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## Hormonal Contraceptive Use in Smokers: Prevalence of Use and Associations with Smoking Motives

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### Abstract

**Introduction**—While endogenous sex hormones influence smoking-related outcomes, little is known about the role of hormonal contraceptives (HCs). This is despite dated estimates suggesting that HC use is prevalent among female smokers. Therefore, we sought to update estimates of the prevalence of HC use among female smokers and explore the association of HC use with various smoking motives (SMs).

### Contributors

Alicia Allen conceived the study idea, was the principal investigator on the project, oversaw data collection efforts, conducted the analyses and wrote the first draft of the manuscript. Kim Lundeen participated in data collection and management, and conducted the literature review. Lynn Eberly oversaw the data analysis. Dorothy Hatsukami, Mustafa al’Absi, Sharon Allen, and Myra Muramoto shared their expertise in terms of research methodologies and measures to use to answer the research question, as well as menstrual cycle physiology and hormonal contraceptives. All authors participated in interpretation of data, as well as writing, editing and approval of the final manuscript.

### Conflict of Interest

All authors declare that they have no conflict of interest.

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**Methods**—This online cross-sectional survey recruited female smokers between the ages of 18–35. Survey questions assessed smoking behavior, SMs, use of HCs, and menstrual cycle regularity.

**Results**—Participants (n=734) were, on average ( $\pm$ standard deviation), 20.72.7 years old and smoked  $7.3\pm 6.7$  cigarettes/day. The majority of females reported a history of HC use (85%) and half reported current use (48%). Cyclical HC users (n=227) scored significantly lower on three SMs compared to naturally-cycling women in the follicular phase (n=62) and significantly higher on 15 SMs compared to naturally-cycling women in the luteal phase (n=29). Women on cyclical HCs differed from women on long-acting HCs (n=128) on two SMs. Further, the naturally-cycling women in the follicular phase scoring significantly higher on 15 SMs compared to those in the luteal phase.

**Discussion**—These observations indicate that HC use remains prevalent in female smokers and may influence SMs. Additional research should replicate these observations and explore the implications on smoking cessation outcomes.

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## 1. Introduction

Sex hormones, specifically progesterone and estradiol, have been shown play a significant role in addictive behaviors in preclinical research.<sup>1,2</sup> In clinical research, menstrual phase is often used as a proxy to examine effects of sex hormones. A recent meta-analysis with 36 studies concluded that withdrawal, and, possibly, craving, is significantly higher during the luteal phase as compared to the follicular phase.<sup>3</sup> However, the effect of menstrual cycle and/or sex hormones on smoking cessation outcomes is mixed. Follicular phase is more favorable for quitting when nicotine replacement therapy is used,<sup>4,5</sup> while the luteal phase is more favorable when nicotine replacement therapy was not used.<sup>6,7</sup> Yet others have observed no difference by menstrual phase.<sup>8</sup> An additional study observed that increasing levels of progesterone during treatment with nicotine patch, but not varenicline, was associated with a higher likelihood of subsequent smoking abstinence.<sup>9</sup> Together, these data suggest that sex hormones may influence smoking-related symptomatology and, possibly, cessation outcomes. Because of the nature of these studies, this work has focused on premenopausal women who have regular, natural menstrual cycles. Incidentally, women on hormonal contraceptives were excluded from these research studies, despite the popularity of hormonal contraceptives. Therefore, the role of hormonal contraceptives in smoking-related outcomes is less known.

To date, research conducted on the role of hormonal contraceptives and smoking-related outcomes has been focused on oral contraceptives (OCs), specifically. First, a cross-sectional study observed women who used oral contraceptives were at 2.42 (95% CI: 1.87–3.14) higher odds of current smoking compared to nonusers among women of reproductive age in the Fourth Korean National Health and Nutrition Examination Survey.<sup>10</sup> Next, three studies have observed faster nicotine metabolism in OC users compared to nonusers,<sup>11–13</sup> which suggests OC users may experience greater smoking reward<sup>14</sup> and have more adverse smoking-related symptomatology (e.g., craving).<sup>15</sup> Greater smoking reward in OC users has been demonstrated by our prior work in which OC users reported greater smoking satisfaction compared to nonusers during ad libitum smoking<sup>16</sup> and by Masson and Gilbert who observed a greater reduction in anxiety after smoking a cigarette in OC users compared

to nonusers.<sup>17</sup> Further, OC users have greater cardiovascular response (e.g., heart rate) to smoking or stress than nonusers.<sup>17–20</sup> The data on cessation-related symptomatology is mixed. While one study of adolescent smokers observed significantly greater craving in OC users compared to nonusers during smoking cessation,<sup>21</sup> we observed significantly lower craving in adult OC users compared to nonusers during acute smoking abstinence in a laboratory based study.<sup>16</sup> These observations suggest that use of OCs may play a role in motives for smoking via an effect on smoking reward and smoking-related symptomatology. However, to date, no published data are available on the effect of long-acting hormonal contraceptives (e.g., depot medroxyprogesterone acetate injection or hormonal implants) in smoking-related outcomes. Thus, it is unknown how other types of hormonal contraceptives may influence motives for smoking.

In general, hormonal contraceptives protect against pregnancy by preventing ovulation, which results in an alteration in the cyclical pattern of progesterone and estradiol.<sup>22</sup> Based on data from the 2002 and 2004 Behavioral Risk Factor Surveillance System, an estimated 33% to 41% of women who smoke and are of reproductive age used some form of hormonal contraception.<sup>23</sup> The most popular type of hormonal contraceptive was oral contraceptives (26.9%), followed by the injectable progesterone commonly marketed as Depo-Provera<sup>®</sup> by Pfizer (6.6%). The prevalence of other forms of hormones (e.g., vaginal ring [NuvaRing<sup>®</sup>], transdermal patch [Xulane<sup>®</sup>], hormonal intrauterine device [Mirena<sup>®</sup>]) were not reported. This work has limitations including a lack of detail regarding type of hormone (e.g., the dose and the type of oral contraceptive is not reported) and the figures are dated by more than 10 years. Despite these limitations, these data suggest use of hormonal contraceptives is popular in smokers. Therefore, additional work is needed to identify current prevalence of use, as well as additional detail regarding the type of hormonal delivery used.

In sum, while there is biological plausibility for hormonal contraceptives (HCs) affecting smoking-related behaviors and dated estimates suggest a high prevalence of use of hormonal contraceptives in premenopausal smokers, the literature is currently lacking in terms of detailed and current estimates of prevalence and exploration into the relationship between different types of hormonal contraceptives and smoking-related outcomes. Therefore, using an online-delivered cross-sectional survey, we pursued two aims. In Aim 1, we estimate the current prevalence in the use of different types of HCs. In Aim 2, we explore differences in motives for smoking between women using HCs as compared to naturally-cycling (NC) women. In Aim 2, we hypothesized that women on cyclical HCs would differ from women using long-acting HCs, as well as from NC women by menstrual phase. These data will provide the necessary groundwork to begin addressing this nearly absent line of research.

## 2. Methods

### 2.1 Study Sample

From June to August 2016, we recruited female and male smokers via Facebook advertising, though this analysis was limited to the female smokers who completed that survey. Advertisements were limited to those who live in the United States and were between the ages of 18 and 35 years, given clinical recommendations that women over the age of 35 who smoke should not use combination oral contraceptives.<sup>24</sup> Upon clicking on the

advertisement, a REDCap<sup>25</sup> (Research Electronic Data Capture) webpage, hosted by the University of Minnesota, appeared. REDCap is a secure, web-based application designed to support data capture for research studies by providing an intuitive interface, audit trails, and automated export procedures.<sup>25</sup> This webpage contained a description of the study and informed consent for participation in the screening survey. Upon providing informed consent, potential participants completed a five-item survey to assess eligibility. After completion of the eligibility survey, participants provided an email address and were told they would receive an invitation to the full survey within three business days if they were eligible to participate.

Study staff reviewed each screening survey to ensure eligibility was met. Eligibility included the following: female between the ages of 18 and 35, established smoker (defined as 100 cigarettes smoked in lifetime) with current use reported at 1 cigarette per day in 4 of last 30 days. REDCap also recorded the IP address of each survey taker. To avoid duplicate study participants, any survey respondents that contained both a duplicate email address and IP address, in combination, were excluded. Upon confirmation of eligibility, study staff emailed study participants an invitation to the full survey.

## 2.2 Survey Data

The invitation to the full survey included a link to a REDCap<sup>25</sup> survey which included informed consent to participate in the survey and was linked to their screening survey. The survey contained the following topics: (1) smoking behavior (e.g., number of days a participant smoked during the past 30, cigarettes smoked per day), (2) history and current use of hormonal contraceptives, (3) menstrual cycle regularity, (4) smoking motives as assessed by Modified Cigarette Evaluation Questionnaire<sup>26</sup> and the Brief Wisconsin Inventory of Smoking Dependence Motives,<sup>27,28</sup>(see Table 3 for list of subscales), and (5) demographics. The length of the survey varied by participant (e.g., longer for those who reported HC use) with the total number of items ranging from approximately 100 to 150 questions. Upon completion of the survey, participants were emailed a \$10 e-gift card for Amazon.

Utilizing these data to address Aim 2, participants were grouped based on *current use* of hormonal contraceptives. Specifically, two groups of HC users were defined based on type of HC: women currently using cyclical hormonal contraceptives (HC-C) including oral contraceptives, vaginal insert, and transdermal patch, and women currently using long-acting hormonal contraception (HC-LA) including hormonal intrauterine device, injectable, and implant. Two groups of women with regular, natural menstrual cycles and divided by menstrual phase as recommended<sup>29</sup> – follicular phase (NC-F; defined within 8 days since the onset of the last menses) and luteal phase (NC-L; defined as 20 to 30 days since the onset of last menses). Given the short-term effects of emergency contraception, we excluded women who reported using emergency contraception within the past 30 days, as well as women who were not using hormonal contraceptives if they reported irregular menstrual cycles and/or were between 9 and 19 days since the onset of last menses given it would be impossible to know when ovulation occurred based on self-report of onset of menses alone.<sup>29</sup>

## 2.3 Statistical Analyses

Descriptive statistics (e.g., percentages, counts) were used to address our first aim of estimating the prevalence of hormonal contraceptive use in young women smokers. We used descriptive statistics, ANOVA (for continuous characteristics) and chi-squared (for categorical characteristics) tests to compare study groups. Next, to examine differences in smoking motives (Aim 2), group differences in smoking motives (each one separately) were then examined by linear regression with pairwise comparisons. Based on significant group differences observed in demographics and smoking behavior, analyses were adjusted for work status (employed versus student versus other versus missing). Therefore, specific variables in the adjusted models included the smoking motive (independent), study group (independent), and work status (covariate). All statistical analyses were conducted using SAS 9.4 with  $p < 0.05$  indicating statistical significance.

## 3. Results

### 3.1 Study Sample

A total of 734 females met eligibility, enrolled in the study, and completed the survey. As displayed in Table 1, participants were, on average (mean  $\pm$  standard deviation),  $20.7 \pm 2.7$  years old and smoked  $7.3 \pm 6.7$  cigarettes per day. Most participants were white (77%), with at least some college (69%) and were daily smokers (62%). The distribution in work status varied by study group and was, therefore, adjusted for in subsequent analyses. There were no other statistically significant differences by study group.

### 3.2 Prevalence of Hormonal Contraceptive Use (Aim 1)

Of the 734 female participants who completed this survey, 626 (85%) reported a history of using hormonal contraceptives with 355 (48%; defined as the any-HC group) currently using hormonal contraceptives (Table 2). Cyclical hormonal contraceptives (HC-C) were more prevalent than long-acting hormonal contraceptives (HC-LA) both in terms of current use (HC-C group: 31%; HC-LA group: 17%) and history of use (69% versus 30%, respectively). The most common type of cyclical hormonal contraceptive was an oral contraceptive (current: 29%; history: 67%) with monophasic combination as the most popular type of oral contraceptive used (current: 28%; history: 21%). The most common type of long-acting hormonal contraceptive based on current use was a hormonal intrauterine device (7%) and based on history of use, an injectable (16%). Finally, half of the participants reported ever using emergency contraception ( $n=365$ ; 50%) with 15 participants (2%) reporting use within the last 30 days.

### 3.3 Differences in Smoking Motives by Menstrual Cycle Phase and Type of Current Hormonal Contraceptive (Aim 2)

Overall, of the 18 smoking motives subscales investigated, 14 subscales significantly differed by study group (Table 3). First, when comparing HC-C to NC groups, the differences varied by menstrual phase. Specifically, compared to NC-L, HC-C scored significantly higher on 15 subscales ranging from 13% higher on Craving Reduction subscale ( $p=0.042$ ) to 35% higher on the Automaticity subscale ( $p < 0.001$ ). In contrast,

compared to NC-F, HC-C scored significantly lower on three subscales ranging from 13% lower on the Smoking Satisfaction subscale ( $p=0.013$ ) to 17% lower on the Enjoyment of Respiratory Tract Sensations subscale ( $p=0.018$ ).

Next, when comparing HC-LA to the naturally-cycling women, a similar pattern was observed. HC-LA scored significantly higher than NC-L on eight subscales ranging from 17% higher on Taste ( $p=0.026$ ) to 33% higher on Automaticity ( $p<0.001$ ). HC-LA scored significantly lower than NC-F on four subscales, from 9% lower on Total WISDM Score ( $p=0.003$ ) to 25% lower on the Enjoyment of Respiratory Tract Sensations subscale ( $p=0.003$ ).

When comparing the HC-C group to HC-LA group, there were two significant differences, with the HC-C group scoring 9% higher on the Psychological Reward subscale ( $p=0.021$ ) and 14% higher on the Aversion subscale ( $p=0.036$ ).

Finally, when comparing the NC groups, there were 15 significant differences on the 18 subscales assessed. On all 15 subscales, NC-F scored higher than NC-L ranging from 17% higher on Craving Reduction ( $p=0.045$ ) to 63% higher on Affective Attachment ( $p=0.003$ ).

#### 4. Discussion

The goal of this internet-delivered cross-sectional survey was to estimate the prevalence of hormonal contraceptive use using an online sample of female smokers of reproductive age and to explore the association between current use of hormonal contraceptives and smoking motives. Overall, we observed that current use of hormonal contraceptives was higher than previous estimates and most smoking motives varied by use of hormonal contraceptives.

The vast majority of female participants reported a history of using hormonal contraceptives with almost half reporting current use. These estimates are higher than those previously reported by McClave and colleagues,<sup>23</sup> which used national representative data collected via a telephone survey for the 2002 and 2004 Behavioral Risk Factor Surveillance System (BRFSS). Approximately 33–41% of female smokers in the BRFSS sample reported current hormonal contraceptive use, with the most popular type being oral contraceptives (27%). Similarly, we observed oral contraceptives as the most popular type (29%). Our data extend the current literature by distinguishing the prevalence of different types of oral contraceptives and reporting on newer forms of hormonal contraceptives. For example, we noted that monophasic combination oral contraceptives were the most popular type of oral contraceptive (19%) and vaginal insert (NuvaRing<sup>®</sup>) was being used by 2% of respondents, with 10% reporting a history of use.

At least four interesting observations were noted in the associations between smoking motives and use of hormonal contraceptives. First, nearly all (15/18) subscales varied by menstrual phase with follicular phase being associated with greater motives for smoking. This concurs with previous literature in that a high progesterone to estradiol ratio (as seen in the luteal phase) may be advantageous to smoking cessation efforts since nicotine may be less rewarding.<sup>2</sup> These data suggest that naturally-cycling women may repeatedly toggle between a period of risk (e.g., follicular phase, when motives are heightened) to a period of



protection (e.g., luteal phase, when motives are dampened). This toggling may place naturally-cycling women at an increased risk for smoking relapse. However, this theory has yet to be explored. Second, there were only two significant differences between women on cyclical hormonal contraceptives compared to those on long-acting hormonal contraceptives. This suggests that the differential effects of hormonal contraceptives on smoking motives may be less than that of menstrual phase effects. Third, overall, nearly all differences between the naturally-cycling women and the women on hormonal contraceptives indicated that the scores reported by women on hormonal contraceptives fell intermediate to those observed in the follicular phase and those observed in the luteal phase. Given that smoking motives, notably the Primary Dependence subscale (comprised of automaticity, craving, loss of control and tolerance subscales), have been linked to both short-term (e.g., one week) and longer-term (e.g., six months) smoking cessation outcomes, these observations suggest that hormonal contraceptives may influence smoking cessation outcomes.<sup>29</sup> Last, a total of 228 women who were not using hormonal contraceptives and reported having irregular menstrual cycles were excluded from this analysis. This suggests that 31% of female smokers of reproductive age may have irregular menstrual cycles and, thus, the observations made on the role of the regular and natural menstrual cycle may not apply to this group of women. It is unknown how these women may differ from naturally-cycling women.

While this study used validated and reliable questionnaires to explore a novel topic, it does contain some limitations. First, these observations may contain selection bias. This convenience sample was selected among Facebook users. Facebook is the most common social networking platform, with approximately 79% of internet users (68% of all Americans) reporting current use of Facebook.<sup>30</sup> The rates of Facebook use are even higher in women (83% of women internet users) and young adults (88% of 18–29 year olds internet users).<sup>30</sup> Recent research indicates that the odds of having a Facebook account vary significantly by gender (male < female), sexual orientation (heterosexual < lesbian, gay or bisexual), race (black < white), and age (45 years or older < 18–24 year olds) but not by smoking status, education, employment or geographical region.<sup>31</sup> Therefore, it is possible that participants may not be representative of the general population. Second, we relied on self-reported data which is prone to error. It is possible that non-smokers joined our study or participants misreported their use of cigarettes or hormonal contraceptives, as well as their menstrual cycle coming. Next, there may be a lack of exchangeability between our study groups, especially with regard to dependence. Specifically, though not statistically significantly different, the NC-L group may be less dependent than the other three groups. If so, this difference would likely bias our results away from the null. However, when analyses were adjusted for time to first cigarette, results were essentially unchanged (data not shown). Therefore, we believe the groups are exchangeable on nicotine dependence and the results are not confounded by this. Last, given the exploratory nature of this work, we did not use any correction to adjust for the many statistical tests we conducted. Thus, there is an increased risk of a Type I error (i.e., false positive).

In conclusion, use of hormonal contraceptives is highly prevalent among female smokers of reproductive age. Further, use of hormonal contraceptives is associated with smoking motives. Future work is needed to replicate these observations and explore the causality of

this relationship, as well as how these observations may be influencing smoking behavior and smoking cessation outcomes.

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### Highlights

- Cross-sectional study on hormonal contraceptives (HCs) and smoking motives (SMs).
- Among female smokers, HC use was prevalent (current=48%; history=85%).
- SMs were highest in follicular phase, followed by HC users and then luteal phase.
- Additional research is needed to explore the causality of HC use and SMs.

Table 1

## Demographics and Smoking Behavior by Study Group (n=734)

	Total (n=734)	NC-F (n=62)	NC-L (n=29)	HC-C (n=227)	HC-LA (n=128)	p-value
Age (years, mean $\pm$ SD)	20.7 $\pm$ 2.7	21.2 $\pm$ 2.9	21.2 $\pm$ 3.5	20.5 $\pm$ 2.6	20.5 $\pm$ 2.4	0.148
Education (% some college)	69%	66%	72%	77%	67%	0.155
Work Status (%)						0.001
Employed	57%	73%	66%	54%	54%	
Student	24%	18%	28%	30%	30%	
Other	7%	5%	7%	7%	5%	
Missing	11%	5%	0%	9%	11%	
Race (% White)	77%	84%	79%	83%	80%	0.802
Daily Smoker (%) <sup>1</sup>	62%	61%	48%	59%	57%	0.688
Cigarettes/Day (mean $\pm$ SD)	7.3 $\pm$ 6.7	6.7 $\pm$ 5.5	5.2 $\pm$ 5.4	7.5 $\pm$ 7.3	6.9 $\pm$ 5.9	0.342
Dependence (% smoke <30 minutes of waking)	35%	32%	17%	33%	35%	0.848

<sup>1</sup> Defined as smoking on at least 27 of the past 30 days.

SD=Standard Deviation; NC-F=Natural Cycle - Follicular Phase; NC-L=Natural Cycle -Luteal Phase; HC-C=Hormonal Contraceptive - Cyclical; HC-LA=Hormonal Contraceptive - Long-Acting

**Table 2**

Prevalence of Hormonal Contraceptive Use among Premenopausal Smokers (n=734)

	Current Use		History of Use	
	N	%	N	%
<b>Any Hormonal Contraceptive</b>	355	48%	625	85%
<b>Long-Acting</b>	128	17%	219	30%
<b>Hormonal Intrauterine Device</b>	53	7%	68	9%
<b>Injectable</b>	30	4%	120	16%
<b>Implant</b>	45	6%	70	10%
<b>Cyclical</b>	231	32%	506	69%
<b>Oral Contraceptive *</b>	212	29%	491	67%
<b>Progestin-Only</b>	4	1%	3	0%
<b>Combination</b>	201	28%	220	30%
<b>Monophasic</b>	140	19%	156	21%
<b>Biphasic</b>	14	2%	11	2%
<b>Triphasic</b>	24	3%	24	3%
<b>Extended cycle</b>	23	3%	24	3%
<b>Unknown Type</b>	7	1%	268	37%
<b>Vaginal Insert</b>	15	2%	75	10%
<b>Transdermal Patch</b>	4	1%	19	3%
<b>Emergency Contraceptive **</b>	15	2%	368	50%

\* The type of last oral contraceptive used is listed.

\*\* Current use defined as use within the last 30 days.

**Table 3**  
Smoking Motives (Mean  $\pm$  Standard Error) by Current Use of Hormonal Contraceptives (n=446)

mCEQ	NC-F (n=62)	NC-L (n=29)	HC-C (n=227)	HC-LA (n=128)	p-value*
Smoking Satisfaction	4.7 $\pm$ 0.2 <sup>L,C,LA</sup>	3.6 $\pm$ 0.3 <sup>F,C</sup>	4.2 $\pm$ 0.1 <sup>F,L</sup>	4.1 $\pm$ 0.1 <sup>F</sup>	0.003
Psychological Reward	4.4 $\pm$ 0.2 <sup>L</sup>	3.6 $\pm$ 0.3 <sup>F,C</sup>	4.4 $\pm$ 0.1 <sup>L,LA</sup>	4.0 $\pm$ 0.1 <sup>C</sup>	0.004
Aversion	2.7 $\pm$ 0.2	2.1 $\pm$ 0.2	2.6 $\pm$ 0.1 <sup>LA</sup>	2.3 $\pm$ 0.1 <sup>C</sup>	0.057
Enjoyment of Respiratory Tract Sensations	4.3 $\pm$ 0.2 <sup>L,C,LA</sup>	3.1 $\pm$ 0.3 <sup>F</sup>	3.7 $\pm$ 0.1 <sup>F</sup>	3.5 $\pm$ 0.2 <sup>F</sup>	0.006
Craving Reduction	5.1 $\pm$ 0.2 <sup>L</sup>	4.3 $\pm$ 0.3 <sup>F,C</sup>	5.0 $\pm$ 0.1 <sup>L</sup>	4.8 $\pm$ 0.2	0.148
<b>WISDM</b>					
Affiliative Attachment	2.8 $\pm$ 0.2 <sup>L</sup>	1.7 $\pm$ 0.3 <sup>F,C,LA</sup>	2.6 $\pm$ 0.1 <sup>L</sup>	2.4 $\pm$ 0.1 <sup>L</sup>	0.014
Affective Enhancement	4.8 $\pm$ 0.2 <sup>L</sup>	3.6 $\pm$ 0.3 <sup>F,C,LA</sup>	4.6 $\pm$ 0.1 <sup>L</sup>	4.5 $\pm$ 0.2 <sup>L</sup>	0.010
Automaticity	3.7 $\pm$ 0.2 <sup>L</sup>	2.4 $\pm$ 0.3 <sup>F,C,LA</sup>	3.8 $\pm$ 0.1 <sup>L</sup>	3.6 $\pm$ 0.2 <sup>L</sup>	0.002
Loss of Control	3.5 $\pm$ 0.2 <sup>L</sup>	2.3 $\pm$ 0.3 <sup>F,C,LA</sup>	3.3 $\pm$ 0.1 <sup>L</sup>	3.1 $\pm$ 0.2 <sup>L</sup>	0.007
Cognitive Enhancement	4.8 $\pm$ 0.2 <sup>L</sup>	3.2 $\pm$ 0.3 <sup>F,C,LA</sup>	4.4 $\pm$ 0.1 <sup>L</sup>	4.2 $\pm$ 0.2 <sup>F</sup>	0.001
Craving	4.1 $\pm$ 0.2 <sup>L</sup>	3.0 $\pm$ 0.3 <sup>F,C,LA</sup>	4.1 $\pm$ 0.1 <sup>L</sup>	3.8 $\pm$ 0.2	0.009
Cue Exposure/Associative Processes	4.9 $\pm$ 0.2 <sup>L</sup>	3.9 $\pm$ 0.3 <sup>F,C,LA</sup>	4.6 $\pm$ 0.1	4.6 $\pm$ 0.1	0.043
Social/Environmental Goals	4.5 $\pm$ 0.2	4.4 $\pm$ 0.3	4.6 $\pm$ 0.1	4.3 $\pm$ 0.2	0.596
Taste	5.0 $\pm$ 0.2 <sup>L,C</sup>	3.8 $\pm$ 0.3 <sup>F,C,LA</sup>	4.5 $\pm$ 0.1 <sup>F,L</sup>	4.6 $\pm$ 0.2 <sup>L</sup>	0.011
Tolerance	3.4 $\pm$ 0.2 <sup>L</sup>	2.4 $\pm$ 0.3 <sup>F,C,LA</sup>	3.2 $\pm$ 0.1 <sup>L</sup>	3.1 $\pm$ 0.2 <sup>L</sup>	0.051
Weight Control	3.9 $\pm$ 0.2	2.6 $\pm$ 0.3 <sup>C</sup>	3.4 $\pm$ 0.1	3.1 $\pm$ 0.2	0.142
Primary Dependence	3.7 $\pm$ 0.2 <sup>L</sup>	2.5 $\pm$ 0.3 <sup>F,C,LA</sup>	3.6 $\pm$ 0.1 <sup>L</sup>	3.4 $\pm$ 0.1 <sup>L</sup>	0.002
Total Score	4.1 $\pm$ 0.2 <sup>L</sup>	3.1 $\pm$ 0.2 <sup>F,C,LA</sup>	3.9 $\pm$ 0.1 <sup>L</sup>	3.8 $\pm$ 0.1 <sup>F,L</sup>	0.001

\* Adjusted for work status (employed vs. student vs. other).

NC-F=Natural Cycle - Follicular Phase; NC-L=Natural Cycle -Luteal Phase, HC-C=Hormonal Contraceptive-Cyclical; HC-LA=Hormonal Contraceptive-Long-Acting

mCEQ= Modified Cigarette Evaluation Questionnaire<sup>26</sup>; WISDM= Brief Wisconsin Inventory of Smoking Dependence Motives<sup>27,32</sup>

<sup>F</sup> p<0.05 compared to the "NC-F" group in pairwise comparisons



$p < 0.05$  compared to the "NC-L" group in pairwise comparisons  
 $p < 0.05$  compared to the "HC-C" group in pairwise comparisons  
 $p < 0.05$  compared to the "HC-LA" group in pairwise comparisons

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