Attachment A: Study Design

Specific Aims

The study has three specific aims.

Aim 1. Determine the body burden of smoke toxins and cardiovascular physiologic reactivity associated with smoking cigarettes across a wide range of cigarette yields ("ultra light," "light," and full-flavored cigarettes).

Aim 2. Determine if the body burden of smoke toxins (biomarkers of exposure) associated with smoking cigarettes with a range of machine-smoked tar and nicotine levels is modified by smoking behavior.

Aim 3. Determine if the machine-smoked yield of "tar" is significantly positively correlated with solanesol levels in spent cigarette filters (a measure of mouth level exposure to tobacco smoke), which in turn will be significantly positively associated with levels of carcinogens and other toxins in smokers.

Statistical Power

Based on a power analyses we project that a total of 360 established adult smokers (90 smokers of "ultra-light" cigarettes, 90 smokers of "light" cigarettes, 90 smokers of full-flavor non-menthol cigarettes, and 90 smokers of full-flavor menthol cigarettes) is sufficient to detect small correlations with power of at least .80 and a significance level of .05.

Power analyses were conducted in two ways: Specificity analysis of sample size needed to detect differences across the range of effect sizes and a post-hoc approach providing a sample size parameter (N = 360) and determining the level of power associated with each level of effect.

Specificity Analysis

A specificity analysis of sample sizes needed to detect differences across the range of effect sizes was conducted for Aim 1. Cohen (1988) recommends that statistical power for clinical research should be equal to or greater than .80; therefore this standard was employed. With a two-tailed test, an alpha level of .05, and a power of .80, the ability to detect small, medium and large effects is estimated to require 779, 82, 26 individuals, respectively (Table 1). This range of samples sizes will accurately detect the effects of machine-smoked tar level on body burden if the relationship is linear, with 95% confidence.

Table 1. Sample size estimates by effect sizes needed to detect a correlation between body burden of toxins and machine-smoked tar levels.

Effect sizes	N
Small (.10)	779
Moderate (.30)	82
Large (.50)	26

*Based on an alpha level of .05, power of >.80, and two-sided test

Post-hoc Power Determination

A post-hoc approach was used to determine the power to detect a significant correlation given the proposed sample of 360 subjects. With a two-tailed test, an alpha level of .05, and n = 360, the power to detect small, medium and large effects is .48, >.99, >.99, respectively (Table 2). The power to detect a small effect (p=.48) is below standard conventions, but is adequate to determine moderate to strong effects (>.99). This range of samples sizes will accurately detect the effects of machine-smoked tar levels on body burden if the relationship is linear, with 95% confidence.

Table 2. Sample size estimates by effect sizes needed to detect a correlation between body burden of smoke toxins and machine-smoked tar levels.

Effect sizes	Power level
Small (.10)	.48
Moderate (.30)	>.99
Large (.50)	>.99

*Based on N = 360, an alpha level of .05, and two-sided test

Because our first hypothesis is directional, that is, that we hypothesize a positive correlation between machine-smoked tar level and body burden of smoke toxins, a one-sided test is more appropriate. In the case of a one-sided test, the sample of 360 is sufficient for detecting a correlation coefficient as low as 0.13 with power of .80 and significance level of .05.

Aim 2 seeks to determine if the relationship between the body burden of smoke toxins and the machine-smoked tar and nicotine levels is modified by smoking behavior (topography). For this aim, we conducted a power analysis for multiple regression. For this analysis, we will control for potential confounding variables (i.e., age, gender, ethnic group indicators, number of cigarettes smoked per day, and level of dependence). A power analysis for ordinary least-squares (OLS) multiple regression with 6 predictor variables, a significance level of .05, a baseline R^2 of 0.35, and power of at least .80, indicates that a sample size of 359 will detect an R^2 difference as small as 0.014.

For Aim 3, to determine if a positive relationship exists between the machine-smoked tar level and solanesol levels in spent cigarette filters, we conducted a power analysis for correlation with one-sided test. Again, because our hypothesis is uni-directional (to test for a positive correlation between the two measures), one-sided tests are most appropriate. The sample size of 360 should be sufficient for detecting a correlation coefficient as small as .13 with power of at least .80 and a significance level of .05.