

Estimation of smokers' mouth level exposure to cigarette smoke with filter analysis method

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1 Introduction

Filter analysis method by calibration curve of retention nicotine or tar yield in part filter versus delivery yield of constituents in mainstream smoke is usually used to estimate mouth level exposure (MLE) in previous research. However, a robust filter analysis method using calibration curve of smoke constituents retention yield in part filter instead of nicotine or tar yield versus delivery yield of constituents in mainstream smoke is more accurate than the previous method for estimating smokers' MLE to harmful constituents.

2 Experimental

2.1 Filter analysis procedure

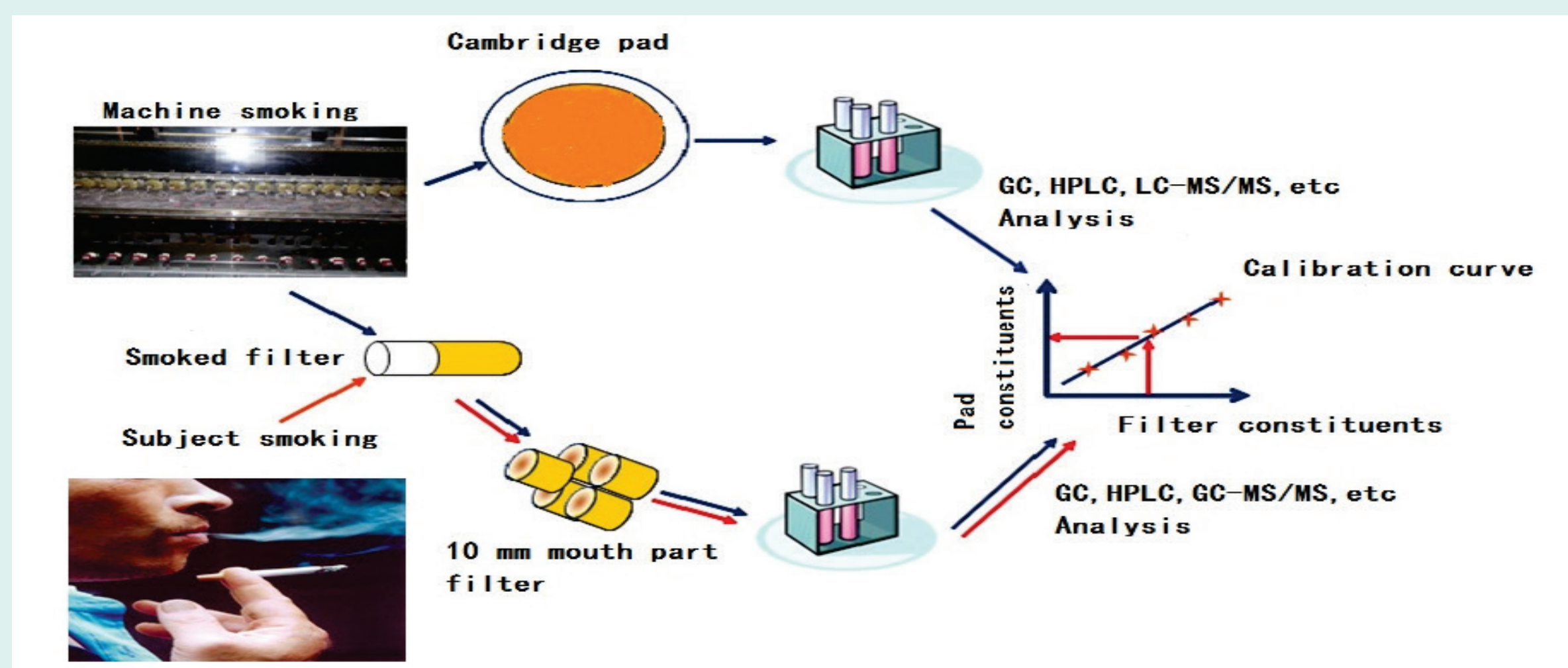


Figure 1: Filter analysis procedure

2.2 Subject

Total of 123 Chinese male recruited smokers were divided into 3 groups. each smoker group had 41 people and smoked one of three cigarettes with labeled ISO tar values of 6, 8 and 12 mg.

Each smoker group smoked one brand cigarette for 15 days, and the least 50 spent filters were collected in last 5 days and stored in aluminium boxes at -18 °C.

2.3 Analytical method

A series of quantitative analysis methods for determining the nicotine, tar, solanesol and six harmful constituents (i.e. ammonia, crotonaldehyde, hydrogen cyanide, phenol, NNK and benzo[a]pyrene) in smoked cigarette filters was developed and shown in table 1.

The mainstream yields of the nine analytes were determined according to China tobacco industry standard methods.

Table 1: Filter analysis methods

Target compounds	Analysis methods	Precisions (%)	Recoveries (%)	LOQ
Nicotine	GC-FID	3.2~7.7	93~108	3.4 µg/tip
Tar	UV	4.8~9.8		
Solanesol	HPLC	2.0~7.3	88~114	1.90 µg/tip
NH ₃	IC	4.9~6.9	92~108	0.99 µg/tip
Crotonaldehyde	HPLC	3.1~9.9	97~109	0.16 µg/tip
HCN	Continuous flow method	4.6~8.9	93~107	0.03 µg/tip
Phenol		3.8~5.2	95~104	20.8 ng/tip
NNK	GC-MS/MS	4.0~6.0	94~109	0.34 ng/tip
BaP		4.6~9.1	90~112	0.24 ng/tip

2.4 Calibration smoking regimes

Six smoking regimes (as shown in table 2) were selected to produce a wide range of the target constituents yields for each cigarette sample. Regime C was referenced from smoking behaviors survey of Chinese smokers.

Table 2: Calibration smoking regimes

Regime	Volume (mL)	Duration (s)	Interval (s)	Smoked Length/Puffs	Number of Cigs
A	35	2	60	T + 3 mm	5
B	40	2	30	T + 3 mm	5
C	50	1.5	20	T + 10 mm	3
D	50	1.5	60	T + 3 mm	5
E	55	2	30	T + 3 mm	3
F	60	2.0	30	T + 3 mm	3

3 Results and discussion

3.1 Correlations of linear regression equations

The correlation coefficients of linear regression equations of the nine constituents for whole-filter or part-filter method were good and more than 0.97, and the part filter analysis method was determined as the robust method for estimating smokers' MLE to the nine constituents. Separate regression equations were produced for each brand of cigarette.

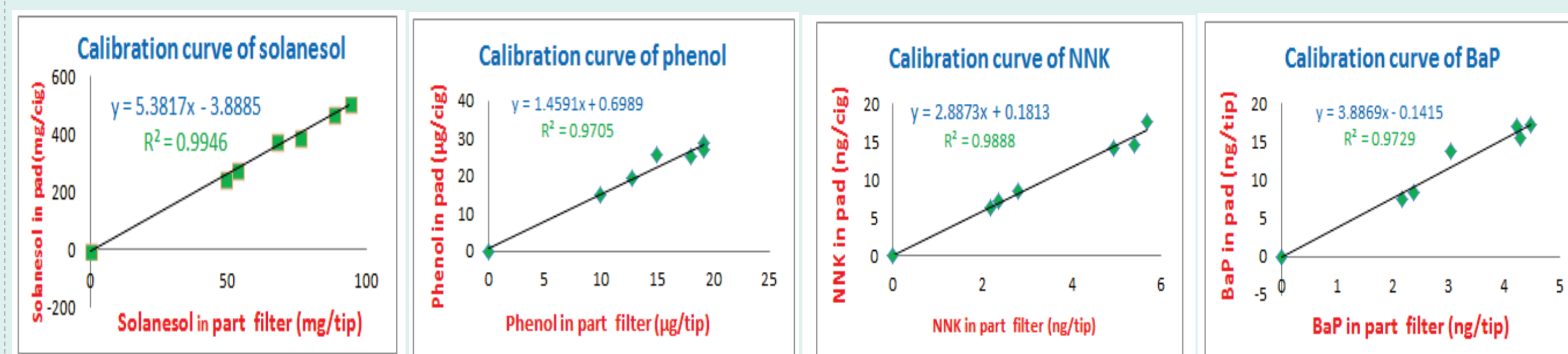


Figure 2: calibration curve of some constituents for part-filter method

3.2 Comparison of mean MLE for single cigarette

Figure 3 showed that for mean MLE per cigarette to nicotine, tar, solanesol, NNK, phenol, ammonia, and BaP, there were significant differences amongst three smoker groups. Moreover, there were decreasing tendencies along with the tar yield reduction of cigarettes. For mean MLE per cigarette to crotonaldehyde and hydrogen cyanide, there were no differences amongst three smoker groups.

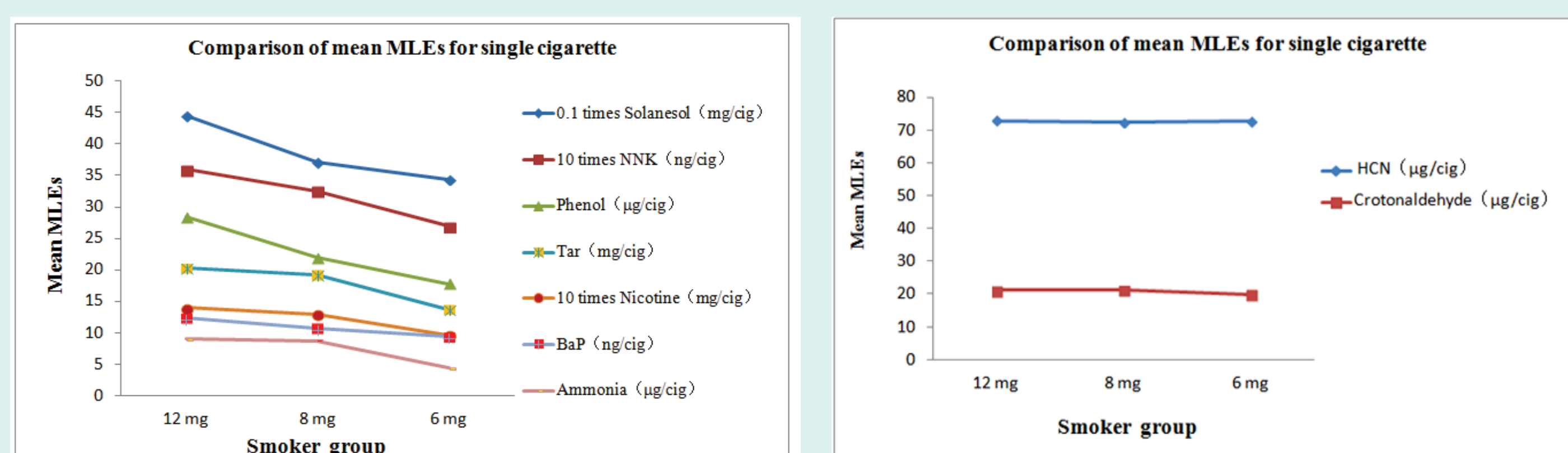


Figure 3: Comparison of mean MLE for single cigarette

3.3 Comparison of mean MLE in 24 h

Figure 4 showed that there were significant differences for mean MLE per day to nicotine, tar, ammonia, NNK and phenol between high tar smoker group and low tar smoker group. there were no differences for mean MLEs per day to solanesol, crotonaldehyde, hydrogen cyanide and BaP between high tar smoker group and low tar smoker group.

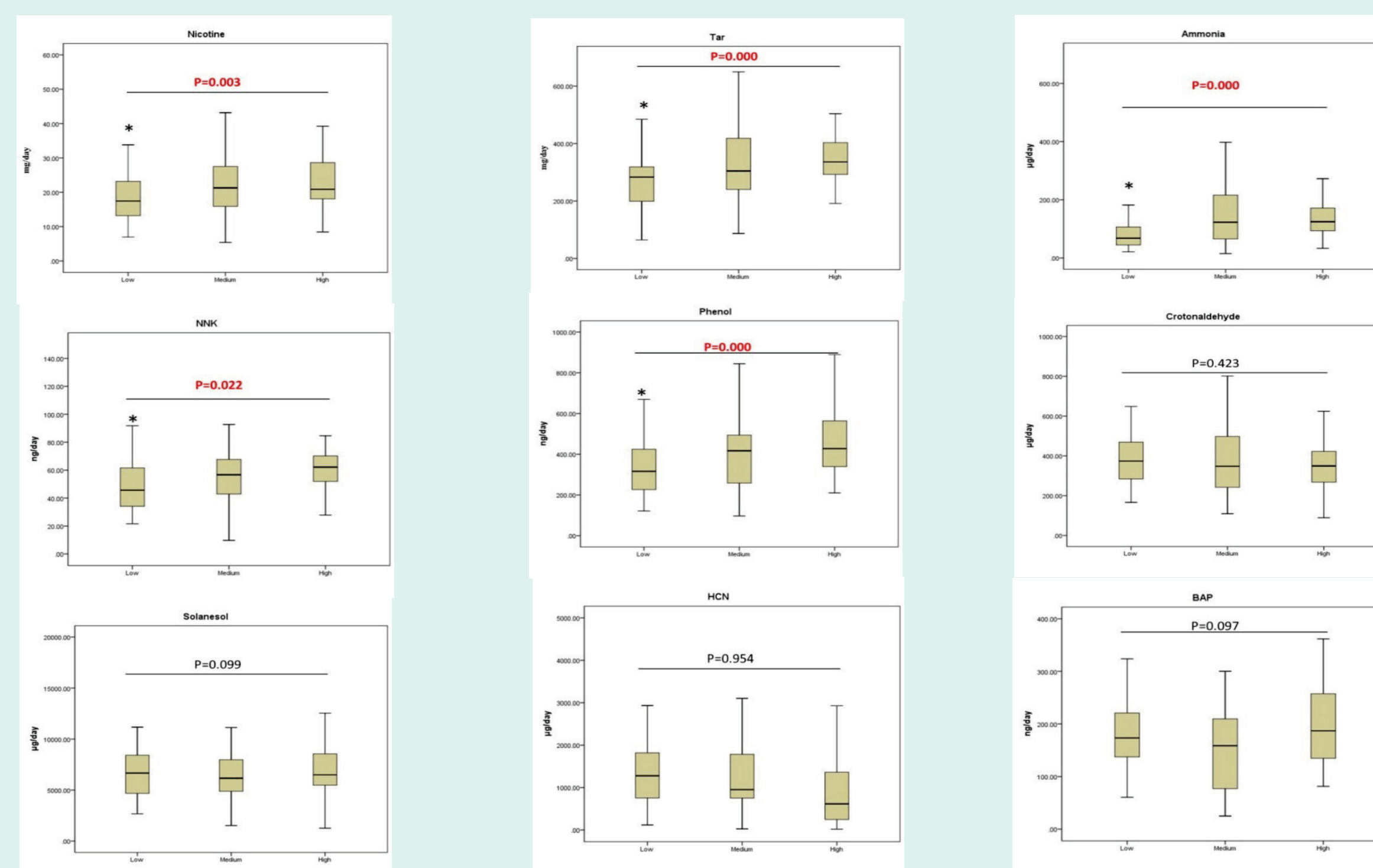


Figure 4: Comparison of mean MLE in 24 h

4 Conclusions

A part-filter analysis method was used to estimate Chinese smokers' mouth level exposure (MLE) to nine constituents in cigarette smoke.

The smokers' mean MLE to smoke of cigarette with labeled ISO tar value of 6 mg was lower than that of 8 or 12 mg.

Reference

- 1.F K St Charles, M Ashley, C J Shepperd, et al. A Robust Method for Estimating Human Smoked Cigarette Yields from Filter Analysis Data. Beitr. Tabakforsch. Int. 2009, 23 (5): 232-243.
- 2.C J Shepperd, F K St Charles, M Lien, et al. Validation of methods for determining consumer smoked cigarette yields from cigarette filter analysis. Beitr. Tabakforsch.Int. 2006, 22 (3): 176-184.