Patterns of intermittent smoking: An analysis using Ecological Momentary Assessment

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Abstract

Non-daily smokers comprise a substantial proportion of US smokers, but there has been little study of their patterns of smoking, which are often assumed to reflect "social smoking." We used Ecological Momentary Assessment methods to study smoking patterns in 27 non-daily smoking adults who recorded each cigarette smoked over three weeks by leaving a voice mail message indicating their circumstances at the time of smoking. All told, 689 cigarettes were recorded over 589 person-days of observation. On average, participants smoked on 67% of days, averaging 2.1 ($SD = 0.91$) cigarettes per day on days they smoked; 22% of all cigarettes were smoked in bouts (within an hour of another cigarette). Altogether, 19% of cigarettes were smoked when drinking alcohol and 29% when participants were socializing. Smoking patterns varied widely across participants. A pair of hierarchical cluster analyses distinguished three groups: Those who smoked primarily (81% of cigarettes) in the daytime (Early smokers; $n = 15$, 58% of total sample), those who smoked primarily (75% of cigarettes) at night (Late smokers; $n = 7$, 27%), and a distinct, classic "Social smoking" group ($n = 4$, 15% of total sample), who smoked mostly at night but also primarily when socializing or drinking (86% of their cigarettes), in the evening (71% of their cigarettes), on weekends (65% of their cigarettes), and in bouts (71% of their cigarettes). Overall, results suggest that non-daily smoking patterns are quite heterogeneous, and that many non-daily smokers may not be primarily social smokers.

Keywords

Non-daily smokers; Social smoking; Ecological Momentary Assessment; Smoking patterns

1. Introduction

The dominant model of smoking posits that cigarette smoking is maintained by nicotine dependence, which drives smokers to smoke at regular and frequent intervals in order to maintain adequate nicotine concentrations and thus avoid lapsing into nicotine withdrawal (Stolerman & Jarvis, 1995). However, changes in population smoking patterns have challenged this account. The traditional account explains the typical pattern of smoking seen in the US, where smokers smoke every day, averaging approximately 20 cigarettes per day (CPD), or more than one cigarette every waking hour (Al-Delaimy et al., 2007). However, US smoking patterns are changing. According to some national surveys (e.g., BRFSS; CDC, 2003; NHSDA, 2002), 25–33% of adult US smokers do not smoke every day (though see Hassmiller, Warner, Mendez, Levy, & Romano, 2003; Wortley, Husten, Trosclair, & Chrismon, 2003). Non-daily, or intermittent, smoking is becoming a significant smoking pattern, at least as common as

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heavy smoking (25+ CPD; CDC, 2005). Further, intermittent smoking seems to be increasing steeply; its prevalence has increased by 40% over 6 years (CDC, 2003; though see CDC, 2006). Shiffman (in press) has suggested that the recent emergence of this smoking pattern is related to increasing restrictions on smoking, including both smoking regulations and the increasing cost of cigarettes. Thus, it seems important to understand intermittent smokers (ITS) and their smoking patterns.

Non-daily smoking has received the most attention among young smokers (e.g., Leatherdale, Ahmed, Lovatco, Manske, & Jolin, 2007), who are at early developmental stages of smoking, but intermittent smoking is not limited to young smokers. Adult ITS are, on average, only 1–2 years younger than daily smokers, averaging 39 years of age (Wortley et al., 2003). Similarly, while many ITS may be in the process of either escalating or reducing their smoking, intermittent smoking is not always a transitional stage: ITS smoking can be stable across time (Hassmiller et al., 2003).

Survey research gives us a window into the demographic characteristics of ITS, but does not shed light on their smoking patterns — that is, it does not help us to understand when and why ITS actually smoke. While almost no data are available, authors have often assumed that ITS are "social smokers" who smoke when others are smoking, for social reasons (Oksuza, Mutlua, & Malhanb, 2007), and whose smoking is associated with "partying" and alcohol consumption (Dierker et al., 2006; Philpot et al., 1999; Stanton, McClelland, Elwood, Ferry, & Silva, 1996), often in bars and nightclubs (Biener & Albers, 2004; De Vries, van't Riet, Panday, & Reubsaet, 2007). It is known that the tobacco industry has sought to promote such social smoking (Katz & Lavack, 2002). Among college students, global reports suggested that most non-daily smokers are social smokers (Moran, Wechsler, & Rigotti, 2004), but it is not clear whether this adequately characterizes adult ITS smoking, or whether other smoking patterns and contexts might also be important in ITS.

Studies among a related group of smokers — "chippers," who smoke daily or nearly daily, but smoke at very low rates — have yielded mixed results on social smoking. On questionnaires, chippers reported more social motives for smoking (Kassel, Shiffman, Paty, Gnys, & Zettler-Segal, 1994). However, the validity of such questionnaire measures has been questioned (Shiffman, 1993), and data collected in real time by palmtop computers using Ecological Momentary Assessment (EMA, Stone & Shiffman, 1994; Stone, Shiffman, Schwartz, Broderick, & Hufford, 2007) suggested different conclusions: While chippers' smoking was concentrated in the evenings, and chippers were more likely to smoke when drinking and when others were smoking, chippers smoked many of their cigarettes when alone, and outside of "indulgent" contexts like parties (Shiffman & Paty, 2006). It is not clear how these findings on chippers, based on data collected over 20 years ago, might apply to the current population of ITS, whose emergence seems to have been fueled by the recent surge of restrictions on smoking (Shiffman, in press). Thus, detailed studies examining the smoking patterns of contemporary ITS are needed.

In this paper, we report an initial exploratory study examining patterns of cigarette consumption in ITS, using real-time recording of smoking (Stone & Shiffman, 2002). Our aim was primarily descriptive — to describe how ITS smoking is distributed over time and situations, and to assess variations in smoking patterns, by classifying subtypes of smokers, both by time of day and by pattern. The temporal distribution of smoking can be informative; for example, smoking in the morning is associated with dependence (Fagerstrom, 2003; Toll, Schepis, O'Malley, McKee, & Krishnan-Sarin, 2007), whereas evening smoking and smoking on weekends might be associated with non-dependent social smoking (Grimshaw et al., 2003). We also explored the temporal and situational patterning of smoking: Social smokers might be expected to

concentrate their smoking in bouts, associated with social situations when they have been drinking.

2. Methods

2.1. Participants

Participants were 27 smokers who reported smoking less than daily, recruited by fliers and ads in local print media. To qualify for entry into the study, individuals had to have: smoked less than daily (≤27 days/month); smoked at least weekly (so that some smoking would be observed); smoked in this way for at least 3 months (so that patterns where somewhat stable). Participants had to be ≥21 years old and have smoked for ≥3 years (to avoid smokers just ramping up to daily smoking; USDHHS, 1988), not planning to quit in the next month or using other forms of tobacco.

The resulting sample was 59% female, 52% Caucasian, 41% African–American, and 7% Hispanic. The average age was 35.8 (SD = 9.4). Participants reported having smoked for 15.5 (10.9) years, averaging 3.5 (SD = 3.7) cigarettes per day, smoking their first cigarette 2.9 h (SD = 3.2) after waking, and scores reflecting a low level of nicotine dependence ($M = 1.5$; SD = 2.1) on the Fagerström Test for Nicotine Dependence (FTND, Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). Most (59%) participants had tried to quit, with an overall average of 2 (SD = 1.1) attempts.

2.2. Procedure

Participants used cell phones to record each cigarette over a three-week period, by calling an assigned telephone number each time they smoked. Automated equipment recorded the date and time of the call and captured the originating phone number. To capture the circumstances of smoking, participants left voice mail messages describing their current situation and activities. The study was approved by the University of Pittsburgh Institutional Review Board.

After screening and informed consent, each participant was given a cell phone and trained on its operation. The cell phone was programmed to call a study phone number with a single keystroke. Participants were instructed to call every time they smoked a cigarette, immediately after it was extinguished, leaving a brief message indicating "where you are, what's going on, and what made you want to smoke." Such messages were left in 96% of calls.

To remind participants and ensure that they were carrying the study phone at all times, participants received 1 or 2 calls at random times each day from the study staff. If a call came at a time when it was not possible to answer, participants were to call back as soon as possible. Over 90% of reminder calls were answered or returned in a timely manner, suggesting that participants were carrying the cell phone consistently.

2.3. Measures

2.3.1. Questionnaire measures—Demographic and smoking-related characteristics were assessed. Participants reported their smoking rate, number of past quit attempts, and completed the FTND.

2.3.2. Smoking behavior—Time and date of each cigarette (call) were automatically captured by software. Messages describing the circumstances of smoking were transcribed and coded. The coding system was drafted a priori, but modified to accommodate themes encountered in the voice-mail data. The codes, described in Table 1, captured the presence of particular characteristics. A single occasion could be coded into multiple categories. To establish inter-rater agreement, two coders independently coded 189 reports (29% of the total).

Cohen's K, which assesses inter-rater agreement corrected for chance, was at least 0.84 for all categories, and averaged 0.95, indicating excellent agreement. Given strong agreement, we used the coding produced by the primary coder. The analysis focused on categories that comprised at least 10% of reported cigarettes.

2.4. Dataset and data analysis

Participants were monitored for an average of 21.8 days each ($SD = 2.87$), totaling 589 person-days, during which 689 cigarettes were recorded. Two participants ended monitoring early because they had to leave the area unexpectedly, but provided usable data for 14 and 11 days, respectively, and one participant monitored for 8 extra days.

For analyses involving distribution of cigarettes over days, the first and last days of monitoring were excluded, because they were incomplete. Time of day was transformed such that cigarettes smoked between midnight and 4 am were ascribed to the preceding day, and assigned a time accordingly (e.g., 1:00 AM would be hour 25). For analysis, we defined 4 blocks of time within each day: Morning (4:00 AM–11:59 AM), Afternoon (12:00 PM–5:59 PM), Evening (6:00 PM–9:59 PM), and Late Night (10:00 PM–4:00 AM). Weekends were defined as running from Friday at 5 pm to Sunday at 5 pm. Cigarettes were considered to be part of a "bout" of smoking if they were smoked within an hour of another cigarette. (We have avoided terms such as "binge smoking" or "chain smoking," which imply unusually intensive smoking, since one cigarette per hour is less than the typical smoking rate in the US.)

Analyses reporting associations among characteristics of smoking occasions used individual cigarettes as the unit of analysis; for others, the data were aggregated by subject. We present descriptive data about when cigarettes were smoked, describing their distribution by time of day and by context. We summarize the percentage of days on which smoking took place, average smoking on those days, percentage of cigarettes that were smoked on the weekend, within each defined time block, and so on. Because the analysis is based on many observations (cigarettes) clustered within participants, we used hierarchical regression models, which take such clustering into account, and are suitable for relatively small samples (Maas & Hox, 2005). These analyses were also used to evaluate between-subject (level-2) effects.

Because substantial variation was evident across participants' smoking patterns, we sought to capture different smoking patterns evident in the data empirically and "inductively" by using cluster analyses to identify patterns from the data itself. The cluster analyses were based on the temporal patterns of smoking, because these were the most objective data in the study. We performed two different cluster analyses using Ward's method, which aims to produce homogeneous clusters, while maximizing the differences between two clusters (Aldenderfer & Blashfield, 1984); solutions using complete linkage produced very similar results. The first cluster analysis aimed to capture different distributions of smoking over the day, and was based on a set of variables indicating the percent of cigarettes each subject smoked in two-hour time blocks. A second cluster analysis was intended to capture more intermittent patterns of smoking that might be associated with social smoking, and was based on the proportion of cigarettes smoked on weekends, proportion smoked in bouts, and proportion of days smoked. Because the second cluster solution proved to sub-divide one of the groups from the first solution, we present the results as a combined three-group classification. Once clusters had been identified in this way, we examined whether there were corresponding differences in the verbally-reported situational correlates of smoking.

Additionally, we identified likely social smokers as those who smoked the majority of their cigarettes under conditions meeting at least two of the following criteria: the participant reported socializing, reported drinking alcohol, or the smoking occurred on a weekend night.

3. Results

3.1. Patterns of cigarette consumption

On average, participants smoked on two out of three days (67%; *SD* = 21%), but this varied substantially: 29% of subjects smoked on 33% of days or less (i.e., 2 days/week or less), and 30% of subjects smoked at least 75% of days. Participants averaged 1.2 (0.81) cigarettes/day; on days when they smoked, the mean consumption was 2.1 (0.91) cigarettes per day. Across participants, the maximum number of cigarettes smoked in any one day averaged 5.5 (2.7) cigarettes.

The distribution of cigarettes by time of day was fairly even, ranging from 8% to 13% in each two-hour block from 7 am to midnight; an additional 4% of cigarettes were smoked after midnight. Overall, 29% of cigarettes were smoked in the morning, 34% in the afternoon, 24% in the evening, and 13% late at night (Table 2). Cigarettes were unevenly distributed across days, with peaks on Thursday and Friday, and equal likelihood on weekdays and weekends.

On average, participants smoked 23.5% of their cigarettes in bouts (*SD*=25.7%), but this varied widely: 30% of participants never smoked cigarettes in bouts, whereas, at the other extreme, 21% smoked the majority of their cigarettes in bouts. Altogether, the average number of bouts was 2.1 (*SD*=2.0) during the entire period of observation; among participants who had any bouts, the average number was 3.0 (1.6), and these accounted for an average of 37% of these subjects' total cigarette consumption. Bouts averaged 2.7 (1.5) cigarettes over 1.0 (1.1) hour.

3.2. Circumstances and situations associated with smoking

A large proportion of cigarettes (41%) were smoked at home, whereas the workplace was only mentioned in connection with 12% of cigarettes. Eating was also mentioned in connection with 12% of cigarettes. In almost half of smoking episodes (48%), participants' descriptions of the situation indicated a transition in activity or location — participants tended to smoke when one activity was ending and another beginning, or while in transit between two locations. Affect was not often mentioned: Negative affect or stress was mentioned in 14% of cigarette reports; positive affect in 5%; and relaxation in 11% of cigarette reports.

Alcohol consumption was mentioned in association with 19% of all cigarettes, and social activity in connection with 29% of all cigarettes. Alcohol and socializing were associated (point biserial correlation = 0.57), and both alcohol and socializing were mentioned in 16% of cigarette reports — thus, most times alcohol or socializing was mentioned, the other was also mentioned.

Factors that related to addiction, such as smoking because of craving, anticipation of a period of non-smoking, simply because it had been a long time since the last cigarette, and as part of a fixed routine, were rarely mentioned, each cited in 1–3% of smoking occasions.

3.3. Characterizing variations in individual smoking patterns

To characterize variations in individual participants' smoking patterns by time of day, we performed two hierarchical cluster analyses. The first classified participants purely on the basis of distribution of smoking across two-hour blocks of the day. This analysis identified two groups: The larger group, "Early" smokers (*n*=15, 58%) smoked almost all their cigarettes (81%) in the morning (40%) or afternoon (41%), and very few after 10 pm (5%) (see Fig. 1). In contrast, "Late" smokers (*n*=12, 44%) smoked most of their cigarettes (88%) in the afternoon, evening, or night. A second, independent, cluster analysis was based on a different set of variables — the percentage of cigarettes smoked on weekends, the percent in bouts, and the percent of days on which participants smoked. This analysis defined two groups, one of

which was drawn completely from the above "Late" cluster. Accordingly, we have broken out these participants, whom we label "Social smokers" (*n*=4, 15%) as a third group, and present (Tables 1 and 2) data for three groups defined by the two cluster analyses: Early smokers (*n*=15), Late smokers (*n*=8), and Social smokers (*n*=4).

As expected from the clustering procedure itself, Late smokers differed from Early smokers in the time distribution of smoking; the Late smokers smoked 55% of their cigarettes after 6 pm, compared to 19% for the Early smokers (Table 2; Fig. 2). Late smokers were also substantially and significantly more likely to smoke on weekends (Fig. 1), and when drinking, when socializing, and when others were smoking (Table 1).

The small Social smoking cluster was most striking because it was distinct, differed significantly from the other two groups in many aspects of their smoking patterns, and embodied the prototype of social smoking (Tables 1 and 2). The Social smokers smoked the vast majority of their cigarettes (86%) when they were either drinking (67%) or socializing (82%). In these respects, the Social smokers differed dramatically from the other two groups: they were over 30 times more likely to smoke while drinking or socializing than the Early smoking group, and over 7 times more likely than the Late smoking group (Table 1). Notably, Social smokers' smoking was more concentrated in time. They smoked only about two days per week, with 86% of their cigarettes falling between Thursday and Saturday, and 65% on the weekend. They also had shorter "runs" of smoking, averaging less than three days. That is, they appeared to approximate weekend smoking. Within smoking days, most of their cigarettes (71%) were smoked in bouts, with an hour of each other. They were less likely to smoke at home, or in transitions between activities. More than half their cigarettes were smoked between 9 pm and midnight (Fig. 2), and only 2% before noon. In other words, they fit the expected profile of social smoking.

3.3.1. Social smokers identified by rule—Four participants were identified as social smokers on the basis that the majority of their cigarettes (>50%) were considered to be social smoking. These corresponded exactly to those placed empirically into the Social Smoker cluster, above.

4. Discussion

This is the first detailed study of ITS's smoking patterns using cigarette-by-cigarette data collected in smokers' natural environments. The results give some insight into ITS's smoking patterns, and their variability. The majority of ITS' cigarettes were smoked in the morning and afternoon, rather than evening or night, most were smoked singly, rather than in bouts, and most were not reported to be associated with drinking or socializing. Cluster analysis did identify a group of ITS who could clearly be characterized as "social smokers," but these constituted only a small proportion (11%) of subjects in this sample. The findings were not consistent with the expectation that ITS are "social smokers" (e.g., Moran et al., 2004; Philpot et al., 1999).

ITS smoking varied considerably over time. Runs of abstinence were common, with 37% of ITS abstaining for at least 5 days in a row. Conversely, runs of smoking were not rare: over a quarter (26%) of ITS smoked at least seven days in a row. Smoking was also distributed unevenly within days: 20% of all recorded cigarettes were concentrated in bouts (i.e., within an hour of another cigarette), which especially characterized cigarettes smoked when drinking and socializing. This suggests that social drinking provokes concentrated bouts of smoking in some ITS. The association between drinking and smoking is well-established, especially for light, non-dependent smokers (Kirchner & Sayette, 2007; Shiffman & Paty, 2006).

Even more striking was the variability among different ITS individuals. Some ITS smoked almost every day for 21 days, while others smoked only two days per week. On days when they smoked, some ITS averaged just one cigarette, while others averaged as many as five cigarettes per day. Some ITS smoked almost all their cigarettes on the weekends, while others did not smoke at all on weekends; some smoked almost all their cigarettes in the evening, others never smoked in the evening; some smoked most of their cigarettes in bouts, others were never observed smoking two cigarettes within an hour of each other. The wide between-subject variability strongly suggests that no single pattern characterizes ITS smoking.

Drawing on the heterogeneity of ITS smoking, we identified distinct groups of ITS based on temporal patterns. An unexpected group was the Early smokers, who constituted the majority of the sample: They frequently smoked in the morning and afternoon, but seldom at night, and they seldom smoked while drinking or socializing, or when others were smoking. Moreover, they were less likely to smoke on weekends compared to weekdays. Though they make up the majority of ITS, Early smokers seem to be the antithesis of "social smokers."

The cluster analyses did identify a subgroup who seems to fitthe expected profile of a Social smoker. These smokers smoked mostly away from home, on the weekends, at night, while drinking and socializing. Their smoking was concentrated in bouts, and they smoked just two days a week on average, mostly on the weekend, with even the longest runs averaging less than three days in a row. However, this group constituted only 10% of the ITS sample studied here. While this was a small convenience sample, and thus the population proportions may be different, this suggests that social smoking is unlikely to be typical of ITS.

The study was subject to several limitations. It was based on a small convenience sample of ITS, and its generalizability is uncertain. The study analyzed data on the situational contexts of smoking, but lacked comparative data on non-smoking situations, which would be necessary to draw inferences about associations between smoking and context (Paty, Kassel, & Shiffman, 1992). We also did not compare reports from ITS with reports from daily smokers; that contrast may be informative (cf. Shiffman & Paty, 2006). The situational data were drawn from relatively unstructured qualitative reports, which are subject to participants' decisions about what to report. Monitoring may have been reactive, causing participants to change their smoking behavior, e.g., smoking more or less than usual. Finally, although participants reported they had made timely recordings of all their cigarettes, we could not verify their compliance, and non-compliance could sway the findings, for example if participants omitted cigarettes when drinking alcohol.

On the other hand, this is the first study to examine contemporary ITS smoking in detail, and used electronically time-tagged real-time reports of individual smoking episodes, which helps overcome problems of retrospection (Stone & Shiffman, 2002) and of back-filling of paper diaries (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2003). The time-tagging of smoking episodes was particularly useful for assessing the temporal distribution of cigarettes and the clustering of cigarettes within bouts of smoking. Population surveys querying prototypical behaviors of the different types of ITS (e.g., On the days that you do smoke, how likely are you to smoke before noon?) could help identify such patterns in broader populations. However, research on questionnaire measures of smoking patterns suggests that global survey questions may not be able to capture such patterns (Shiffman, 1993).

This preliminary study provided some initial insight into ITS smoking patterns. Some ITS smoking conformed to "social smoking" stereotype — late weekend night bouts of smoking while drinking and socializing. However, the majority of ITS smoking occurred during the day, even the morning, and in the absence of either socializing or alcohol. It seems clear that the smoking patterns and motives for ITS are diverse, and deserving of further study.

Acknowledgments

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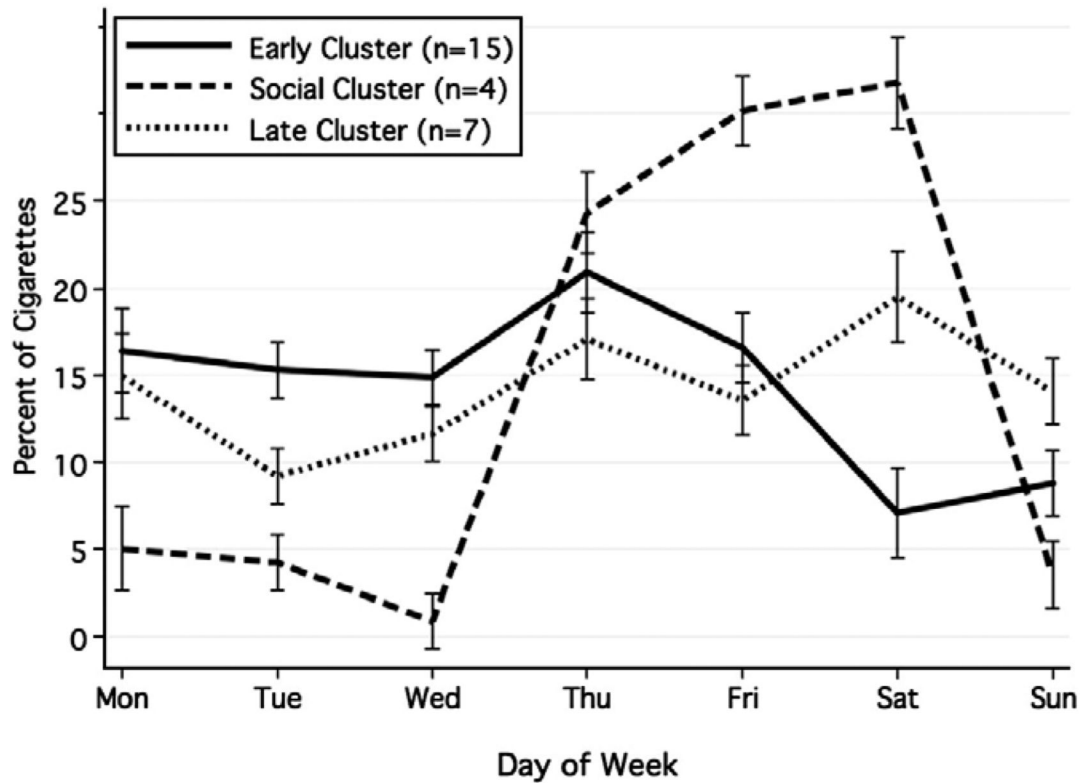
Fig. 1.
The distribution of cigarettes by day of the week for participants in the Early, Late and Social smoking clusters, based on all cigarettes, but excluding the first and last days of observation, and weighted to account for different representation of days of week in each participant's period of observation. The graph shows the percentage on each day±SE. If cigarettes were distributed equally across the seven days, 14.3% would be expected to be smoked each day.
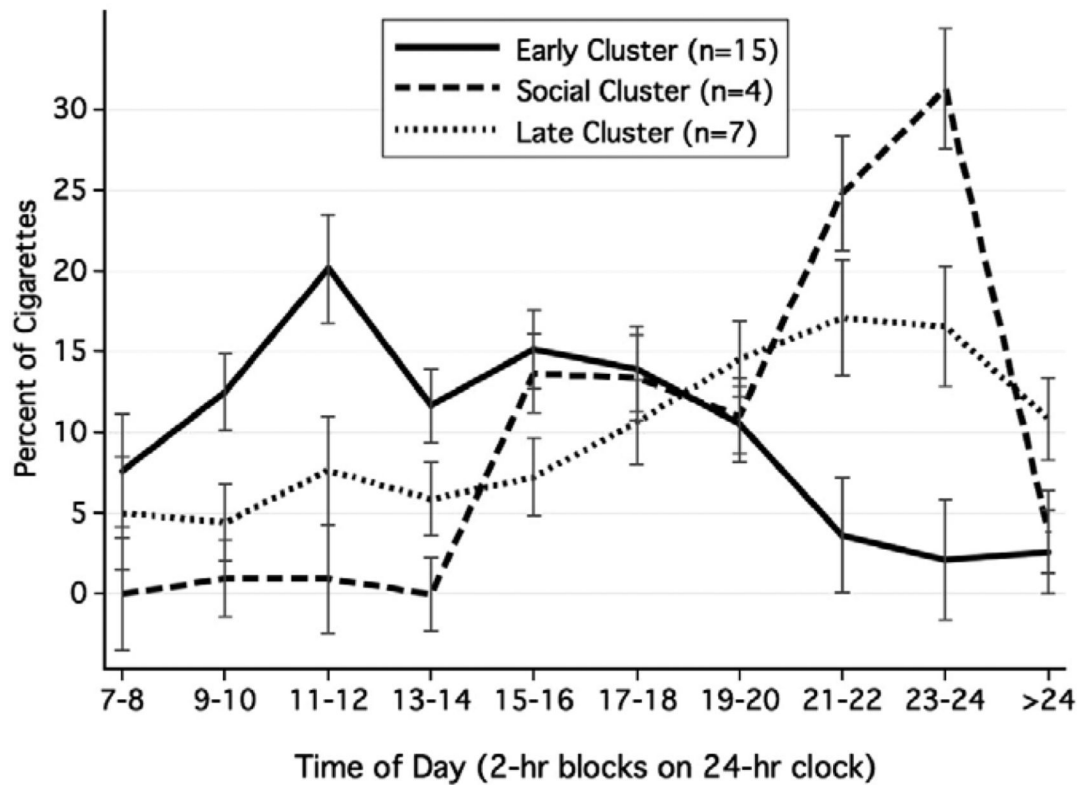
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Fig. 2.
The distribution of cigarettes by time of day, for participants in the Early, Late and Social smoking clusters. Figures are averages of participant averages±SE. The graph shows percentage of cigarettes falling into each 2-hour time-block. Cigarettes smoked after midnight but before 4 AM are shown as occurring very late (>24 h) rather than early the next day.

Table 1

Situational codes by cluster.

Situational code	Complete sample		Cluster mean (SD)			Cluster comparison (OR)		
	All cigarettes[a] (n = 689)	All participants[b] (n = 27)	Early smoking cluster (n = 15)	Late smoking cluster (n = 8)	Social smoking cluster (n = 4)	Social vs Late	Social vs Early	Late vs Early
At home	0.40 (0.24)	0.38 (0.25)	0.39 (0.25)	0.48 (0.24)	0.13 (0.06)	0.19*	0.21*	1.19
At workplace	0.11 (0.17)	0.10 (0.16)	0.14 (0.20)	0.06 (0.10)	0.04 (0.07)	0.56	0.20	0.44
In vehicle	0.08 (0.12)	0.06 (0.12)	0.08 (0.15)	0.06 (0.09)	0.00 (0.00)	0.76	1.89	1.56
On break	0.08 (0.13)	0.07 (0.13)	0.09 (0.16)	0.05 (0.09)	0.06 (0.08)	1.59	0.98	0.60
Transition	0.46 (0.21)	0.42 (0.23)	0.46 (0.22)	0.49 (0.18)	0.17 (0.19)	0.20**	0.17**	0.92
Eating	0.11 (0.10)	0.09 (0.09)	0.11 (0.10)	0.09 (0.07)	0.06 (0.10)	0.67	0.40	0.60
Alcohol	0.18 (0.21)	0.21 (0.24)	0.08 (0.08)	0.22 (0.15)	0.67 (0.20)	7.25	32.95***	4.27**
Coffee	0.07 (0.08)	0.07 (0.09)	0.08 (0.11)	0.06 (0.07)	0.07 (0.06)	1.20	0.80	0.54
Socializing	0.28 (0.26)	0.30 (0.30)	0.17 (0.19)	0.30 (0.24)	0.82 (0.19)	9.46***	49.12***	3.96*
Others smoking	0.08 (0.14)	0.07 (0.12)	0.03 (0.04)	0.13 (0.19)	0.10 (0.13)	0.59	3.30	6.21*
Negative affect	0.14 (0.15)	0.18 (0.22)	0.23 (0.26)	0.12 (0.14)	0.08 (0.09)	0.57	0.22	0.43
Positive affect	0.05 (0.07)	0.03 (0.05)	0.04 (0.06)	0.02 (0.03)	0.03 (0.03)	1.05	0.62	0.61
Relaxing	0.11 (0.13)	0.10 (0.13)	0.10 (0.12)	0.14 (0.16)	0.00 (0.00)[c]	0.07	0.11	1.49
Boredom	0.04 (0.05)	0.04 (0.07)	0.04 (0.06)	0.06 (0.08)	0.00 (0.00)[c]	0.24	0.24	0.98
Urge	0.03 (0.06)	0.03 (0.06)	0.03 (0.07)	0.03 (0.07)	0.00 (0.00)[c]	0.78	0.43	0.21
Long time[d]	0.01 (0.04)	0.02 (0.05)	0.02 (0.07)	0.01 (0.02)	0.00 (0.00)[c]	0.44	0.76	1.42
Habitual time[e]	0.03 (0.04)	0.03 (0.04)	0.03 (0.04)	0.03 (0.03)	0.00 (0.00)[c]	0.29	0.32	0.99
Loading[f]	0.03 (0.05)	0.03 (0.05)	0.03 (0.04)	0.03 (0.06)	0.04 (0.07)	1.04	1.16	1.73

Note. Entries are mean proportions (SD). Category code names refer to the circumstances immediately preceding each cigarette. Categorization was based on explicit report in the open-ended cigarette report. A single response could fall into multiple categories.

[a] Proportions calculated across all cigarettes reported (n = 689).

[b] Average (SD) across 27 participants of within-participant proportions.

[c] A single positive observation was added to each group so that an OR could be computed when the proportion in the Social group was 0.

[d] Long time refers to passing of some specified time period (e.g., "haven't smoked in two days").

[e]Habitual time refers to a regular daily time (e.g., "smoking my morning cigarette").

[f]Loading refers to anticipation of entering a smoking-restricted setting (e.g., a movie or work).

*
$p<.05$.

**
$p<0.005$.

***
$p<0.0005$.

Table 2

Smoking patterns by cluster.

Variable	Complete sample		Cluster mean (SD)			Cluster comparisons		
	All cigarettes (n = 689) or days^a (n = 285)	All participants^b (n = 27)	Early smoking cluster (n = 15)	Late smoking cluster (n = 8)	Social smoking cluster (n = 4)	Social vs Late	Social vs Early	Late vs Early
Person-level: average								
Proportion of days smoked	0.67 (0.24)	0.55 (0.26)	0.63 (0.26)	0.52 (0.23)	*0.30 (0.11)*	2.94*	3.93**	0.58
Cigarettes per day (all days)	1.68 (0.84)	1.23 (0.81)	1.37 (0.92)	1.17 (0.76)	0.79 (0.13)	1.88	2.36*	0.18
Cigarettes per day (smoking days)	2.45 (0.78)	2.14 (0.91)	1.98 (0.73)	1.99 (0.79)	3.05 (1.41)	−1.20	−1.45	−0.47
Max. cigarettes on one day	c	4.56 (2.74)	4.13 (2.45)	4.38 (2.72)	6.50 (3.70)	−0.79	−1.24	−0.68
Consecutive days smoked	c	5.63 (4.50)	6.93 (5.50)	4.63 (2.26)	2.75 (0.50)	3.21*	2.91*	1.13
Consecutive days abstinent	c	3.89 (2.75)	3.33 (2.99)	4.13 (2.59)	5.50 (1.73)	−1.10	−1.87	−0.51
Cigarette level: proportion of cigarettes								
In bouts	0.22 (0.42)	0.23 (0.26)	*0.16 (0.16)*	*0.13 (0.16)*	*0.71 (0.21)*	18.99***	23.44***	1.07
Weekend	0.30 (0.19)	0.28 (0.22)	*0.21 (0.13)*	*0.24 (0.20)*	*0.65 (0.16)*	3.78**	7.69***	2.17**
Morning (4:00 AM-11:59 AM)	0.29 (0.18)	0.29 (0.19)	*0.40 (0.13)*	*0.21 (0.15)*	*0.02 (0.04)*	0.21	0.09***	0.34**
Afternoon (12:00 PM-5:59 PM)	0.34 (0.12)	0.34 (0.14)	*0.41 (0.09)*	*0.24 (0.12)*	*0.27 (0.21)*	0.87	0.30**	0.35***
Evening (6:00 PM-9:59 PM)	0.24 (0.14)	0.21 (0.14)	*0.14 (0.08)*	*0.28 (0.14)*	*0.36 (0.21)*	0.77	1.57	2.05*
Late night (10 PM-4:00 AM)	0.13 (0.15)	0.16 (0.17)	*0.05 (0.07)*	*0.27 (0.17)*	*0.35 (0.16)*	2.21	18.55**	8.29***

Note. Entries in italics indicate variables that were part of the cluster analysis that defined the listed group.

[a] Proportions calculated across all cigarettes reported (n = 689) or, for per-day quantities, across days (excluding first and last (n = 285).

[b] Average (SD) across 27 participants of within-participant statistics.

[c] These parameters could only be meaningfully defined at the participant level.

*
 $p < .05$.

**
 $p < 0.005$.

***
 $p < 0.0005$.