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A source of healthcare disparity: Race, skin color, and injuries after rape among adolescents and young adults

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Abstract

Differences in anogenital injury resulting from rape may occur because of racial or skin color differences in adult women. It is critical to determine if these differences also are associated with differences in injury prevalence and frequency in adolescents and young adults. In a retrospective review of medical records, we examined whether Black adolescent/young adult females had different anogenital injuries as compared to White females following rape. Next, we examined whether skin color differences explained a significant amount of the racial difference in injuries. We reviewed charts of 234 female victims of rape ages 14 to 29. Overall injury prevalence was 62.8%. Race was significantly associated with frequency of injuries in several anatomical locations, with White victims having a higher frequency of injuries than Black victims. Skin color was significantly associated with injury frequency in many anatomical locations, with victims with light skin sustaining more injuries than victims with dark skin. Even when skin color was included in the relationship, race remained a statistically significant factor, suggesting that the relationship between race and injuries may be more complicated than merely a skin color difference that has been mislabeled a racial difference.

Keywords

Adolescents; forensic nursing; injuries; race; rape; sexual assault; skin color

In 2004, approximately 200,000 people were victims of rape in the United States (Catalano, 2005). Women comprised 90% of all rape victims and adolescents had the highest rates of reported rapes when compared to all other age groups (American Academy of Pediatrics, 2001; Rennison & Rand, 2003). More than half of victims of rape whose victimization was reported to the police, were treated for their injuries by a healthcare provider (Rennison, 2002). A key element of healthcare providers' interactions with rape victims is the identification of injuries. From a healthcare perspective, injuries need to be assessed, managed, and treated; from a criminal justice perspective, documentation of injuries serves as supporting evidence in legal proceedings.

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Investigators have reported the finding that anogenital injury prevalence varies across victims of different races and ethnicities. Sommers et al. (2006) found higher genital injury prevalence among White (White/Caucasian/non-Hispanic) victims of rape as compared to Black (Black/African American/non-Hispanic) victims. These findings replicated those of Cartwright (1987) and were similar to other investigators, who found the same trend among White adult male rape victims as compared to non-White adult male rape victims (Coker, Walls, & Johnson, 1998) and among White women following consensual sexual intercourse as compared to Black women following consensual sexual intercourse (Sommers et al., 2008). In this latter study, the investigators also found that the effect of race became nonsignificant after adding skin color values to the model predicting occurrence of external genital injury, indicating the spurious nature of the relationship between race and injury prevalence.

One possible explanation for differences in injury prevalence based on the race of the victim is that there is an intrinsic difference in the skin of women of different races or different skin colors that puts some women at a greater risk for sustaining injuries. An alternative explanation is that the methods used to detect injury are less sensitive to visualize anogenital injury in victims with darker skin. In this latter explanation, the victim's race is not the primary variable of interest but instead is a confounding variable in a relationship between skin and mucous membrane color and anogenital injury prevalence.

If differences are found in anogenital injury prevalence because of skin and mucous membrane color, a healthcare disparity may exist in the current examination techniques. Injuries may not be detected as readily in victims with dark skin. Currently, healthcare providers conduct the same forensic examination for all adolescent and adult victims of rape regardless of their race or skin color (Department of Justice [DOJ], Office of Violence Against Women, 2004), and it is not known whether the current protocol is the best practice across the continuum of skin color.

We used a retrospective chart review with digital image analysis (DIA) of the forensic photographs to address these questions by examining the relationship between race and injuries to determine whether racial differences that have been reported by other investigators studying adult rape victims are found in an adolescent and young adult sample. We also studied the associations among the race and skin color of the victims, as well as the number and location of injuries, to determine whether a true racial difference exists or if this difference is a function of skin color. Specifically, this study addressed the following hypotheses: Following an acute rape (occurring within 72 hours of the forensic examination), Black females will have different anogenital injuries than White females in an adolescent and young adult sample. Furthermore, skin and mucous membrane color will explain a significant amount of the variance in anogenital injury between Black and White adolescents and young adult females following an acute rape.

Methods

We used a retrospective chart review of data from females examined at a sexual assault forensic examiner (SAFE) program housed in a level 1 trauma center's emergency department. A standardized protocol was followed for all examinations conducted by the forensic nurse examiners at this program: (1) head-to-toe assessment to identify physical and emotional injuries; (2) collection of forensic evidence, including clothing, oral, anal, and vaginal swabs, and nail scrapings; (3) assessment of injuries through an unaided visual assessment; and (4) assessment of injuries with a colposcope. During the examination, all injuries were photographed with a digital camera. In addition to images of injuries, a standard series of photographs were taken of all victims, regardless of whether injuries were present or not, using the digital camera attached to the colposcope and set at a standard magnification of 3.75×.

Institutional review board approval was obtained from the affiliated university prior to data collection. Data were obtained from all medical records of rape victims examined by forensic nurses between June 2003 and December 2005. The inclusion criteria were: medical records of females between the ages of 14 to 29 years, medical records that included documentation of age and/or birth date; race; the presence or absence of injury; a report of a rape involving oral, vaginal, and/or anal penetration; a forensic examination conducted within 72 hours of the assault; and at least one of three specific digital images (images of the victim's skin, external genital mucous membrane, and internal genital mucous membrane). Medical records were excluded if no *Consent for Treatment* document was signed prior to the examination. Incomplete medical records were excluded.

Injury data were collected from a Sexual Assault Injury Scoring Sheet that was completed by the examiner immediately following the forensic examination. This sheet contained documentation of the numbers, types, and locations of injuries visualized by the examiner's unaided eye and through magnification with colposcopy. The number of injuries involved a simple count of injuries. Injury type was described as tear, ecchymosis, abrasion, redness, or swelling (Slaughter, Brown, Crowley, & Peck, 1997). Injury location was defined by the following categories: thighs, labia majora, perineum, labia minora, periurethral area, posterior fourchette, fossa navicularis, hymen, cervix, vagina, or anus.

Injury frequency and prevalence

Using the data collected from the examiners' documentation, we calculated injury prevalence by dividing the number of victims with one or more injuries by the total number of victims. We determined injury prevalence overall and injury prevalence related to each anatomical location. We calculated injury frequency by counting the total number of injuries for each victim, and dividing the total by the number of victims for the mean injury frequency. Overall injury frequency was assessed and injury frequency as it related to each anatomical location was assessed.

Skin color

We determined skin color through DIA of the images captured during the examination. Color was measured using the CIELAB system (see Table 1; Chardon, Cretois, & Hourseau, 1991; Fairchild, 2005). Color measurements of the victim's skin, external mucous membranes, and internal mucous membranes were obtained using the colorimetry functions within Adobe PhotoShop CS2 with procedures that are standard for DIA of skin color (Sommers et al., 2008). Each technician recorded at least nine measurements of L*, a*, and b* values for each tissue location. DIA software resulted in values that could be transformed, through either scaling or shifting, into standard L*, a*, and b* values. The digital images were analyzed by two separate raters who quantified L*, a*, and b* values for victims' skin, external mucous membranes, and internal mucous membranes.

Data management and analysis

The digital images were analyzed by two independent raters to obtain color data. To evaluate interrater reliability in the color analysis, intraclass correlations were assessed after the first 35 victims, 70 victims, and 105 victims (every 15% of the data). In each of these analyses, interrater intraclass correlations were above 0.90. After assessing the first 45% of the color data and without finding any correlations below 0.90, interrater correlations for the entire set of color data were calculated at the end of color analysis. The final interrater correlations for the entire color data set were all above 0.90 (see Table 2).

To evaluate the relationship between injuries and the victims' race, a series of logistic regressions were run regressing presence of injury on race. First a logistic regression was run using overall injury prevalence and then several logistic regression models were run using injury prevalence at each of the anatomical locations. Statistical significance was set at $\alpha = 0.01$ to decrease the risk of a Type I error associated with multiple comparisons. Next, zero inflated Poisson (ZIP) regression analyses were performed by regressing the frequency of injury, overall and at each anatomical location, on race. Again, a correction was applied to reduce the chance of Type I error and statistical significance was reported for $\alpha = 0.01$.

After assessing the relationship between race and injuries, the skin color variables were added to the models to evaluate their effect. The same process described previously was followed first regressing injury prevalence, overall and at each anatomical location, on race and then adding the three color variables to the models. Next overall injury frequency, and injury frequency at each anatomical location, was regressed on race and then the three color variables were added to the models.

Results

Sample

A total of 648 SAFE Program medical records were reviewed. The preliminary review of the records involved exclusion of records that were missing key variables or did not meet the inclusion criteria. Records missing the patient's age or birth date ($N = 7$), race ($N = 117$), number of hours since the assault occurred ($N = 14$), the Sexual Assault Injury Scoring Sheet ($N = 4$), and records missing a corresponding file that contained digital images taken during the examination ($N = 35$) were excluded. Two hundred and eleven charts were excluded because the patients were older than 29 years. The digital images of the remaining records were reviewed and records were excluded because they did not include photographs of each of the three anatomical locations of interest (skin, external mucous membrane, internal mucous membrane) ($N = 11$), the images were photographed in black and white instead of color ($N = 10$), the images were taken with the green filter on the colposcope turned on thereby discoloring all images green ($N = 4$), or the images were too dark to identify anatomical structures ($N = 1$). The review of the medical records and digital image files resulted in a total of 414 records being excluded from the study and the final sample size was 234.

The age of the victims ranged from 14 years old to 29 years old (M = 20.91 years, SD = 3.57). The sample consisted of 132 White females (56.4%), 100 Black females (42.7%), one Asian female (0.4%), and one female who self-identified as an “other” race (0.4%). The majority of the sample self-identified as non-Hispanic/Latina ($N = 233$, 99.6%) and one victim as Hispanic/Latina (0.4%).

Skin color

For each victim, color data were obtained for three anatomical locations (skin, external genital mucous membrane, and internal genital mucous membrane). L*, a*, and b* values for skin color significantly differed based on the race of the victim, with Black victims on average having darker ($t(228) = -12.70$, $p < 0.001$), less red ($t(228) = -3.11$, $p = 0.002$), and less yellow ($t(228) = -3.52$, $p = 0.001$) skin color than White victims. Similar differences were found in external mucous membrane color, which was different based on the race of the victim, with Black victims having darker ($t(217) = -7.38$, $p < 0.001$), less red ($t(217) = -8.80$, $p < 0.001$), and less yellow ($t(217) = -3.88$, $p < 0.001$) external mucous membranes when compared to White victims. Finally, when comparing the internal mucous membrane color, there was no statistically significant difference in lightness ($t(214) = 1.37$, $p = 0.173$), redness ($t(214) = -1.54$, $p = 0.124$), or yellowness ($t(214) = -0.25$, $p = 0.800$) between Black and White victims (see Table 3).

Even though there were statistically significant differences in the mean L*, a*, and b* values based on race, there was great overlap in the range of skin color based on race. For example, Black victims' L* values ranged from 26.11 to 84.23 while White victims' L* values ranged from 27.56 to 91.68. This overlap demonstrates that the skin color of victims of different racial and ethnic categories are not mutually exclusive and therefore supports the importance of examining color as a separate variable not entirely described by race or ethnicity.

Injuries

The overall injury prevalence in this sample was 62.8%. Injury prevalence among Black victims was 59% and among White victims was 66.4%. The most common injury location among Black victims was the cervix (26.3%), followed by the posterior fourchette and labia minora (both 13%). The most common injury locations among White victims were the cervix (24%), followed by the posterior fourchette and labia minora (both 19.1%).

Race

When regressed on injury prevalence, race was not a statistically significant predictor ($OR = 0.72$, 99% CI: 0.36, 1.46, $p = 0.231$). Additionally, when each anatomical location was considered, there was no statistically significant association between race and injury prevalence. In other words, race was not a significant predictor of whether or not a victim was injured.

When considering overall injury frequency, race was not a significant predictor ($Z = 1.64$, $p = 0.101$). Race was significantly associated with frequency of thigh injuries ($Z = 3.88$, $p < 0.001$), with White victims sustaining a higher frequency of injuries to the thighs than Black victims. For three of the anatomical locations (labia majora, perineum, and anus), a ZIP regression model could not be fit to the data with confidence because of the scarcity of the data. Therefore, conclusions about the statistical significance of associations between race and injury frequency to the labia majora, perineum, and anus could not be made. When entered as the only predictor variable in the model, race was not significant in injury frequencies for the other anatomical locations.

Color

Before running regression models that included the color variables, collinearity diagnostics were run to assess the relationships among race and the three color values (L*, a*, and b*) within each tissue type (skin, external genital mucous membrane, and internal genital mucous membrane). No collinearity problems were identified (tolerance: minimum = 0.24, maximum = 0.98; variance inflation factor (VIF): minimum = 1.02, maximum = 4.13). Since no severe collinearity was present, data reduction techniques were not applied.

After ruling out problems with collinearity, injury prevalence was examined by conducting separate multiple logistic regressions with overall presence of injury and then with injury prevalence at each anatomical location regressed on race, L*, a*, and b*. When predicting overall injury prevalence, none of the predictor variables was statistically significant. In the multiple logistic regressions modeled to predict injury presence in each of the anatomical locations, the only statistically significant association was between race and thigh injury prevalence ($Z = 2.80$, $OR = 0.03$, 99% CI: 0.001, 0.75, $p = 0.005$).

Next, injury frequency was examined by running multiple ZIP regression models. In these analyses, injury frequency, overall and for each anatomical location, was regressed on race, L*, a*, and b*. In predicting overall injury frequency, none of the covariates was statistically significant. When analyzed by anatomical location, race was a statistically significant predictor in frequency of injury to the posterior fourchette ($Z = 2.78$, $p = 0.006$) and the fossa navicularis ($Z = 3.21$, $p = 0.001$), with White victims sustaining a higher frequency of injuries to these locations than Black victims.

Color also played a significant role in predicting frequency of injuries in several locations. The b* value of the external mucous membranes, measuring the yellowness of the tissue, was significantly associated with the frequency of injury to the labia minora ($Z = 3.02$, $p = 0.003$) and the posterior fourchette ($Z = 2.75$, $p = 0.006$). Color of the internal mucous membranes was associated with frequency of hymenal and cervical injuries, with the a* value of the internal mucous membrane, a measurement of redness, significantly predicting frequency of hymen injuries ($Z = 3.38$, $p = 0.001$) and the b* value of the internal genital mucous membrane color, a measurement of the yellowness of the internal mucous membranes, significantly predicting cervix injuries ($Z = 2.85$, $p = 0.004$). Overall injury frequency and injury frequency to the labia majora, periurethral area, and vagina were not significantly predicted by any of the covariates in the model. Scarcity of data prevented modeling of perineum or anus injuries.

Discussion

Overall injury prevalence and injury prevalence in each of the anatomical locations, except the thighs, was not significantly predicted by race or skin color in any of the statistical models. Thus, the only statistically significant association was between race and the presence of thigh injuries, with White victims being more likely to sustain thigh injuries than Black victims. This finding suggests either that soft tissue injuries to the epidermis may be more difficult to visualize in adolescents and young adults with dark skin as compared to those with light skin or that light skin and dark skin have different protective properties.

While the majority of the hypothesized associations between *injury prevalence* and both race and color was nonsignificant, many of the predictor variables were significantly associated with *injury frequency*. Race was a significant predictor in the models of injury frequency in the labia majora, posterior fourchette, and fossa navicularis. For each of these locations, the mean number of injuries was higher among White victims when compared to Black victims. The color variables were also significant in models where the outcome was injury frequency in the labia minora, posterior fourchette, hymen, and cervix. When considering the injury frequency data overall, frequency of injuries was highest among White victims and among victims with lighter skin and mucous membrane color.

Injury *prevalence* was not associated with color. However, the *frequency* of injuries, particularly frequency of injuries to the fossa navicularis, hymen, cervix, and anus were significantly associated with color variables. Injury frequency increased with increased lightness of the skin at the anus and with increased yellowness of the mucous membranes at the fossa navicularis and cervix. With both lighter skin and more yellow skin, injuries are likely easier to visualize than injuries to darker skin.

The association between the redness of the tissues (a*) and injury was conflicting. At the hymen, increased redness resulted in increased injury frequency; however, at the fossa navicularis, increased redness resulted in decreased injury frequency. Redness is a somewhat confusing variable because redness itself is one of the injury categories (Slaughter et al., 1997). Therefore, it is not surprising that increased redness was associated with increased injury frequency at the hymen. However, the findings that increased redness corresponded with decreased injury frequency at the fossa navicularis also make sense. Tissue that is very red, but not determined to be red from injury, could appear darker and therefore could result in tissue that is more difficult in which to visualize injuries.

Previous literature reports significant differences in injuries based on race, with White victims being more likely to sustain injury following rape than Black victims (Cartwright, 1987; Coker et al., 1998; Sommers et al., 2006; Sommers, Zink, Baker, Schafer, & Fargo, 2004). These investigators reported racial differences in injury prevalence but did not report racial differences in frequency of injury. Sommers et al. (2008) found that race was a significant predictor of injury occurrence and frequency in the external genitalia. This study found racial differences in injury frequency to the thighs, labia majora, posterior fourchette, and fossa navicularis. In each of these locations, injury frequency was higher among White victims when compared to Black victims. Racial differences were not found in injury prevalence but were found with injury frequency. The decrease in data variability when frequency data were reduced to dichotomous data (injury prevalence) could explain these findings.

In several of the best-fitting models, race and color variables were significant contributors. It appears that skin color and mucous membrane color contribute to injury prevalence and injury frequency at some anatomical locations. However, even when color is included in the model, race often remains significant, suggesting that the relationship between race and injuries may be more complicated than merely a mislabeling of a racial difference.

The findings of this study are important in directing the next step in a research trajectory studying injury prevalence and injury frequency among adolescent and young adult rape victims. This study suggests that race and color play a role in injuries. This retrospective study was important in exploring the phenomenon and directing future work. Since associations were found among the variables, there is more support for the need for prospective studies. Prospective work that includes more refined protocols would be crucial in advancing the science. A standardized training for examiners, quality assurance measures to evaluate examiners' practices, and changes in technology that result in better quality digital images and direct color measurement through spectrophotometry would allow for a more detailed exploration of the phenomenon. Finally, alternative examination techniques that do not rely on direct visualization of injury that is affected by skin color should be examined.

Limitations

The study had several limitations. Data were collected from a retrospective review of medical records, which may have contained errors in injury measurement. Because of missing data on some records, we used a convenience sample of records rather than a probability sample. The sexual assault forensic examiners were highly trained and used the DOJ, Office of Violence Against Women (2004) protocol for the forensic examination. However, the possibility exists that human error may have led to injury misidentification. Injuries may have been missed that were actually present (false negative results) or areas that were identified as injury may have been pigment differences or structural changes that were falsely identified as injury (false positive results). We have confidence that the forensic techniques the examiners used minimized error because injury prevalence was calculated based on injury identification by two methods: visual inspection and examination with a colposcope.

Other limitations also may have affected our results. The digital images were not captured in a controlled setting with controlled lighting. Hence our calculations of skin color had a varying degree of error. The classification of injury (tear, ecchymosis, abrasion, redness, and swelling), while used in clinical practice, has not undergone extensive testing for interobserver reliability. Finally, differences in injury may be a result of differences in the mechanical properties of the skin, and skin mechanics were not measured in this study. If differences in injury prevalence result from differences in the innate properties as they differ across the continuum of skin color, then perhaps dark skin is in some way more elastic, or less likely to be injured, than light skin (Sommers et al., 2008).

Clinical implications

The findings of this study have important implications for nursing practice, especially for nurses practicing as SAFE. The current forensic examination, even when implemented according to national protocols (DOJ, Office of Violence Against Women, 2004) may not be sensitive to all injuries across the range of skin colors. Thus, new technologies may be necessary to identify and document all injuries, and practicing SAFE need to be actively engaged in developing new techniques for the examination. Another important clinical implication is that injury frequency at several anatomical locations varies based on the race and skin color of the victim. In patients with dark skin, particular attention should occur to the thighs, labia majora, posterior fourchette, and fossa navicularis to make sure that all injuries are noted. However, until further research is done, clinicians need to recognize that the differences in injury prevalence and frequency at these locations may be due to a protective nature of dark skin. Hence, the lack of injury in these places should not be construed as an error. Finally, part of the assessment of the patient needs to be consideration of her skin color. Training programs need to include practice with patients across the continuum of skin color so that new examiners become comfortable with injury detection in both light and dark skin.

The findings also have important implications for sexual assault forensic examiners during testimony. When injuries are considered as forensic evidence, it is important that the associations among injuries, race, and color are acknowledged. For example, when testifying in cases that involve Black victims or victims with darker skin and mucous membrane color, the forensic examiner should explain the findings that injuries are detected less frequently among these populations. Until the science behind the forensic examination is advanced, it is crucial that other parts of the testimony, including the victim's statement about the rape, are considered equally important, if not more important, than the injuries documented.

Conclusion

In our sample of cases from a sexual assault program, injury prevalence (proportion of cases with one or more injuries as compared to overall number of cases) in all locations except the thighs was not significantly predicted by race or skin color in any of the statistical models. In contrast, injury frequency (total number of injuries for each case) was significantly associated with race and skin color. White victims had a higher frequency of injuries than Black victims. Skin color was significantly associated with injury frequency in many anatomical locations, with victims with light skin sustaining more injuries than victims with dark skin. Further research is needed to determine if these differences are related to lack of sensitivity of the current forensic exam procedures to the continuum of skin color or innate differences in the properties of the skin.

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Table 1

L*, a*, and b* definitions

	Definition
*L**	Measurement of lightness/darkness; ranges from 0 (black) to 100 (white)
*a**	Measurement of redness/greenness; no specific numeric limits; positive value (red), negative value (green)
*b**	Measurement of yellowness/blueness; no specific numeric limits; positive value (yellow), negative value (blue)

Table 2

Intraclass correlation coefficients (ICCs) for color data

	ICC
Skin color	
*L**	0.977
*a**	0.904
*b**	0.953
External mucous membrane color	
*L**	0.943
*a**	0.922
*b**	0.974
Internal mucous membrane color	
*L**	0.956
*a**	0.904
*b**	0.969

Table 3

Mean *L**, *a**, and *b** values by race/ethnicity

	L*	***a****	***b****
Asian (*N* = 1)			
Skin	65.28	19.69	39.26
External mucous membrane	33.56	22.22	27.78
Internal mucous membrane	38.56	32.44	36.33
Black, non-Hispanic (*N* = 100)			
Skin	53.82 (14.99)	14.79 (6.91)	20.91 (12.61)
External mucous membrane	46.99 (11.24)	15.80 (8.05)	17.94 (13.00)
Internal mucous membrane	61.81 (12.89)	25.23 (8.20)	21.72 (15.40)
White, non-Hispanic (*N* = 131)			
Skin	75.04 (10.28)	17.57 (6.54)	27.18 (13.86)
External mucous membrane	58.47 (11.51)	26.52 (9.53)	25.40 (14.88)
Internal mucous membrane	59.43 (12.41)	27.10 (9.24)	22.26 (15.58)
White, Hispanic (*N* = 1)			
Skin	83.25	14.79	14.74
External mucous membrane	45.44	7.11	3.56
Internal mucous membrane	58.67	16.44	5.56
Other (*N* = 1)			
Skin	67.84	26.87	47.47
External mucous membrane	45.78	21.56	31.22
Internal mucous membrane	77.11	27.11	49.44