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Multiplex Social Factors Affecting HIV Prevalence in Colorado

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☒ By checking this box, I indicate that my mentor has read and reviewed my draft proposal prior to submission (I am in the Aug./Sept. Short Course with Dr. Todd)

Abstract

Objective: The objective of this paper was to investigate and analyze the relationships between the prevalence of HIV and geographic location, high-risk behaviors, and education status in Colorado in 2020. *Methods:* The author of this paper conducted Spearmen correlations on HIV prevalence with rural status, rates of flu vaccinations, and drug overdose deaths, as well as performed stepwise linear regressions on the variance of HIV prevalence accounted for by rates of teen births, sexually transmitted infections, high school graduation, and college education status. *Results:* Incidence of other STIS and teen births ($F_{2,42} = 7.69$, $p = .001$), as well as rates of high school graduation status and college education status ($F_{2,46} = 4.52$, $p = .016$), accounted for significant variance in the HIV prevalence. Associations with high school graduation rates ($B = -8.303$, $t = -3.01$, $p = .004$) and other STIs ($B = .42$, $t = 3.69$, $p = .001$) was most significant. No correlation was found between HIV prevalence and rural status, flu vaccinations, or drug overdose deaths.

Key Words: (list 3-10 key words here) Colorado, HIV, AIDS, NCHHSTP, SDH

Introduction & Literature Review

There is an estimated 38 million people worldwide who are HIV-positive.[1] As of 2018, 1,173,900 individuals within the United States were living with HIV.[2] 86% of these people knew that they were HIV-positive, and yet only 56% were virally suppressed below detectable levels due to treatment.[2] This fails to meet the 90-90-90 target for 2020 by UNAIDS for 90% of HIV-positive individuals to know their HIV status, 90% of diagnosed individuals to be treated with sustained therapy, and 90% of treated individuals to be virally suppressed.[1] Incidence varies significantly by state, but rates were as low as 2.1 new diagnoses of HIV per 100,000 medical diagnoses in Idaho and Montana and as high as 23.8 per 100,000 diagnoses in Georgia for the same year of 2018.[2] Rates in most states lies roughly in the middle, such as Colorado with 7.0 per 100,000 new HIV diagnoses in that year.[2]

HIV-risk and incidence vary by geographic distribution and are associated with particular social determinants of health (SDH). Regression analysis on the incidence of HIV accounted for by particular SDH: education, employment, housing, income, and insurance suggested that two factors: education and housing had the greatest statistical significance when accounting for variance in HIV and AIDS incidence.[3] The findings ultimately suggested that interstate variance in HIV-incidence and AIDS-incidence models were respectively explained at 55% and 40% by housing and education alone, suggesting an important relationship between HIV-incidence and housing and education status.[3]

Regression analyses performed on county-level HIV prevalence in Southern US counties showed that HIV rates were positively correlated with proportions of Black constituents, unemployment rates, female head of households, poverty rates, and urbanicity, and negatively correlated with owner-occupied housing units.[4]

Geographic distributions of pre-exposure prophylaxis (PrEP) eligibility closely follow distributions of HIV-risk and prevalence.[5] Epidemiology following PrEP use thus serves as a reasonable proxy to HIV-risk epidemiology.[5] A study of PrEP-eligibility within Colorado showed significant intercounty variance.[5] A demographic breakdown found that of individuals indicated for PrEP use, 81% were men who have sex with men (MSM) and 65% lived in large central or large fringe metropolitan areas.[5]

Risk multiplexity, i.e. multiple high-risk behaviors, further increases HIV risk.[6] A study within Colorado Springs showed that sexual activity, needle-sharing, and drug use, corresponding to increased HIV risk, were clustered into racial and ethnic groups and were highest in white and Hispanic populations.[6] The study further suggested that knowing one's own status reduced these multiplex-risk behaviors.[6]

Health outcomes related to HIV-status are dramatically improved by following recommended treatment and by following the recommended preventative-care guidelines, due to an increased risk for contraction and severity of comorbid infections.[7] The CDC recommends that all HIV-positive adults, even with a $CD4^+$ T-cell count greater than $200/mm^3$, receive vaccines for pneumococcal infection, meningococcus, hepatitis B, human papillomavirus (HPV), varicella, and measles, mumps, and rubella (MMR).[8] Further guidelines include immunization against hepatitis A for most HIV-positive individuals as well as the shingles (herpes zoster) vaccine for anyone older than age 50.[9] Additionally, the CDC recommends that HIV-positive adults should receive regular Tdap vaccines and annual influenza vaccines.[8] Flu vaccinations are of particular importance for people living with HIV, as HIV infection and T-cell abnormalities elicit significant vulnerability to influenza infection and secondary complications such as bacterial pneumonia and congestive heart failure, or even death.[7] A 2015 study in Texas

suggested that fewer than 50% of the HIV-positive population received an annual flu shot, well below the Healthy People 2020 general population target coverage of 70%.[7]

Testing and preventative care is an important aspect of mitigating HIV incidence, however both factors tend to be reduced in MSM who are non-disclosed or are non-gay.[10] Non-disclosed and non-gay MSM thus present an obstacle and gap in traditionally LGBTQ+ directed prevention campaigns as well as epidemiological studies.[10] This thus represents a significant gap in research and public health. One systematic review suggested that fewer than 25% of HIV/AIDS articles focused on employment status, housing, education, stigma, community context, health care, or neighborhood context.[11] The authors suggested that future research should thus place a greater emphasis on relationships between SDH and HIV/AIDS status.[11] The literature likewise showed a substantial gap in research examining multiplex-risk relationships with HIV.[6] More targeted and recent data, such as HIV statistics in individual states such as Colorado, is additionally lacking in the literature.

This paper will attempt to address the intercounty relationships between HIV prevalence, multiplex risk behaviors, and SDH within Colorado. **RQ1**: How does prevalence of HIV correlate with rural status in Colorado counties in 2020? **RQ2**: How do rates of teen births and sexually transmitted infections account for the variance in HIV prevalence in Colorado counties in 2020? **RQ3**: How does prevalence of HIV correlate with rates of flu vaccination in Colorado counties in 2020? **RQ4**: How does prevalence of HIV correlate with rates of drug overdose deaths in Colorado counties in 2020? **RQ5**: How do high school graduation and college education status account for the variance in HIV prevalence in Colorado counties in 2020?

Methods

Context/Protocol

The 2020 County Health Rankings data for the state of Colorado is used for these statistics.[12]

"HIV prevalence" is defined as the rate of individuals, per 100,000, age 13 or older, with diagnosed human immunodeficiency virus in a given year. Counties reporting between one and four cases are suppressed from the data. The measure does not only include residents, but all those living in a given county in that particular timeframe. Data comes from the National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention for the year 2016.[13]

"Rural" is defined as a percentage, calculated as the number of "rural census tracts" in a county divided by the total number of census tracts in that county. A "rural census tract" is defined as a United States census tract which has a population less than 2,500.[16] Data comes from the 2010 Census Bureau's Population Estimates Program.

"Teen births" is the rate of the number of females between the ages of 15 and 19 who give birth in a seven-year time frame per 1,000 females in that age group. Teen births are attributed to the county in which the mother's address is listed, not the location of the child's birth. Counties reporting twenty or fewer teen births are suppressed from the data. Data comes from the National Center for Health Statistics, through the National Vital Statistics System for the year 2018.[14]

"Sexually transmitted infections" is defined as the rate of new chlamydia diagnoses per 100,000 individuals in a population in a given year. Data is suppressed in counties reporting three or fewer cases. Data comes from the National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention for the year 2017.[15]

"High school graduation", in a given ninth-grade cohort, is defined as the percentage who graduate twelfth grade in four years. Data comes from the Colorado Department of Education for the school-year 2017-2018.[16]

"Some college" is defined as the percentage of 25-44 year-old adults with some level of post-secondary education, including any time enrolled at four-year college, junior school, or technical college. Data comes from the American Community Survey, with five-year estimates for the years 2014-2018.[17]

"Flu vaccinations" is defined as the percentage of age-adjusted Medicare enrollees who had a reimbursed flu vaccination in a given year, divided by the total number of age-adjusted Medicare enrollees. Data comes from the Mapping Medicare Disparities tool through the Centers for Medicare & Medicaid Services Office of Minority Health for the year 2017.[18]

"Drug overdose deaths" is defined as the rate of deaths caused by drug poisoning per 100,000 total individuals in the population. County statistics are based on where the person who died claimed residence, not where the death occurred. Data is suppressed in counties reporting nine or fewer cases. Data comes from the National Center for Health Statistics – Mortality Files, via the National Vital Statics System for the years 2016-2018.[19]

Data Collection

Inclusion criteria includes all 51 Colorado counties which reported HIV prevalence in the 2020 County Health Rankings. Exclusion criteria includes the 13 Colorado counties which did not report HIV prevalence in the 2020 County Health Rankings: Baca, Cheyenne, Custer, Dolores, Hinsdale, Kit Carson, Lake, Philips, Rio Blanco, San Juan, San Miguel, Sedgwick, and Washington.

Rural status is defined by the United States Census Bureau as census tracts with population less than 2,500 people.[20] Nonrural status is a defined as census tracts or urban clusters with at least 2,500 people.

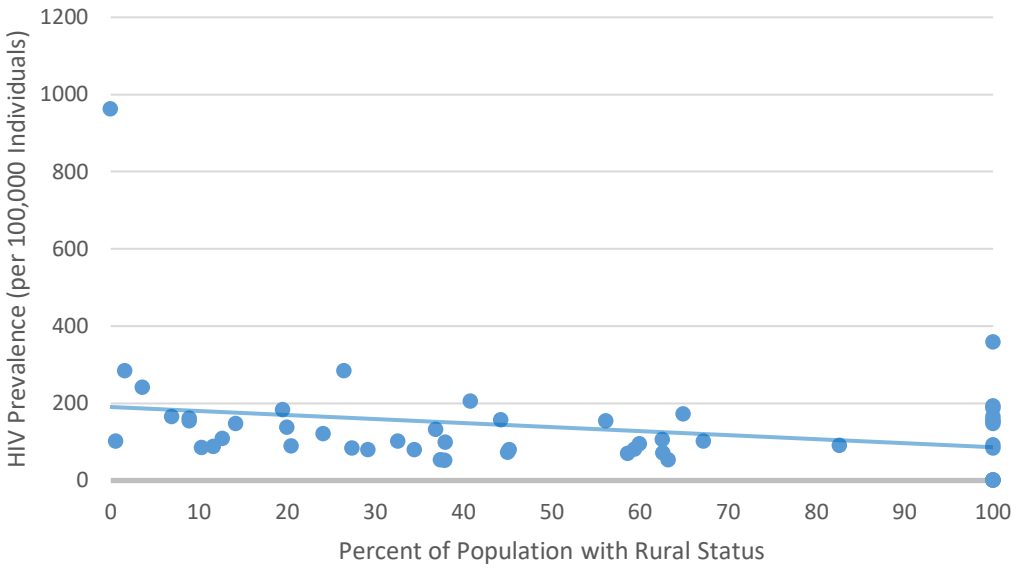
Data Analysis

A Spearman correlation was performed to correlate the prevalence of HIV with percentage of rural status (RQ1), rates of flu vaccination (RQ3), and rates of drug overdose deaths (RQ4) in Colorado counties in 2020. A stepwise linear regression was performed to determine how the variance in HIV prevalence in Colorado counties in 2020 can be accounted for by rates of teen births and sexually transmitted infections (RQ2), as well as by high school graduation and college education status (RQ5).

Results

When studying the relationship between HIV prevalence and percent of rural status in Colorado in 2020 (RQ1), a Spearman correlation found that there was no significant correlation (r = -.258 and p = .068) (Figure 1).

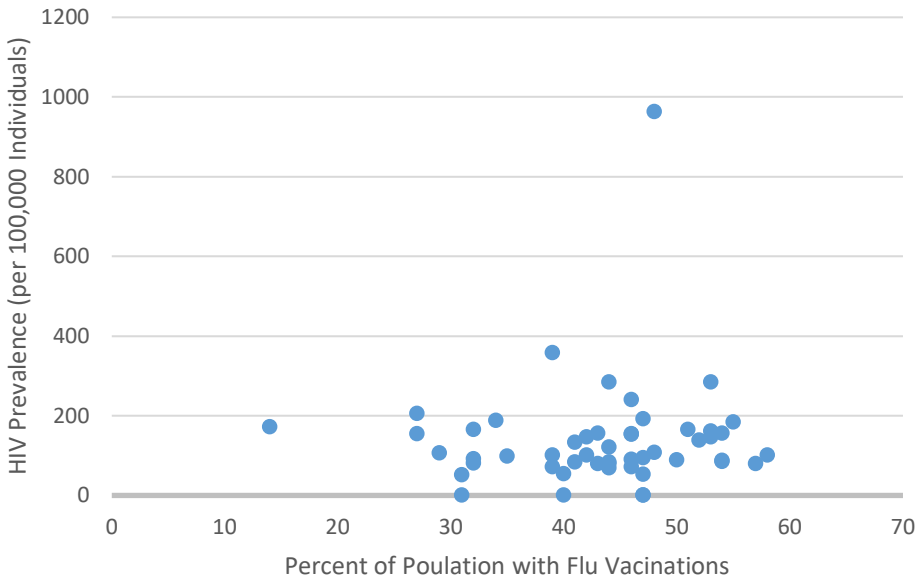
Figure 1: Correlation Between HIV Prevalence and Percent Rural Status in Colorado 2020



To determine how rates of chlamydia infections and rates of teen births factor into the model of HIV prevalence in Colorado in 2020 (RQ2), a stepwise linear regression was performed, showing that best fitting model was statistically significant ($F_{2,42} = 7.69$, $p = .001$) and contributed to 26.8% of the variance in HIV prevalence. Rates of chlamydia infections contributed significantly to the model ($B = .42$, $t = 3.69$, $p = .001$) whereas teen birth rates did not contribute significantly.

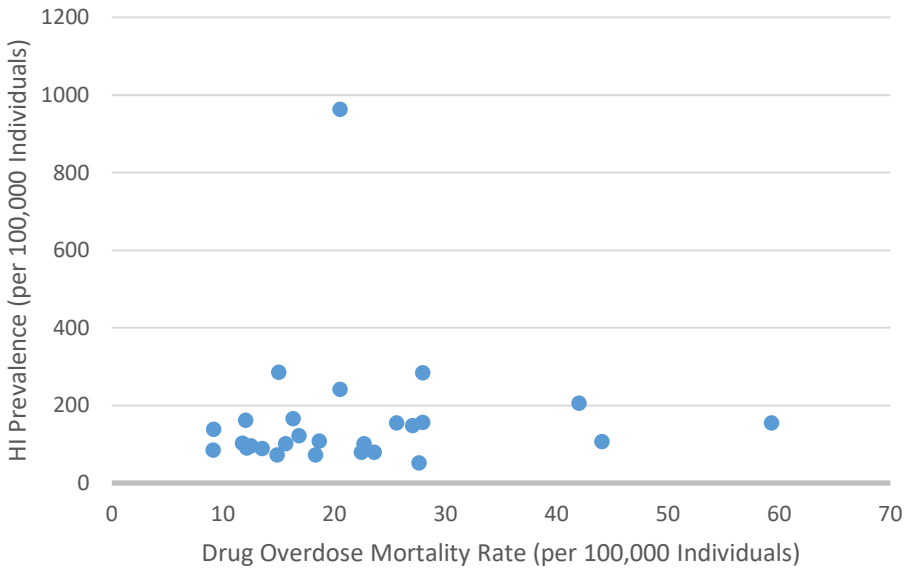
When comparing the relationship between HIV prevalence and rates of flu vaccinations in Colorado in 2020 (RQ3), a Spearman correlation showed that there was no significant correlation ($r = .080$ and $p = .578$) (Figure 2).

Figure 2: Correlation Between HIV Prevalence and Flu Vaccination Rates in Colorado 2020



Again, when comparing the relationship between HIV prevalence and rates of drug overdose mortality in Colorado in 2020 (RQ4), a Spearman correlation found that there was no significant correlation (r = .226 and p = .257) (Figure 3).

Figure 3: Correlation Between HIV Prevalence and Drug Overdose Deaths in Colorado 2020



When identifying how rates of high school graduation and college education status factor into the model of HIV prevalence in Colorado in 2020 (RQ5), a stepwise linear regression again showed that the best fitting model was statistically significant ($F_{2,46} = 4.52$, $p = .016$), establishing 16.4% of the variance in HIV prevalence. Rates of high school graduation contributed significantly to the model ($B = -8.303$, $t = -3.01$, $p = .004$) whereas college education status did not contribute significantly.

Discussion

The purpose of this paper was to examine the relationships between HIV prevalence in the state of Colorado in 2020 and various socioeconomic and behavioral factors, including rural status, education, preventative health behavior, drug-related deaths, teen births, and other sexually transmitted infections. The author found significant correlations between HIV prevalence and rural status (RQ1), flu vaccination rates (RQ3), or drug overdose deaths (RQ4) in Colorado in 2020. Although teen births, rates of chlamydia infection, high school graduation, and college education status all factored into models for HIV prevalence in Colorado in 2020,

only chlamydia infection and high school graduation contributed significantly to the variance. Chlamydia infections and rates of teen births defined a model which contributed to 26.8% of the variance in HIV prevalence (RQ2), whereas high school graduation rates and college education status defined a model which only contributed 16.4% in the variance of HIV (RQ5).

The findings suggest that there lacks a significant relationship between HIV prevalence rural status, certain preventative behaviors such as flu vaccination rates, or certain multiplex behaviors such as drug-overdose deaths. The lack of correlation between HIV and rural status (RQ1) is surprising, considering documentation in the literature which suggests a propensity for HIV prevalence to be highest in metropolitan areas.[5] This may suggest implications on questioning the effectiveness of traditionally "urban" LGBTQ+-targeted HIV testing and treatment propaganda, where non-disclosed status may more commonly complicate the efficacy of such propaganda for MSM in "rural" areas.[10] This finding, however, may be related to limitations of the aggregate-level nature of this paper.

The lack of significant relationship between HIV prevalence and flu vaccination rates (RQ3) is contradictory to what would be expected from studies in multiplex risk behaviors.[6] It could be inferred that preventative health behaviors reduce risk multiplexity and thus would be associated with reduced additive high-risk behaviors and decreased HIV prevalence, however this paper does not support that conclusion.[6] Furthermore, the lack of positive correlation between HIV prevalence and flu vaccinations holds an important clinical and public health implication. Based on CDC guidelines, annual flu vaccinations should occur with any HIV diagnosis.[8] A lacking correlation therefore may be suggestive of insufficient provider-driven or public health-driven preventative recommendations. Preventative health measures for this vulnerable population should thus be a greater focus of public health goals and clinical practice.

An important limitation in this study, however, is its exclusively aggregate data, rather than individual-level data. Because the literature suggests that individual-level data for HIV-positive populations may actually be well-below guidelines and Healthy People 2020 goals, further research should focus on individual-level HIV-status and preventative health behavior.[7] Furthermore, the measure only includes Medicare enrollees which is a significant limitation in age and income status, and which may not accurately depict the demographics of the HIV-positive population.[18]

This paper likewise found no correlation between HIV prevalence and drug overdose deaths (RQ4). Studies of risk multiplexity, however, suggest that HIV prevalence is often associated with drug use, needle-sharing, and inferably drug overdose deaths.[6] The lack of correlation found in this paper may be related to the route of HIV infection in the sample population. Significant association of HIV with rates of chlamydia infection (RQ2), but not with drug overdose deaths, suggests that HIV prevalence in Colorado in 2020 may be associated more strongly with sexual transmission than by other bloodborne means (i.e. needle-sharing). One limitation is that drug overdose deaths are considered statistically rare events, making data unreliable.[19]

Teen birth rates and rates of chlamydia infections both factored into a significant model for HIV prevalence, contributing to 26.8% in its variance. The findings of this paper suggest that for every 1% increase in chlamydia incidence, HIV prevalence increased by 0.42%. Chlamydia rates were thus positively associated with HIV prevalence. This was thus consistent with the multiplex risk model for high-risk behaviors and HIV prevalence defined by Emmanuel Koku, et al in the literature.[6] As discussed previously, comparing this to the lack of correlation between HIV prevalence and drug overdose deaths, suggests an inclination towards sexually-transmitted

rather than injection drug use in the Colorado community in 2020. Furthermore, chlamydia infections contributed significantly to the model, whereas teen births did not, possibly related to either the demographics of the HIV-positive population or to inferred differences in relevant contraception. In the United States, sexually-transmitted HIV incidence in MSM is over double that between cisgender, heterosexual partners.[21] While sexually-active heterosexual individuals may use oral contraceptive pills (OCP) and/or barrier contraceptives (i.e. condoms) to prevent unwanted pregnancy with only the latter preventing sexually transmitted infections (STI), MSMs only benefit from barrier contraceptives to prevent STI.[22] The gap between the role of teen births versus chlamydia incidence in the variance of HIV prevalence may thus be due to either the differences in the protective functions of OCP versus condoms and a population preference to use OCP without condoms, or simply the differences in incidence of both STI and HIV in heterosexual partners versus MSM.[22]

Limitations in the measurement of "teen births" is that the measure does not include any mothers under the age of 15, as well as the fact that the measure only accounts for teen births, not all teen pregnancies.[14] Limitations in defining rates of sexually transmitted infections include the testing sensitivity and specificity, variations in screening, and possibility of repeat infections.[15] Furthermore, chlamydia is used here to approximate numbers of non-HIV sexually transmitted infections when many other diseases exist, and may not be effectively reflected due to dissimilar rates.[15] Chlamydia rates may or may not thus act as a valid proxy to STI and conclusions about safe sex.

High school graduation rates and college education status also likewise factored into a significant model for HIV prevalence, contributing to 16.4% in its variance. The findings show that for every 1% increase in high school graduation rates, HIV prevalence decreased by 8.30%.

High school graduation rates were thus negatively associated with HIV prevalence. This is consistent with demonstration by the literature that education status plays a strong contribution in modeling the likelihood of HIV-incidence.[3] Interestingly, in this paper high school graduation status contributed significantly to the model, whereas college education status did not. While studies do suggest that HIV incidence continues to decrease with each subsequent year of secondary school, the evidence is lacking regarding the role of postsecondary schooling on HIV incidence.[23] This may imply that high school education status is sufficient to influence HIV rates, whereafter the beneficial effects of education status on mitigating HIV incidence may plateau. Public health measures should thus continue to encourage adolescents to stay in secondary school, as well as insist upon effective sex education. Students who are exposed to HIV/AIDS education in school has been shown to significantly reduce injectable-drug use and increase condom use, effectively reducing high-risk behaviors in male students and increasing HIV-testing rates in minority females.[24] Inclusion of HIV/AIDS-specific sex education is thus fundamental for schools, both to promote short-term positive behaviors and long-term health outcomes. In addition to the public health repercussions, the literature and these findings are important for clinical practice by healthcare providers, in order to ensure that adolescents who do not complete high school are still adequately educated on sex education and HIV/AIDS, and that particular attention is thus paid to this population.

One limitation in "high school graduation" status includes inconsistencies in defining "ninth-grade cohorts" when accounting for transfer students and special-needs students, as well as the fact that cohorts or students enrolled in a specific school may not necessarily live in that school's county.[16] A major limitation in "college education status" is the ambiguity of "some college" and the wide range between degrees and the percentage of degree-completion.[17]

Implications regarding plateaued efficacy of education on HIV prevalence following completion of secondary school may thus be inaccurately inferred due to the imprecision in the data which ignores specific landmarks of postsecondary education.

The findings thus suggest that while high school graduation status is negatively associated with HIV prevalence, and rates of other sexually transmitted infections are positively associated, drug overdose deaths, rural status, flu vaccinations, college education status, and teen births have no significant relationship with HIV prevalence. Public health measures and clinical encounters should thus place a strong emphasis on safe-sex behaviors and sex education, especially in individuals who do not have not completed high school. Reflected in the flu vaccination rates, preventative health recommendations for HIV-positive patients should thus also be emphasized by public health employees and healthcare providers. However, in addition to the limitations of aggregate rather than individual-level data, an important limitation for all data in this paper is the classification of HIV prevalence by County Health Rankings.[13] The measure of HIV prevalence includes all those living in a given county, including prisons and military bases which may inaccurately inflate HIV numbers.[13] Insufficient testing and barriers in determining accurate data due to stigma act as further and important limitations.

Conclusion

The purpose of this paper was to investigate the role of various social determinants of health on impacting the prevalence of HIV in Colorado counties in 2020. In concordance with the literature, high school graduation status was shown to be negatively associated with HIV rates, although postsecondary education played no statistical significance in affecting HIV

prevalence.[3] This finding emphasizes the importance of adequate and HIV-specific sex education in schools.[24] Also concordant with the literature, rates of chlamydia were positively associated with HIV rates, appropriately following the risk multiplexity model of HIV incidence, suggesting that certain high-risk behaviors cluster together.[6] No significant correlation, however, was found between HIV prevalence and drug-overdose deaths, rural status, teen birth rates, or influenza vaccinations. These findings may suggest that HIV incidence in Colorado in 2020 was predominantly sexually-transmitted, as well as reemphasize the importance of ample and appropriate public health-mediated and clinically driven safe sex education and preventative health recommendations, especially for high-risk and HIV-positive populations.

References

1. UNAIDS. *UNAIDS Goal 90-90-90: An Ambitious Treatment Target to Help End the AIDS Epidemic*.; 2014.

2. CDC. *HIV in the United States by Region*.; 2020. Accessed August 25, 2020. www.cdc.gov/hiv

3. Zeglin RJ, Stein JP. Social determinants of health predict state incidence of HIV and AIDS: A short report. *AIDS Care - Psychol Socio-Medical Asp AIDS/HIV*. 2015;27(2):255-259. doi:10.1080/09540121.2014.954983

4. Sutton MY, Gray SC, Elmore K, Gaul Z. Social determinants of HIV disparities in the southern United States and in counties with historically black colleges and universities (HBCUs), 2013-2014. *PLoS One*. 2017;12(1). doi:10.1371/journal.pone.0170714

5. Donnelly JA, Deem TT, Duffy MA, et al. Applying national estimates of adults with indications for pre-exposure prophylaxis to populations of men who have sex with men and people who inject drugs in Colorado: Modeling study. *J Med Internet Res*. 2019;21(1):1-10. doi:10.2196/11113

6. Felsher M, Koku E. Explaining HIV Risk Multiplexity: A Social Network Analysis. *AIDS Behav*. 2018;22(11):3500-3507. doi:10.1007/s10461-018-2120-7

7. Zuñiga JA, García AA, Fordyce J, Huang Y-C, Park J, Champion JD. Predictors of Flu Vaccination for Persons Living With HIV in Central Texas. *J Assoc Nurses AIDS Care*. 2019;30(5):593-597. doi:10.1097/JNC.0000000000000013

8. CDC. HIV Infection and Adult Vaccination. National Center for Immunization and

Respiratory Diseases. Published May 2, 2016. Accessed September 22, 2020. https://www.cdc.gov/vaccines/adults/rec-vac/health-conditions/hiv.html

9. *Vaccinations for Adults with HIV Infection*. Accessed September 22, 2020. https://www.immunize.org/catg.d/p4041.pdf

10. Ragonnet-Cronin M, Hué S, Hodcroft EB, et al. Non-disclosed men who have sex with men in UK HIV transmission networks: phylogenetic analysis of surveillance data. *Lancet HIV*. 2018;5(6):e309-e316. doi:10.1016/S2352-3018(18)30062-6

11. Friedman EE, Dean HD, Duffus WA. Incorporation of social determinants of health in the peer-reviewed literature: A systematic review of articles authored by the national center for hiv/aids, viral hepatitis, std, and tb prevention. *Public Health Rep*. 2018;133(4):392-412. doi:10.1177/0033354918774788

12. Health Outcomes in Colorado | County Health Rankings & Roadmaps. University of Wisconsin Population Health Institute. Published 2020. Accessed September 22, 2020. https://www.countyhealthrankings.org/app/colorado/2020/rankings/outcomes/overall

13. CDC. AtlasPlus - Tables - HIV. Published 2016. Accessed August 27, 2020. https://gis.cdc.gov/grasp/nchhstpatlas/tables.html

14. CDC WONDER. Natality, 2016-2018 expanded Request Form. Accessed August 27, 2020. https://wonder.cdc.gov/controller/datarequest/D149

15. CDC. AtlasPlus - Charts - STD. Accessed August 27, 2020. https://gis.cdc.gov/grasp/nchhstpatlas/charts.html

16. Colorado Department of Education. 2018 Graduation Statistics | CDE. Published 2018.

Accessed August 27, 2020. http://www.cde.state.co.us/cdereval/2017graduationstatistics-0

17. United States Census Bureau. Sex by Age by Educational Attainment for the Population 18 Years and Over. Published 2018. Accessed August 27, 2020. https://data.census.gov/cedsci/table?q=B15001&tid=ACSDT5Y2018.B15001&hidePreview=true

18. Center for Medicare & Medicaid Services. Mapping Medicare Disparities. Published June 29, 2020. Accessed August 27, 2020. https://data.cms.gov/mapping-medicare-disparities

19. CDC WONDER. Underlying Cause of Death, 1999-2018 Request Form. Published 2018. Accessed August 27, 2020. https://wonder.cdc.gov/controller/datarequest/D76

20. United States Census Bureau. Urban and Rural. Published February 24, 2020. Accessed August 27, 2020. https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html

21. CDC. *Diagnoses of HIV Infection in the United States and Dependent Areas, 2018 (Updated); Vol. 31*.; 2018. Accessed September 22, 2020. https://www.cdc.gov/hiv/statistics/overview/index.html

22. Woods JL, Shew ML, Tu W, Ofner S, Ott MA, Fortenberry JD. Patterns of Oral Contraceptive Pill-taking and Condom Use among Adolescent Contraceptive Pill Users. *J Adolesc Heal*. 2006;39(3):381-387. doi:10.1016/j.jadohealth.2005.12.014

23. De Neve JW, Fink G, Subramanian S V., Moyo S, Bor J. Length of secondary schooling and risk of HIV infection in Botswana: evidence from a natural experiment. *Lancet Glob Heal*. 2015;3(8):e470-e477. doi:10.1016/S2214-109X(15)00087-X

24. Ma ZQ, Fisher MA, Kuller LH. School-based HIV/AIDS education is associated with reduced risky sexual behaviors and better grades with gender and race/ethnicity differences. *Health Educ Res*. 2014;29(2):330-339. doi:10.1093/her/cyt110