

## The variation of 18 different smoke constituent yields across UK cigarette brands and their relationship to two smoking regimes

Lion Shahab, Dave Hammond, Richard O'Connor & Ann McNeill

## European product regulation directive

- Tar/nicotine/carbon monoxide (TNCO) yields gradually reduced by EU directives since 90s
- January 2004 implementation of 2001/37/EC placing upper limits on yields using International Standards Organisation (ISO) tests:
  - 10 mg tar
  - 1 mg nicotine
  - 10 mg carbon monoxide
- But is this wishful thinking?
  - how useful is ISO smoking regime?
  - how useful is classification in terms of tar?

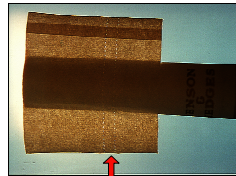
## Smoking Regimes

- US Federal Trade Commission (FTC) introduced standard testing tar and nicotine yields in 1967 followed by ISO
- Relatively arbitrary testing parameters used:

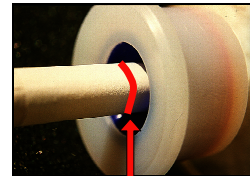
Smoking Regime	Puff Volume (ml)	Puff Frequency (sec)	Filter Blockage (%)	Flow Rate (ml/sec)
ISO	35	60	0	17.5

## Smoking Regimes - Ctd

- Testing parameters unrealistic (e.g. Djordjevic, Hoffmann & Hoffmann, 1997) as smokers:
  - take greater puffs
  - Inhale more deeply and frequently
  - block ventilation holes



Location of filter vent holes



Location of filter vent holes outside ISO testing machine

### Smoking Regimes - Ctd

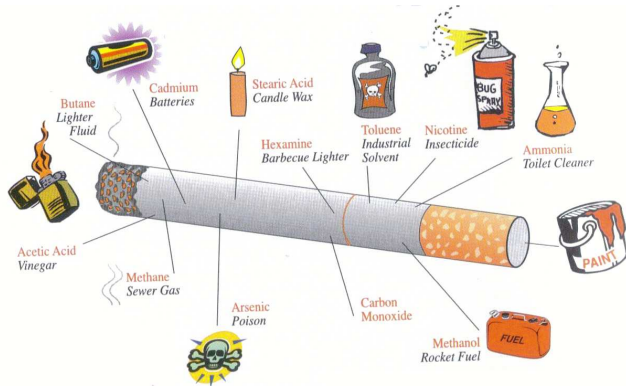
- Testing parameters unrealistic (e.g. Djordjevic, Hoffmann & Hoffmann, 1997) as smokers:
  - take greater puffs
  - Inhale more deeply and frequently
  - block ventilation holes
- Leads to systematic underestimation of yields by ISO (e.g. Hammond, Collishaw, Callard, 2006)
- In 1999 introduction of more intensive smoking regime in Canada (Canadian Intense, CI)

### Smoking Regimes - Ctd

- Testing parameters unrealistic (e.g. Djordjevic, Hoffmann & Hoffmann, 1997) as smokers:
  - take greater puffs
  - Inhale more deeply and frequently
  - block ventilation holes

Smoking Regime	Puff Volume (ml)	Puff Frequency (sec)	Filter Blockage (%)	Flow Rate (ml/sec)
ISO	35	60	0	17.5
CI	55	30	100	27.5

### Smoke constituents



### Smoke constituents

- Concept of tar misleading as not homogenous substance
  - Definition: cigarette smoke condensate/total particulate matter minus nicotine and water
- Currently at least 4800 known components (IARC, 2004) including at least 69 carcinogens (Hoffmann & Hoffmann, 2001)
- Biggest likely impact on cancer risk (Hecht, 1999):
  - Polycyclic aromatic hydrocarbons (PAH)
  - Tobacco specific *N*-nitrosamines (TSNA)
- Suggestion to go beyond TNCO testing to include known toxins and impose upper limits (e.g. Gray, Zatonski & Boyle, 1999)

### Aims

- To evaluate the meaningfulness of 10-1-10 policy, our aim was to:
  - Compare standard ISO with a more intensive testing regime (CI)
  - Compare generic 'tar' yields with TSNA and PAH yields
  - Compare actual exposure levels of smokers of different brands with their ISO/CI yields

### Methods

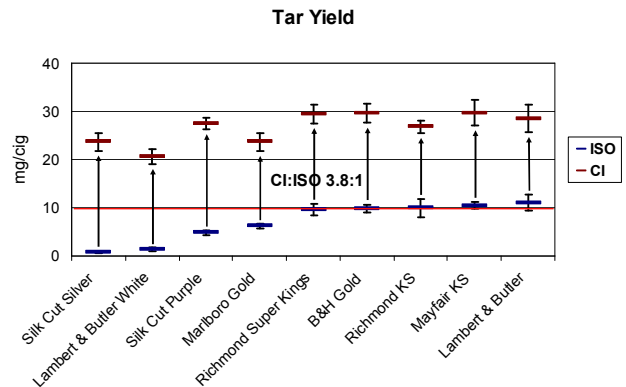
- 9 popular UK cigarette brands tested according to both ISO and CI standards for:

Standard	TSNAs	PAHs
"Tar"	NAT	Naphtalene
		Flourene
Nicotine	NAB	Phenanthrene
		Flouranthene
	NNK	Pyrene
CO	NNN	Benz-anthracene
		Chrysene
		Benzo(e)pyrene
		Benzo(a)pyrene
		Idenopyrene

### Methods

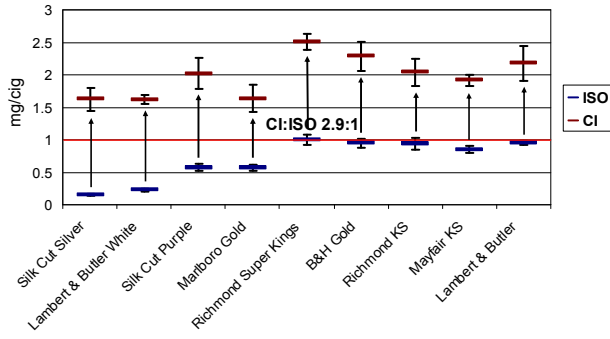
- 9 popular UK cigarette brands tested according to both ISO and CI standards for TNCO, TSNA, PAH
- Also collected variety of physiological measures from 131 smokers of UK brands, including saliva to assess cotinine
- Smokers were included if they:
  - Aged between 18-60
  - Smoked at least 5 cigarettes per day
  - Smoked primarily one of eligible brands for at least 3 months

### 1.) Comparison ISO with CI: 'Tar'



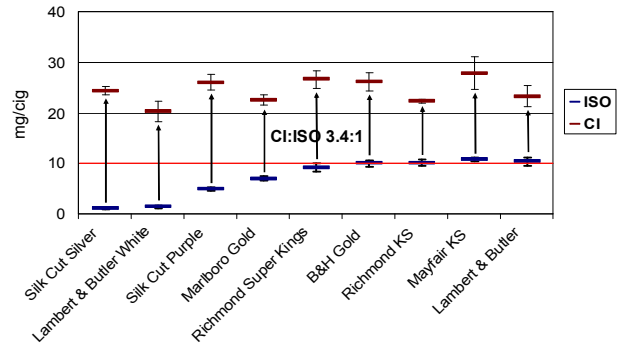
### 1.) Comparison ISO with CI: Nicotine

Nicotine Yield



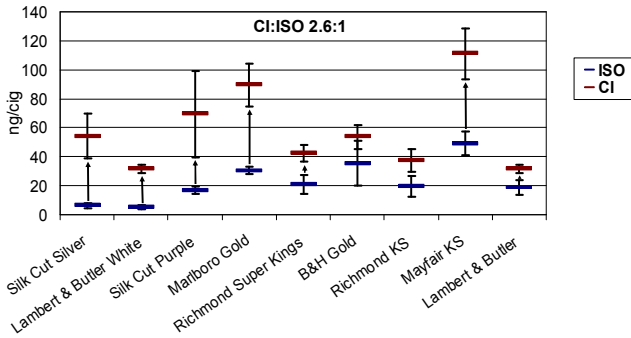
### 1.) Comparison ISO with CI: CO

Carbon-monoxide



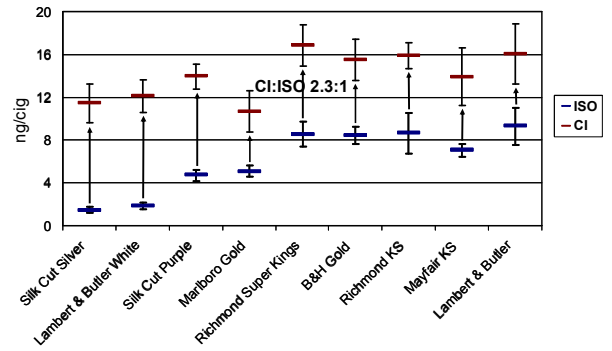
### 1.) Comparison ISO with CI: TSNAs

NNK Yields

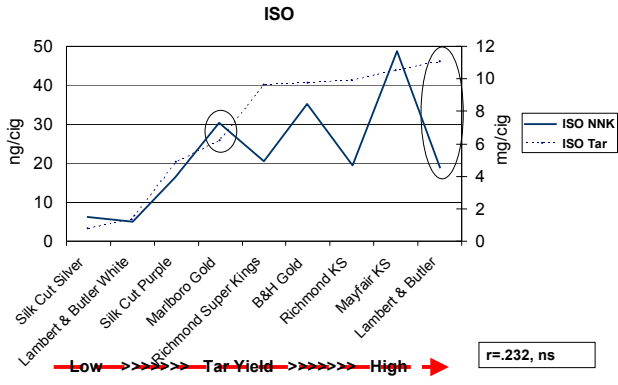


### 1.) Comparison ISO with CI: PAHs

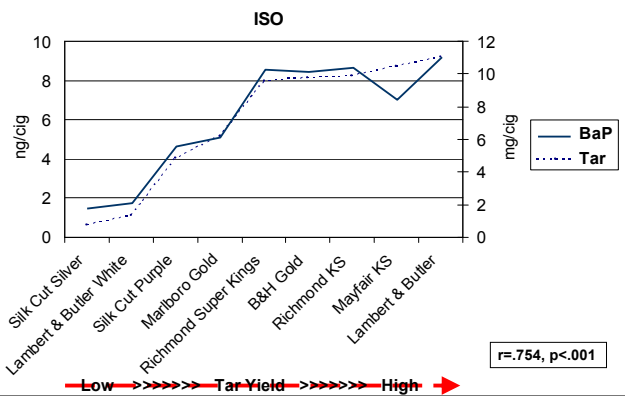
Benzo(a)pyrene (BaP)



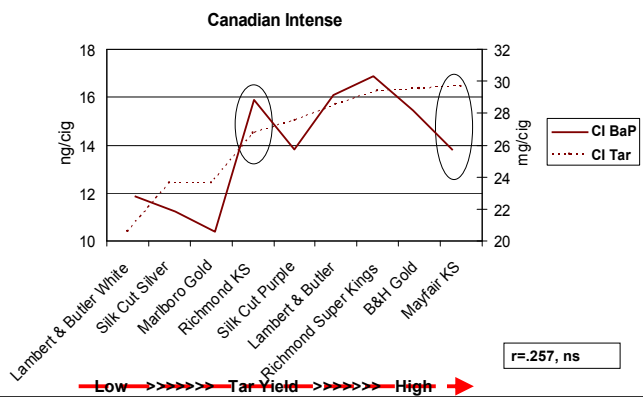
## 2.) Comparison 'Tar' with TSNA: ISO



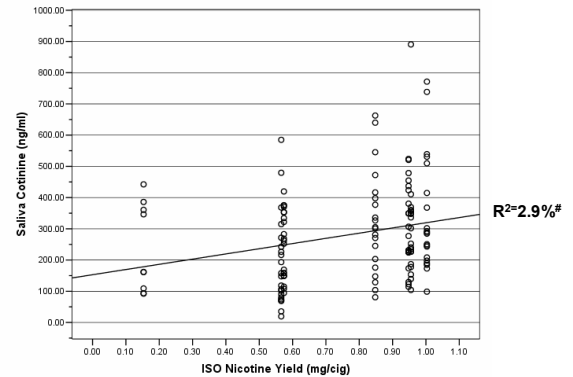
## 2.) Comparison 'Tar' with PAHs: ISO



## 2.) Comparison 'Tar' with PAHs: CI

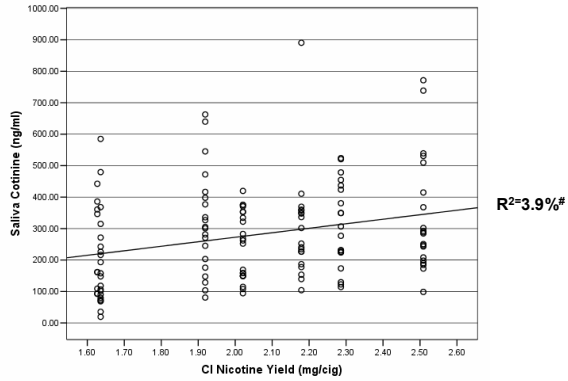


## 3.) Human Exposure: cotinine vs ISO

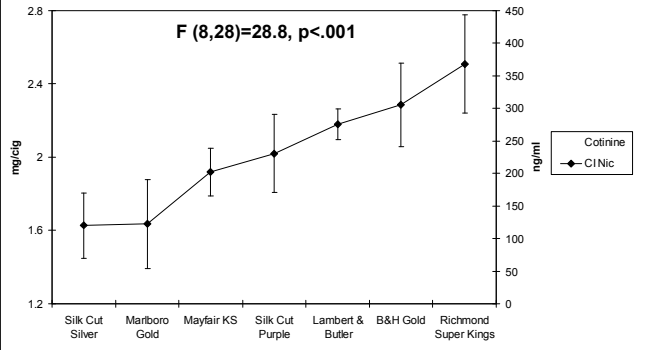


<sup>#</sup>Controlling for age, sex, BMI and cigarettes per day

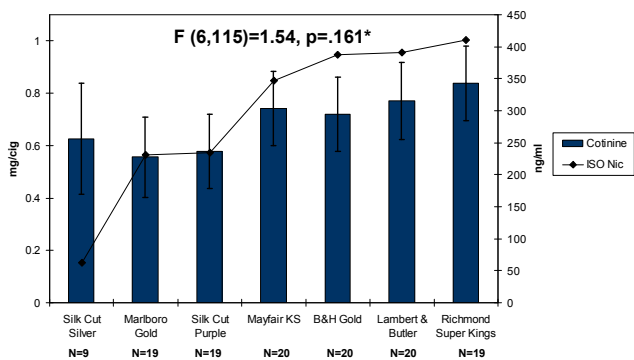
### 3.) Human Exposure: cotinine vs CI



### 3.) Human Exposure: cotinine vs ISO/CI



### 3.) Human Exposure: cotinine vs ISO/CI



^\#Controlling for age, sex, BMI and cigarettes per day

### Conclusions

- European directive essentially meaningless as:
  - ISO greatly underestimates yields compared to a more realistic intensive smoking regime
  - Ranking of cigarette brands implied by varying tar yields does not reflect known carcinogens emissions
- Neither ISO nor CI accurately characterise human smoking as effort to obtain nicotine
  - Kozlowski & O'Connor, 2000: lower nicotine yielding cigarettes smoked more intensely
  - Wiebel et al: each brand smoked to reach fixed nicotine target with tailored set of puffing parameters

## Future directions

- Meaningful product regulation should:
  - a) Avoid misinforming the public (lower yields>lower risk?)
  - b) If not safe, then at least make tobacco use as safe as possible (combustibles vs. non-combustibles?)
- This requires better understanding of:
  - a) How various smoking regimen emissions relate to actual human exposure (and thus risk)
  - b) How cigarette design features affect machine emissions (and thus potentially circumvent regulation)
  - c) How cigarette design and human puffing behaviour interact (and thus lead to differential toxic exposure)

## Acknowledgments

- Arista Laboratories

