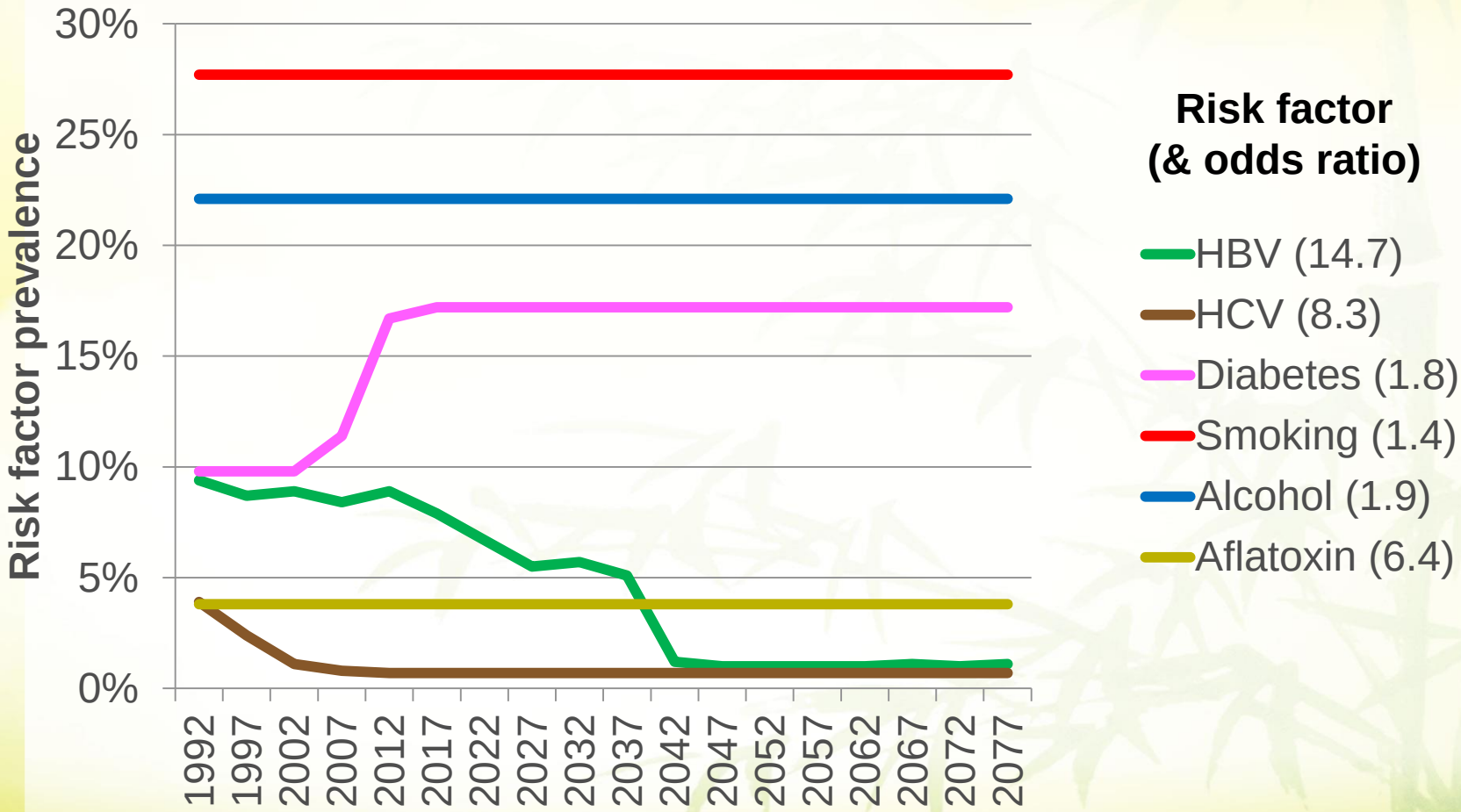
Qualitative conclusions

- Asia is an endemic area of liver cancer but the situation is improving.
- HBV and HCV infections are still the major causes of this condition, but with different weights by country.
- Dietary exposure to aflatoxin in China and SEA made the situation worse for both its direct toxic effect and the strong synergistic effect with HBV infection.
- These major factors are under better control than in the past as a result of improved awareness and efforts from various parties.
- Although some factors, including water pollution, alcohol intake, smoking and metabolic disorders, are presenting uncertainties, the favourable trend observed is **unlikely to be reversed in the near future.**

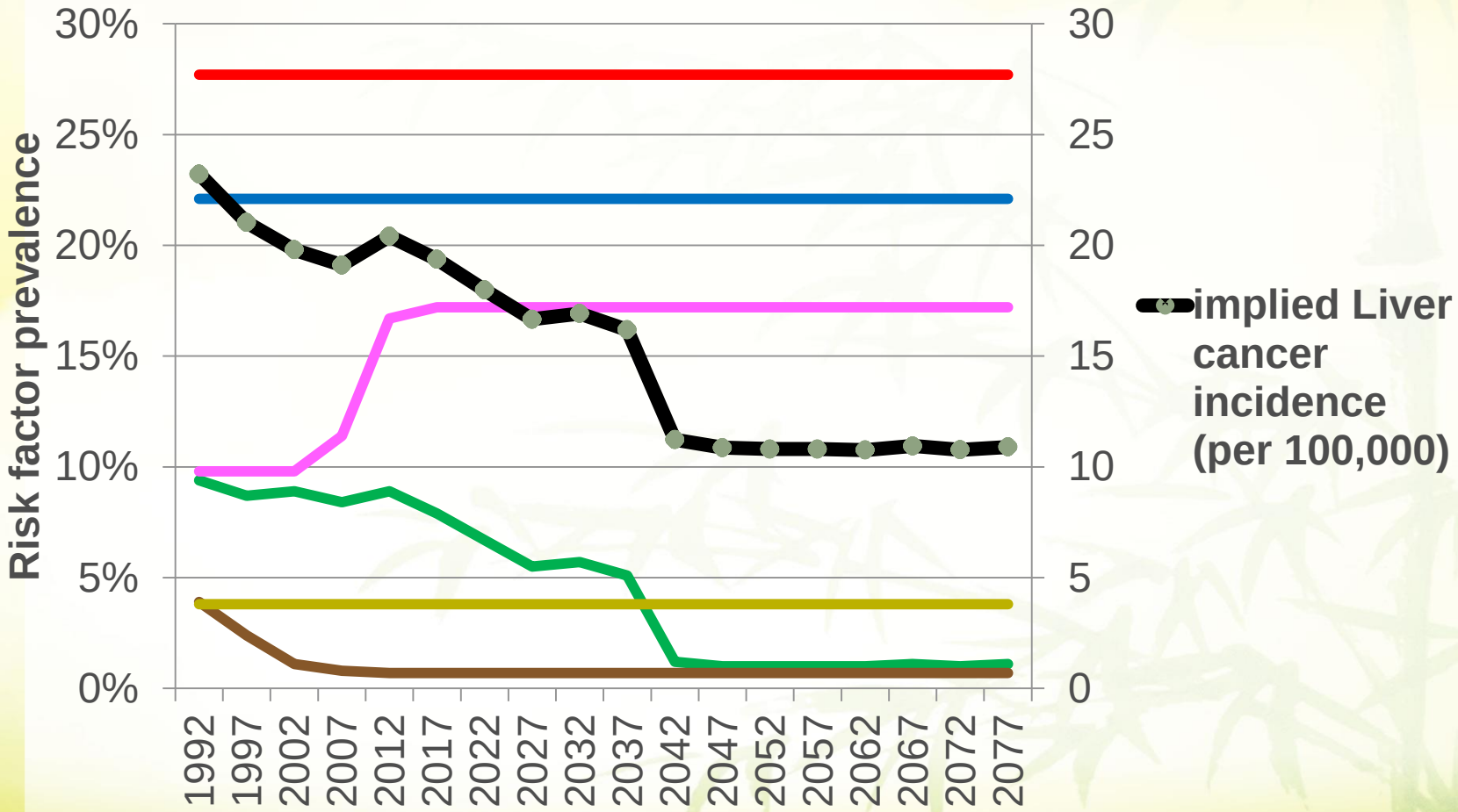
A quantitative approach

1. Derivation of attributable fraction of major risk factors
    a) prevalence rate of risk factors in general population
    b) prevalence rate of risk factors in liver cancer population
    c) relative risk factors or odds ratios
2. Project the change and future patterns of risk factors (HBV as example)
    a) past trends in adults
    b) starting year of universal vaccination for new born babies
    c) coverage rate of vaccination
    d) floor prevalence rate
3. Determine future incidence rate

Worked example
(China,40-49)



Worked example
(China,40-49)



2014 EAAC IN TAIPEI TAIWAN

18TH EAST ASIAN ACTUARIAL CONFERENCE

12-15 October 2014

Taipei International Convention Center in Taipei Taiwan

CASE 2: THYROID CANCER

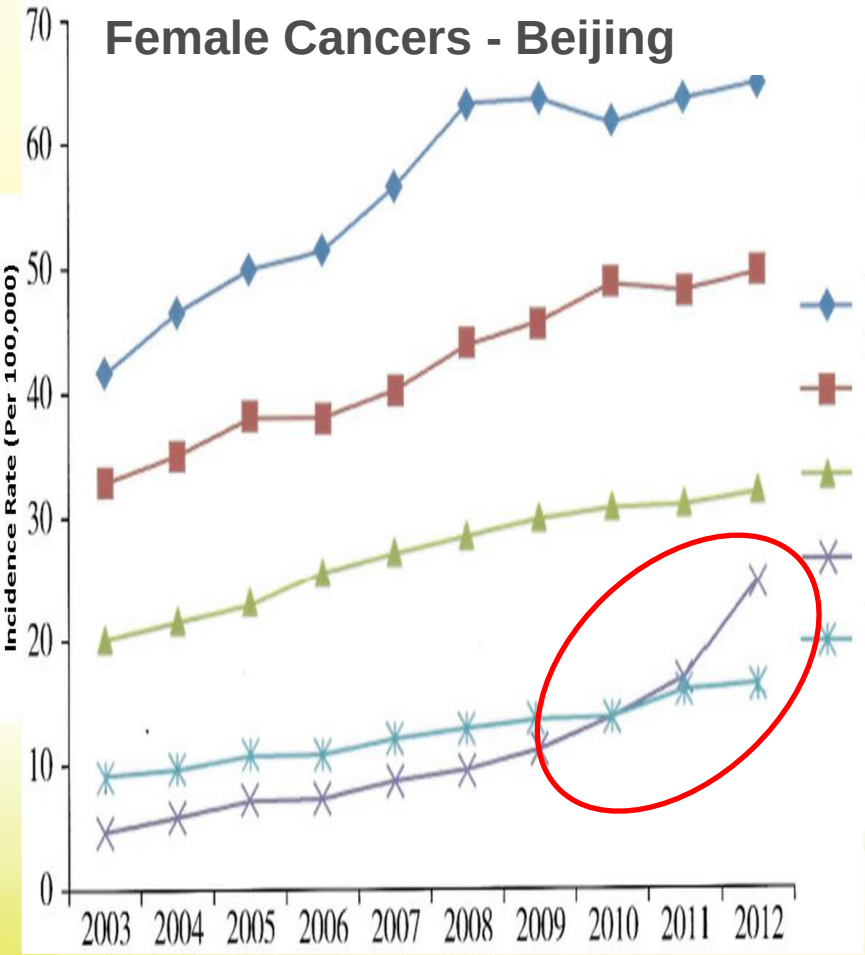
EAAC

Risk factors

- Only ionizing radiation has been confirmed by The IARC with sufficient evidence.
  - Large scale exposure to such radiation mainly comes from nuclear accidents, or medical radiation (eg x-ray)
- In studies

  - A linear dose-incidence relationship was observed.
  - The impact is mainly for children at the time of exposure.
  - The impact lasts very long but the excessive relative risk decreases with longer duration after exposure.

An increasing risk

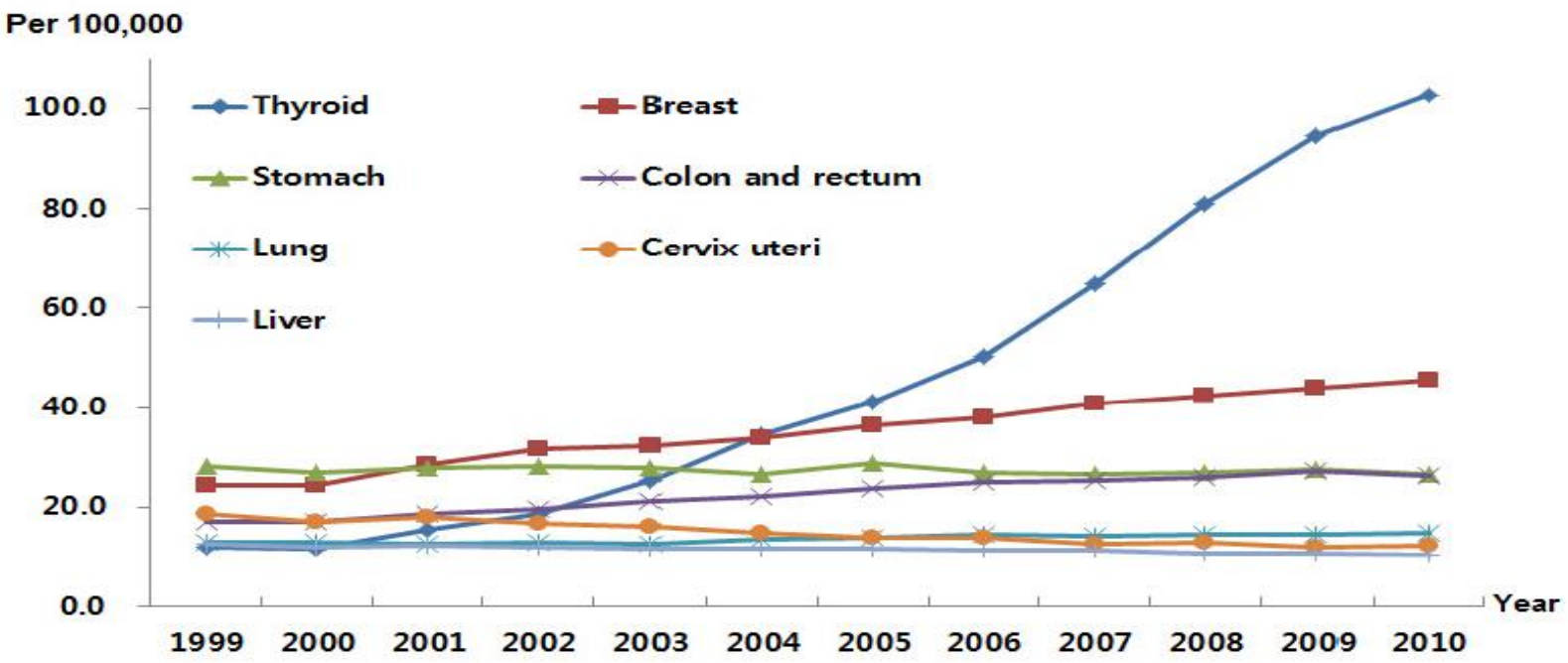


According to a 2014 report:

- In 2012, it increased by about 40% compared to 2011 - ranked No. 4. female cancer
- Similar findings also observable in Shenzhen, Shanghai etc.
- Some insurance companies have reported alarming trend of thyroid cancer claims, especially in eastern provinces/cities.

It is not a potential risk anymore but a realistic one.

Similar pattern in Korea



Source) Ministry of Health & Welfare, Korea Central Cancer Registry, 2012

Note) ASR (Age-standardized rate) standard population: Korean mid-year population in 2010

Risk Factors

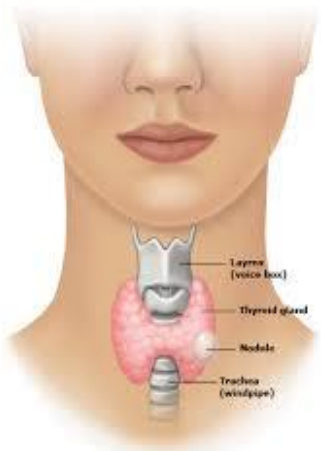
Ionizing radiation doesn't help to explain the rapid increase of thyroid cancer incidence observed in Beijing and Korea for the following reasons:

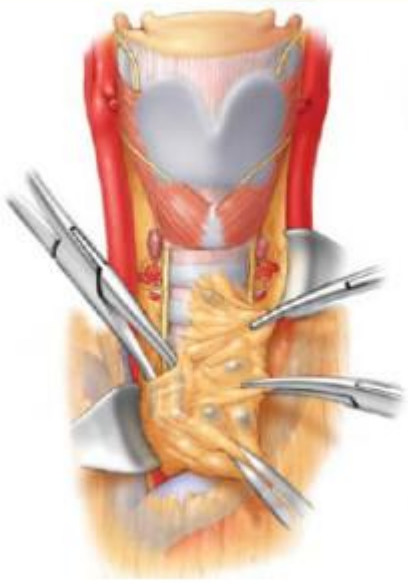
- Ionizing radiation mainly affects juvenile ages at exposure. Adult exposure brings very little additional risk.
- Beijing and Korea didn't suffer from nuclear accidents.
- Medical exposure is generally small and increases gradually rather than in sharp pattern.

The Beijing report commented that:

- The rapid increase of thyroid cancer incidence is inconsistent with the stable mortality rate due to thyroid cancer.
- The mainstream view is that it is caused by improvement and wide utilization of imaging techniques. Such increase is not a real increase of risk. Instead, it is probably "over-diagnosis".

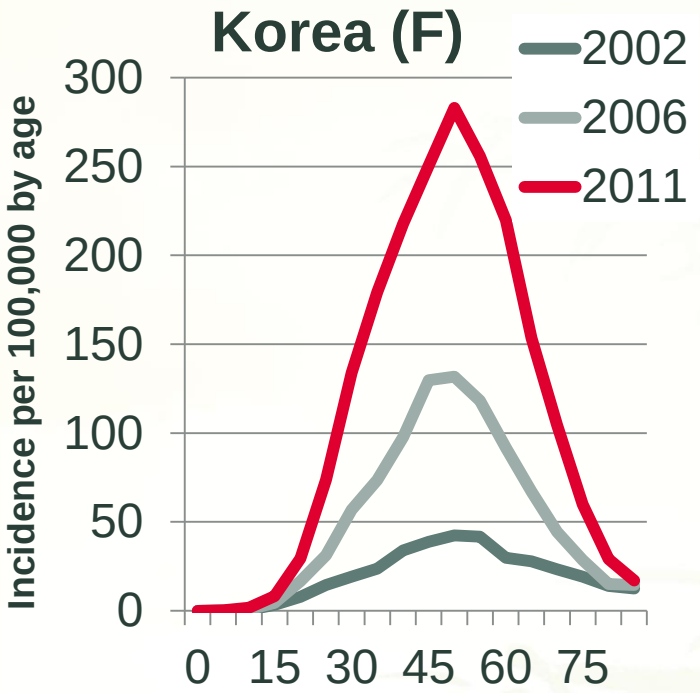
Screening

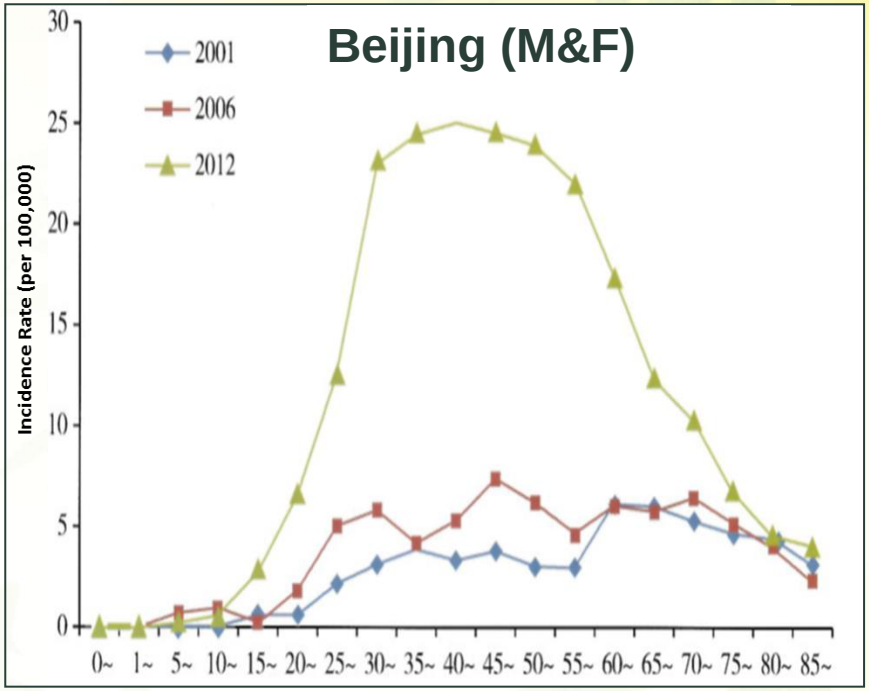




- Cheap/Easy
- Painless
- Together with other cancer screening
- Awareness/fear of cancer
- Abuse
- Financial incentive?

A propensity to screen





- Current rates in China are still much lower than those observed in Korea (about 1/6 at major ages) and still have big room for further increase.

- However, in China, thyroid cancer (any stage) is not excluded from the standardized cancer definition (released in 2007). This is a big risk for critical illness business, especially when rates are guaranteed.

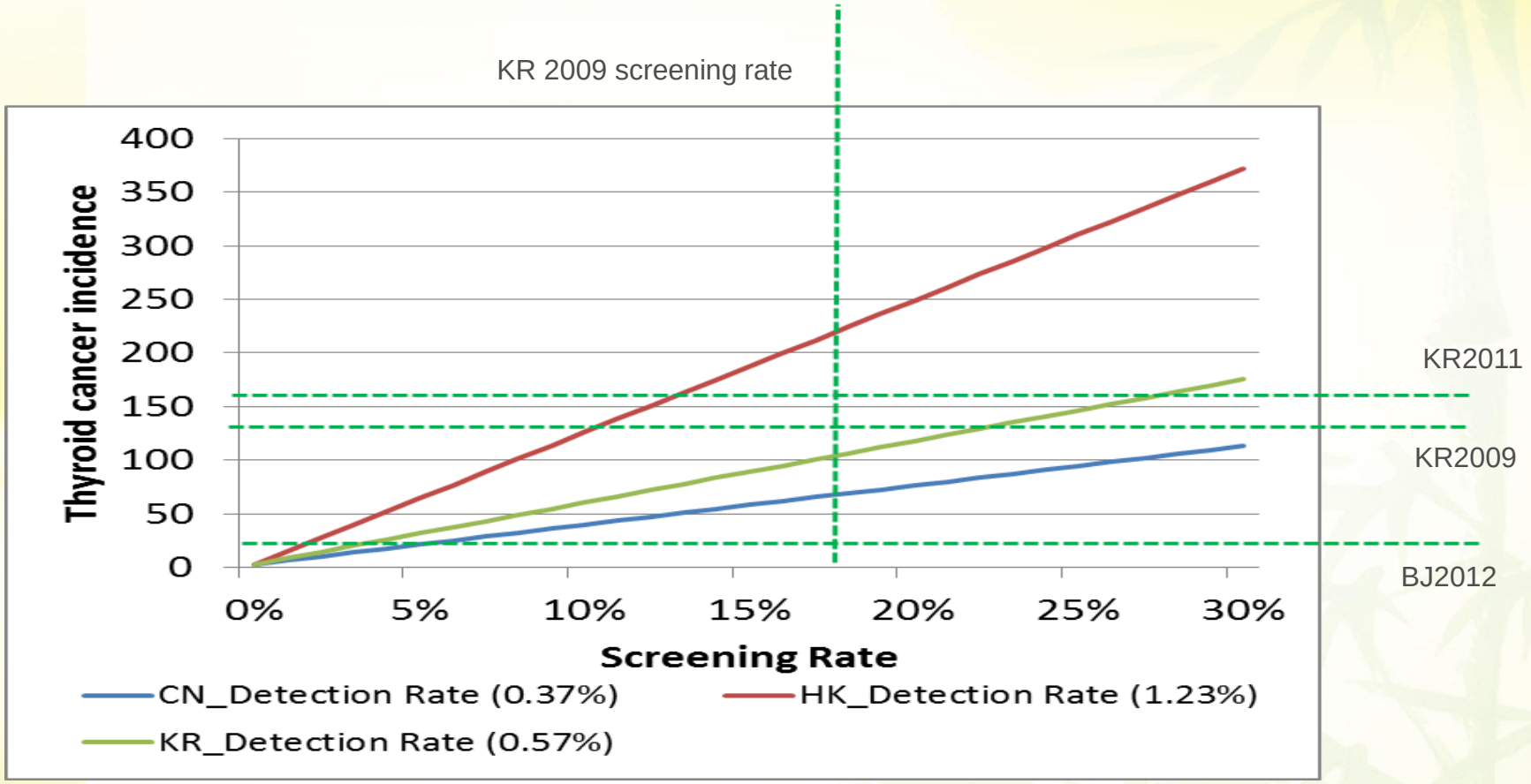
A quantitative approach

1. Assume a rate of incidence in the absence of screening based on available data
2. Determine a relationship between screening and detection based on experience from other markets
3. Project future screening rates and infer diagnosis rate

Worked example: Beijing age 50-59

– assume the rate in 2001 is before screening

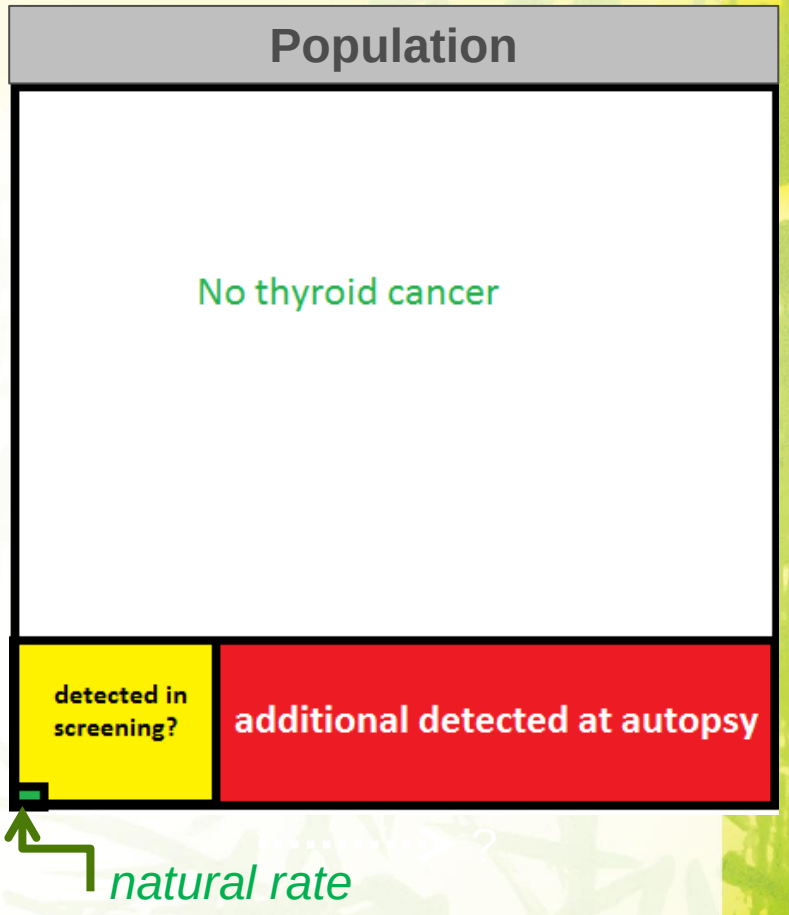
Projection for Beijing



Incidence is sensitive to assumed detection rate, but shows how rapidly rates could increase should screening prevalence increase

How high can it go?

- "Natural" incidence
  - up to 0.01%
- Screening detection rate
  - 0.3%-2.6% (varies by study)
  - c100x natural rate
- Autopsy prevalence rate
  - 10-20% in Asian countries
  - Claims rate could increase as diagnostic methods improve



An insurable risk?

- Prevalence rate of thyroid cancer in autopsies ranges between 10% -20%.
  - This provides the highest possible positive rate for screening.
- Most of these cases are papillary thyroid cancer that having the best prognosis. Exclusion of PTC could be good enough.
- Difference of prevalence rate in autopsies between genders is smaller than that observed in clinical diagnosis. Males are not exempted although females have 3-5 times risk of clinically diagnosed thyroid cancer.
- A big part of those cases are smaller than 1mm and not able to be detected by current screening method (ultrasound can detect nodules of 2-3mm). But with advancement in technology, this is not impossible.
- Most of those cases are smaller than 1 cm (micro-carcinoma). Exclusion of micro-carcinoma may protect us from further advancement in ultrasound resolution.

Thyroid cancer summary

- Confirmed risk factors not important for the trend risk
- Screening has already resulted in a significant increase in diagnosis rates
  - Insurance population may have more incentive/awareness to seek health check-up, thyroid cancer screening and treatment
- In Beijing, the incidence rate of thyroid cancer increased by about 40% from 2011 to 2012.
- The high prevalence rate (10%-20%) of thyroid cancer observed in autopsy studies provided an upper bound
  - Most of these cases could be latent for life if they are not detected

Conclusion

- Long term guarantees mean future incidence rates require significant thought
- Given the interaction of numerous moving parts, extrapolating past experience is insufficient
- Considering underlying drivers can help, but
  - each cancer has numerous risk factors, that are not fully understood
  - detailed analysis is informative, but risk remains

Appendices

How many cancers can be prevented?

Although there are some things we can't control about our cancer risk, decades of research have clearly shown that by living a healthy life, people can reduce the risk of developing the disease. But how many cancers in the UK are really caused by things we can change?

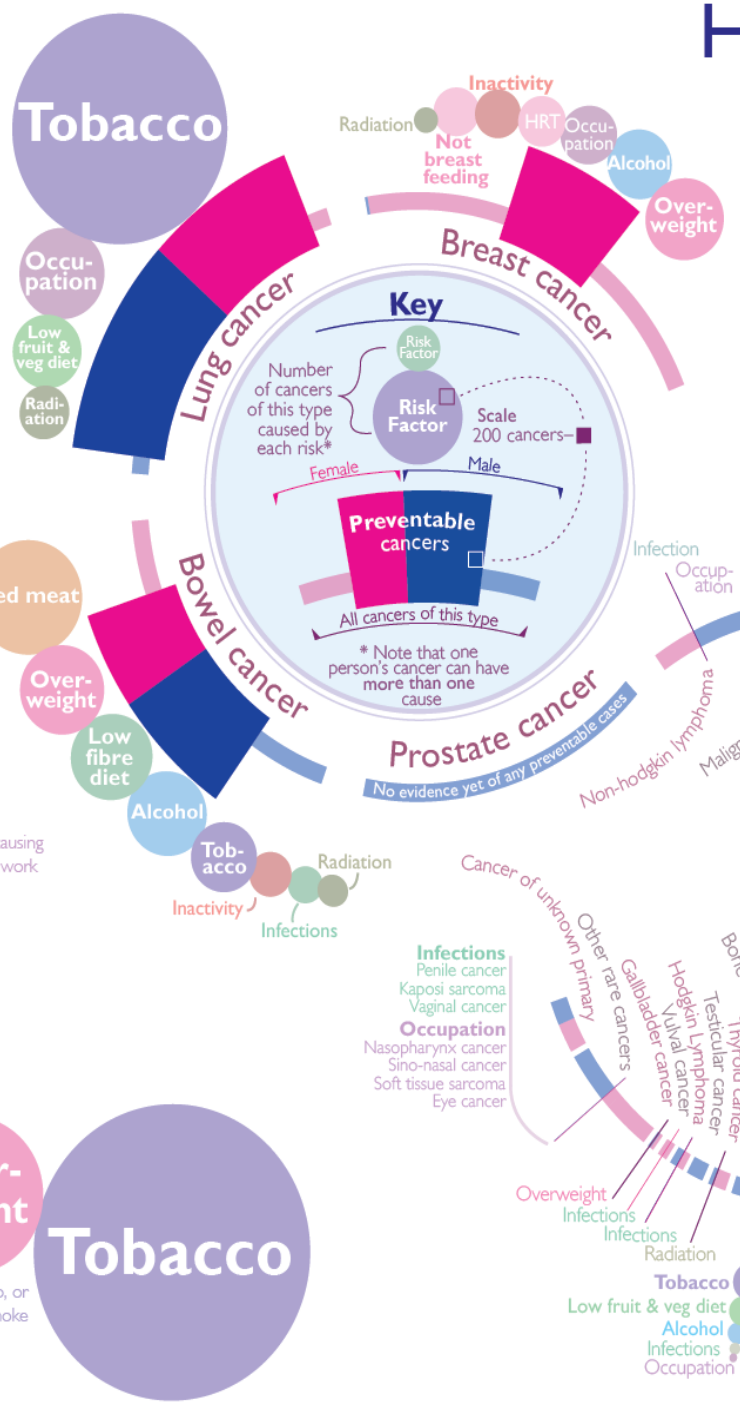
This diagram shows the results of new research funded by Cancer Research UK, which aims to show the number of cancer cases in the UK that could be prevented by known lifestyle and environmental factors, like being a non-smoker, keeping a healthy weight, drinking less alcohol, eating a healthy, balanced diet, and avoiding being exposed to certain infections or radiation.

The thin lines show the total number of cancers of each type from the latest UK incidence figures, and the large bars in the centre of each line show the proportion of these cases that could be prevented in men and women. Around the outside, you'll see the lifestyle and environmental factors that are linked to each cancer type. On the left is the contribution of each lifestyle factor to cancer overall.

All cancers

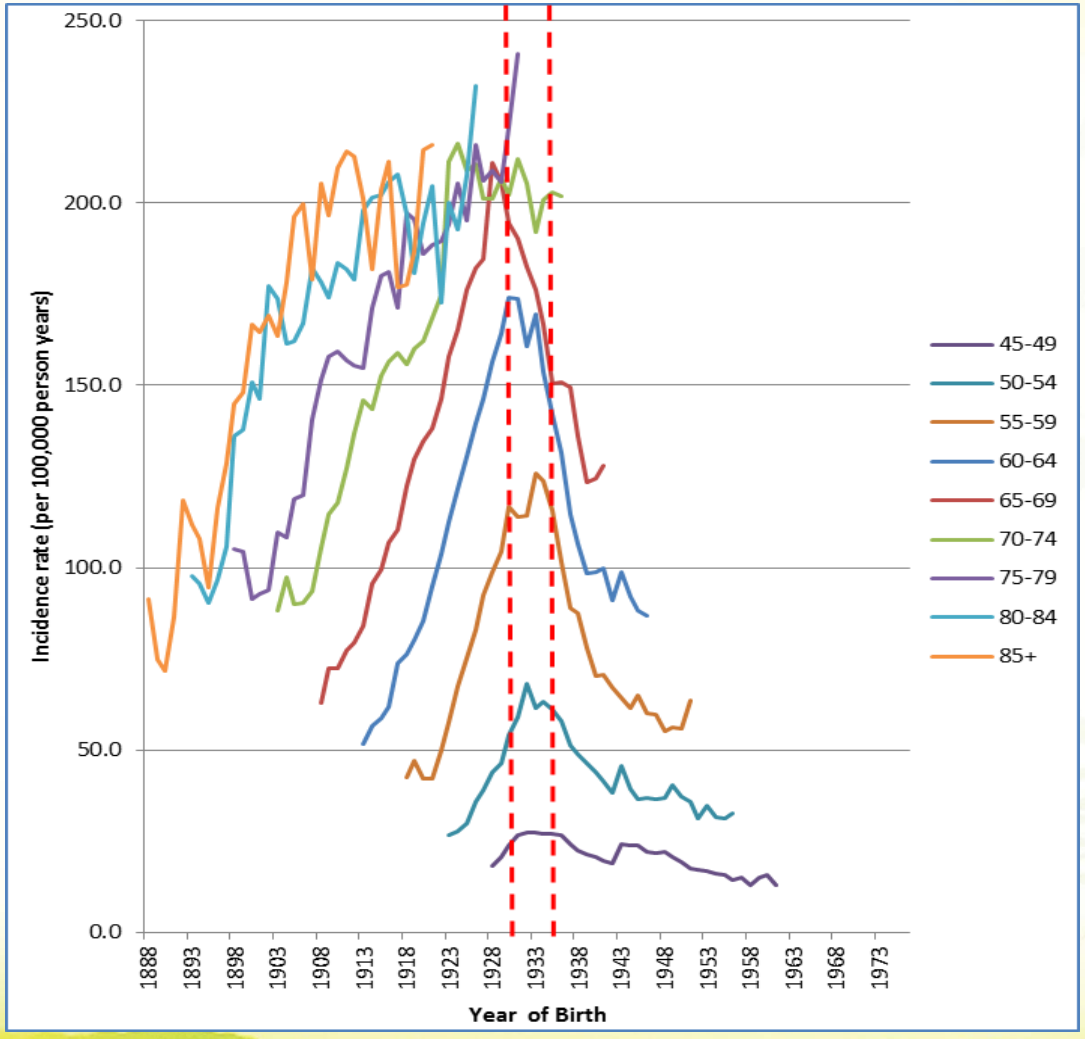
- **HRT** — Taking any type of Hormone Replacement Therapy
- **Salt** — Having at least 6 grams a day
- **Not breast-feeding** — Breastfeeding each child for less than 6 months
- **In-activity** — Being moderately active for less than 150 minutes a week
- **Low fibre diet** — Having less than 23 grams of fibre a day
- **Radi-ation** — Being exposed to any ionising radiation, including background levels such as those released from the earth
- **Red meat** — Eating any red or processed meat
- **Infections** — Exposure to cancer-causing infections like HPV and Hepatitis B or C
- **Sunlight & sunbeds** — Getting more UV than was typical for people born in 1903
- **Occupation** — Being exposed to cancer-causing chemicals or conditions at work
- **Alcohol** — Drinking any type of alcohol
- **Low fruit & veg diet** — Getting fewer than five portions a day
- **Over-weight** — Having a BMI of 25 kg/m² or over
- **Tobacco** — Smoking or chewing any form of tobacco, or exposure to environmental tobacco smoke

Together we will beat cancer



CANCER RESEARCH UK

Japan and HCV



Source:
Japan cancer registry data

- Japan has a unique risk profile and trend is due to strong cohort effect.
- Japan is the only country in Asia with liver cancer dominated by HCV infection
- People born in late 1920's and early 1930's were infected with HCV during and after WWII via drug abuse, sharing of syringe/needles, etc.
- When this generation get old or die, the liver cancer incidence tend to decrease.

Screening result

Target Population	Beijing, China Health checkup	Hong Kong Volunteers without thyroid symptom	Japan Military force without thyroid symptoms	Korea 1 Health checkup	Korea 2 Breast screening cohort
Study Period	Jan 2009 -Jun 2011	Jan 2007-Apr 2009	1990-2012	Mar 2006 - Feb 2008	Dec 1997 - Jul 1998
Sample size (M/F)	5970/4933	292/848	6331/91	7491	1401, all female
Average age	46/45 years	45 years	95% people > =50 years		
Palpable nodules+enlargement		47			
US nodules		103/408	936/10	2747	353
Accept biopsy		258		658	94
Suspicious (Biopsy)				22	18
Cancer (Biopsy)				79	47
Suspicious and Cancer (Biopsy)		26		101	65
Taken Surgery	54	19		46	43
Surgey confirmed	14/26	14	20/0	43	37
Classification	39 PTC, 1 FTC	13 PTC, 1FTC	17 PTC, 2 FTC, 1 unknown	43 PTC	36 PTC, 1 other type
Size					
Microcarcinoma (< 1cm)	40%	71%	42%	63%	56.80%
Staging (I/II/III/IV)			39%/11%/50%/0%	58.7%/0%/41.3%/0%	
Detection rate (per 100,000)	366.9	1228.1	316.4	574.0	2641.0
	No biopsy performed. Sugery was suggested if nodule is considered as high risk by US	All nodules greater than 5 mm are suggested biopsy. Nodules less than 5 mm are suggested biopsy if there is high risk indicator.	Nodule is defined as diameter ≥ 3mm; Pure cysts excluded (about 5%). Only nodules having malignancy indicator under US and greater than 5 mm are recommended for biopsy	Nodules greater than 1 cm: if they are dominated by cyst or have an internal spongiform apperance, no biopsy is not suggested. Nodules less than 1 cm are suggested biopsy if there is high risk indicator under US. Only biopsy malignant are suggested sugery	Only nodules suggested high risk by US are recommended biopsy Only biopsy malignant are suggested sugery

- Nodules detectable under ultrasound is much more common than palpable nodules.
- Most detected cases are papillary thyroid cancer that having the best prognosis. Exclusion of PTC could be good enough.
- Detection rate ranges from 300-2000+ per 100,000, varying by country and target population. This is much higher than a normal clinical diagnose rate in the past but much lower than autopsy results. Small change in screening rate may have big impact on clinical diagnose rate.
- Not all people that are suggested biopsy or surgery accept the procedure and this lowered the detection rate. People with insurance may have stronger incentive to accept those procedures.
- Different doctors/hospitals may have different criteria for biopsy and/surgery. Hospitals with a lot of vacant beds may be more aggressive.
- Some cases confirmed by biopsy proved non-cancer after surgical removal. Biopsy based histology evidence could be not enough for lump sum payment.
- A big portion of the cases have invaded lymph nodes and are classified as stage III. It is reasonable to believe even these cases are not harmful if not detected. Traditional exclusion (T1N0M0 or stage I) doesn't fully relieve the risk from screening.

Source:
10903名健康体检人群超声普查甲状腺癌发生率
Ultrasonographic screening for occult thyroid cancer
New evidence about thyroid cancer prevalence, prevalence of thyroid cancer in younger and middle aged Japanese population
Prevalence of Thyroid Cancer at a Medical Screening Center
Ultrasonographic Mass Screening for Thyroid Carcinoma, a study in women scheduled to undergo a breast examination