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ORIGINAL PAPER

Changes in high-risk sexual behavior, HIV and other STI testing, and PrEP use during the COVID-19 pandemic in a longitudinal cohort of adolescent men who have sex with men 13 to 18 years old in the United States

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Abstract
The COVID-19 pandemic has disrupted sexual health services among those most vulnerable to HIV acquisition, such as adolescent men who have sex with men (AMSM). We sought to characterize the changes in sexual-risk behaviors, HIV and other STI testing, and pre-exposure prophylaxis (PrEP) use among a longitudinal cohort of AMSM aged 13 to 18 years before and during the COVID-19 pandemic. We observed a significant decline in HIV testing and a marginal decrease in other STI testing since the pandemic began in March 2020. Outreach efforts and innovative remote delivery of sexual health services are needed to support access to healthcare services among AMSM as the pandemic persists.

Keywords adolescent MSM · coronavirus · condomless anal sex · HIV prevention · health disparities · prevalence rates · prospective analysis

Resumen
La pandemia de COVID-19 ha afectado la prestación de servicios de salud sexual para los más vulnerables, tales como los hombres adolescentes que tienen relaciones sexuales con hombres (AMSM; por sus siglas en ingles). En una cohorte longitudinal de AMSM de 13 a 18 años, examinamos los cambios en comportamientos sexuales de alto riesgo, la prueba de VIH, las pruebas de otras enfermedades de transmisión sexual, y el uso de Profilaxis Preexposición (PrEP) para el VIH antes y durante la pandemia. Desde el inicio de la pandemia en marzo de 2020, observamos una disminución significativa en la frecuencia de pruebas de VIH y una disminución marginal en la frecuencia de pruebas de otras enfermedades de transmisión sexual. Mientras persista la pandemia, serán necesarios más esfuerzos de divulgación e innovaciones en la prestación remota de servicios de salud sexual para apoyar el acceso a dichos servicios por parte de AMSM.

Introduction

As of August 2022, the COVID-19 pandemic has caused over one million deaths in the United States (US) and continues to evolve with new variants[1]. Public health efforts such as physical distancing and shelter-in-place orders to curb the spread of the virus have resulted in unprecedented social disruptions that have disproportionately impacted sexual and gender minorities such as gay, bisexual, and other men who have sex with men (MSM)[2]. Since COVID-19 began, MSM have experienced increasing rates of unemployment and income reduction, limited access to health care, and mental health illnesses[3, 4]. These unforeseen consequences may exacerbate the existing social and mental health disparities[5] among this population and make them more vulnerable to negative impacts from the pandemic compared to the general population.

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Meanwhile, MSM continue to be disproportionately impacted by the HIV epidemic in the US. In 2019, MSM accounted for nearly 70% of all new HIV diagnoses in the US, with about a quarter of new HIV cases within MSM reported among those aged 13 to 24 years[6], highlighting the greater burden among adolescent MSM (AMSM). Indeed, adolescence is a critical developmental phase between childhood and adulthood where individuals experience biological, psychological, and social changes. It is an important period for sexual development when adolescents invest in social connections and learn behaviors from their peers and friends in school and community. In particular, adolescence is often considered as the start of sexual maturation and changes in familial and social relations have significant impact on adolescent's sexual behaviors[7, 8]. The COVID-19 pandemic and associated public health measures have not only disrupted their lives and interactions with peers, but also imposed additional barriers to HIV prevention services, due to reduced hours and closure of sexual health clinics in response to the physical distancing orders. These have resulted in reduced access to routine testing for HIV and other sexually transmitted infections (STI), condom and lubricant resources, and pre-exposure prophylaxis (PrEP) refills for MSM[9].

Studies based on retrospective recall have documented changes in sexual behaviors among AMSM since the start of the pandemic in March 2020[10], however, the findings have been equivocal and potentially limited by recall bias. One investigation of 151 AMSM aged 14 to 17 years found that participants reported seeing in-person sexual partners less often[11], while another investigation found some AMSM had increased in-person sexual activities[9]. Neither of these studies assessed changes in condomless anal sex. Moreover, several US-based studies reported that AMSM have encountered disruption in PrEP and HIV testing services during the pandemic. In the Southern US, a fifth of MSM discontinued or took PrEP less frequently since the start of the pandemic[12]. Another study from the Southern US reported that a substantial number of MSM had difficulties in accessing HIV or STI testing[13]. A national sample of diverse AMSM aged 17 to 24 years found that one in seven PrEP users stopped taking PrEP, and more than 10% had difficulty accessing HIV and STI testing during the pandemic[9]. Sanchez et al.,[13] reported that, compared to MSM aged 25 years and older, AMSM aged 15 to 24 were more likely to report difficulty accessing condoms and HIV/STI testing services since the pandemic started.

These disruptions in services and access may have profound impacts on HIV transmission among AMSM. Identifying changes in longitudinal trends could better contextualize the impact on HIV risk and inform public health messaging to reduce HIV disparities among AMSM. The objective of this study is to describe the prevalence and change in condomless anal sex, HIV and other STI testing, and PrEP uptake in a longitudinal cohort of AMSM in the year leading up to, and during, the COVID-19 pandemic.

Methods

Data collection and procedures

Data were derived from a randomized clinical trial, Male Youth Pursuing Empowerment, Education, and Prevention around Sexuality (MyPEEPS) Mobile, an mHealth HIV prevention intervention for AMSM aged 13 to 18 years. We conducted a secondary data analysis of the delayed intervention (i.e., waitlist control) participants as a longitudinal observational cohort. The MyPEEPS trial is described in detail in a previous report[14]. Briefly, AMSM were recruited from community events and organizations through four regional hubs (Birmingham, Alabama; Chicago, Illinois; New York City, New York; Seattle, Washington) and nationwide through internet-based advertisements on popular social media sites, including Facebook, Twitter, Instagram, and Snapchat. To be eligible, participants were: (1) aged 13 to 18 years at the time of enrollment; (2) assigned male sex at birth and self-identified as male; (3) lived in the US; (4) self-reported HIV-negative or unknown HIV status; and (5) had either kissed another male in the past or planned to engage in sexual activities with another male in the next year. We limited our analysis to delayed intervention participants who participated in the study between January 1, 2019 and December 31, 2020, before they were given access to the intervention. This period includes the calendar year preceding the declaration of the global pandemic by the World Health Organization and the national emergency by the US federal government on March 16, 2020[10] through the end of 2020. A total of 371 participants met the analytic criteria. Online survey assessments were administered in English, and the study protocol was reviewed and approved by the Institutional Review Board of Columbia University[14].

Measures

The baseline online survey included questions on basic sociodemographic characteristics (e.g., age in years, race/ethnicity, sexual orientation), sexual behaviors, and HIV prevention service utilizations such as HIV/STI testing, and PrEP use. Follow-up assessment surveys were conducted at 3, 6, and 9 months after baseline.

Sexual behaviors. Participants were asked questions related to recent anal sex with other male sexual partners at each assessment. Specifically, participants were asked, "*In*

the past 3 months, how many guy(s) have you put your penis in their butt?" and "*In the past 3 months, how many guy(s) have put their penis in your butt?*". Those who indicated a number greater than 0 were asked, "*Of these guy(s) in the past 3 months, with how many guy(s) have you put your penis in their butt, even for a little while, without wearing a condom?*" and "*Of these guy(s) in the past 3 months, with how many guy(s) put their penis in your butt, without wearing a condom?*". We then created a dichotomous indicator for whether participants had condomless anal sex in the past three months (= 1) or did not have condomless anal sex in the past three months (= 0).

HIV and other STI testing. At each assessment, participants were asked "*When was your last HIV test?*" The follow-up surveys asked, "*In the last 3 months, how many times have you been tested for HIV?*" For those who indicated their last HIV test was in the last three months at baseline or received at least one HIV test in the 3 months preceding the follow-up surveys were coded as either having received an HIV test in the past three months (= 1) or having not received an HIV test in the past three months (= 0) at the corresponding assessment. Regarding other STI testing, we asked respondents the following question: "*In the past 3 months, were you tested for any of the following sexually transmitted infections (STIs) or diseases?*" Response options included *syphilis, chlamydia, gonorrhea, HPV or genital warts, genital herpes, genital lice, hepatitis, and others*. If participants responded "yes" to any option, their responses was recoded as 1. Those who chose "*I haven't gotten an STI test in the last 3 months*" were recorded as 0.

PrEP use. We assessed at baseline and follow-up assessments participants' current PrEP use by asking them *"Are you currently using PrEP now?"* after we presented a brief description of oral PrEP for HIV prevention (1 = Yes, 0 = No).

Descriptive Analysis

We used descriptive statistics to determine the frequency and proportion of study variables across all time points. Next, we examined the rates of HIV testing, other STI testing, and PrEP use only among those who reported having had condomless anal sex in the past three months.

Longitudinal Analysis of Prevalence Rates

To evaluate prevalence rates over time in condomless anal sex, HIV testing, other STI testing, and PrEP use, we used generalized estimating equations (GEE)[15]. GEE is an extension of generalized linear modeling that is appropriate for modeling longitudinal or clustered data. A "working correlation" structure is defined a priori and specifies the hypothesized relation between repeated observations on a subject. An exchangeable correlation structure was chosen for all GEE models, which is functionally equivalent to a repeated measures analysis of variance. Each outcome was analyzed in a separate GEE model, all of which were specified with a logit link function for dichotomous outcomes.

A piecewise linear approach was used to model longitudinal trends in the prevalence of each outcome in two parts: (a) the "pre-pandemic period", which we defined as Winter 2019 to Winter 2020 (i.e., January 2019 to March 2020), and (b) the "pandemic period" from Spring 2020 to Autumn 2020 (i.e., April 2020 to December 2020). In these models, the outcome was regressed on time, with time partitioned into two linear parameters corresponding with the outcome trajectory during the pre-pandemic period and a "deflection" term representing the change in trajectory upon entering the pandemic period. No additional covariates were included in these models. The time variable was defined in calendar quarters starting with Winter 2019 (January-March 2019) and ending with Autumn 2020 (October-December 2020). Thus, the prevalence rate for each quarter (e.g., Spring 2020: April-June 2020) was based on survey assessment data collected within the corresponding three-month range. For ease of interpretation, we defined Spring 2020 as the start of the pandemic period, as this roughly corresponds with the declaration of the COVID-19 global pandemic by the World Health Organization on March 11, 2020. Data were analyzed in R version 4.2.1 with version 4.13-23 of the GEE package[16].

Results

Sample Characteristics

The mean age at baseline of the 371 participants was 16.2 years old (*SD* = 1.4) and most were born in the US (92.6%). Most participants self-identified as gay (75.8%) or bisexual (20.3%). Over one-third (35.0%) identified as White, followed by Black (18.9%) and multiracial (15.1%); 44.5% identified as Hispanic/Latino. Over two-thirds (69.0%) of participants reported having ever had oral or anal sex with another guy, and 43.4% reported having ever had anal sex with another guy without using a condom. Only a third (33.2%) had tested for HIV in their lifetime.

Prevalence of condomless anal sex, HIV/STI testing, and PrEP use before and during the pandemic

Quarterly prevalence rates (e.g., Winter = January to March) for the study outcomes and the modelled trajectories in prevalence from before to during the pandemic are presented in

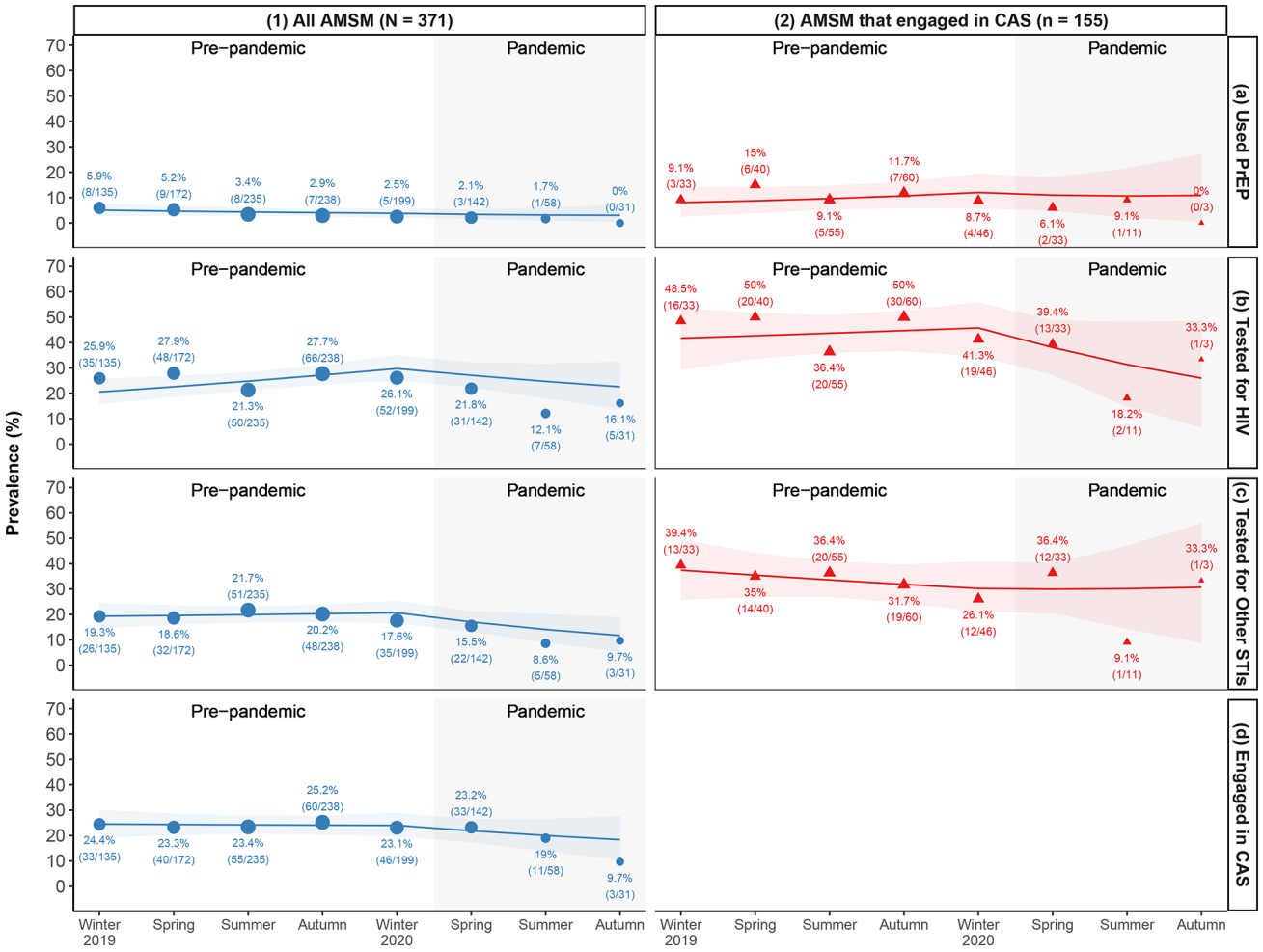

Fig. 1 Past 3-month prevalence rates of preexposure prophylaxis (PrEP) use, HIV testing, and other STI testing among (1) all adolescent men who have sex with men (AMSM; blue circles) and (2) those AMSM who engaged in condomless anal sex (CAS; red triangles) from 2019 to 2020

Note: The circular and triangular symbols correspond with the raw prevalence rates the Winter (January-March), Spring (April-June), Summer (July-September), and Fall (October-December) quarters. The trend lines and shaded regions correspond with the longitudinally modeled prevalence rates and 95% confidence intervals, respectively

Fig. 1. From Winter 2019 to Winter 2020 (pre-pandemic period), approximately one-quarter of all AMSM engaged in condomless anal sex, which was relatively stable across quarters. From Spring to Autumn 2020 (pandemic period), the rate of condomless anal sex declined from 23.2 to 9.7%. However, the observed decrease in condomless anal sex from pre-pandemic to pandemic was not statistically significant (*Odds Ratio* [*OR*] = 0.89, 95% CI [0.69, 1.16]).

For HIV testing, the pre-pandemic prevalence for all AMSM (Winter 2019 to Winter 2020) varied between 21.3% and 27.9%, with decreasing rates during the pandemic (Spring to Autumn 2020). Specifically, 25.9% of AMSM reported HIV testing in Winter 2019 with a similar prevalence rate in Winter 2020. However, from Winter to Autumn 2020, there was a decrease in HIV testing rates, from 26.1 to 16.1%. In the fitted model, the estimated prevalence of HIV testing among AMSM trended towards decreasing rates from 27.1% in Spring 2020 to 22.6% in Autumn 2020 (change=-4.5%, 95% CI [-10.7, 2.3]). During the same Spring to Autumn period in 2019 (pre-pandemic), the estimated prevalence of HIV testing among AMSM increased from 22.6 to 27.2% (change = 4.3%, 95% CI [1.1, 7.5]). The decrease in HIV testing over time from before to during the pandemic among all AMSM was statistically significant (*OR* = 0.78, 95% CI [0.61, 0.99], $p = .041$).

For other STI testing, the prevalence for all AMSM remained relatively stable before the pandemic (Winter 2019 to Winter 2020), varying between 17.6% and 21.7%. There was, however, a marginal decrease in STI testing prior to the pandemic among all AMSM (*OR* = 0.77, 95% CI [0.57, 1.03], $p = .083$). In the fitted model, the estimated prevalence of other STI testing among all AMSM during

the pandemic (Spring to Autumn 2020) decreased from 17.0 to 11.7% (change=-5.3%, 95% CI [-9.5, -0.3]). In contrast, during the same nine-month period in 2019 (pre-pandemic), the estimated prevalence of other STI testing among all AMSM was relatively stable, ranging from 19.6 to 20.3% (change = 0.6%, 95% CI [-2.8, 4.0]).

For PrEP use, the prevalence among all AMSM remained low before and during the pandemic (Winter 2019 to Autumn 2020). In Winter 2019, 5.9% AMSM were using PrEP, which decreased to 2.5% in Winter 2020. From Spring 2020 to Autumn 2020, the rate of PrEP use declined from 2.1 to 0.0%. In the fitted model, there was not a statistically significant difference in the decrease from pre-pandemic to during the pandemic (*OR* = 0.94, 95% CI [0.56, 1.60]).

Finally, we evaluated the prevalence and longitudinal trends in HIV testing, other STI testing, and PrEP use among AMSM who reported having had condomless anal sex (see Fig. 1, column 2). The prevalence of HIV and other STI testing, and PrEP use and the predicted value in the fitted model shared a similar pattern to all AMSM. However, none of the changes over time between pre- and during the pandemic was statistically significant.

Discussion

This study examined the prevalence rates of condomless anal sex, HIV and other STI testing, and PrEP use from January 2019 to December 2020 in a diverse cohort of AMSM, to better understand the potential impact of the COVID-19 pandemic on AMSM vulnerability to HIV acquisition. We found that AMSM continued to be sexually active and engaged in condomless anal sex during the pandemic. Results also showed there was a significant decrease in HIV testing among this group since the pandemic began. These results provide important cautionary notices for public health and healthcare providers to continue to provide comprehensive HIV prevention services to AMSM as the pandemic continues to evolve.

A quarter of AMSM in our longitudinal cohort reported engaging in condomless anal sex pre-pandemic. Although these rates dropped slightly after the start of the pandemic, that drop was not statistically significant. One in eight still engaged in condomless anal sex six months into the pandemic (i.e., Autumn 2020), and, more concerning, less than half of those engaging in condomless anal sex reported HIV or other STI testing at that same point in time. It is possible that the reduced HIV/STI testing rates and discontinuation in PrEP use were due to the reductions in sexual risk behaviors, including condomless anal sex. It may also result from inadequate access to healthcare services. As the pandemic recedes and many of the public health measures are lifted, continuing efforts to promote sexual health services including routine HIV and other STI testing among AMSM is warranted.

Indeed, HIV is still mostly transmitted through condomless anal sex among gay and bisexual men, particularly if the sexual partner's HIV status is unknown or the HIV-positive partner's viral load is detectable[17]. AMSM, in general, are the least likely to know their HIV status than any other age groups in the US[18]. In our study, only about a quarter of AMSM had recently received an HIV test before the pandemic, and we found a significant decrease in HIV testing over time from before to during the pandemic. Particularly, the testing rate reached the lowest in the July to September 2020 period, which corresponds with testing that occurred during the Spring of 2020 when most of the shelter-in-place and stay-at-home orders were implemented. Our results add evidence to the literature that the COVID-19 related safety measures caused disruptions to routine sexual health access for AMSM[19].

Of note, PrEP use has remained low among AMSM in our study, both before and during the pandemic, which is consistent with prior research on PrEP use among AMSM[20, 21]. PrEP is a highly effective biomedical HIV prevention intervention among at-risk populations when taken as prescribed[22]. In May 2018, the US Food and Drug Administration expanded the clinical practice guideline and approved PrEP for the prevention of HIV among adolescents younger than 18 years old and weighing at least 77 lbs (35kg).[23]. A modeling study predicted that more than a quarter of new HIV infections could be prevented if PrEP was successfully targeted and initiated after first anal intercourse among AMSM[24]. Despite the high efficacy in preventing HIV, PrEP uptake is still low among AMSM. Several reasons may explain low PrEP uptake, such as medical mistrust, concerns about side effects and adherence, and lack of insurance coverage[25–27]. Future research should focus on identifying opportunities and developing interventions to promote awareness and willingness to use PrEP among AMSM, with particular focus on addressing barriers that decrease access to PrEP-related care and services for AMSM. A recent study found that most adolescents who had ever heard of PrEP reported learning about it through the internet or popular social media[28]. Our parent study, MyPEEPS, may hold great promise in promoting PrEP use and inform successful future research and practice directions on PrEP implementation.

Adolescence is a critical development phase and the ongoing pandemic has caused serious disruptions in daily life and placed additional psychological stressors by the pandemic and containment measures[29]. In addition, it is an important period for sexual development and the initiation of sexual behavior, which requires consistent medical

care to support sexual health needs in this critical phase of growth[30, 31]. To our knowledge, this is one of the first studies documenting the changes in sexual behaviors, HIV and other STI testing, and PrEP use over time before and during the COVID-19 pandemic among AMSM aged 13- to 18-years-old. The strength of the study includes the longitudinal design and the racial and geographic diversity of the study participants. However, there are some limitations. First, data were self-reported; therefore, they may be subject to social desirability bias and recall bias. Second, our survey did not differentiate between the types of sexual partners (main partner vs. casual partner) and their HIV status with respect to condomless anal sex. A finer-grain assessment of these risk factors in the context of condomless anal sex would clarify the degree of HIV transmission risk. Third, only a relatively small proportion of participants ($n = 155$) reported condomless anal sex or PrEP use ($n = 25$), limiting our statistical power to assess trends in these subgroups of AMSM. However, despite these data-related limitations, this information is still valuable in the light of the vulnerability of HIV infection among AMSM and the limited descriptive data on PrEP use in this age group.

Conclusion

This study provides insights into the rates of condomless anal sex, HIV and other STI testing, and PrEP use among AMSM during an unprecedented period of social and health service interruptions. Findings underscore the need to facilitate additional access to sexual health services during the COVID-19 pandemic. Remote service delivery strategies, including telehealth and home HIV testing, may be needed for AMSM and other populations vulnerable to HIV infection. Public health practitioners and healthcare providers should continue promoting HIV prevention interventions such as PrEP to reduce HIV incidence and eliminate the disparities among AMSM and eventually end the HIV epidemic in the US.

Authors' contributions CH, DH, and CRP conceptualized the research question, analyzed the data, and drafted the manuscript. RS was responsible for overseeing all aspects of the study as Principal Investigator. All other authors provided feedback on data analysis, interpretation of results, and manuscript revisions. All authors provided intellectual content to the paper and reviewed and approved the final manuscript.

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Availability of data and material No applicable.

Code Availability No applicable.

Declarations

Conflict of interest All authors declare no conflict of interest.

Ethical Approval The study was reviewed by the Institutional Review Board of Columbia University (IRB-AAAQ6500, Rebecca Schnall, Principal Investigator). Under this Institutional Review Board, the study met the regulatory guidelines for the protection of human subjects and involves no more than minimal risk (45 CFR 46.404/21 CFR 50.51; i.e., "Sect. 404"). No parental permission was obtained because each of the criteria for waiving parental permission apply (45 CFR 46.408(c)).

Informed Consent All participants provided informed consent.

Consent to participate All study participants provided informed consent in-person or through an online video call.

Consent for publication No applicable.

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