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RESEARCH ARTICLE

The sexual health, orientation, and activity of autistic adolescents and adults

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Abstract

Small studies suggest significant differences between autistic and nonautistic individuals regarding sexual orientation and behavior. We administered an anonymized, online survey to $n = 2386$ adults ($n = 1183$ autistic) aged 16–90 years to describe sexual activity, risk of sexually transmitted infections (STIs), and sexual orientation. Autistic individuals are less likely to report sexually activity or heterosexuality compared to nonautistic individuals, but more likely to self-report asexuality or an 'other' sexuality. Overall, autistic, and nonautistic groups did not differ in age of sexual activity onset or contraction of STIs. When evaluating sex differences, autistic males are uniquely more likely to be bisexual (compared to nonautistic males); conversely, autistic females are uniquely more likely to be homosexual (compared to nonautistic females). Thus, both autistic males and females may express a wider range of sexual orientations in different sex-specific patterns than general population peers. When comparing autistic males and females directly, females are more likely to have diverse sexual orientations (except for homosexuality) and engage in sexual activity, are less likely to identify as heterosexual, and have a lower mean age at which they first begin engaging in sexual activity. This is the largest study of sexual orientation of autistic adults. Sexual education and sexual health screenings of all children, adolescents, and adults (including autistic individuals) must remain priorities; healthcare professionals should use language that affirms a diversity of sexual orientations and supports autistic individuals who may have increased risks (affecting mental health, physical health, and healthcare quality) due to stress and discrimination from this intersectionality.

KEYWORDS
adults, adolescents, sexual health, sexual orientation, sexual activity

INTRODUCTION

Autism spectrum conditions (henceforth autism) are a set of lifelong, neurodevelopmental conditions characterized by social and communication differences, restricted interests, and repetitive behaviors. In addition, autistic individuals may also have differences in cognitive profile, including atypical sensory perception, information processing, and motor abilities; critically, the autistic population is heterogeneous and may exist along the full spectrum of intellectual ability (American Psychiatry Association, 2013). Historically autism was classified as a rare condition; however, prevalence estimates have increased in recent years and now approximately 1%–2% of the population are diagnosed as autistic (likely due to changes in diagnostic criteria and improved recognition of the condition due to increased awareness) (Maenner et al., 2020). There also appears to be a sex-bias in autism: Males are diagnosed approximately three to four times more frequently than females (Loomes et al., 2017; Maenner et al., 2020). As autism diagnoses become more frequent, greater numbers of adolescents and adults are

being recognized as autistic than ever before; however, there is still relatively little large-scale research on the experience of these groups, particularly in regard to their sexual activity and orientation.

Traditionally, it was incorrectly thought that autistic individuals were largely uninterested in sexual or romantic relationships; however, research and clinical practice has demonstrated that most autistic individuals are interested in sexual and/or romantic relationships (with most research in the area focusing on autistic individuals without co-occurring intellectual disability) (Dewinter et al., 2013; Sala et al., 2020). Recent research in several, relatively small samples has established significant differences between autistic and nonautistic individuals in the areas of sexual activity and sexual orientation, which may vary based on sex. Autistic individuals, and particularly autistic females, are more likely to report greater sexuality diversity, including less sexual desire/libido (Bejerot & Erikson, 2014; Bush, 2019; Bush et al., 2020; Pecora et al., 2019), higher rates of asexuality (Bush, 2019; Bush et al., 2020; George & Stokes, 2018a), higher rates of hypersexual behavior/ fantasies (Schöttle et al., 2017), lower rates of heterosexuality (Dewinter et al., 2017; George & Stokes, 2018a; Pecora, Hancock, et al., 2020), and higher rates of nonheterosexuality (including homosexuality and bisexuality specifically) (Bejerot & Erikson, 2014; Dewinter et al., 2017; George & Stokes, 2018a; Pecora, Hancock, et al., 2020). One very large study (n = 47,000+ individuals) found that individuals with self-reported high autistic traits were 1.73 times (95% CI: 1.01–2.90) as likely to identify as bisexual and 3.05 times (95% CI: 2.56–3.63) as likely to identify with a sexuality that could not be described as hetero-, homo-, nor bisexual (Rudolph et al., 2018). A recent study of autistic females found that they were 2.33 times (95% CI: 1.33–4.09) as likely to identify as bisexual and 2.39 times (95% CI: 1.26–4.52) as likely to identify as homosexual (Pecora, Hooley, et al., 2020); and in the general population, several studies suggest that females may be more likely to identify as bisexual and that males may be more likely to identify as homosexual (Copen, Chandra, & Febo-Vazquez, 2016; Wang et al., 2019). However, the authors are not aware of any similar studies that use adjusted regression analyses (controlling for demographic differences) to estimate the relative odds of identifying with particular sexual orientations across all autistic individuals, or any studies that attempt to quantify sex differences.

The sexuality and experiences of autistic individuals may have significant implications for healthcare, as studies suggest that intersectionality of autism and being Lesbian, Gay, Bisexual, Trans, Queer, Asexual, and other identities not listed here (LGBTQA+) may result in worse mental health symptoms, worse overall health, and lack of adequate healthcare (even including being refused healthcare) likely due to institutionalized sources of marginalization (e.g., inadequate insurance coverage for healthcare needs) and minority stress (George & Stokes, 2018b; Hall et al., 2020; Pecora, Hancock, et al., 2020; Warrier et al., 2020).

Autistic individuals are also particularly vulnerable to sexual victimization and increased risk of inappropriate offending (Pecora et al., 2019; Pecora, Hancock, et al., 2020). Autistic females report higher rates of unwanted sexual experiences than both nonautistic individuals and autistic males (Brown-Lavoie et al., 2014; Pecora, Hooley, et al., 2020), and this may be differentially affected by sexuality (Pecora, Hooley, et al., 2020). Likelihood of sexual victimization may be partially mediated by sexual knowledge (Brown-Lavoie et al., 2014); yet, studies suggest that autistic individuals may have reduced access to and/or inadequate sexual education (Dewinter et al., 2013; Pecora, Hancock, et al., 2020), as well as less perceived and actual sexual knowledge (Brown-Lavoie et al., 2014). Taken collectively, these results suggest a pattern of unique vulnerability among autistic individuals, and particularly among autistic females, likely due to additive effects of marginalization based on sex, sexual orientation, limited sexual education/knowledge, and perpetrators taking advantage of certain common features of autism (e.g., social naïveté, misunderstanding friendships, etc.).

In addition to consequences regarding sexual victimization, lack of appropriate sexual education and/ or sexual knowledge may increase the likelihood of contracting sexually transmitted infections (STIs), which continue to be a primary public health concern due to their capacity to pose long-term physical health problems. A few studies have shown reduced risk of STIs among individuals with autism, intellectual disability, and other developmental disabilities (Fortuna et al., 2016; Schmidt et al., 2019). However, crucially, the authors are not aware of any studies on the relative risk of STIs that exclude individuals who have not engaged in any sexual activity. Considering evidence of diminished sexual contact/ libido among autistic individuals, current studies may not be measuring relative risk of STIs between autistic and nonautistic individuals but instead are capturing relatively lower risk of engaging in sexual activity in general; thus, future studies must work to estimate whether the prevalence of STIs differs among autistic and nonautistic individuals who have been sexually active.

Even though current research into sexual health and sexual orientation of autistic adolescents and adults is limited in size and scope, it is clear that differences in these areas may leave autistic individuals vulnerable to wide-ranging negative consequences with regards to both mental and physical health. The current study aims to address these gaps and establish a comparison of experiences regarding sexuality and sexual activity between autistic and nonautistic individuals from adolescence to old age.

METHODS

The survey

Using an anonymous, self-report survey, participants completed demographic information, a short version of the Autism Spectrum Quotient (a measure of autistic traits, AQ-10) (Allison et al., 2012; Greenberg et al., 2018), questions about lifestyle-related factors (including exercise, diet, sleep, disability, and social/sexual history), personal medical history, and family medical history, as part of the Autism and Physical Health Survey (APHS). Thus, the present study uses a sample from the APHS dataset to investigate the sexual health, orientation, and activity patterns of autistic and nonautistic adolescents and adults. All questions related to sexual and social history were developed using publicly available information from the National Health Service (NHS), National Institute for Health and Care Excellence, National Institutes of Health (NIH), and the World Health Organization (WHO). All questions related to social and sexual history were optional, as they may be sensitive in nature for some participants. The specific phrasing of all questions is provided in Figures S1—S5.

Recruitment

This study used a cross-sectional, anonymized online survey to identify the patterns of sexual activity and sexual orientation among autistic and nonautistic adults. It used a convenience sampling framework and recruited participants via the Cambridge Autism Research Database (CARD), Autistica's Discover Network, autism support groups and charities (including the Autism Research Trust), and social media (specifically Twitter and Facebook). As the study was advertised to some groups and forums related to autism, the control population may be biased toward those with an interest in autism or those with undiagnosed autism. To limit this bias, we also publicized the study via Facebook in an advertisement that did not mention autism but instead asked individuals to provide further information about their physical health to researchers. In addition, we intentionally advertised the study to any individuals over the age of 16 from an international population (and did not target individuals based on interests or group participation in any way)—as this provided the best opportunity for a general population sample. After clicking onto the survey, the consent form and information sheet did specify that the study was related to understanding differences between autistic and nonautistic adults; as such, the study recruitment was likely still subject to some selection bias even if this strategy attempted to mitigate it. All advertisements were advertised to both nonautistic and autistic individuals. Although the survey was only available in English, we aimed to recruit an international cohort. Our use of social media enabled us to advertise the study to individuals around the globe and participants from 62 different countries were included in this study.

The survey first opened in February 2018 and data collection ended in August 2019; however, there were two periods in which survey collection was paused, in order to consider different means of advertising the survey. We performed a sensitivity analysis for all analyses and used z-tests to determine if these pauses affected our results for all binomial regression analyses; we found no statistically significant differences. Full results from the sensitivity analysis are provided in Table S1.

The cohort

$N = 3657$ individuals accessed the survey. Any consenting individual of at least 16 years of age was eligible to participate. 1102 individuals were excluded due to 'incomplete' response, meaning that they exited the survey before completing required questions in the lifestyle section (which includes information on substance use and sexual health). 83% of excluded individuals ($n = 914$) did not even complete the demographics section of the survey, making their responses unusable. Due to their potentially sensitive nature, questions related to sexual health were optional; and participants were not excluded due to nonresponse on any optional questions. We developed an algorithm to exclude potential duplicate responses (as we did not collect any personally identifiable data). We excluded all responses ($n = 112$) that matched any previous response on 11 criteria (autism diagnosis [yes/no], specific autism diagnosis, type of diagnosing practitioner, year of autism diagnosis, country of residence, sex assigned at birth, current gender identity, education-level, age, maternal age at birth, and paternal age at birth). In addition, we excluded one intersex individual, as our analysis strategy covaries for sex assigned at birth.

The autistic cohort included all eligible individuals who self-reported an autism diagnosis made by a qualified health practitioner. As the survey was anonymous, we did not ask participants to provide evidence of their diagnosis; however, we asked participants to disclose additional information (type of practitioner who diagnosed them, the year of their diagnosis, their specific diagnosis, and whether they have a syndromic form of autism) in order to verify their diagnosis. The control group included all eligible individuals without a diagnosis of autism. As we followed a case–control design, we excluded any individual from both the autistic and control groups for whom we could not verify their autism status ($n = 56$); this included individuals who self-diagnosed as autistic, suspected autism, or were awaiting autism assessment. The final sample was composed of $n = 2386$ individuals, including 1183 autistic individuals.

Covariates

We controlled for age, sex assigned at birth, education-level, ethnicity, and country of residence. We defined education-level as the highest qualification held with the following options: "No formal qualifications", "Secondary School/High School level qualifications", "Further vocational qualifications", "University Undergraduate level qualifications (BA, BSc, etc.)", and "University Postgraduate level qualifications (MA, MSc, PhD, Certificate, etc.)". It was coded as a categorical variable and used as a proxy measure of socio-economic status. Due to low response rates from each non-White ethnic background, we used a binary representation of ethnicity (white vs. non-White) in our analyses. Finally, as we recruited a diverse, international population, we derived a categorical variable of country of residence based on the most frequent countries listed with the following options: "United Kingdom," "United States of America," "Germany," "Australia," and "Other." Full information on the distribution of participants' ethnicity are available in Table 1.

Statistical analysis

We used *R Version 3.6.2* to conduct all analyses. Across nearly all analyses regarding sexual history, we utilized an unadjusted and adjusted model, employing Fisher's exact tests (using the 'CrossTable' function from the 'gmodels' package) and Binomial Logistic Regression (using the 'glm' function from the 'stats' package) controlling for sex assigned at birth, age, ethnicity, education-level, and country of residence, respectively. The only exception is regarding age of sexual activity onset; for this analysis, we used the Wilcoxon Signed-Rank test for the unadjusted model and multiple linear regression for the adjusted model (again controlling for sex assigned at birth, age, ethnicity, education-level, and country of residence), as the outcome of interest was continuous.

We also assessed sex and age differences across all analyses. Autistic individuals may be more likely to experience a wider range of gender identities than others;[17] as such, our designation of individuals as 'females' and 'males' speaks only to their sex assigned at birth and not of their gender identity. To consider sex effects, we first conducted additional binomial logistic regression models accounting for the interaction of sex and diagnosis (as well as controlling for sex assigned at birth, age, ethnicity, education-level, and country of residence). For all analyses, which showed a significant effect, we estimated sex-specific values by using the 'glht' function of the 'multcomp' package and reported sex-specific values in lieu of our overall model. Second, we employed both unadjusted and adjusted models (using Fisher's exact tests and Binomial Logistic Regression controlling for sex assigned at birth, age, ethnicity, education-level, and country of residence, respectively) to compare all patterns of sexual activity, orientation, and health between autistic males and females directly.

To consider the effect of age, we stratified our sample into two age groups: (1) Younger adults aged 16–40 years and (2) Older adults aged 41–90 years. We ran binomial logistic regression models (controlling for sex, age, ethnicity, education-level, and country of residence) to test differences between autistic and nonautistic groups for sexual orientation, activity, and health in the younger and older samples separately.

Missingness for the covariates of age, education-level, ethnicity, and country of residence was addressed using predictive mean matching for five imputations using the 'MICE' package (Azur et al., 2011). For continuous measurements of age of sexual activity onset, only one imputation was used due to the incompatibility of R packages. Table 2 provides further information on missing data among covariates. Finally, to minimize Type I errors from multiple testing, we utilized the False Discovery Rate correction and used a p threshold of 0.05 across all analyses (Benjamini & Hochberg, 1995).

RESULTS

The sample predominantly comprised females, White individuals, UK residents, and those without intellectual disability. There were significant group differences, and this was expected based on the methodology and recruitment strategies employed. A summary of demographic information for both the autistic and nonautistic cohorts has been provided in Table 1 below.

Overall, we found few quantitative differences in sexual activity between autistic and nonautistic participants. Confirming previous findings in smaller samples, autistic males (compared to nonautistic males) and autistic females (compared to nonautistic females) were both less likely to report ever having engaged in sexual activity—though autistic males are particularly less likely to have engaged in sexual activity; however, a majority of all groups (autistic females, autistic males, nonautistic females, and nonautistic males) all report having been sexually active. Interestingly, as shown in Table 2 below, our results suggest that there are no differences between risk of contracting an STI between autistic and nonautistic adolescents and adults (Adjusted Model 1), even before accounting for differences in lifetime engagement with sexual activity. Further, these results do not change after asexuality is included in the analyses as a covariate (Adjusted Model 2). There was also no statistically significant difference in the mean age of sexual activity onset between autistic (mean: 18.51; SD: 4.44) and nonautistic (mean: 18.25; SD: 3.70) adolescents and adults who reported ever engaging in sexual activity in our analyses using an unadjusted model (FDR p value: 0.412), Model

TABLE 1 Participant demographics

Characteristics	Autism ($n = 1183$)	Controls ($n = 1203$)	p values (sig. Level)
Age (years), mean (SD)	41.04 (14.41)	41.86 (15.59)	0.344
Age (years), categories, *N* (%)			
16–29	303 (25.61)	311 (25.85)	
30–39	250 (21.13)	240 (19.95)	
40–49	252 (21.30)	252 (20.95)	
50–59	214 (18.09)	206 (17.12)	
60–69	113 (9.55)	127 (10.56)	
70+	25 (2.11)	52 (4.32)	
Missing	26 (2.20)	15 (1.25)	
Sex assigned at birth, *N* (%)			0.005 (**)
Female	746 (63.06)	825 (68.58)	
Male	437 (36.94)	378 (31.42)	
Gender identity, *N* (%)			<0.001 (***)
Cisgender	1031 (87.15)	1178 (97.92)	
Transgender	149 (12.60)	24 (2.00)	
Missing	3 (0.25)	1 (0.08)	
Ethnicity, *N* (%)			0.007 (**)
White	1045 (88.33)	1020 (84.78)	
Non-White	135 (11.42)	183 (15.21)	
Mixed race	77 (6.51)	73 (6.07)	
Asian	18 (1.52)	43 (3.57)	
Latin American/Hispanic	7 (0.59)	23 (1.91)	
Arab/Middle Eastern	0	17 (1.41)	
Jewish	16 (1.35)	17 (1.41)	
African/Black/Caribbean	6 (0.51)	9 (0.75)	
Other	11 (0.93)	1(0.08)	
Missing	3 (0.25)	0	
Education, *N* (%)			<0.001 (***)
No formal qualifications	57 (4.82)	14 (1.16)	
Further vocational qualifications	215 (18.17)	138 (11.47)	
Secondary school/High school	211 (17.84)	171 (14.21)	
University undergraduate	354 (29.92)	354 (29.43)	
University postgraduate	344 (29.08)	523 (43.47)	
Missing	2 (0.17)	3 (0.25)	
Country of residence			<0.001 (***)
United Kingdom	842 (71.17)	759 (63.09)	
United States of America	120 (10.14)	174 (14.46)	
Germany	31 (2.62)	33 (2.74)	
Australia	33 (2.79)	20 (1.66)	
Other	156 (13.19)	214 (17.79)	
Missing	1 (0.08)	3 (0.25)	
Intellectual disability, *N* (%)			<0.001 (***)
Self-identified	21 (1.78)	4 (0.33)	

Abbreviation: SD, standard deviation.

Note: Significance Level: ***($p < 0.001$), **($p < 0.01$), *($p < 0.05$), Δ ($p < 0.10$). p values were from Pearson's Chi Square test (categorical) or from a Mann–Whitney U test (means). These are demographic data before imputation. The results remain highly similar after imputation.

TABLE 2 Sexual activity of autistic individuals compared with nonautistic individuals

	Autistic			Nonautistic			Unadjusted model		Adjusted model 1[a]		Adjusted model 2[b]	
	Yes (*n*)	Total (*n*)	%	Yes (*n*)	Total (*n*)	%	OR (95% CI)	FDR	OR (95% CI)	FDR	OR (95% CI)	FDR
Ever sexually active (females)	561	738	76.02	727	819	88.77	0.401 (0.301, 0.532)	<0.001	0.384 (0.248, 0.593)[c]	0.002	0.482 (0.303, 0.768)[c]	0.002
Ever Sexually Active (males)	306	436	70.18	330	371	88.95	0.293 (0.194, 0.435)	<0.001	0.222 (0.118, 0.417)[c]	0.002	0.239 (0.124, 0.458)[c]	0.002
Ever contracted an STI	122	1175	10.38	154	1199	12.84	0.786 (0.701, 0.881)	0.103	0.805 (0.620, 1.045)	0.146	0.844 (0.648, 1.100)	0.274
Ever contracted an STI[d]	116	868	13.36	154	1066	14.45	0.914 (0.698, 1.194)	0.603	0.929 (0.711, 1.213)	0.713	1.003 (0.723, 1.391)	0.993

Abbreviations: FDR, false discovery rate; 95% CI, 95% confidence interval; OR, odds ratio.

[a]Binomial logistic Regression adjusting for age, sex, ethnicity, education, and country of residence.

[b]Binomial Logistic Regression adjusting for age, sex, ethnicity, education, country of residence, and asexuality.

[c]Exact *p* value was too small to be precisely determined; for the purposes of the FDR calculations, we estimated this *p* value as equal to 0.0009, in order to provide the most conservative analysis.

[d]All individuals who reported never being sexually active were excluded.

1 (FDR *p* value: 0.066), or Model 2 (FDR *p* value: 0.142). However, Figure 1 below provides a visual representation of these patterns, which supports a relatively wider age range for autistic compared to nonautistic individuals.

As we did not define the term "STI" specifically in the survey text and other infections (including urinary tract infections, yeast infections, etc.) can easily be misclassified as STIs, we also performed a sensitivity analysis using data from the specific STI question. For the purposes of the sensitivity analysis, among those who reported any data related to STIs, individuals were coded as having an STI only if they reported contracting one of the following: chancroid, chlamydia, crabs, gonorrhea, hepatitis, herpes, HIV/AIDS, HPV/Warts, molluscum contagiosum, scabies, syphilis, trichomoniasis, or pelvic inflammatory disease; all others were coded as having no confirmed STI. We also asked individuals to endorse whether they had a yeast infection, vaginosis, or yeast in men—as these are commonly mistaken for STIs; individuals who only reported one of those three infections were coded as having no STI. Even using this stricter definition of STI, the results did not change in either the unadjusted (OR: 0.847; 95% CI: 0.639–1.121; *p* value: 0.244) or adjusted models (OR: 0.858; 95% CI: 0.649–1.135; *p* value: 0.284).

Our results replicate previous findings regarding sexual orientation among autistic adolescents and adults, showing far greater likelihood of identifying as asexual or 'other' sexual orientation compared to nonautistic individuals. We also found that autistic individuals were less likely to identify as heterosexual than others. There were significant interactions of sex and diagnosis for bisexuality and homosexuality (and sex-specific values have been reported below). These results indicate that autistic males are uniquely more likely to identify as bisexual compared to nonautistic males (whereas there was no significant difference between female groups); conversely, autistic females are uniquely more likely to identify as homosexual compared to sex-matched peers (whereas there was no significant difference between male groups). Full results are provided below in Table 3.

Our results regarding sex differences were of particular interest, as they suggest a different and more complex pattern than was previously reported. When comparing autistic females and males directly, our results largely support previous findings. Autistic females report greater sexual diversity than autistic males (George & Stokes, 2018a)—except for homosexuality (for which there were no significant differences). They are more likely to report ever having engaged in sexual activity compared to autistic males (Bush, 2019). Our study provides the first evidence that autistic females (mean: 18.02; SD: 4.00) who report ever engaging in sexual activity may begin initial sexual contact at a younger age than autistic males who report ever engaging in sexual activity (mean: 19.44; SD: 5.06) using unadjusted (FDR *p* value:

<0.001) and adjusted models (FDR *p* value: <0.001). Full results are presented in Table 4 below. Additionally, Figure 2 shows the distribution of age of first sexual activity between autistic males and females separately. As a note, autistic female and male groups did differ on demographic variables of age, education-level, and country of residence; however, these factors were controlled for in our adjusted model to limit biases resulting from these differences.

Finally, we performed analyses stratified into two age groups to determine if there were different patterns between younger autistic vs. nonautistic adults (aged 16–40 years) and older autistic vs. nonautistic adults (aged 41–90 years). Overall, we found similar patterns of sexual orientation, activity, and health among younger and older adult groups. However, we also found that older autistic adults were particularly likely to identify as bisexual compared to nonautistic older adults (likely driving this effect overall); in contrast, there were larger differences between younger groups than older groups in regard to the likelihood of identifying as homosexual (with younger autistic adults being particularly likely to

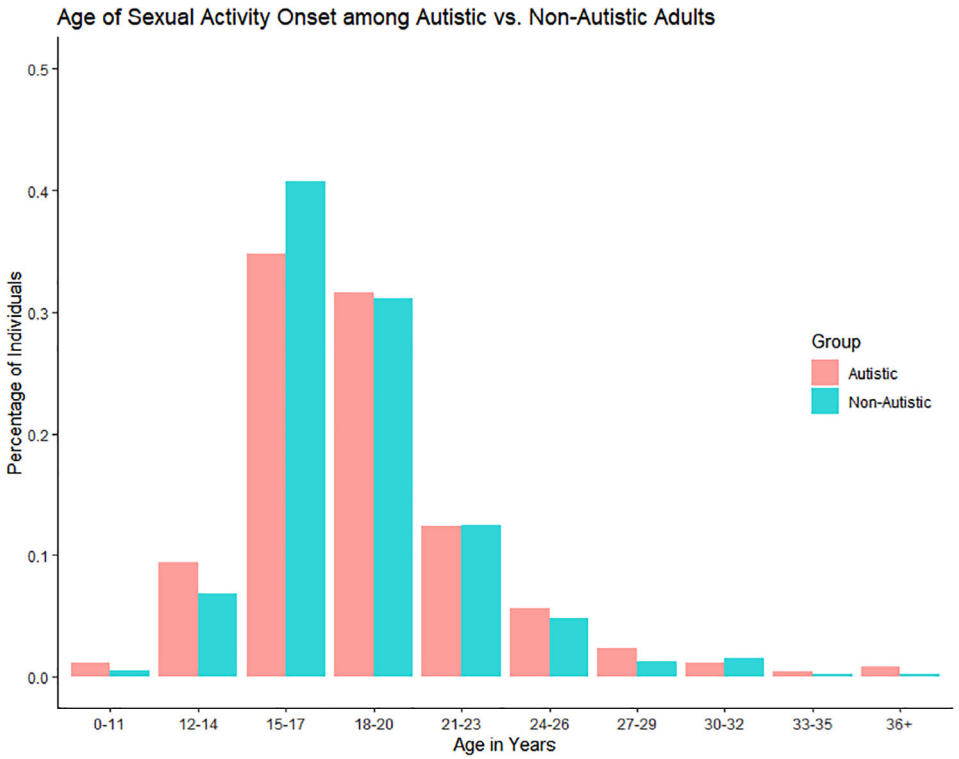

FIGURE 1 Age at which autistic and nonautistic individuals first engaged in sexual activity

TABLE 3 Sexual orientation of autistic individuals compared to nonautistic individuals

	Autistic			Nonautistic			Unadjusted model		Adjusted model[a]		
	Yes (*n*)	Total (*n*)	%	Yes (*n*)	Total (*n*)	%	OR (95% CI)	FDR	OR (95% CI)	FDR	Sig.
Asexual	118	1174	10.05	18	1194	1.51	7.295 (4.385, 12.825)	<0.001	8.107 (4.860, 13.525)	<0.001	***
Bisexual (females)	119	738	16.13	109	820	13.29	1.254 (0.937, 1.679)	0.166	1.259 (0.826, 1.917)	0.816	
Bisexual (males)	41	436	9.40	13	374	3.48	2.879 (1.483, 5.955)	0.001	3.459 (1.342, 8.919)	0.005	**
Heterosexual	740	1174	63.03	992	1194	83.08	0.347 (0.285, 0.423)	<0.001	0.309 (0.252, 0.379) [b]	0.002	**
Homosexual (females)	56	738	7.59	20	820	2.44	3.282 (1.916, 5.835)	<0.001	3.105 (1.445, 6.670)[b]	0.002	**
Homosexual (males)	33	436	7.57	32	374	8.56	0.875 (0.510, 1.504)	0.658	0.791 (0.364, 1.718)	0.993	
Other	67	1174	5.71	10	1194	0.84	7.161 (3.639, 15.687)	<0.001	7.612 (3.860, 15.013)	<0.001	***

Abbreviations: FDR, false discovery rate; 95% CI, 95% confidence interval; OR, odds ratio.
Note: Significance level: ***($p < 0.001$), **($p < 0.01$), *($p < 0.05$), Δ($p < 0.10$).
[a]Binomial logistic regression adjusting for age, sex, ethnicity, education, and country of residence.
[b]Exact *p* value was too small to be precisely determined; for the purposes of the FDR calculations, we estimated this *p* value as equal to 0.0009, in order to provide the most conservative analysis.

TABLE 4 Different patterns of sexual orientation, activity, and health between autistic males and females

	Females			Males			Unadjusted model		Adjusted model[a]		
	Yes (*n*)	Total (*n*)	%	Yes (*n*)	Total (*n*)	%	OR (95% CI) ‡	FDR	OR (95% CI)[b]	FDR	Sig.
Asexual	96	738	13.01	22	436	5.05	2.812 (1.722, 4.774)	<0.001	2.644 (1.619, 4.318)	<0.001	***
Bisexual	119	738	16.13	41	436	9.40	1.851 (1.257, 2.771)	0.003	1.558 (1.055, 2.300)	0.039	*
Heterosexual	415	738	56.23	325	436	74.54	0.439 (0.335, 0.573)	<0.001	0.485 (0.370, 0.637)	<0.001	***
Homosexual	56	738	7.59	33	436	7.57	1.003 (0.629, 1.621)	1.00	0.934 (0.585, 1.493)	0.777	
Other	52	738	7.05	15	436	3.44	2.126 (1.161, 4.120)	0.017	2.220 (1.217, 4.049)	0.017	*
Ever sexually active	561	738	76.02	306	436	70.18	1.346 (1.022, 1.771)	0.050	1.652 (1.225, 2.227)	0.002	**
Ever contracted an STI	83	741	11.20	39	434	8.99	1.277 (0.844, 1.960)	0.304	1.417 (0.936, 2.147)	0.128	
Ever contracted an STI[c]	78	564	13.83	38	304	12.50	1.123 (0.730, 1.752)	0.678	1.202 (0.779, 1.854)	0.456	

Abbreviations: FDR, false discovery rate; 95% CI, 95% confidence interval; OR, odds ratio.
Note: Significance level: ***($p < 0.001$), **($p < 0.01$), *($p < 0.05$), Δ($p < 0.10$).
[a]Binomial logistic regression adjusting for age, sex, ethnicity, education, and country of residence.
[b]Odds ratios and 95% confidence intervals use autistic males as the reference group.
[c]All individuals who reported never being sexually active were excluded.

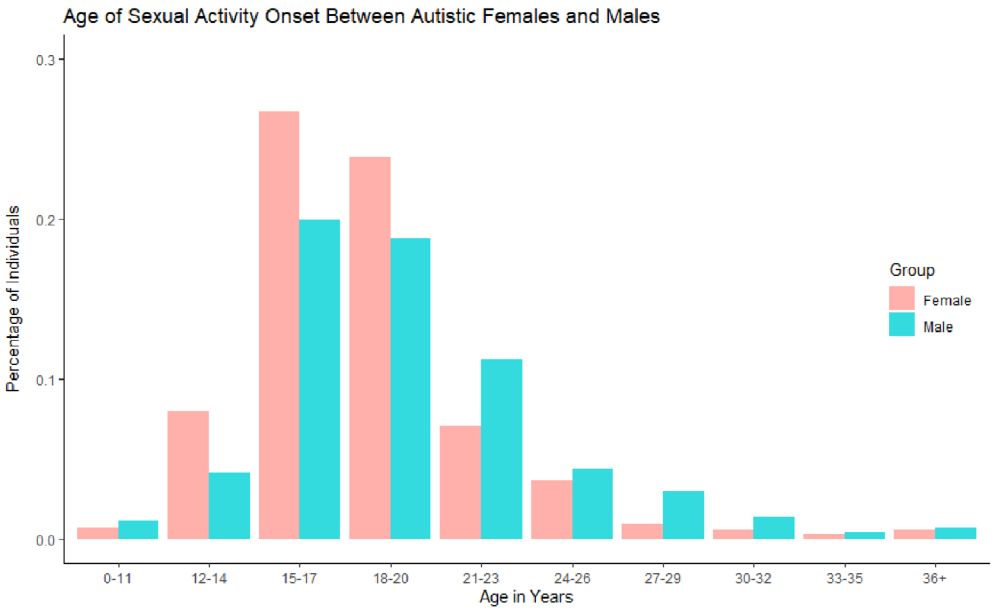

FIGURE 2 Age at which autistic males and females first engaged in sexual activity

report this identity). Aligning with previous research on this age group, we found that younger autistic individuals were less likely to have ever contracted an STI compared to younger nonautistic adults (Fortuna et al., 2016; Schmidt et al., 2019). Full results can be found in Table 5 below.

DISCUSSION

Autistic adolescents and adults may be less likely to engage in sexual activity than nonautistic individuals but may be more likely to have diverse sexual orientations; further, sex-specific patterns of sexual orientation and activity may be different between autistic and nonautistic adults. Overall, our results do not suggest differences in lifetime risk of STIs or age of sexual activity onset between autistic and nonautistic adolescents and adults. These findings may have important implications for the healthcare of autistic individuals, and in particular regarding sexual health screenings and support for mental health.

Our findings bolster previous evidence that autistic individuals identify with a wider range of sexual orientations than others (Bush, 2019; Bush et al., 2020; Dewinter et al., 2017; George & Stokes, 2018a; Pecora, Hancock, et al., 2020; Pecora, Hooley, et al., 2020; Rudolph et al., 2018). Our results clarify that autistic males are uniquely more likely to identify as bisexual than other males and autistic females are uniquely more likely to identify as homosexual than other females—suggesting that autistic adults do not conform to the same sex-specific patterns of sexual orientation observed in the general population. Autistic individuals are 8.1 and 7.6

TABLE 5 Different patterns of sexual orientation, activity, and health between autistic and nonautistic adults stratified by age group

	Younger adults adjusted model[a]			Older adults adjusted model[a]		
	OR (95% CI)	**FDR**	**Sig.**	**OR (95% CI)**	**FDR**	**Sig.**
Asexual	7.548 (3.838, 14.841)	<0.001	***	10.277 (4.564, 23.142)	<0.001	***
Bisexual	1.391 (1.008, 1.919)	0.059	Δ	1.914 (1.167, 3.140)	0.016	*
Heterosexual	0.327 (0.250, 0.428)	<0.001	***	0.267 (0.190, 0.374)	<0.001	***
Homosexual	1.925 (1.204, 3.077)	0.011	*	1.456 (0.782, 2.709)	0.290	
Other	7.740 (2.929, 20.453)	<0.001	***	6.684 (2.528, 17.676)	<0.001	***
Ever sexually active	0.262 (0.188, 0.366)	<0.001	***	0.242 (0.150, 0.392)	<0.001	***
Ever contracted an STI	0.623 (0.410, 0.947)	0.039	*	0.839 (0.593, 1.185)	0.349	
Ever contracted an STI[b]	0.805 (0.521, 1.243)	0.349		0.907 (0.637, 1.292)	0.588	

Abbreviations: FDR, false discovery rate; 95% CI, 95% confidence interval; OR, odds ratio.
Note: Significance level: ***($p < 0.001$), **($p < 0.01$), *($p < 0.05$), Δ($p < 0.10$).
[a]Binomial logistic regression adjusting for age, sex, ethnicity, education, and country of residence.
[b]All individuals who reported never being sexually active were excluded.

times more likely to self-report identifying as asexual or 'other' sexual orientation than nonautistic individuals, respectively. These odds ratios are far higher than those previously reported in a large sample of individuals with high autistic traits (ORs: 1.7–3.1) (Rudolph et al., 2018), and in a smaller sample of autistic females (ORs: 2.3–2.4) (Pecora, Hooley, et al., 2020). These results align with previous findings in the field to confirm relatively greater likelihood of identifying as a nonheterosexual sexual orientation and relatively lower likelihood of identifying as heterosexual; however, future research should focus on replicating these findings in population-based samples of both autistic females and males to confirm actual odds of identifying with each sexual orientation and the sex differences therein.

Further, when comparing autistic females and males directly, our results suggest that autistic females tend to identify with a wider range of sexual orientations (except for homosexuality), are more likely to engage in sexual activity, and are more likely to do so initially at a relatively younger age. Further, our results confirm previous findings showing that the majority of both autistic males and females endorsed engaging in sexual activity (Bush, 2019; Dewinter et al., 2013; Sala et al., 2020), even if the relative proportion of individuals was smaller than nonautistic males and females (Bush, 2019; George & Stokes, 2018a).

Our results refute previous findings suggesting that autistic individuals have reduced risk of STIs compared to others (Fortuna et al., 2016; Schmidt et al., 2019), instead supporting that there is no significant difference in relative lifetime risk of STIs. While our age-stratified results suggest that younger autistic adults (aged 16–40 years) may be less likely to engage in sexual activity than younger nonautistic adults, this effect was eliminated after removing individuals who have not ever engaged in sexual activity from the analysis. It is also possible that our results differ from the two previous studies in this area for practical reasons: The first study only included a sample of 255 autistic adults which is unlikely to be demographically representative of all autistic adults (Fortuna et al., 2016) and the second study only considered STI risk among individuals with any intellectual or developmental disability, grouping together a highly heterogeneous sample of individuals with autism, cerebral palsy, down syndrome, spina bifida, intellectual disability, as well as those with fragile X, prader willi, and fetal alcohol syndrome (Schmidt et al., 2019). Thus, it is likely that previous studies have not accurately captured the sexual activity and behavior of sexually active autistic individuals specifically.

The results from our main analyses also support that risk of STIs may be partially mediated by high rates of asexuality and lack of ever engaging in sexual activity among autistic adults overall, as significance and odds ratios attenuated after accounting for these factors separately and additively. Although our study does not directly inquire about interest in sexual activity, our results confirm that asexuality may play a key role in reducing sexual activity among autistic individuals—and particularly among autistic females. The results from Adjusted Model 1 suggest that autistic females were 38% and autistic males were 22% as likely to report ever having engaged in sexual activity compared to sex-matched peers; however, the group differences decreased to autistic females being 48% and autistic males being 24% as likely to report ever having engaged in sexual activity compared to sex-matched peers in Adjusted Model 2, after accounting for self-reported asexuality among the participants. Interestingly, asexuality does not account for all of the variance between autistic and nonautistic females and males (respectively) regarding sexual activity. It is possible that this difference could be accounted for by reduced libido previously reported among autistic individuals (Bejerot & Erikson, 2014; Bush, 2019; Pecora et al., 2019), or that autistic adults' actual sexual activity may not meet their desire for it, due to differences with social communication, sensory sensitivities, or mental health conditions such as anxiety, which can often co-occur with autism (Croen et al., 2015; Hand et al., 2019). Taking into account

reports of limited sexual knowledge/ education, low healthcare satisfaction, and high odds of unmet healthcare needs (Dewinter et al., 2013; Mason et al., 2019; Nicolaidis et al., 2013; Pecora, Hancock, et al., 2020), existing research may have underestimated true rates of STIs among autistic adults. Future research should focus on clarifying true lifetime prevalence rates of STIs among autistic and nonautistic adults comparatively.

Our age-stratified results also suggest that older autistic adults may be uniquely likely to identify as bisexual, whereas younger autistic adults may be uniquely likely to identify as homosexual compared to peers of similar age ranges (respectively). These findings provide some evidence that social norms (which change across time) may have affected individuals' acceptance of their specific sexual orientation; yet, our results support overall that autistic individuals of both age groups are more likely than others to identify with diverse sexual orientations and less likely to identify as heterosexual—which may be affected by social norms, biological differences, other factors, or a combination of these. Our findings do not support a difference in the mean age at which autistic and nonautistic adults report first engaging in sexual activity; however, Figure 1 above shows a relatively wider distribution among autistic adults, with a greater number of outliers on both sides. This is particularly concerning regarding sexual activity prior to the age of 13 years, which may relate to child sexual victimization; however, as our study did not define sexual activity specifically or ask about child sexual abuse, no definitive conclusions can be drawn from these findings at this time.

Our online, self-report, and cross-sectional methodology enabled recruitment of a large cohort of autistic adolescents and adults (aged 16–90 years; mean age approximately 41 years), providing the unique opportunity to describe the sexual health and orientation across the lifespan. This is the largest study of sexual orientation of autistic adolescents and adults and the first to consider asexuality and likelihood of ever engaging in sexual activity in measures of sexual health. This is also the first study that quantifies the odds of identifying with a particular sexual orientation, as well as the relative sex differences of those patterns while controlling for key demographic confounders, such as age, sex (where appropriate), ethnicity, education-level, and country of residence.

Limitations

Despite recruiting a large number of autistic individuals (particular older and female autistic individuals), the results presented are unlikely to represent the experiences of all autistic individuals. Our survey design and recruitment methods inherently exclude individuals without access to a computer and/or the internet, as well as those who are not physically or intellectually able to fill in a self-report survey. They also exclude non-English speakers, as the survey was only distributed in English; this is reflected in the demographics of our sample, as the vast majority of participants reported countries of residence with English as the native language (over 80% of the population resided in the United Kingdom, United States, or Australia). Further, white individuals, UK residents, and females were overrepresented in our sample; as such, our results may not be representative of all individuals. In particular, as attitudes toward sexual orientation and sexual activity may depend on norms within different languages, religions, and cultures, differences between our findings and past work in the area may simply reflect sampling biases (e.g., our study oversampled individuals from the UK and US whereas previous studies may have oversampled individuals from Europe and Australia). Additionally, our recruitment methods may have also biased our control group toward individuals with an interest in autism, including those who may have undiagnosed autism—underestimating true group differences between autistic and nonautistic adults; to minimize this risk, we excluded all individuals who suspect autism, are awaiting autism assessment, and/or self-diagnosed as autistic from both the autistic and nonautistic control groups.

There are also several other limitations of the study that should be considered. First, it is possible that the odds of identifying as a nonheterosexual orientation are greater among actually autistic individuals compared to those with high autistic traits; however, it is also possible that our study is underpowered to provide true effect size differences, and that the odds ratios represented here are artificially inflated due to "winner's curse" (a statistical phenomenon common to epidemiology and genetics where the effect size reported first is greater than the effect sizes reported in later studies of the same group) (Ioannidis, 2008). Second, our survey did not specifically define the terms "sexual activity", "STIs", or "sexual orientation"; however, our results largely align with several previous studies in these areas (Bush, 2019; Bush et al., 2020; Dewinter et al., 2017; George & Stokes, 2018a; Pecora, Hancock, et al., 2020; Pecora, Hooley, et al., 2020; Rudolph et al., 2018), and our results did not change when more strictly defining "STIs" in a sensitivity analysis. Third, sexual health and sexual activity are complex and attitudes toward them may change over time; this study cannot accurately describe all aspects of these multifaceted experiences. Fourth, the study relied on a self-report methodology on topics that may have been taboo or sensitive for some participants. For this reason, we explicitly told participants that the survey was anonymous and that all questions regarding sexual health were optional; however, we maintained high response rates even through this section (>99% for all questions related to sexual orientation and health). Still, it is possible that autistic individuals may have been more candid about their experiences than others due to differences in communication style and/or lessened concerns about

adherence to social norms. Fifth, as we do not yet understand the factors that contribute to an individual's sexual orientation, the group differences observed regarding sexual orientation may correspond to these factors or to differences in acceptance of one's own sexuality (again, possibly due to differences in communication style/ lessened adherence to social norms typical of autism).

Clinical implications

Currently, autistic individuals overall report lower satisfaction and self-efficacy within healthcare, as well as higher odds of unmet healthcare needs than others (Mason et al., 2019; Nicolaidis et al., 2013); and LGBTQA+ autistic individuals may be particularly vulnerable to worse mental and physical health, as well as inadequate healthcare (George & Stokes, 2018b; Hall et al., 2020; Pecora, Hooley, et al., 2020). Previous research that suggests that current sexual education of autistic individuals remains inadequate (Dewinter et al., 2013; Pecora, Hancock, et al., 2020), and that autistic females have self-reported lower rates of cervical cancer screenings (Nicolaidis et al., 2013). Our results also suggest that autistic adults are just as likely to contract STIs as others; further, other studies suggest that autistic females may be more likely to have gynecological and/or hormone-associated conditions (including polycystic ovarian syndrome) (Cherskov et al., 2018; Ruta et al., 2011), which can increase risk of diabetes, cardiovascular conditions, and cancers (Bhupathy et al., 2010; Brand et al., 2011; Cherskov et al., 2018; Mantovani & Fucic, 2014). Thus, improving sexual education and ensuring regular gynecological/ sexual health appointments for autistic adolescents and adults across the spectrum should remain a priority.

Healthcare professionals should be aware of increased risk of sexual victimization and abuse among autistic individuals across the lifespan (Brown-Lavoie et al., 2014; Pecora et al., 2019), and should take extra time and care to communicate effectively with autistic people when discussing relationships, sexual contact, and sexual health to ensure appropriate safeguarding; these risks may be particularly acute for autistic females and those with diverse sexual orientations (Pecora et al., 2019; Pecora, Hooley, et al., 2020). As challenges with social communication are a core feature of autism, practitioners providing these wellness checks (including sexual health screenings, as well as screenings for abuse during pediatric visits) may need extra time with autistic individuals and should focus on asking specific, rather than open-ended questions; further, practitioners should allow individuals to communicate in the way they feel most comfortable, including via written communication (Nicolaidis et al., 2015). Providers should also be aware that autistic individuals may be more likely to identify with a wider spectrum of genders and sexualities, and their language should be affirming and inclusive of all these identities, particularly when discussing sexual education, sexual health, and consent. Psychiatrists should also be aware of possible intersectionality between gender, sexual orientation, and/or disability, as their autistic patients may be particularly likely to experience mental or physical health problems due to discrimination and minority stress (George & Stokes, 2018b; Hall et al., 2020). Healthcare providers should work cooperatively with autistic and non-autistic individuals alike to communicate effectively and make plans to ensure that sexual relationships and sexual contact remain affirming, safe, and fulfilling.

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ETHICS STATEMENT

This study received ethical approval (HBREC.2017.28) from the University of Cambridge Human Biology Research Ethics committee. All participants included in this sample provided informed consent.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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