

**Typology of drug use in United Kingdom men who have sex with men and associations
with socio-sexual characteristics**

SHORT TITLE: Drug use typology in UK MSM

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Abstract

Background. Analysis of specific drug use patterns in men who have sex with men (MSM) is important in targeting HIV prevention and harm reduction interventions and in developing a fuller picture of drug use in context as opposed to considering use of specific drugs in isolation.

Objectives. We sought to develop a typology of recent drug use in MSM, and to explore how distribution of MSM across the classes in this typology differs by socio-sexual characteristics.

Methods. We examined last-year drug use reported by 16,814 MSM as part of a cross-sectional, internet-based survey of MSM living in the UK for which data were collected in late summer 2014. We tested models with between two and eight classes for types of specific drug use, and related socio-sexual covariates to the classes in the best model using multinomial regression.

Results. Our five-class model described a range of drug use patterns, including minimal users, low-threshold users, old-skool users, chemsex-plus users and diverse users. MSM identifying as gay were more likely to not be minimal users. HIV-positive MSM were more likely to be chemsex-plus users than HIV-negative MSM. Number and type of non-steady partners, ethnicity and education were each related to class membership, though trends were complex.

Conclusions. Findings from associations between correlates and latent classes suggest avenues for service development beyond current attention to opiates or chemsex drugs. Our findings draw attention to heterogeneity in drug use patterns in MSM beyond what current discourse on chemsex drugs would suggest.

Keywords. Men who have sex with men; chemsex; sexual behaviour; HIV; risk factors; latent variable modelling

Introduction

Analyses of drug use patterns in men who have sex with men (MSM) have generally focused on examining individual drugs in isolation (Digiusto & Rawstorne, 2013; Vosburgh, Mansergh, Sullivan, & Purcell, 2012), or have examined polydrug use as a unitary variable (Boone, Cook, & Wilson, 2013; Daskalopoulou et al., 2014) without regard to types of drugs combined. This leaves aside two important points for analysis—namely, understanding how patterns of specific drug use cluster together within MSM, and how different drug use patterns are associated with socio-sexual variables.

Understanding specific drug use patterns is important in targeting HIV prevention and harm reduction interventions and in developing a fuller picture of drug use in context. For example, reports of sexualised drug use among MSM (also known as ‘chemsex’) in the UK focus on the use of three specific drugs—crystal methamphetamine, or ‘crystal meth’; gamma-hydroxybutyric acid, or GHB; and mephedrone (McCall, Adams, Mason, & Willis, 2015), with ketamine at times included as a chemsex drug (Bourne, Reid, Hickson, Torres-Rueda, Steinberg, et al., 2015; Bourne, Reid, Hickson, Torres-Rueda, & Weatherburn, 2015). Other latent class-based approaches to understanding typologies of substance use have drawn primarily from the US context (McCarty-Caplan, Jantz, & Swartz, 2014; Tobin, Yang, King, Latkin, & Curriero, 2016; Yu, Wall, Chiasson, & Hirshfield, 2014). Thus, whether these drugs form a coherent pattern of use, or whether they are part of broader patterns of drug use, has not yet been investigated in the UK context using quantitative data.

In this analysis, we use latent class analysis of data from a cross-sectional community-based survey of MSM living in the UK to develop a typology of recent drug use in MSM, and to explore how distribution of MSM across the classes in this typology differs by socio-sexual characteristics (including demographics, HIV testing history and sexual risk-related variables). Latent class analysis is a type of factor analysis. It constructs underlying and non-

observed variables from observed data, specifically multicategorical latent variables, which can be used to develop underlying typologies of people. This analysis is important to understand patterns of use of specific drugs in the context of use of other drugs and to move beyond bivariate associations between use of specific drugs and other person-level characteristics.

Methods

This study used data from the 2014 Gay Men's Sex Survey. This open-access, internet-based survey recruited a community sample of MSM via general-interest gay dating websites and apps, Facebook, and the websites of community organisations in late summer 2014. While a community sample may lead to underrepresentation or overrepresentation of certain individual characteristics or risk behaviours, it is difficult to establish a probability sample of a group as diffuse in terms of behaviour and identity as MSM. It is likely that our survey may have oversampled MSM with high-risk sexual behaviour or drug use (Prah et al., 2016). The survey received ethical approval from the London School of Hygiene and Tropical Medicine ethics committee. This study included men living in the UK aged 16 or over who were sexually attracted to men.

We first constructed a latent class model with manifest indicators corresponding to the use of specific drugs in the last 12 months. The drugs we enquired about were poppers (nitrite inhalants), erectile dysfunction medications, tranquilisers, cannabis, ecstasy (MDMA), speed (amphetamine), mephedrone, GHB/GBL, ketamine, crystal methamphetamine and cocaine. We did not consider alcohol as its use was too high to be helpful in distinguishing between men, and we excluded LSD, heroin and crack as prevalence of use was too low to result in a stable model (less than 2% reported use in the last year in all cases). We tested models with between two and six latent classes, and chose the model that best balanced interpretability and fit as judged by the Bayesian information criterion, a penalised log-

likelihood measure, and the scaled relative entropy, which is analogous to an R^2 for a linear regression. In scaled relative entropy, 0% indicates very poor certainty in classification and 100% indicates perfect certainty. We then inspected the conditional probabilities for each of the drugs in each class. In this case, conditional probabilities are interpreted as the predicted prevalence of last-year use of each drug for people in a specific class of drug use.

Once we had chosen an appropriate latent class model, we examined whether socio-sexual covariates were correlated with the latent classes. We examined HIV testing status, measured as HIV positive, last test HIV negative, or never received an HIV test result; sexual identity, measured as gay or another non-heterosexual identity (e.g. bisexual, queer, or ‘any other term’ besides straight/heterosexual); and non-steady sexual partner risk in the last year, measured as no non-steady partners, non-steady partner(s) with no unprotected anal intercourse, one non-steady partner with unprotected anal intercourse and two or more non-steady partners with unprotected anal intercourse. We also examined ethnicity (White, Black, Asian, all others) and education (high, to degree level; medium, at or above secondary school but below degree level; low, below secondary school completion). We tested these covariates in a multinomial logistic regression framework; that is, the latent classes formed a multicategorical dependent variable, and each socio-sexual covariate was tested in a separate bivariate model. We used the ‘flexible model-based’ method described by Lanza, Tan and Bray (2013) to account for error in classification of each observation to the different latent classes. For ease of interpretation, we transformed the multinomial logistic regression coefficients into marginal probabilities of belonging to each class for each category of the tested covariates. We did not estimate models with multiple socio-sexual correlates as these would have been uninterpretable. All analyses were undertaken in Stata v. 14 (Statacorp, College Station, TX).

Results

The analysis sample consisted of 16,814 participants resident in the UK with data available for analysis. Of this group, 81.9% were White British and 11.3% were White non-British, 3.3% were Asian, and 1.9% were Black. An additional 1.6% identified with other ethnic groups. Participants were on average 35.1 years of age (SD 13.2). Almost half (48.5%) had a university degree. In terms of HIV status, 24.0% had never received an HIV test result, 8.8% had tested positive, and 67.2% had a last test that was negative. Furthermore, 84.4% identified as gay and 15.6% described another sexual identity. Overall, 39.7% of respondents in the analysis sample did not report use of any of the 11 drugs included in our model; 26.7% described using one drug in our model; 12.6% described using two drugs; and 21.0% described using three or more drugs.

Latent classes. We tested latent class models with between two and six latent classes. We judged that a five-class model formed the best trade-off between parsimony, complexity and model fit (see Table 1). Models with two or three classes did not show clear separation, and were thus difficult to interpret. A four-class model had comparatively worse fit, as measured by the Bayesian information criterion, compared to a five-class model. Models with six and greater classes were similarly difficult to interpret (classes were not readily distinguishable from each other, improvements in fit were marginal, and small class sizes made associations with socio-sexual covariates difficult to interpret). The five-class model had a scaled relative entropy of 79.3%, which indicates that model classification was satisfactory. Based on our inspection of the conditional probabilities for last-year drug use in each of the latent classes, we named each of the five latent classes (see Table 2).

Class 1: minimal users formed 64.2% of the respondents. One in five (20.4%) MSM in this group used poppers in the last year, whereas 11.0% used erectile dysfunction medications and 10.9% used cannabis. Conditional probabilities of all other drug use were negligible.

Class 2: low-threshold users, who formed 14.0% of the respondents, were primarily distinguished by their use of historically popular drugs that have low threshold to entry; that is, that may not be particularly stigmatised or illicit and that may be easier to access than more novel psychoactive substances. Most MSM in this group (90.3%) used poppers in the last year, while about half (47.7%) used erectile dysfunction medications. About one in five (20.4%) used cannabis. Probabilities of all other drugs were low or negligible.

Class 3: old-skool users formed a similar proportion of the respondents (14.0%) as class 2. As compared to respondents in class 2, respondents in class 3 were less likely to use poppers (though this probability was still high at 62.5%), and less likely to use erectile dysfunction medications (20.2%). However, a majority of respondents in this class reported use of several drugs which were very popular through the 1990s and the first decade of the 2000s among UK MSM (Keogh et al., 2009). For example, two-thirds each used ecstasy (61.6%) and cocaine (65.9%). This class also had notable use of more recently popular chemsex-associated drugs, specifically mephedrone (23.9%) and ketamine (18.4%); each of these drugs was more prevalent in this specific class than in the sample overall (10.8% for mephedrone, 7.4% for ketamine).

Class 4: chemsex-plus drug users formed the smallest proportion of the sample (3.1%), and was characterised by high use of both low-threshold drugs and drugs associated with chemsex, though not necessarily in the context of sex. In addition to high rates of poppers (89.0%) and erectile dysfunction medication (88.3%) use, MSM in this group had high rates of mephedrone (80.9%) and GHB (67.3%) use. Almost half (48.6%) reported last-year use of crystal meth, a prevalence more than ten times as high as in the sample as a whole (4.7%). Nearly a third (32.2%) reported ketamine use in the last year. The other drugs considered in this analysis were also frequently used by respondents in this class, though

compared to class 3, respondents belonging to class 4 were less likely to have used cannabis (45.3%) or ecstasy (43.1%).

Class 5: diverse users formed 4.7% of the respondents. Each drug considered in this analysis was used by a majority of respondents in this class. Apart from poppers, erectile dysfunction medications and cannabis, each drug was used more in this class than in any other class. Nearly three-quarters of the respondents in this class used GHB (74.6%) or ketamine (76.6%), and more than nine in ten (92.1%) used mephedrone. More than half used crystal meth in the last year (51.4%).

Correlates. Each correlate of latent class membership was tested in a separate model. All correlates were statistically significant (all $p < 0.05$), indicating that on the whole probabilities of class assignment differed by each category within a correlate. Additionally, because relationships between correlates and latent classes were tested in a multinomial logistic regression framework, pairwise comparisons for each correlate between class 1 and every other class were estimated. Findings are presented as marginal probabilities of belonging to each class for ease of interpretation (see Table 3), and estimates from the multinomial logistic regressions are presented in Online Table 1. Description of pairwise comparisons reflects whether odds ratios from multinomial logistic regressions suggest differences in membership to specific classes by each category in socio-sexual correlates.

Sexual identity. Compared to MSM who identified as gay, MSM who had other sexual identities were more likely to be minimal users (59.5% vs. 68.0%) and correspondingly less likely to belong to any other class. All pairwise comparisons were statistically significant (all $p < 0.05$).

HIV status. MSM who last had a negative HIV test were most likely to be either minimal users (43.5%) or low-threshold users (31.6%). The first three classes—minimal users (75.4%), low-threshold users (11.8%) and old-skool users (10.8%) covered almost all of

the MSM who had never tested. In contrast, MSM in this group were least likely to be a chemsex-plus user (0.1%). More than half of MSM who reported an HIV positive test result (51.5%) were low-threshold users, and an additional 31.3% were chemsex-plus users. Of note is that while MSM who were diagnosed HIV positive were less likely to be diverse users than MSM who last tested negative (1.5% vs. 4.3%), this was the only pairwise comparison between HIV status and probability of latent class assignment that was not statistically significant.

Non-steady partners. The probability of being a minimal user ranged from 77.7% for respondents with no non-steady partners to 18.6% for MSM with two or more non-steady UAI partners, and it steadily decreased as the volume of non-steady partners rose. In contrast, probability of being a low-threshold user increased across categories from 8.4% in those with no non-steady partners to 42.2% in those with two or more non-steady UAI partners, with similar trends in probability of being a chemsex-plus user (0.5% to 10.1%) and of being a diverse user (1.7% to 12.7%). All pairwise comparisons were statistically significant (all $p < 0.01$).

Ethnicity. The probability of being a minimal user was greatest in Asian MSM (70.8%) and least in those in the category of all others (53.5%). Almost a quarter (22.6%) of Black MSM were old-skool users, compared to a low of 9.2% amongst Asian MSM. Ethnic minority MSM generally were more likely to be chemsex-plus users and diverse users than White MSM. While each ethnic group was a statistically significant correlate of class assignment, pairwise comparisons for Asian and Black MSM between classes 2, 4 and 5 against class 1 were not statistically significant, as were pairwise comparisons for all other MSM between classes 2 and 3 and class 1.

Education. Though each correlate was statistically significant, there were few obvious trends. Highly educated MSM were least likely to be minimal users (60.9%) and

most likely to be chemsex-plus drug users (4.3%), though there were few discernible differences in the probability of belonging to the class of diverse users by educational status. Men with medium education were least likely to be low-threshold users (12.7%) as compared to other educational statuses and most likely to be old-skool users (16.1%).

Discussion

This analysis developed a set of latent classes to summarise different typologies of drug use in MSM living in the United Kingdom. The five latent classes described a range of drug use patterns, including minimal users, low-threshold users, old-skool users, chemsex-plus users and diverse users. The model achieved good separation and classification of respondents, and key socio-sexual characteristics were found to predict class membership.

Several noteworthy observations emerged from this latent class model. First, though pairwise comparisons arising from the multinomial logistic regression were all statistically significant for comparisons between class 1 and class 3, probabilities of membership in class 3 did not appear to be meaningfully different across socio-sexual correlates, though there was evidence of a spread across ethnic groups. This suggests a certain ‘baseline’ subgroup of drug users that is similar across socio-sexual characteristics (but perhaps not ethnic groups).

Second, despite the observation that respondents in class 3 generally used more drugs than those in class 2 (low-threshold users), poppers and erectile dysfunction medications were less commonly used in this class. Furthermore, the probability of cocaine use in class 4, chemsex-plus drug users, was somewhat lower than in class 3. This could suggest some degree of ‘switching’ for cheaper drugs for greater variety between different latent classes of drug use, or the development of specific drug use habits related to contextual preferences. We noted as well that respondents in class 3 reported using drugs that were most popular before current interest in chemsex drugs. It is difficult to hypothesise based on cross-sectional data

why this is, but it may be that respondents in class 3 developed individually significant substance use behaviours before the increase in popularity of chemsex drugs.

Third, the conditional probabilities in class 4 (chemsex-plus users) and class 5 (diverse users) provide empirical evidence regarding heterogeneity among MSM who engage in sexualised drug use. In particular, class 4 suggests that chemsex is often characterised by recent use of a variety of chemsex drugs rather than just one drug of choice, and that mephedrone and GHB are the most commonly used chemsex drugs. Additionally, the separation between respondents in class 4 and those in class 5 suggests that there is a group of drug users whose use of chemsex drugs is in combination with an even broader variety of drugs. Previous qualitative research on chemsex in MSM has suggested that polydrug use is normative (Bourne, Reid, Hickson, Torres-Rueda, & Weatherburn, 2015), a finding that is often ignored in encounter-level and person-level studies of drug use in MSM. Our findings also suggest that a smaller number of MSM than current discourse on chemsex would suggest (Stuart, 2013) are using these drugs, and that not all drug use by MSM, including during sex, includes chemsex drugs.

Findings from associations between socio-sexual correlates and latent classes generalise findings for specific drugs (Bonell, Hickson, Weatherburn, & Reid, 2010; Daskalopoulou et al., 2014) to broader patterns of drug use. Though differences between MSM identifying as gay and MSM reporting another sexual identity were statistically significant, they were not pronounced across classes. However, HIV status and number of non-steady partners were strongly related to class membership. In particular, MSM with multiple non-steady partners in the last year were about twenty times as likely to belong to the class of chemsex-plus users and more than seven times as likely to belong to the class of diverse users compared to MSM with no non-steady partners; similarly, MSM who reported

being HIV positive were more than six times as likely to belong to the class of chemsex-plus users as MSM whose last test was negative.

Our findings also extend previous latent class analyses examining drug use patterns in MSM to the UK context, nearly all of which, like ours, focused on period prevalence of drug use. McCarty-Caplan, Jantz and Swartz (2014) derived a typology of four subgroups of drug use patterns (low drug user, moderate drug user, sex drug user and polydrug user) among MSM living in the United States. However, possibly because our study benefited from a larger sample, we were able to discern the presence of a fifth latent class to distinguish between low-threshold drug users and old-skool users with greater probability of diverse drug use who did not have high uptake of chemsex drugs. Another analysis by Yu and colleagues (Yu et al., 2014) identified six classes (minimal drug use, recreational drug use, poppers with prescription erectile dysfunction medications, poppers with both prescription and non-prescription erectile dysfunction medications, combination of recreational, club, and erectile dysfunction drug use, and high polydrug use) that were broadly consonant with the ones that we derived. However, they distinguished between prescription use and non-prescription use of erectile dysfunction medications, and split these by brand (i.e. Viagra, Levitra, Cialis), and focused on drug use before sex rather than period prevalence of drug use. In contrast to their findings, our analyses distinguished between low-threshold drug use and old-skool drug use. Two analyses in Malaysian MSM (Lim et al., 2015) and African-American MSM (Tobin et al., 2016) each identified three classes: one with low substance use, one with low-threshold drug use and one with polydrug use. We were able to distinguish more specifically between different types of drug use in our analysis.

Implications for research are several. Similar to other major cross-sectional analyses of UK MSM (Sewell et al., 2017), we found that membership to classes characterised by more and more novel drug use was predicted by increasing levels of sexual risk. Moreover,

consistent with previous analyses (McCarty-Caplan et al., 2014; Yu et al., 2014), this work suggests that it is important to better understand subgroups of MSM in terms of the heterogeneity of drug use patterns and sexual risk. A key opportunity to extend this work is by examining encounter-level latent classes to better understand polydrug combinations used before or during sex. This could offer more fine-grained knowledge about the ways in which specific drug use practices are implicated in sexual risk behaviours. Moreover, future work could account for the relationship between psychosocial variables (e.g. cognitive escape or sensation seeking (Kalichman, Weinhardt, DiFonzo, Austin, & Luke, 2002), or psychopathology) and classes of drug use, or if longitudinal data become available, correlates of movement between latent classes over time (e.g. via latent transition analysis). In addition, given potential differences by location in drug use cultures and practices, future researchers may wish to examine how regional cultures influence typologies of drug use.

Emerging drug use and harm reduction services for MSM in the UK now tend to focus on chemsex (Stuart, 2013) as if this were the only way in which any MSM might use drugs. Our findings also point to the need to consider that drug-related harm may arise from more than the subset of drugs considered ‘chemsex drugs’. In fact, one of the classes identified corresponded to high rates of ecstasy and cocaine use in the last-year. Both of these drugs have their own potential harms, which may not be readily addressed through services targeting chemsex drug users. As drug use services shift towards meeting the needs of chemsex drug users, it is important not to forget the needs of old-skool users, a group more sizeable than either of the two latent classes associated with greater diversity of drug use in the last year. As observed by Rose (1992), the greatest number of cases of a disease may not necessarily occur in the highest-risk (and thus generally small) subgroup or the population, but in the larger medium risk group, even though average risk is lower. Thus, the greatest

number of sexual encounters leading to HIV transmission may well occur in the largest classes, in which prevalence of chemsex drug use was not especially high.

This analysis has several strengths and limitations. It draws on recent data, benefits from a large sample of MSM, and uses robust analytic methods. This analysis was also able to look at a wide range of drugs to characterise subgroups about which little is known. However, this analysis relied on cross-sectional data and, because of the limitations of accessible statistical methods and of the data collected, was unable to jointly consider whether drug use was recent or frequent in the last year, whether drug use was proximal to sex or where relevant was by prescription, nor were we able to distinguish whether relationships between socio-sexual correlates and latent classes were durable to confounding. Because data are cross-sectional, causality cannot be inferred. It is difficult to measure HIV status using a behavioural questionnaire, and thus our use of ‘last HIV test negative’ may be limited by the date of last test and changes in sexual risk behaviour, and HIV serostatus, from that date. Similarly, it is difficult to capture sexual risk in a way that accounts for varying degrees of risk, especially in the context of steady partnerships. Our use of sexual risk within non-steady partnerships was thus a proxy for understanding sexual risk generally. Finally, because this was a community-recruited sample, it is likely that survey participants were more likely to report both drug use and sexual risk than the wider population of MSM living in the UK (Prah et al., 2016).

Conclusion

In our analysis, we were able to discern five distinct drug use subgroups of MSM in the UK and we identified how these relate to key socio-sexual characteristics and other demographic characteristics. This latent class model, like all analyses of its kind, is tentative and should be revisited as cultures and contexts of drug use change over time. However, it points to the need for service providers and clinicians to understand how MSM ‘engage’ with

the full range of drugs both individually and in the context of multiple drug use, and in relation to their social contexts and sexual behaviour.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1. Latent class fit indices

Number of classes	Bayesian information criterion	Scaled relative entropy (%)
2	6580	92.9
3	3596	89.9
4	3004	81.6
5	2674	79.3
6	2401	78.6

Table 2. Latent classes, conditional probabilities and sample prevalence of specific last-year drug use.

	Prevalence in the sample	Class 1: minimal users	Class 2: low-threshold users	Class 3: old-skool users	Class 4: chemsex-plus users	Class 5: diverse users
Poppers	43.4%	20.4%	90.3%	62.5%	89.0%	90.0%
Erectile dysfunction medications	23.4%	11.0%	47.7%	20.2%	88.3%	71.0%
Tranquilisers	7.6%	2.8%	6.4%	13.6%	21.6%	50.3%
Cannabis	26.2%	10.9%	20.4%	75.8%	45.3%	75.8%
Ecstasy	15.4%	0.3%	0.2%	61.6%	43.1%	97.2%
Speed	6.0%	0.04%	0.3%	20.5%	9.5%	54.9%
Mephedrone	10.8%	0.1%	1.7%	23.9%	80.9%	92.1%
GHB	6.4%	0.01%	1.0%	3.7%	67.3%	74.6%
Ketamine	7.4%	0.001%	0.4%	18.4%	32.2%	76.6%
Crystal meth	4.7%	0.1%	1.0%	3.0%	48.6%	51.4%
Cocaine	17.4%	1.3%	6.5%	65.9%	51.3%	92.6%
Probability of membership		64.2%	14.0%	14.0%	3.1%	4.7%

Table 3. Socio-sexual correlates of class membership.

Variable	Distribution in analysis sample	Probability of assignment to class				
		Class 1: minimal users	Class 2: low-threshold users	Class 3: old-skool users	Class 4: chemsex-plus users	Class 5: diverse users
Identity						
Gay	84.4%	59.5%	17.2%	14.4%	3.7%	5.3%
Other	15.6%	68.0%	13.3%	13.9%	1.7%	3.1%
HIV status						
Last test negative	24.0%	43.5%	31.6%	15.8%	4.8%	4.3%
Never tested	8.8%	75.4%	11.8%	10.8%	0.1%	2.0%
Positive	67.2%	3.3%	51.5%	12.4%	31.3%	1.5%
Non-steady partners						
No non-steady partners	26.9%	77.7%	8.4%	11.6%	0.5%	1.7%
Non-steady partner(s), no UAI	38.3%	56.7%	24.2%	15.1%	1.1%	3.0%
1 non-steady partner with UAI	13.1%	44.7%	30.9%	17.6%	2.7%	4.1%
2+ non-steady partners with UAI	21.7%	18.6%	42.2%	16.3%	10.1%	12.7%
Ethnicity						
White	93.2%	64.0%	14.4%	14.0%	2.9%	4.6%
Asian	3.3%	70.8%	10.8%	9.2%	4.0%	5.2%
Black	1.9%	59.0%	7.8%	22.6%	4.3%	6.3%
All others	1.6%	53.5%	15.1%	16.5%	6.6%	8.3%
Education						
Low	33.8%	63.2%	18.9%	11.8%	1.8%	4.3%
Medium	17.7%	64.1%	12.7%	16.1%	2.2%	4.9%
High	48.5%	60.9%	16.6%	13.5%	4.3%	4.8%