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The Demographic and Psychological Moderators to the Associations Between Geosocial Networking Apps (GSNA) Use and Risky Sexual Behaviors Among US Young Adults

Minhao Dai[1]

Abstract

Introduction Previous literature has established positive associations between geosocial networking apps (GSNA) use and risky sexual behaviors. The current study seeks to confirm such associations and further explore the potential demographic and psychological moderators of such relationships.

Methods The current study conducted a cross-sectional survey with young adults ($n = 680$) in the USA. We tested the main and interaction effects of age, sex, relationship status, Greek affiliation, sociosexuality, sexual compulsivity, and sexual sensation seeking, while controlling for race, sexual orientation, and college student status.

Results The results showed that GSNA use was significantly associated with having three or more sexual partners, having more hookups, and having condomless sex within the last 6 months. Furthermore, moderated regression models showed that age, being male, being single, being in a Greek organization, sociosexuality, sexual compulsivity, and sexual sensation seeking moderated the relationships between GSNA use and different risky sexual behavioral outcomes. The GSNA use was not associated with having an STI in the last year, potentially due to under-testing and under-reporting of STI.

Conclusions GSNA use has magnifying effects on risky sexual behaviors among younger single males. The relationships between GSNA and risky sexual behaviors might be more prominent among certain individuals, such as those who are sociosexually unrestricted, sexually compulsive, and sexual sensation seekers.

Policy Implications Some risk-reduction messages promoting condom use and regular STI testing could be strategically placed on GSNA to target those susceptible GSNA users, an effective strategy for GSNA primarily used among men who have sex with men.

Keywords Geosocial networking apps (GSNA) · Risky sexual behaviors · Demographic moderators · Psychological moderators · Sociosexuality · Sexual compulsivity · Sexual sensation seeking

Between 2017 and 2018, cases of three major sexually transmitted infections (STIs) steadily increased in the USA. For example, syphilis cases increased by 71%, chlamydia cases increased by 19%, and gonorrhea cases increased by 63% (Centers for Disease Control and Prevention [CDC], 2019). More than half of all STI cases occur in people 24 years of age or younger in the USA (CDC, 2019). This group of adolescents and younger adults "are at higher risk of acquiring STDs for a combination of behavioral, biological, and cultural reasons" (CDC, 2018). Previous research has linked these rapidly growing rates of STIs among younger adults to online partner-seeking behaviors (Tsai et al., 2019), especially to the geosocial networking apps (GSNA) use (Rogge et al., 2020). GSNA have become increasingly popular, especially among younger adults (Rogge et al., 2020). For example, it was estimated that GSNA use was responsible for an average of 16% increase in the HIV infection rate in the USA (Chan & Ghose, 2012). Most GSNA before 2012 largely served the men who have sex with men (MSM) population until the release of Tinder (Greenfield, 2013). GSNA targeting younger adults have swept the market with popularity. According to a US national survey (Statista, 2018), approximately 38%

✉ Minhao Dai
  mdai@kennesaw.edu

1 School of Communication and Media, Radow College of Humanities and Social Sciences, Kennesaw State University, Kennesaw, GA, USA

of adults between 18 and 34 have reported using GSNA in the USA. The most popular app among all was Tinder. Tinder, released in late 2012, now estimates 50 million users and 10 million active members who use it daily. Reportedly, 36% of Tinder users reported engaging in casual sex with other users through Tinder in 2016 (Statista, 2018). Arguably, GSNA dramatically changed the perceptions of dating and sex, especially among younger heterosexual adults. Thus, the current study examines the positive associations between GSNA use and risky sexual behaviors among younger adults, which the previous literature has established (Choi et al., 2016a, b; Rogge et al., 2020; Sawyer et al., 2018). More importantly, the current study expands the current literature by exploring the potential demographic and psychological moderators to the associations between GSNA use and risky sexual behaviors.

GSNA Use and Risky Sexual Behaviors

While a systematic review (Tsai et al., 2019) concluded that only half of the reviewed studies supported the positive associations between general online partner-seeking and increased sexual risks (i.e., condomless sex and STI status), more recent studies (Choi et al., 2016a, b; Rogge et al., 2020; Sawyer et al., 2018; Tomaszewska & Schuster, 2020) supported such positive correlations. Several previous articles examining this topic studied the MSM population (Beymer et al., 2014; Landovitz et al., 2012; Lehmiller & Ioerger, 2014; Rice, 2012). Specifically, MSM who reported higher involvement with GSNA reported more risky sexual behaviors. For example, Beymer et al. (2014) found that MSM who used hookup apps for sexual encounters had higher odds of testing positive for gonorrhea and chlamydia than MSM who met partners using in-person methods only. Recent studies on this topic have been expanded to the overall younger adult population, given the large user pool of GSNA and the increased risky sexual behaviors among younger adults (Choi et al., 2016a; Dai, 2021; Rogge et al., 2020). For example, Choi et al. (2016a) surveyed 666 younger adults living in Hong Kong and found that the use of dating apps was significantly associated with condomless sexual intercourse with casual partners. In another example, Rogge et al. (2020) surveyed a large sample of 3180 adults in the USA and found that the quantity of GSNA use venues (i.e., how many different GSNA the participants used) was associated with six risky sexual behavior measures. These measures included "having three or more sex partners in the last year, having hookups in the last 2 months, having hookups involving alcohol or drug use, condomless sexual activity with new partners in the last 2 months, and ever having had a sexually transmitted infection" (Rogge et al.,

2020, p. 1263). Based on the previous literature, the current study proposes the following hypotheses:

> H1: Younger adults who are active users of GSNA will report more risky sexual behaviors than those who are not.
> H2: More frequent uses of GSNA will be positively associated with more risky sexual behaviors among younger adults.

Potential Moderators

The current study seeks to examine the potential moderators to the associations between GSNA use and risky sexual behaviors among younger adults. Identifying these moderators could tell us among whom GSNA use is most strongly associated with risky sexual behavior outcomes. For example, suppose we know that GSNA use and sexual behavior are more strongly related for some groups than for others among younger adults. In that case, we may be able to better target interventions and public health resources. The past literature has focused on demographic moderators and psychological moderators.

Demographic Moderators

Based on a systematic review of studies on online partner seeking and increased sexual risk (Tsai et al., 2019), age and sex were crucial to examine as moderators in this context as women are at higher risks for psychological consequences associated with risky sexual behaviors (Tsai et al., 2019). The literature has noted there are significant differences in some of the risky sexual behaviors, namely hook up, between men and women (Dai et al., 2018; Owen et al., 2010). More importantly, the previous literature showed significant differences in the motives of using GSNA between men and women (Griffin et al., 2018; Sumter et al., 2017). Specifically, both previous studies noted that men were more likely to be motivated to use GSNA for casual sex and thrill of excitement. If men were more likely to use GSNA for casual sex purposes, the relationships between GSNA uses and risky sexual behavioral outcomes might be stronger among men than women. Second, another important demographic moderator to explore is relationship status. It is estimated that between 18 and 25% of Tinder users are in committed relationships (Timmermans et al., 2018). Non-single Tinder users were more motivated to use Tinder to "have one-night stands and casual sexual relationships with other Tinder users compared to single Tinder users" (Timmermans et al., 2018, p. 129). Thus, higher GSNA use combined with these stronger motivations to seek high-risk sexual interactions might lead to more risky sexual behaviors among

non-single users. Lastly, Greek organization affiliation has been established to be associated with more risky health behaviors, such as more sexual partners and sex under the influence of alcohol or drugs (Eberhardt et al., 2003; Scott-Sheldon et al., 2008). Using GSNA more could potentially give Greek members, who are already prone to have riskier sex, more opportunities and ease of access to further engage in risky sexual behaviors. However, as the literature lacks the direct evidence to support such moderating relationships, we ask a research question. Thus, in attempts to explore these demographic moderators, the current study proposes the following research question:

> RQ1: How would (a) age, (b) sex, (c) relationship status, and (d) Greek affiliation influence the positive associations between GSNA use and risky sexual behaviors among younger adults?

Psychological Moderators

Three individual differences in psychological factors are closely related to GSNA use and risky sexual behaviors, especially among adolescents and younger adults; namely, sociosexuality, sexual compulsivity, and sexual sensation seeking. Attitudes toward sex, specifically casual sex, are still rapidly changing among younger heterosexual adults, as casual sex was being viewed as a taboo to now normatively acceptable (Garcia et al., 2012). Sociosexuality refers to "the overall orientation toward uncommitted sexual activity" (Botnen et al., 2018, p. 68), and more unrestricted individuals in sociosexuality are more willing to engage in casual sex without love, commitment, or closeness (Simpson & Gangestad, 1991). Sociosexuality is directly associated with GSN app uses, as GSNA users reported being less restricted in their sociosexuality than those who did not use GSNA (Botnen et al., 2018; Sevi et al., 2018). Moreover, sociosexuality is associated with more risky sexual behaviors (Vrangalova & Ong, 2014; Zheng & Zheng, 2014). Those who use GSNA more might be more sociosexually unrestricted, and those who are sociosexually unrestricted might use GSNA more, and we know both variables are associated with more risky sexual behaviors, so it is reasonable to assume these two factors would interact with each other to be associated with even more frequent risky sexual behaviors. Thus, we propose the following hypothesis:

> H3: Sociosexuality would positively moderate the positive associations between GSNA use and risky sexual behaviors among young adults.

Sexual compulsivity is defined as "an insistent, repetitive, intrusive, and the unwanted urge to perform specific acts often in ritualized or routinized fashions" (Kalichman & Rompa, 1995, p. 587). Sexual sensation seeking is defined as the "propensity to prefer exciting, optimal, and novel

stimulation or arousal" in sexual experiences (Kalichman et al., 1994, p. 387). The associations between individual differences in both factors and risky sexual behaviors, especially high HIV-risk behaviors, have been well established in the current literature (Dodge et al., 2004; Grov et al., 2010; Gullette & Lyons, 2005; Kalichman & Cain, 2004; Kalichman & Rompa, 1995; Mashegoane et al., 2002). For example, younger college students who reported higher sexual compulsivity scores or sexual sensation seeking scores engaged more in unprotected oral, vaginal, and/or anal sex in the last 3 months and had more sexual partners (Dodge et al., 2004; Mashegoane et al., 2002). Although the links of GSNA use with sexual compulsivity and sensation seeking have not been specifically examined by previous research, it has been linked with sexually compulsive behavior disorder (Turban et al., 2020). As previously stated, GSNA provide opportunities and ease of access to casual and risky sex, and such opportunities and ease could conjointly magnify how much those who are highly sexually compulsive and sexual sensation seekers have risky sexual behaviors. These opportunities to casual and risky sex presented by GSNA use might be more compulsively followed through for sensation purposes. Thus, we propose the following hypothesis:

> H4: (a) Sexual compulsivity and (b) sexual sensation seeking would positively moderate the positive associations between GSNA use and risky sexual behaviors among young adults.

Methods

Participants

The study recruited college students and other young adults from two undergraduate participant pools at two large Midwestern universities in the USA and social media posting. A total of 921 respondents participated in the survey, and a total of 237 respondents either dropped out before completing 30% of the survey ($k = 117$) or failed the attention checks (e.g., self-reported attention scores) in the survey ($k = 120$). A univariate outlier analysis identified and removed outliers ($k = 4$) who scored $+/-3$ standard deviations from the grand mean on any continuous scale. The final sample ($n = 680$) reported the age range between 18 and 35 (M = 20.15, SD = 2.16), and about half of the participants identified as female ($n = 395$, 58.1%). Most participants identified as White/Caucasian ($n = 452$, 66.5%), followed by Asian ($n = 80$, 11.8%) and Black/African American ($n = 70$, 10.3%). Most participants reported being single ($n = 373$, 54.9%) and were a college student ($n = 415$, 61.0%). Approximately a quarter of the participants ($n = 152$, 22.4%)

reported being actively affiliated with a Greek organization. The full demographic information of the sample is presented in Table 1.

Procedures

The current study conducted a cross-sectional survey on Qualtrics to assess young adults' GSNA use, various sexual behaviors, demographic moderators, and psychological moderators. The participants must be between the age of 18 and 35 and live in the USA to be eligible to participate. To avoid potential social desirability issues in the participants' responses, we repeatedly stated the anonymous nature of the data collection. The institutional review board approved all research procedures. The participation was voluntary, and the recruitment procedures and messages remained the same in both recruitment methods (i.e., university participation pool, social media). However, all participants who participated through the undergraduate participant pools earned small course credits. Those who participated through social media posting were entered to win an Amazon gift card. Moreover, undergraduate participant pools only had undergraduate students, whereas the social media recruitment could have potentially reached a wider audience. We also tested any potential differences in demographic variables between the samples collected from the two recruitment methods using t-tests and chi-square tests, no significant statistical differences (all $p > .05$) were detected.

Measures

GSNA Use

We first offered a definition and several examples of GSNA to all participants. We defined GSNA as "social networking apps that use geographic location people use to romantic or sexual interests, such as Tinder, Bumble, Coffee Meets Bagel, and Hinge." We first asked whether participants had used GSNA in the last 30 days. A portion of participants ($n = 189$, 27.8%) reported that they did not use GSNA of any kind in the last 30 days. We then asked the 537 active users of GSNA to check how many minutes they have used GSNA in total in the last week. We gave step-by-step instructions on how to do so on an IOS or Android smartphone through the screen time report, and we asked participants to type in the time (minutes) they spent in the last week and divided the number by seven. Those participants who did not use any GSNA were asked to enter 0. The results showed that participants who used GSNA reported spending an average of 55.50 min per day (SD = 100.24, Mdn = 22.00, Range: 0–480.00).

Risky Sexual Behaviors

We assessed the total number of male and female sexual partners, the number of hookups (hookup was defined as "having a sexual encounter with someone who you are not in a committed relationship with"), hookups involving either alcohol or drug, presence of condomless sexual activity, and the self-reported STI status. All questions of risky sexual

Table 1 Demographic Information ($n = 680$)

	Count (percentage)		Count (percentage)
Sex			
Male	285 (41.9%)	Female	395 (58.1%)
Race			
Caucasian/White	452 (66.5%)	Native American	8 (1.2%)
Black/African American	70 (10.3%)	Multi-racial	17 (2.5%)
Hispanic/Latinx	37 (5.4%)	Missing	16 (2.4%)
Asian/Pacific Islander	80 (11.8%)		
Sexual orientation			
Straight/heterosexual	629 (92.5%)	Bisexual	7 (1.0%)
Gay/lesbian	39 (5.7%)	Missing	5 (0.8%)
Relationship status			
Single	373 (54.9%)	Monogamous marriage	18 (2.6%)
Monogamous relationship	269 (39.6%)	Open marriage	4 (0.6%)
Open/casual relationship	16 (2.4%)		
Greek affiliation			
Yes	152 (22.4%)	No	528 (77.6%)
College student			
Yes	415 (61.0%)	No	265 (39.0%)

behaviors referred to the last 6 months, besides STI status was measured within the last year. Participants, on average, reported a total of 3.35 (SD = 2.08) sexual partners, 4.35 (SD = 1.45) times of hookups, 1.84 (SD = 1.06) times of hookups involving either alcohol or drug within the last 6 months. Having condomless sex at least once in the last 6 months was measured using one dichotomous item; 278 (40.9%) participants reported never having condomless sex in the last 6 months, and the rest of the participants (n = 402, 59.2%) reported having condomless sex at least once in the last 6 months. Having STI within the last year was measured using one dichotomous item; the majority of the participants (n = 559, 82.2%) did not report having an STI within the last year, and a small portion of participants (n = 121, 17.8%) reported having at least one STI in the last year. We then transformed all risky sexual behavior variables measured using an ordinal item into dichotomous (yes = 1, no = 0) variables, following previous research articles (e.g., Choi et al., 2016a, b; Rogge et al., 2020). Those participants who did not report having sex within the last 6 months (sexually nonactive) were marked as 0. The ordinal risky sexual behavior variables were transformed into (1) having three or more sex partners in the last 6 months (yes = 295, 43.4%), (2) having hookups in the last 6 months (yes = 348, 51.2%), (3) having hookups involving alcohol or drug use in the last 6 months (yes = 260, 38.2%). Having condomless sex at least once in the last 6 months and having at least one STI in the last year were measured dichotomously and did not undergo any transformation.

Demographic Moderators

The demographic information is presented in *Participants* and Table 1. Sex (male = 1, female = 0) and Greek affiliation (yes = 1, no = 0) were measured using a dichotomous question. Participant's relationship status was measured as a categorical variable but then transformed (see the *Analysis Plans*) into a dichotomous variable.

Psychological Moderators

We used validated scales to measure sociosexuality, sexual compulsivity, and sexual sensation seeking. The Revised Sociosexual Orientation Inventory (Penke & Asendorpf, 2008) is a nine-item measure that assesses the unrestricted sexual behaviors (e.g., "With how many different partners have you had sexual intercourse on one and only one occasion?"), the unrestricted attitudes toward casual sex (e.g., "Sex without love is OK."), and the casual sex desires and fantasies (e.g., "How often do you experience sexual arousal when you are in contact with someone you are not in a committed romantic relationship with?") on a nine-point scale. We used the full measure and followed

the scaling and scoring rules from Penke and Asendorpf (2008). The items formed a scale (M = 5.10, SD = 1.23) with good reliability (α = .88). The Sexual Compulsivity Scale (Kalichman & Rompa, 1995) is a ten-item measure that assesses sexual compulsivity (e.g., "My sexual thoughts and behaviors are causing problems in my life.") on a four-point Likert scale (1 = Not at all like me, 4 = Very much like me). We used the full measure, and the items formed a scale (M = 1.81, SD = 0.70) with good reliability (α = .93). The Sexual Sensation Seeking (Kalichman et al., 1994) is an eleven-item measure that assesses the tendency to seek sexual sensation (e.g., "I like wild 'uninhibited' sexual encounters.") on a four-point Likert scale (1 = Not at all like me, 4 = Very much like me). We used the full measure, and the items formed a scale (M = 2.08, SD = 0.85) with good reliability (α = .92).

Analysis Plans

As previously mentioned, the five descriptive risky sexual behaviors variables were transformed into dichotomous variables. To test H1, which hypothesized that active users of GSNA would report more risky sexual behaviors than those who were not, we performed a series of chi-square tests of the dichotomous risky sexual behaviors between users and non-users. To test H2, which hypothesized that more frequent uses of GSNA would be positively associated with more risky sexual behaviors, we performed a series of binary logistic regression analyses from the dichotomous risky sexual behavior variables onto the frequency of GSNA use without any moderators entered into the models. To analyze the potential demographic and psychological moderators, we tested each moderator's main and interaction effects to the binary logistic regression models used to test H2. In the models, we entered the GSNA use frequency into the first block of the models. Then, we added the demographic and psychological moderators (main terms) into the second block of the model. We transformed the participant's relationship status into a dichotomous variable with single participants (n = 373, 54.9%) as 1 and those who were in a relationship (n = 307, 45.1%) as 0; participant's sex (0 = female; 1 = male) and Greek affiliation (0 = no; 1 = yes) were collected as dichotomous variables. We also entered three additional demographic variables to control potential influences: recoded race (0 = White/Caucasian; 1 = all other races/ethnicities), recoded sexual orientation (0 = heterosexual/straight, 1 = all other sexual orientations), and college student status (0 = no, 1 = yes); lastly, we added all interaction terms into the third block of the model. We used the final model fit indices, adjusted odds ratios, and *p* values to interpret the results. All analyses were computed using SPSS 27.

Results

Differences Between Users and Non-users

H1 hypothesized that active users of GSNA would report more risky sexual behaviors than those who were not. A series of chi-square tests showed that GSNA use in the last 30 days (1 = yes, 0 = no) had non-random associations with having three or more sex partners in the last 6 months ($\chi^2 = 5.32$, $df = 1$, $p < .05$), having hookups in the last 6 months ($\chi^2 = 6.94$, $df = 1$, $p = .008$), having hookups involving alcohol or drug use ($\chi^2 = 4.69$, $df = 1$, $p = .03$), and having condomless sex at least once in the last 6 months ($\chi^2 = 4.10$, $df = 1$, $p = .04$), but *not* with having at least one STI in the last year ($\chi^2 = 2.08$, $df = 1$, $p = .15$). Thus, H1 was mostly supported, besides that GSNA users were not more likely to have had at least one STI in the last year than non-users.

Relationships Between GSNA Uses and Risky Sexual Behaviors

H2 hypothesized that more frequent uses of GSNA would be positively associated with more risky sexual behaviors. The series of binary logistic regression showed that standardized GSNA use frequency was significantly associated with having three or more sex partners in the last 6 months ($\chi^2 = 22.56$, $df = 1$, $OR = 2.95$, $p < .001$), having hookup at least once in the last 6 months ($\chi^2 = 27.17$, $df = 1$, $OR = 3.37$, $p < .001$), having hookup at least once involving alcohol or drug use in the last 6 months ($\chi^2 = 5.35$, $df = 1$, $OR = 1.65$, $p = .02$), and having condomless sex at least once in the last 6 months ($\chi^2 = 17.01$, $df = 1$, $OR = 2.42$, $p < .001$), but was *not* associated with having at least one STI in the last year ($\chi^2 = 1.70$, $df = 1$, $OR = 0.95$, $p = .19$). Thus, the results were similar to the results testing H1, more frequent uses of GSNA were mostly positively associated with more reports of dichotomous risky sexual behaviors *besides* having had at least one STI in the last year.

Logistic Regression Models with Moderators

Three or More Sexual Partners

We specified the binary logistic regression model of having three or more sex partners in the last 6 months based on the analysis plans. The model ($\chi^2 = 44.29$, $df = 18$, $p < .001$) showed that GSNA use (A*OR* [adjusted odds ratio] = 2.76, $p < .001$, 95% *CI* [2.01, 3.58]), relationship status (A*OR* = 2.03, $p = .007$, 95% *CI* [1.50, 2.35]), Greek affiliation (A*OR* = 1.41, $p = .05$, 95% *CI* [1.05, 1.87]), sociosexuality (A*OR* = 1.69, $p < .001$, 95% *CI* [1.28, 2.01]), sexual

compulsivity (A*OR* = 1.89, $p = .007$, 95% *CI* [1.41, 2.37]), and sexual sensation seeking (A*OR* = 2.03, $p < .001$, 95% *CI* [1.23, 2.95]) all had significant main effects on having three or more sex partners in the last 6 months. Moreover, sex (A*OR* = 1.30, $p = .03$, 95% *CI* [1.08, 1.55]), relationship status (A*OR* = 1.92, $p = .01$, 95% *CI* [1.62, 2.36]), Greek affiliation (A*OR* = 1.27, $p = .04$, 95% *CI* [1.10, 1.67]), sociosexuality (A*OR* = 2.05, $p < .001$, 95% *CI* [1.57, 2.64]), sexual compulsivity (A*OR* = 2.40, $p < .001$, 95% *CI* [1.87, 3.09]), and sexual sensation seeking (A*OR* = 2.95, $p < .001$, 95% *CI* [2.50, 3.47]) all had significant interaction effects of GSNA use frequency on having three or more sex partners in the last 6 months. The full results of all binary logistic regression models with acceptable model fit indices are presented in Table 2. The results showed that the relationships between GSNA use frequency and having three or more sex partners in the last 6 months were stronger among males, current drinkers, single individuals, Greek organization members, those more sociosexually unrestricted, more sexually compulsive, or more likely to seek sexual sensation.

Hookups

We specified the binary logistic regression model of *having hookups in the last 6 months* based on the analysis plans ($\chi^2 = 53.16$, $df = 18$, $p < .001$). The model showed that GSNA use (A*OR* = 3.70, $p < .001$, 95% *CI* [2.97, 4.49]), age (A*OR* = 0.71, $p = .02$, 95% *CI* [0.54, 0.86]), sex (A*OR* = 1.39, $p = .009$, 905% *CI* [1.14, 1.70]), recoded relationship status (A*OR* = 1.56, $p = .004$, 95% *CI* [1.21, 1.88]), Greek affiliation (A*OR* = 1.80, $p < .001$, 95% *CI* [1.23, 2.30]), sociosexuality (A*OR* = 1.77, $p < .001$, 95% *CI* [1.33, 2.25]), sexual compulsivity (A*OR* = 1.91, $p < .001$, 95% *CI* [1.50, 2.46]), and sexual sensation seeking (A*OR* = 2.04, $p < .001$, 95% *CI* [1.41, 2.63]) all had significant main effects on having hookups in the last 6 months. The model showed that age (A*OR* = 0.70, $p = .01$, 95% *CI* [0.54, 0.88]), sex (A*OR* = 1.49, $p = .007$, 95% *CI* [1.20, 1.82]), Greek affiliation (A*OR* = 1.88, $p < .001$, 95% *CI* [1.39, 2.31]), sociosexuality (A*OR* = 2.13, $p < .001$, 95% *CI* [1.74, 2.60]), sexual compulsivity (A*OR* = 2.69, $p < .001$, 95% *CI* [1.84, 3.41]), and sexual sensation seeking (A*OR* = 3.09, $p < .001$, 95% *CI* [2.20, 4.01]) all had significant interaction effects on the relationships between GSNA use frequency and having hookups in the last 6 months. Two controlled covariates, recoded sexual orientation (A*OR* = 1.25, $p = .04$, 95% *CI* [1.08, 1.37]) and being a college student (A*OR* = 1.42, $p = .01$, 95% *CI* [1.19, 1.65]) had significant effects on having hookups in the last 6 months. The results showed that the relationships between GSNA use frequency and having hookups in the last 6 months were stronger among younger adults, males, Greek organization members, those more

Table 2 Results of binary logistic regression models with moderators

	Three or more sexual partners	Hookup	Condomless sex
GSNA use	AOR = 2.76, p < .001 [2.01, 3.58]	AOR = 3.70, p < .001 [2.97, 4.49]	AOR = 2.68, p < .001 [2.01, 3.28]
Main effects			
Age	AOR = 0.96, p = .56 [0.72, 1.19]	AOR = 0.71, p = .02 [0.54, 0.86]	AOR = 1.35, p = .03 [1.14, 1.48]
Sex	AOR = 1.18, p = .17 [0.88, 1.45]	AOR = 1.39, p = .009 [1.14, 1.70]	AOR = 1.08, p = .52 [0.94, 1.19]
Relationship status	AOR = 2.03, p = .007 [1.50, 2.35]	AOR = 1.56, p = .004 [1.21, 1.88]	AOR = 0.40, p < .001 [0.27, 0.55]
Greek affiliation	AOR = 1.41, p = .05 [1.05, 1.87]	AOR = 1.80, p < .001 [1.23, 2.30]	AOR = 0.72, p = .03 [0.61, 0.84]
Sociosexuality	AOR = 1.69, p < .001 [1.28, 2.01]	AOR = 1.77, p < .001 [1.33, 2.25]	AOR = 2.00, p < .001 [1.49, 2.56]
Sexual compulsivity	AOR = 1.89, p < .001 [1.41, 2.37]	AOR = 1.91, p < .001 [1.50, 2.46]	AOR = 3.20, p < .001 [2.08, 4.37]
Sexual sensation seeking	AOR = 2.03, p < .001 [1.23, 2.95]	AOR = 2.04, p < .001 [1.41, 2.63]	AOR = 2.27, p < .001 [1.75, 2.80]
Interaction effects			
Age	AOR = 0.94, p = .91 [0.82, 1.07]	AOR = 0.70, p = .01 [0.54, 0.88]	AOR = 1.46, p = .009 [1.21, 1.80]
Sex	AOR = 1.30, p = .03 [1.08, 1.55]	AOR = 1.49, p = .007 [1.20, 1.82]	AOR = 1.16, p = .26 [0.95, 1.34]
Relationship status	AOR = 1.92, p = .01 [1.62, 2.36]	AOR = 1.25, p = .07 [0.99, 1.50]	AOR = 0.65, p = .007 [0.42, 0.83]
Greek affiliation	AOR = 1.27, p = .04 [1.10, 1.67]	AOR = 1.88, p < .001 [1.39, 2.31]	AOR = 0.90, p = .38 [0.81, 1.03]
Sociosexuality	AOR = 2.05, p < .001 [1.57, 2.64]	AOR = 2.13, p < .001 [1.74, 2.60]	AOR = 2.38, p < .001 [1.83, 2.94]
Sexual compulsivity	AOR = 2.40, p < .001 [1.87, 3.09]	AOR = 2.69, p < .001 [1.84, 3.41]	AOR = 3.99, p < .001 [3.14, 4.89]
Sexual sensation seeking	AOR = 2.95, p < .001 [2.50, 3.47]	AOR = 3.09, p < .001 [2.20, 4.01]	AOR = 3.29, p < .001 [2.48, 4.12]
Controlled covariates			
Recoded race	AOR = 1.10, p = .55 [0.92, 1.20]	AOR = 1.06, p = .60 [0.94, 1.12]	AOR = 1.03, p = .81 [0.98, 1.08]
Recoded sexual orientation	AOR = 1.07, p = .68 [0.93, 1.16]	AOR = 1.25, p = .04 [1.08, 1.37]	AOR = 1.10, p = .48 [0.95, 1.22]
College student	AOR = 1.06, p = .71 [0.94, 1.15]	AOR = 1.42, p = .01 [1.19, 1.65]	AOR = 1.01, p = .95 [0.99, 1.03]

The 95% confidence interval is included within the parenthesis as [lower-level AOR, higher-level AOR]

AOR adjusted odds ratio

sociosexually unrestricted, more sexually compulsive, or more likely to seek sexual sensation.

Hookups with Alcohol or Drug

We specified the binary logistic regression model of *having hookups involving alcohol or drug in the last 6 months* based on the analysis plans. The model did not show an acceptable fit to the data ($\chi^2 = 24.28$, $df = 18$, $p = .15$). We did not interpret the regression coefficients in this model.

Condomless Sex

We specified the binary logistic regression model of *having condomless sex at least once in the last 6 months* based on the analysis plans ($\chi^2 = 41.43$, $df = 18$, $p < .001$). The model showed that GSNA use (AOR = 2.68, $p < .001$, 95% *CI* [2.01, 3.28]), age (AOR = 1.35, $p = .03$, 95% *CI* [1.14, 1.48]), recoded relationship status (AOR = 0.40, $p < .001$, 95% *CI* [0.27, 0.55]), Greek affiliation (AOR = 0.72, $p = .03$, 95% *CI* [0.61, 0.84]), sociosexuality (AOR = 2.00, $p < .001$, 95% *CI* [1.49, 2.56]), sexual compulsivity (AOR = 3.20,

$p < .001$, 95% *CI* [2.08, 4.37]), and sexual sensation seeking (A$OR = 2.27$, $p < .001$, 95% *CI* [1.75, 2.80]) all had significant main effects on having condomless sex at least once in the last 6 months. The model showed that age (A$OR = 1.46$, $p = .009$, 95% *CI* [1.21, 1.80]), recoded relationship status (A$OR = 0.65$, $p = .007$, 95% *CI* [0.42, 0.83]), sociosexuality (A$OR = 2.38$, $p < .001$, 95% *CI* [1.83, 2.94]), sexual compulsivity (A$OR = 3.99$, $p < .001$, 95% *CI* [3.14, 4.89]), and sexual sensation seeking (A$OR = 3.29$, $p < .001$, 95% *CI* [2.48, 4.12]) all had significant interaction effects on the relationships between GSNA use frequency and having condomless sex at least once in the last 6 months. The results showed that the relationships between GSNA use frequency and having condomless sex at least once in the last 6 months were stronger among younger adults, single individuals, those more sociosexually unrestricted, more sexually compulsive, or more likely to seek sexual sensation.

STI

We specified the binary logistic regression model of *having at least one STI in the last year* based on the analysis plans. The model did not show an acceptable fit to the date ($\chi^2 = 14.10$, $df = 18$, $p = .72$). We did not interpret the regression coefficients in this model.

Discussion

The current study sought to test the relationships between GSNA use and risky sexual behaviors. Our findings showed that more frequent GSNA use was positively associated with having three or more sex partners, having hookups, and having condomless sex at least once, but did not with having at least one STI in the last year. More importantly, we tested a variety of demographic and psychological moderators to the relationships. We found that the relationships between GSNA use frequency and different outcome variables varied among different groups of individuals. Moreover, the three psychological moderators, namely sociosexuality, sexual compulsivity, and sexual sensation seeking consistently moderated the relationships between GSNA use and all three significant risky sexual behaviors. The current discussion further expands on the results.

Contributions to the Current Literature

The current literature shows that GSNA have been well integrated into young adults' daily lives (Choi et al., 2016a, b; Rogge et al., 2020). Our results showed that the large majority of participants were active users of GSNA, and users spent a considerable amount of time on these apps. Our participants reported a much higher

average amount of time spent on GSNA at 55.62 min per day than those reported in previous studies (e.g., Rogge et al., 2020; 24 min per day). We asked participants to report their GSNA use based on their screen time reports on their smartphone devices, and this can be a promising way to potentially address the self-report bias related to survey questions asking about private and potentially stigmatized issues (Johnson & Fendrich, 2005). Nevertheless, this study adds to the growing evidence that shows GSNA have become an inseparable integration of young adults' lives.

The findings revealed the "magnifying" moderation effects of these demographic and psychological moderators on the positive relationships between GSNA use and risky sexual behaviors. The relationships between GSNA use frequency and some risky sexual behaviors were more prominent among younger adults and males. It is possible women are less susceptible to the influences of GSNA on their sexual decision-making because of how they communicate on GSNA. For example, a study (Dai & Robbins, 2020) found that female Tinder users paid attention to far more communication cues, such as perceived positive attributes (e.g., kindness, intelligence), perceived attractiveness, message humor, and message compliment than male users. These findings aligned with research on evolutionary psychology, where women are more selective in their mate selection in online interactions (Abramova et al., 2016; Oesch & Miklousic, 2012). Interestingly, the results showed that age had both positive main and interaction effects on condomless sex, which somewhat aligned with a national probability sample survey (Reece et al., 2010). They found that condom use was higher among adolescents (i.e., age 14–18) than adults. This could potentially be explained by two factors. First, older adults were more likely to be in a monogamous or committed relationship, where a condom is not generally used. Our data supported the fact that those in a committed relationship were more likely to have condomless sex. Second, adults *might* hold less restrained attitudes to risky sexual behaviors as they age (Herlitz & Forsberg, 2010), and they may underestimate and underreport their sexual risks as they age. Although our findings showed that older adults engaged in less risky sexual behaviors, future research should confirm such negative correlations between age and risky sexual behaviors were indeed related to less risky sexual behaviors, rather than underreporting of their behaviors. Lastly, Greek affiliation was consistently associated with risky sexual behaviors, specifically having a higher chance of having three or more sexual partners and more hookups. However, contradictory to the findings of previous research (Scott-Sheldon et al., 2008), Greek organization members reported higher condom use even though they had more sexual partners and hookups. This could potentially be related to the interventions and education programs related

to condom use and sexual wellbeing awareness targeted at Greek student organizations (e.g., Sleap et al., 2012).

Psychological moderators, including sociosexuality, sexual compulsivity, and sexual sensation seeking, were consistently the strongest moderators to the positive relationships between GSNA use and almost all risky sexual behavioral measures. These findings extend the current literature by examining the individual differences in these psychological factors as moderators, whereas the previous literature has treated them as direct predictors. The quick visual-based interactions with a large pool of potential mates on GSNA could potentially explain the strong moderating effects of sociosexuality on risky behaviors. Previous studies (Arnocky et al., 2016; Duncan et al., 2007) found that unrestricted sociosexuality is associated with mate abundance and visual attention of attractiveness, which both are prominent characteristics of GSNA interactions. Furthermore, it is important to note that sexual compulsivity and sensation seeking are often linked to compulsive sexual behaviors or sex addictions, which can potentially be intervened (Fong, 2006). A recent study reported the associations between GSNA use and compulsive sexual behavior disorder but called for further examination of the relationships (Turban et al., 2020). Future research should investigate how these highly sexually compulsive and high sexual sensation seekers utilize GSNA and consequentially affect their offline sexual behaviors.

Contrary to our hypothesis, GSNA use and all the moderators were not related to having at least one STI within the last year. As previously discussed, the estimated STI rate is particularly high among younger adults between the age of 18 and 35 (CDC, 2019). A previous study (e.g., Rogge et al., 2020) operationalized the variable as had an STI ever, and that might be a more accurate way to operationalize STI status. It is also possible that self-report bias exists in this measure as underreporting of STI status is common among younger adults; for example, in a study, only 68.7% of the adolescents with positive STI results accurately self-reported their STI statuses (Harrington et al., 2001). Given the underreporting issues, future research might want to consider expanding the measure to STI testing, as it is one of the most effective and practical harm-reduction approaches to rising STI rates among younger adults (Wombacher et al., 2018).

Policy Implications

The current study pointed out several significant demographic moderators (e.g., single males) and psychological moderators (e.g., sexual sensation seekers) that could be targeted in behavioral interventions. Although GSNA use carries significant benefits for social interactions and romantic relationships, those who are extremely sexually

compulsive and high sexual sensation seekers might need to be intervened (Coleman et al., 2003; Fong, 2006). Intervention messages for those GSNA users should be visually appealing, and the contents should focus on harm-reduction approaches. Intervening GSNA users' psychological predispositions can be highly time-consuming or even unrealistic. The more cost-effective way to reduce risky sexual behaviors might be accentuating the importance of proper protection and regular STI testing. Previous studies suggested this harm-reduction approach could be effective among younger adults (Choi et al., 2016a; Rogge et al., 2020; Wombacher et al., 2018). For example, Choi et al. (2016a) recommend messages to promote dating apps' safe use. Safe behavioral messages embedded within GSNA can be a promising tool in promoting responsible behaviors. For example, Blued, the largest GSNA for MSM in Asia, uses automatic language detection algorism and sends safety reminders when intentions of risky sexual behaviors or unsafe financial transactions are detected. Similarly, these embedded messages can be used to promote protections and regular testing. For example, Grindr, the largest GSNA for MSM in the US, sends regular pop-up messages that promote STI testing and PrEP uptake (Kok et al., 2006). The purposes of these reminders and pop-up messages are not to dissuade people from using the GSNA but rather to educate and promote effective protection methods. Furthermore, self-learning algorithms could more precisely identify and predict psychological predispositions, such as sexual sensation seeking, among GSNA users through natural language processing. Thus, with the help of self-learning algorithms, these reminder and pop-up messages could potentially be specifically delivered and tailored to the high-risk GSNA users found in the current study (e.g., single males, sexual sensation seeker) based on their use patterns. Researchers have successfully integrated interventions targeting risky sex behaviors among MSM using these GSNA, and successful messages and strategies could be replicated and adopted among other users (Kok et al., 2006).

Limitations and Future Research

The findings of the current study should be interpreted within its limitations. First, the current study measured a large range of moderators and tested each moderator's effects separately. However, it is entirely possible that two or more moderators can influence the relationships together (i.e., codependent moderation), or one variable can explain how a moderator could influence the relationships (i.e., mediated moderation). In the possible case of codependent moderation, previous research found that sociosexuality and sensation-seeking together moderated the relationship between gender and online sexual activities (Zheng & Zheng, 2014). In the case of mediated

moderation, it might be plausible that sociosexuality can be the mediator that explains the significant moderation effects of motivation to use GSNA for casual sex. Exploring and analyzing these more complex moderations address separate sets of research questions from the current manuscript, and it would require substantially more space beyond the length of this manuscript. Thus, we plan to explore such questions with additional variables in a different manuscript as part of the future efforts of this project. Second, the present study only recruited younger adults between the age of 18 and 35, and that is a limited representation of GSNA users. Although younger adults have been one of the primary populations that previous research has focused on due to its high utilization of GSNA and elevated risks, this is not the only population that uses GSNA. Older users might just choose different venues than the ones used by younger adults, and the popular ones among mature daters include OurTime and Silver Singles. The STI rate has also been on the steady rise among adults of 45 or older in the US since 2016 (Centers for Disease Control and Prevention, 2018), and future research should study the relationships between GSNA use and online dating outcomes among this understudied population. Third, the current study sample only included a small portion of participants who identified as sexual orientations other than straight/heterosexual. However, even with such a small group, the findings showed that sexual orientation was directly related to hookups. The relationships between GSNA use and risky sexual behaviors among sexual minority men have been well studied in the current literature (Jayawardena et al., 2021; Wang et al., 2018; Zou & Fan, 2017). The ecology appears to have some differences compared to our findings. Related to this limitation in our sampling, we only measured participants' biological sex on a binary male/female dichotomy, instead of self-identified gender. This potentially ignores the possibilities of and potential differences related to gender non-binary and gender expansive individuals in our dataset. Very little is known about GSNA use and its impacts among transgender, gender non-binary, and gender expensive individuals, and future studies should explore such topics among this understudied population. Lastly, it is important to note that the data collected in the current project is cross-sectional in nature, and a weakness of this approach is that the time frame for the predictors (i.e., GSNA use) did not proceed the time frame for the outcomes (which are over 6 months or 1 year). Therefore, the findings of the current study should be interpreted with such concerns about the temporality of the data structure.

Declarations

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