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## Types of group sex and their association with sexual risk behaviors among HIV-negative men who have sex with men

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### Abstract

The current study sought to identify types of group sex acts among HIV-negative men who have sex with men (MSM) and assess their association with different sexual risk behaviors using cross-sectional data of group sex acts reported during 6 waves (2015–2018) of the Amsterdam MSM Cohort Study. Latent class analysis was performed to identify group sex types based on size, familiarity with partners, location, planning, and drug use. Associations between group sex types and sexual behaviors were evaluated using logistic regression with generalized estimating equations, employing the sample mean as a reference. Data at the level of group sex acts were analyzed, while correcting variance estimations for repeated measurements within MSM. 392 MSM engaged in group sex 1 times, totaling 1033 group sex acts. Four types of group sex emerged: familiar (29%), intimate (27%), impromptu (36%), and party (8%). Familiar group sex (characterized by high proportions of mostly known partners, occurring in private places and involving drug use) had an increased adjusted odds of risky fingering (aOR=1.6, 95%CI:1.3-2.0) and of risky fisting and/or use of sex toys (aOR=2.3, 95%CI:1.6-3.1). Intimate group sex (characterized by high proportions of threesomes, occurring in private places, and not involving drug use) had a decreased adjusted odds of risky fisting and/or use of sex toys (aOR=0.6, 95%CI:0.4-0.9). Impromptu group sex (characterized by high proportions of spontaneity, mostly unknown partners, and taking place in public places) had a decreased adjusted odds of risky fisting and/or use of sex toys (aOR=0.5, 95%CI:0.3-0.7) and of condomless anal intercourse (CAI)

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(OR=0.6, 95%CI:0.5-0.8). Party group sex (characterized by high proportions of larger groups, mostly unknown partners, and being planned) had an increased adjusted odds of risky fisting and/or use of sex toys (aOR=1.6, 95%CI:1.0-2.7) and of CAI (aOR=1.5, 95%CI:1.1-2.1). The identified types of group sex reflect different dynamics and characteristics, with some types riskier for STIs and others HIV. HIV and STI prevention efforts could be tailored accordingly. For example, in certain type of public sex environments (e.g. cruising parks), traditional HIV and STI prevention efforts, such as promoting of condom use and PrEP, might be sufficient. However, in other settings (e.g. private parties), where group sex is more likely to be planned and where behaviors such as fisting, sharing of sex toys, and CAI are more likely to take place, which carry different levels of risk for HIV and STI transmission, including that of Hepatitis C, different approaches might be needed, such as broader HIV and STI prevention education efforts, or targeting the organizers of group sex events.

### Keywords

group sex; collective sex; HIV; sexually transmitted infections; men who have sex with men

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### Introduction

Gay, bisexual and other men who have sex with men (MSM) are at high risk of acquiring HIV and other sexually transmitted infections (STIs) (HIV/AIDS surveillance in Europe 2018 (2017 data), 2018; Sexually transmitted infections in Europe 2013, 2015). Group sex among MSM is a sexual behavior that is generally assumed to involve increased risk due to the opportunity to engage in many different sexual acts with different partners within a short period of time. This can enhance the probability of transmission of HIV and other STIs (Callander et al., 2019; Grov, Rendina, Ventuneac, & Parsons, 2013; E. Meunier and Siegel, 2019; G. P. Prestage, Hudson, Down, et al., 2009). Engaging in group sex has also been found to be associated with drug use (Hirshfield et al., 2015; G. Prestage, Grierson, Bradley, Hurley, & Hudson, 2009), which has been shown to increase sexual risk behavior (Rehm, Shield, Joharchi, & Shuper, 2012; Shuper et al., 2010). An internet-based survey of 7,158 MSM found that men who engaged in group sex had significantly higher polydrug use and sexual risk behavior than did the men not reporting group sex (Hirshfield, et al., 2015). MSM engaging in group sex have reported levels of condomless anal intercourse (CAI) ranging from 25%–55% (Mimiaga et al., 2010; Mimiaga et al., 2011; Phillips et al., 2014; G. P. Prestage, Hudson, Jin, et al., 2009; Rosenberger et al., 2011).

However, a recent analysis of data from the Amsterdam MSM Cohort Study (ACS) compared reports from men who engaged in both group and dyadic sex to those who only engaged in dyadic sex events, and found group sex behavior to be less risky than often assumed (van den Boom et al., 2016). Specifically, men were more likely to use condoms during group sex than dyadic sex. However, men who engaged in both group and dyadic sex had higher levels of gonorrhea. These findings suggest that group sex encounters might be more nuanced than they are commonly conceptualized. Other qualitative research on group sex events support this assumption that group sex encounters are varied, with distinct types of participants and collective norms about what constitutes acceptable behaviors (Frankis

and Flowers, 2009; É. Meunier, 2018). Therefore, we wanted to explore whether group sex encounters exist as distinct sexual settings according to a range of characteristics. Should we be able to identify different types of group sex settings, we were then interested in exploring whether there are varying levels of risk in these different settings.

The nature of this inquiry is supported by existing theory about the individual and collective factors that govern behavior in sexual encounters, such as social norms theory. Individual norms (an individual's standards of behavior) and collective norms (perceived standards of behavior in a group or context, e.g., descriptive norms) have been shown to influence sexual behavior (McKechnie, Bavinton, & Zablotska, 2013). Research suggests that in the context of certain places where group sex occurs, such as circuit parties or sex clubs, men are more willing to engage in behavior they perceive to be normative in that context, and at least temporarily, de-prioritize their other individual norms (Ghaziani and Cook, 2005; Melendez-Torres and Bonell, 2017; van den Boom et al., 2015). Qualitative interviews on perceived collective norms among MSM recruited from private sex parties in New York City showed that collective norms in group sex encounters were perceived to varied widely depending on the context (e.g. spontaneous sex parties compared to specifically designated 'bareback' parties) (É. Meunier, 2018).

There are several dimensions on which group sex varies that have been described in the literature; for example, the number of people involved, whether and how the participants know each other, and where the group sex takes place (Elwood, Greene, & Carter, 2003; É. Meunier, 2018). Additional dimensions on how group sex varies include whether it was planned or spontaneous (Rosenberger, et al., 2011), and whether the participants engaged in substance use before or during the group sex encounters (Hirshfield, et al., 2015; G. Prestage, et al., 2009).

These factors could also influence sexual risk behavior during a group sex event. For example, familiarity and intimacy have been found influence sexual risk behavior among MSM in both steady (Darbes, Chakravarty, Neilands, Beougher, & Hoff, 2014; Davidovich, de Wit, & Stroebe, 2000, 2004; Hoff, Chakravarty, Beougher, Neilands, & Darbes, 2012; Starks, Gamarel, & Johnson, 2014), and casual relationships (van den Boom, Stolte, Sandfort, & Davidovich, 2012). Also, substance use is a known risk factor for increased sexual risk behavior (Rehm, et al., 2012; Shuper, et al., 2010). Number of partners, familiarity with partners, and drug use prior to have sex have been as studied event-level predictors of sexual risk behavior (Knox et al., 2019; Sandfort, Yi, Knox, & Reddy, 2013; van den Boom, et al., 2012). We also hypothesized that prior planning might predict sexual risk behavior during group sex as it could facilitate certain sexual behaviors, like providing opportunity for sex toys or condoms to be on hand. Other research has shown that location and environment influence sexual risk behavior (Drumright, Weir, & Frost, 2018; Passaro et al., 2019; van den Boom, et al., 2015). Therefore, we also hypothesized that that certain locations might predict sexual risk behavior. For example, outdoor locations, such as parks or cruising areas, might not be as conducive to certain sexual behaviors compared to a private home or an organized public sex location with better facilities.

Therefore, the aims of the present study are to try and identify discernible types of group sex behavior (group sex acts were characterized by number of partners, familiarity with the partners, location where group sex took place, whether it was planned and whether it involved drug use excluding alcohol) among MSM within the ACS who engaged in group sex over a 3-year period (2015–2018). We then investigate whether types of group sex are associated with different sexual risk behaviors (barrierless and shared receptive fingering, fisting and/or use of sex toys and (insertive and receptive) CAI).

## Methods

### Study procedures

The ACS among MSM, which started in 1984, is an open on-going prospective cohort study to investigate the epidemiology, psycho-social determinants of sexual risk, course of infection, and pathogenesis of HIV and other blood-borne and sexually transmitted infections, and to evaluate the effect of interventions among HIV-negative and HIV-positive MSM (van Griensven, de Vroome, Goudsmit, & Coutinho, 1989). Men are eligible to participate in the study if they are living in or around Amsterdam and have had at least one male sexual partner in the preceding 6 months. Men are recruited into the ACS by convenience sampling (e.g., brochures at STI clinics, advertisements in gay periodicals) and chain referral sampling (Jansen et al., 2011).

Participants visit the Public Health Service of Amsterdam every 6 months to complete a self-administered questionnaire regarding their sexual behavior in the preceding 6 months. At each study visit, blood is drawn to test for HIV. HIV-antibodies testing is done using two commercially available enzyme-linked immunosorbent assays (AxSYM; Abbot Laboratories, North Chicago, IL, USA; Vironostika, Organon Teknika, Boxtel, the Netherlands).

### Ethical approval

The ACS is approved by the Medical Ethical Committee of the University Medical Center, University of Amsterdam, the Netherlands (MEC 07/182).

### Study sample

We used data from six data waves (either the initial enrollment interview or a repetition of the questionnaire, which takes place every 6 months) of the ACS collected between 2015 and 2018. For this study sample, we selected all group sex acts reported during this period by MSM who were HIV-negative at the time of interview. As reported in the previous analyses of group sex among MSM in the ACS, men who reported both group sex and dyadic sex compared to just dyadic sex were significantly older, were more likely to have a steady partner and had more casual sex partners in the preceding six months (van den Boom, et al., 2016).

## Measures

**Outcome measures:** Three sexual behaviors were considered as outcome measures. They were selected because they conferred risk of HIV or other STI transmission to the respondent.

**Risky fingering:** Participants were identified as having engaged in risky fingering if they reported that their partner(s) had fingered them without using a glove or with glove(s) that had been used with another man specific to their last group sex act.

**Risky fisting and/or use of sex toys:** Participants were identified as having engaged in risky fisting and/or use of sex toys if they reported that their partner(s) had fisted them without using glove(s) or with glove(s) that had been used with another man, and/or if their partner(s) had put sex toy(s) in their anus that had been used with another man specific to their last group sex act.

**Condomless anal intercourse (CAI):** Participants were asked whether they had practiced insertive and/or receptive anal sex during group sex in the preceding 6 months and whether a condom was used during group sex (ranging from ‘never’ to ‘always’ on a 5-point scale). CAI was defined as anything from never to not always using condoms.

### **Independent variables:**

**Characteristics of group sex:** Group sex was defined as a sexual encounter that involved more than one sexual partner (casual or steady). Participants were asked about the characteristics of their last group sex act, including: 1) how many men the group consisted of, which was categorized into threesomes, 4-5 men and 6+ men; 2) if the group consisted of mostly known people, mostly unknown people or as many known as unknown; 3) where the group sex took place: outdoors (e.g. park, track), inside public (e.g. sauna, sex club) or inside private (e.g. home, at others house, hotel). Outdoors and inside (public) were combined into a public/private group; 4) how the group sex came about, whether it was unplanned (spontaneous) or planned (e.g. by invitation, announcement, etc.). Participants also reported on drug use in the past 6 months, including if they engaged in drug use during group sex. Drug use included the following drugs (i.e., amphetamines (speed, PEP, amph, apple speed), anabolic steroids, antidepressants (not as prescribed), benzodiazepines (valium, oxazepam) (not as prescribed), 2-CB, cocaine, DHEA, erection agents (Viagra, Sildenafil, Tadalafil, Cialis, Vardenafil, Levitra), GHB, GBL, hash / weed, heroin, ketamine (special K), mushrooms, LSD, mephedrone (meow meow), methylamphetamine, non-heroin opiates (oxycontin, methadone), poppers, Ritalin, testosterone, XTC (ecstasy), or other drugs that the participant specified). Alcohol use was assessed but not included because it was ubiquitous.

**Co-variables:** Co-variables included age, educational level, born in the Netherlands (yes/no), living in Amsterdam (yes/no) and exclusively homosexual (yes/no). Age was treated continuously. Educational level was considered “high” with completion of higher vocational education or university, and “middle and low” with completion of secondary vocational education, high school, basic vocational education, or primary school.

**Statistical analyses:** For all analyses, we considered data at the level of group sex act. When reporting data, we refer to group sex acts by  $n$  and number of participants as  $N$ .

We employed latent class analysis (LCA) to identify specific types of group sex (Bartholomew, Knott, & Moustaki, 2011). In brief, we considered an LCA model for characteristics during group sex,  $x$ . These variables included the following: group size (dichotomous indicator variables), constitution of known partners (dichotomous indicator variables), location (dichotomous), whether it was planned (dichotomous), and presence of drug-use (dichotomous). Huber/White/sandwich variance estimations were used to correct for the repeated observations within individuals. We let the categorical latent variable  $c$  have  $K$  classes ( $k=1, 2, \dots, K$ ). A latent class model was employed, whereby (i) the conditional item probabilities for each class and (ii) class probabilities were estimated. The conditional probability of each variable given latent class  $k$  was modeled by an intercept,  $\alpha_{xk}$ , specific to  $x$  and class  $k$ . Models were estimated using maximum likelihood, which was calculated by summing all conditional likelihoods of each latent class multiplied by the associated latent class probabilities. The posteriori probability of a group sex act  $i$  belonging to each class  $k$ ,  $\pi_{ik}$ , was determined from this likelihood. Participants were then assigned a latent class  $k$  corresponding to the highest probability  $\pi_{ik}$ . In order to determine the number of clusters  $K$ , models with consecutively increasing numbers of latent classes were run and compared using Bayesian Information Criteria (BIC). We selected the model with the lowest BIC. Marginal probability distributions of each variable were calculated across latent classes using this model. The degree to which classes were correlated within the same individual across study waves was examined using an intraclass correlation (ICC), as estimated from a one-way analysis of variance modeling between individual and within individual variance. Models were estimated using the ‘gsem’ command in STATA, while posteriori probabilities were obtained from the ‘predict’ postestimation commands.

Binomial logistic regression models were used to investigate the association between assigned group sex type and three sexual risk behavior outcomes separately: 1) risky fingering, 2) risky fisting and/or use of sex toys, 3) CAL. These outcomes were not modeled directly in the LCA model because we were interested in how group sex types differed in terms of levels of sexual risk. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated from these models. Rather than identifying an arbitrary reference group, ORs were calculated in reference to the sample mean. Generalized estimating equations (GEE) were used to account for within-participant correlation of repeated behavioral measures over time, assuming an unstructured correlation matrix. We report OR both unadjusted and adjusted for age (continuous) and country of birth (in the Netherlands versus outside the Netherlands). Significance was determined using a  $p$ -value  $<0.05$ . All analyses were performed with STATA (v15.0, College Station, TX, USA).

## Results:

In total,  $N=392$  MSM who were HIV-negative at the time of interview reported group sex during this period. At first cohort visit (Supplementary Table 1), participants had a median age of 41 (IQR=33-48) at the time of the survey in which they reported their first group sex event, and the majority had an educational level of college degree or higher (77%).



Participants had a total of  $n=1033$  visits at which they reported having group sex in the preceding 6 months. Participants contributed an average of 2.6 group sex events (out of a maximum of 6 reportable events) during the study period;  $N=139$  (35%) reported 1 event,  $N=76$  (19%) reported 2 events,  $N=63$  (16%) reported 3 events,  $N=48$  (12%) reported 4 events,  $N=35$  (9%) reported 5 events, and  $N=31$  (8%) reported 6 events.

LCA using group sex characteristics revealed 4 types of group sex ( $BIC=7682.7$ , compared to  $BIC=7718.0$  and  $BIC=7768.9$  with three and two latent classes, respectively). Table 1 shows the distribution of the group sex characteristics of group sex acts across the 4 types, which we labeled as follows: familiar (29%,  $n=303$ ), intimate (27%,  $n=279$ ), impromptu (36%,  $n=370$ ), and party (8%,  $n=81$ ). The first group, termed “familiar” group sex, was characterized by high proportions of mostly known partners (65%), occurring in private places (98%) and involving drug use (94%). The second group, termed “intimate” group sex, was characterized by high proportions of threesomes (95%), occurring in private places (97%) and not involving drug use (60%). The third group, termed “impromptu” group sex, was characterized by high proportions of spontaneity (98%), mostly unknown partners (81%) and taking place in public places (76%). The final group, termed “party” group sex, was characterized by high proportions of larger groups (i.e. 6+ men) (82%), mostly unknown partners (89%) and being planned (78%). Of the 253 individuals reporting more than one group sex act, 104 (41%) were identified with the same group sex class throughout follow-up, while these individuals reported slightly lower average number of total group sex acts (3.1) compared to those identified with different group sex classes throughout follow-up (3.8,  $p<0.001$ ). The ICC for the correlation of classes attributed within individuals was 0.47.

Table 2 shows the distribution of participant characteristics according to group sex type. The median age of participants by group sex type was 42 (IQR:36-49) in familiar group sex acts, 39 (IQR:31-45) in intimate group sex acts, 44 (IQR:38-50) in impromptu group sex acts, and 46 (IQR:37-51) in party group sex acts; a statistically significant difference ( $p<0.001$ ). The proportion of participants born in the Netherlands by group sex type was 84% in familiar group sex acts, 89% in intimate group sex acts, 85% in impromptu group sex acts, and 67% in party group sex acts; a statistically significant difference ( $p<0.001$ ). The proportion of participants that were exclusively homosexual by group sex type was 85% in familiar group sex acts, 82% in intimate group sex acts, 85% in impromptu group sex acts, and 67% in party group sex acts; a statistically significant difference ( $p=0.001$ ).

We subsequently assessed whether group sex types were associated with sexual risk behaviors during group sex. Participants engaged in sexual risk behaviors during group sex events at the following frequencies: 40% ( $n=412$ ) risky fingering, 10% ( $n=107$ ) risk fisting and/or use of sex toys, 26% ( $n=266$ ) CAI. Table 3 shows the distribution of the sexual risk behaviors, and the unadjusted and adjusted odds of each respective risk behavior by group sex type, compared to the sample mean. Familiar group sex had an increased adjusted odds of risky fingering (aOR=1.6, 95%CI:1.3-2.0) and of risky fisting and/or use of sex toys (aOR=2.3, 95%CI:1.6-3.1). Intimate group sex had a decreased adjusted odds of risky fisting and/or use of sex toys (aOR=0.6, 95%CI:0.4-0.9). Impromptu group sex had a decreased adjusted odds of risky fisting and/or use of sex toys (aOR=0.5, 95%CI:0.3-0.7) and of condomless anal intercourse (CAI) (OR=0.6, 95%CI:0.5-0.8). Party group sex had an

increased adjusted odds of risky fisting and/or use of sex toys (aOR=1.6, 95%CI:1.0-2.7) and of CAI (aOR=1.5, 95%CI:1.1-2.1).

## Discussion:

In the current study, we identified four types of group sex with distinct characteristics and found that they were differentially associated with sexual risk behaviors, further demonstrating that group sex encounters should be recognized as distinct sexual settings with specific risk characteristics.

We confirmed previous findings that group sex events involved considerable sexual risk behavior, particularly with regards to fingering (39%) and CAI (26%). The frequency of CAI that we observed was within the range of CAI reported among MSM engaging in group sex from previous studies (25%–55%) (Mimiaga, et al., 2010; Mimiaga, et al., 2011; Phillips, et al., 2014; G. P. Prestage, J. Hudson, F. Jin, et al., 2009; Rosenberger, et al., 2011). We also found that certain group sex types (familiar and intimate) were associated with behaviors that would be risky for transmitting STIs (risky fingering or risky fisting and/or use of sex toys). Other types of group sex (impromptu and party) were associated with behaviors that would be risky for transmitting STIs and HIV (CAI). These findings suggest that further research should consider the context of group sex in order to better characterize its associated risks of HIV and STI transmission. Indeed, variation between studies regarding levels of certain risk behaviors could be related to differences between samples in the distribution of different types of group sex. Therefore, future research should also take into consideration the distribution of different types of group sex as variation in the frequency in these types will yield different risk patterns. In all, the current findings further explicate recent findings showing that group sex encounters are distinct sexual settings with specific risk characteristics (van den Boom, et al., 2016).

We also found that certain person-level characteristics were associated with certain types of group sex. Specifically, there were lower proportions of exclusively homosexual men and men born in the Netherlands that reported party group sex events. Also, respondents who reported party group sex events had the highest median age and respondents who reported familiar group sex events had the lowest median age. This suggests that certain types of individuals are more likely to engage in certain types of group sex. However, our findings that group sex types were associated with sexual risk behavior when controlling for these person-level characteristics also provide empirical support for theory, such as social norms theory (McKechnie, et al., 2013), which helps explain why men might be more willing to engage in behaviors that they perceive to be normative in a particular context, thus allowing themselves to be influenced by descriptive norms (Ghaziani and Cook, 2005; Melendez-Torres and Bonell, 2017; van den Boom, et al, 2015). This is supported by other research showing that perceived collective norms, or descriptive norms, vary in group sex settings, as well as men's perceived ability to communicate about those norms (É. Meunier, 2018).

We are able to hypothesize about specific reasons for the observed associations between group sex types and sexual risk behaviors. For example, familiar group sex was positively associated with risky fisting and/or use of sex toys. The fact that the men in these encounters



were likely to know each other and mostly had sex in private places could have led these men to feel more comfortable taking a certain level of risk with each other (although this group did not have higher levels of CAI). It is also likely that these men could have communicated about their desires in advance, such as enjoying fisting or using sex toys, and they could prepare accordingly, i.e. by bringing sex toys with them, or having sex toys on premises. Engaging in drug use also heightens the probability of being able to endure more intensive sexual practices, such as fisting or the use of sex toys. Intimate group sex, which was mostly threesomes and had lower levels of drug use, was negatively associated with risky fisting and/or use of sex toys. Having less frequent drug use might lower the probability of men being able to endure these more intensive sexual practices. In addition this group is not characterized by knowing the other group sex partners, which might lower the probability of being able to prepare for these more intensive sexual practices. Also, being in a smaller group might increase accountability towards each other and perceptions of social control during the group sex encounter, which could facilitate condom use. Impromptu group sex was negatively associated with CAI. Impromptu group sex was characterized by sexual partners who were mostly unknown to each other, that met spontaneously and in public places, which suggests contexts such as cruising parks and other public meeting places. These are situations where men might be passing by in search of quick, spontaneous sex. Without privacy or facilities (beds, sanitary conditions), lighter forms of sex that can be performed quickly and more easily (e.g., while standing), such as oral sex or mutual masturbation, could be more common, and more intensive sexual practices, like CAI, less common. Lastly, party group sex was positively associated with CAI. Party group sex emerged as a distinct type of group sex that was more often planned, with higher numbers of mostly unknown partners. This type of group sex likely characterizes many sex parties that occur in clubs, saunas, or other venues. These facilities often have beds, cabins, or private areas, as well as sanitary facilities (e.g. showers) that are better suited for anal sex, which then could be condomless. Qualitative research is needed to further corroborate these assumptions, and to explore other possible explanations for the observed associations.

There are certain limitations to the current study. First, one of the outcome variables, CAI was measured during all group sex acts over the past 6 months, and may not have occurred during the last group sex act. This implies that the different types of group sex would be associated with certain behavioral outcomes, in general, and not specifically during group sex. In addition, pre-exposure prophylaxis (PrEP) use was not considered in this study. In the ACS, recent use of PrEP was measured and reported by only 2% of the cohort in 2015 and then by 7% of the cohort in the first half of 2017 (Coyer et al., 2018). Since overall PrEP uptake was low in the ACS at the time the data for this study was collected, and probably similarly low among MSM in Amsterdam, we assume that the overall effect of PrEP use on cluster membership and sexual risk behavior would be limited. However, future research should definitely measure PrEP use as it significantly lowers the risk of HIV transmission, although not STTs. Lastly, participants were not asked about oral sex during group sex, even though it also carries risk for STI transmission. Further research should consider this important sexual behavior.

Study limitations are offset by several strengths. The study capitalized on a large and rigorously assessed sample of MSM from a prospective cohort, the ACS. The ACS has high retention rates and detailed assessment of group sex at multiple waves over a 3-year period. The current study advances our understanding of group sex behavior by having provided greater attention to the context of group sex and to the specific features of group sex behavior (E. Meunier, 2014; E. Meunier, Escoffier, & Siegel, 2019; E. Meunier and Siegel, 2018). By further characterizing distinct patterns of sexual behavior within group sex, we further dispel notions that group sex is inherently risky (Frank, 2019; E. Meunier, et al., 2019). Rather, we demonstrate that further research and HIV and STI prevention efforts need to consider the context of group sex in order to more effectively promote risk reduction. Specifically, regarding intervention efforts, in certain type of public sex environments (e.g. cruising parks), traditional HIV and STI prevention efforts, such as promoting of condom use and PrEP, might be sufficient. However, in other settings (e.g. private parties), where group sex is more likely to be planned and where behaviors such as fisting, sharing of sex toys, and CAI are more likely to take place, which carry different levels of risk for HIV and STI transmission, including that of Hepatitis C, different approaches might be needed, such as broader HIV and STI prevention education efforts, or targeting the organizers of group sex events.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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**Table 1:**

Distribution of group sex characteristics across types of group sex

		<b>Familiar Known partners Private places Drug use</b>	<b>Intimate Threesomes Private places Low drug use</b>	<b>Impromptu Spontaneous Unknown partners Public places</b>	<b>Party Large groups Planned Unknown partners</b>
n <sup>I</sup> %		303 29%	279 27%	370 36%	81 8%
Group size	Threesome 4-5 men 6+ men	37% 35% 28%	<b>95%</b> 5% 0%	47% 45% 8%	0% 18% <b>82%</b>
Known partners	Same known and unknown Mostly known Mostly unknown	35% <b>65%</b> 0%	54% 23% 23%	2% 17% <b>81%</b>	0% 11% <b>89%</b>
Location	Public Private	2% <b>98%</b>	3% <b>97%</b>	<b>76%</b> 24%	52% 48%
Planned	Spontaneous Planned	32% 68%	51% 49%	<b>99%</b> 1%	22% <b>78%</b>
Drug use	No drugs Drugs	6% <b>94%</b>	<b>60%</b> 40%	33% 67%	23% 77%

Percentages are marginal estimates obtained from the latent class model.

<sup>I</sup>n in this table represents number of group sex events (total of 1033 events occurring in 392 participants)

**Table 2:**

Distribution of participant characteristics according to group sex type

	<b>Familiar Known partners Private places Drug use</b>	<b>Intimate Threesomes Private places No drug use</b>	<b>Impromptu Spontaneous Unknown partners Public places</b>	<b>Party Large groups Planned Unknown partners</b>	$p^2$
n <sup>1</sup>	303 29%	279 27%	370 36%	81 8%	
Median (IQR) age	42 (36-49)	39 (31-45)	44 (38-50)	46 (37-51)	<0.001
% born in the Netherlands	84%	89%	85%	67%	<0.001
% with university degree or higher	80%	82%	83%	75%	0.38
% residing in Amsterdam	78%	83%	81%	81%	0.55
% exclusively homosexual	85%	82%	85%	67%	0.001

This table concerns data on participants each time they reported a group sex act. Some participants reporting multiple group sex acts over the course of follow-up could belong to more than one group.

<sup>1</sup> n in this table represents number of group sex events (total of 1033 events occurring in 392 participants)

<sup>2</sup> Overall significance determined from Pearson's  $X^2$  test for categorical variables or Kruskal-Wallis test for continuous variables.

**Table 3:**

Frequency of group sex risk behaviors and associated odds with type of group sex

Risky (receptive) fingering					
GS class	% <sup>1</sup>	Unadjusted		Adjusted <sup>2</sup>	
		OR (95% CI)	P	OR (95%CI)	P
Familiar	54%	<b>1.6 (1.3-1.9)</b>	<b>&lt;0.0001</b>	<b>1.6 (1.3-2.0)</b>	<b>&lt;0.0001</b>
Intimate	33%	0.8 (0.7-1.1)	0.1461	0.8 (0.7-1.1)	0.1616
Impromptu	33%	0.8 (0.7-1.1)	0.0648	0.8 (0.6-1.0)	0.0518
Party	40%	0.9 (0.7-1.3)	0.7022	0.9(0.7-1.3)	0.7326
Risky (receptive) fisting and or sex toys					
GS class	% <sup>1</sup>	Unadjusted		Adjusted <sup>2</sup>	
		OR (95% CI)	P	OR (95%CI)	P
Familiar	24%	<b>2.0 (1.5-2.8)</b>	<b>&lt;0.0001</b>	<b>2.3 (1.6-3.1)</b>	<b>&lt;0.0001</b>
Intimate	4%	<b>0.6 (0.4-0.9)</b>	<b>0.0126</b>	<b>0.6 (0.4-0.9)</b>	<b>0.0271</b>
Impromptu	2%	<b>0.5 (0.4-0.8)</b>	<b>0.0031</b>	<b>0.5 (0.3-0.7)</b>	<b>0.0006</b>
Party	16%	1.6 (0.9-2.5)	0.0635	<b>1.6 (1.0-2.7)</b>	<b>0.0486</b>
CAI					
GS class	% <sup>1</sup>	Unadjusted		Adjusted <sup>2</sup>	
		OR (95% CI)	P	OR (95%CI)	P
Familiar	31%	1.1 (0.9-1.4)	0.2515	1.1 (0.9-1.4)	0.2389
Intimate	24%	1.0 (0.8-1.2)	0.8032	1.0 (0.8-1.2)	0.8281
Impromptu	21%	<b>0.6 (0.5-0.8)</b>	<b>0.0001</b>	<b>0.6 (0.5-0.8)</b>	<b>&lt;0.0001</b>
Party	36%	<b>1.5 (1.1-2.1)</b>	<b>0.0191</b>	<b>1.5 (1.1-2.1)</b>	<b>0.0188</b>

GS=group sex, CAI=condomless anal intercourse, OR=odds ratio, CI=confidence interval

<sup>1</sup>.% in this table represents the percentage of group sex events during which the outcome was reported (from a total of 1033 events occurring in 392 participants)

<sup>2</sup>.Adjusted for age (continuous) and born in the Netherlands.