

# Puff Profile Monitoring Equipment and Test Setting Both Influence Human Yield-in-Use Measures

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## Introduction

Yield-in-use (YIU) is a technique by which the amount of smoke drawn through the filter end of a cigarette can be determined.<sup>1</sup> Also referred to as mouth-level exposure, YIU represents the maximum amount of cigarette smoke to which a smoker could be exposed when smoking a cigarette. YIU has also been shown to correlate well with biomarkers of exposure to cigarette smoke.<sup>2,3</sup>

When YIU is measured in conjunction with puff profiling, additional information can be gathered that provides insight into how a cigarette is smoked. However, marked differences have been observed between yields from cigarettes smoked in the lab in conjunction with puff profiling and typical yields determined from cigarettes smoked in the field. Lab measurements have been reported to be 20-50% higher than yields obtained from corresponding cigarettes smoked in more typical settings.<sup>4,5</sup> A number of plausible explanations for the differences have been suggested including the focus on smoking when in the lab, unfamiliar and potentially uncomfortable procedures associated with smoking in the lab, and the potential for the puff-profiling apparatus to influence smoking behavior.

Results from two studies were analyzed to gain a better understanding of the impact of smoking in a laboratory setting and the use of a puff profiler on smoking behavior as measured by YIU. In the first study, YIU nicotine was determined from sequentially smoked profiled and unprofiled cigarettes to evaluate the impact of puff profiling on YIU measurements. In the second study, YIU "tar" and nicotine from cigarettes smoked outside the lab were compared to the same measures determined from profiled and unprofiled cigarettes smoked in the lab.



Cigarette With- and Without Probe Attached

## Study 1: Profiled vs. Unprofiled

### Methods

- 30 Smokers completed two testing sessions
- 14 Females, 16 Males; Ages: 25-50
- Subjects smoked 14 Usual Brand (UB) cigarettes or 14 Test cigarettes in two sessions
- Subjects used Test cigarette exclusively for two weeks before second session
- Subjects abstained from all cigarette use for 8-10 hours prior to each test session
- Subjects smoked one cigarette every 30 minutes until the end of the session
- Puff-profile data was collected for 5 cigarettes (Cigarettes 1, 2, 6, 10, 14)
- All other cigarettes were smoked without puff-profile equipment
- All butts were collected and analyzed for nicotine yield

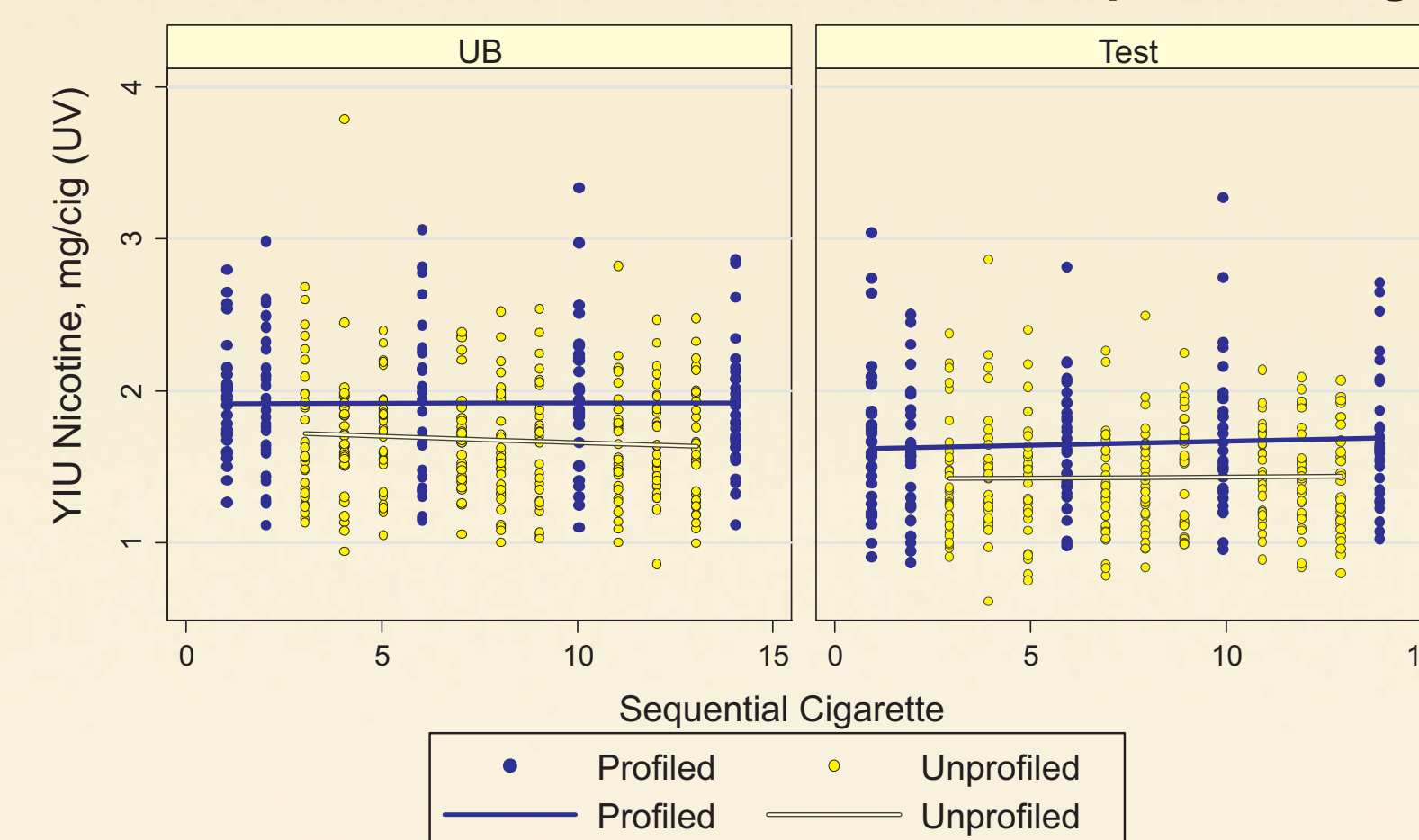
### Cigarettes

#### Cambridge Pad Yields

	UB Average	Test
"Tar" (mg/cig)	9.2	8.7
Nicotine (mg/cig)	0.78	0.82
T:N	11.8	10.6

### Results

#### Yield Differences Between Profiled and Unprofiled Cigarettes



#### Average YIU Nicotine (mg/cig) from Profiled and Unprofiled Cigarettes

	UB	Test
Profiled	1.92	1.65
Unprofiled	1.68	1.43

A mixed model, treating cigarettes within subject as repeated measures, was used to test for equality of means between profiled and unprofiled cigarettes. The p-value for the test was <0.001, whether testing both cigarettes together or separately. This result indicates that profiled cigarettes had a higher YIU nicotine than unprofiled cigarettes.

## Study 2: Lab vs. Field

### Methods

- 44 Smokers completed three testing sessions
- 23 Females, 21 Males; Ages: 23-53
- Subjects smoked two of the same Test cigarette in each of three sessions (three different Test cigarettes used)
- Subjects used Test cigarettes exclusively for four days prior to each test session
- Subjects collected butts from all cigarettes smoked during the day prior to each test session (Field)
- Subjects abstained from all cigarette use for at least 30 minutes prior to each test session
- Subjects smoked two cigarettes 30 minutes apart in the lab and butts were collected
- Puff-profile data was collected from the first cigarette, the second cigarette was unprofiled
- Subjects smoked field cigarettes without puff-profile equipment
- All collected butts were analyzed for "tar" and nicotine yields

### Cigarettes

#### Cambridge Pad Yields

	Test A	Test B	Test C
"Tar" (mg/cig)	6.0	6.0	6.2
Nicotine (mg/cig)	0.52	0.51	0.52
T:N	11.5	11.8	11.9

### Results

#### Average YIU Nicotine (mg/cig) from Field, Unprofiled and Profiled cigarettes

Cigarette	Field	Lab Unprofiled	Lab Profiled
A	1.40	1.46	1.65
B	1.28	1.41	1.52
C	1.32	1.45	1.55
Overall	1.34	1.44	1.57

#### Average YIU "Tar" (mg/cig) from Field, Unprofiled and Profiled Cigarettes

Cigarette	Field	Lab Unprofiled	Lab Profiled
A	13.9	17.0	18.9
B	12.8	16.6	17.2
C	13.5	17.2	17.8
Overall	13.4	16.9	18.0

#### Average YIU T:N from Field, Unprofiled and Profiled cigarettes

Cigarette	Field	Lab Unprofiled	Lab Profiled
A	10.0	12.0	11.5
B	10.0	11.8	11.5
C	10.2	11.9	11.7
Overall	10.1	11.9	11.5

YIU and T:N ratios measured from cigarettes smoked in the field, lab unprofiled and lab profiled cigarettes were compared using a paired t-test. In the tables above, green lines connect data pairs that were not statistically significantly different from each other. All other data pairs in each row were significantly different at the  $p < 0.05$  level.

## Discussion

The first study of YIU nicotine from profiled and unprofiled cigarettes showed a clear, statistically significant increase in nicotine yield when the cigarettes were smoked in conjunction with a puff profiler probe. That increase was consistent across time for both test sessions, suggesting that people tend to smoke differently when a cigarette is attached to a probe.

The second study illustrates several differences between cigarettes smoked in the lab and field and between profiled and unprofiled cigarettes. As had been observed in previous studies, profiled cigarettes yielded statistically significantly more "tar" and nicotine than cigarettes smoked in natural settings (Field). Additionally, for each cigarette tested, the YIU "tar" of lab unprofiled cigarettes was statistically significantly higher than that observed in the field. For nicotine, the difference between the field and unprofiled lab cigarettes was not as clear. For all three cigarettes, YIU nicotine was nominally higher for unprofiled lab cigarettes; however, the difference was statistically significant for only one of the test cigarettes examined. As was seen in the first study, YIU nicotine was significantly different between profiled and unprofiled cigarettes smoked in the lab. YIU "tar" from the profiled cigarettes was nominally higher than for unprofiled cigarettes smoked in the lab, but the increase was statistically significant for only one of the Test cigarettes. These results also suggest that smokers smoke differently when puff profiling is taking place, and may smoke more intensely in a laboratory setting than in the field.

It is interesting to note that the T:N ratios measured in the lab for profiled and unprofiled cigarettes were not statistically significantly different from each other, but the ratios measured in the lab were statistically significantly different from the ratios measured from field-smoked cigarettes. Factors which may lead to the relative difference in T:N ratio between lab and field smoked cigarettes have not been well characterized.

## Conclusions

- YIU nicotine determined from profiled cigarettes was higher than YIU nicotine determined from unprofiled cigarettes smoked in either the lab or field.
- YIU "tar" determined from cigarettes smoked in the lab was higher than YIU "tar" determined from cigarettes smoked in the field.
- The YIU T:N ratio obtained from cigarettes smoked in the lab was higher than the YIU T:N ratio obtained from cigarettes smoked in the field.
- Smoking of cigarettes in the lab, particularly when the cigarettes were attached to a puff-profiling probe, tended to lead to increased yields to the smoker relative to when the cigarettes are smoked in a natural setting.

## References

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