When mating is not so random: coupling patterns across ethnicities in the US population

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Objective

US Census Data from 2010 shows 15% of new marriages occur between spouses of different ethnicities, a more than double increase over the previous two decades[1]. We set out to observe the inter- and intra-ethnic coupling patterns in individuals who presented for carrier screening as part of reproductive planning.

Methods

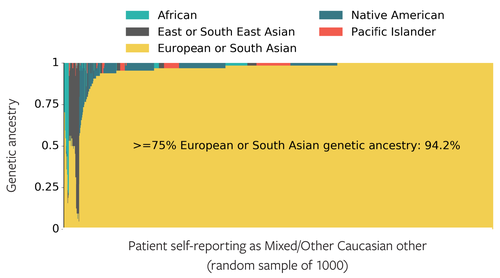
Counsyl's carrier screening was performed on 37,719 self-identified couples through physician selection between 2009-2016. Ethnicity for each individual was reported by the ordering clinic or patient directly using a test requisition form with 15 options for self-identification: African/African-American, Ashkenazi Jewish, French Canadian/Cajun, Mixed/Other Caucasian, East Asian, Finnish, Hispanic, Middle Eastern, Native American, Northern European, Pacific Islander, South Asian, Southeast Asian, Southern European, or Unknown. Self-reported ethnicities were further categorized according to the US Census definitions of race and ethnicity. Couples with at least one Unknown individual were removed from analysis leaving a total of 33,000 couples.

Mapping of Counsyl ethnicity options to US Census categories.

Counsyl Ethnicity Options		US Census Race* and Ethnicity *excluding Hispanic or Latino
Northern European	ne	White
Southern European	so	
Ashkenazi Jewish	aj	
Middle Eastern	me	
French Canadian/Cajun	cj	
Finnish	fi	
African/African American	af	Black
East Asian	ea	Asian
South Asian	sa	
Southeast Asian	se	
Hispanic	hi	Hispanic or Latino
Native American	na	American Indian and Alaska Native
Pacific Islander	pi	Native Hawaiian and Pacific Islander
Caucasian Other	co	Mixed + White

We use Counsyl population data to simulate the forward trends in intermarriage rates over the course of two generations, taking into account current patterns in inter-ethnic coupling. We start by redistributing couples with at least one self-identified 'Mixed/Other Caucasian' individual assuming 94% are actually 'White'[2]. Every inter-ethnic couple will produce 'Mixed' offspring in the next generation. We also assume that every couple is equally likely to produce offspring, and we assume male mating patterns in future generations are constant (although there is no significant difference if we assume female mating patterns).

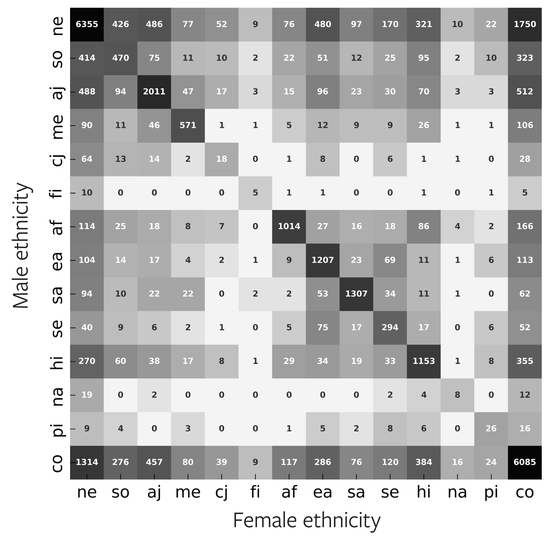
Inferred ancestry of self-reported 'Mixed/Other Caucasian'



In another study, we estimate ancestry of self-reported 'Mixed/Other Caucasian' to be around 94% 'White' and 6% 'Mixed' as defined by US Census data[2].

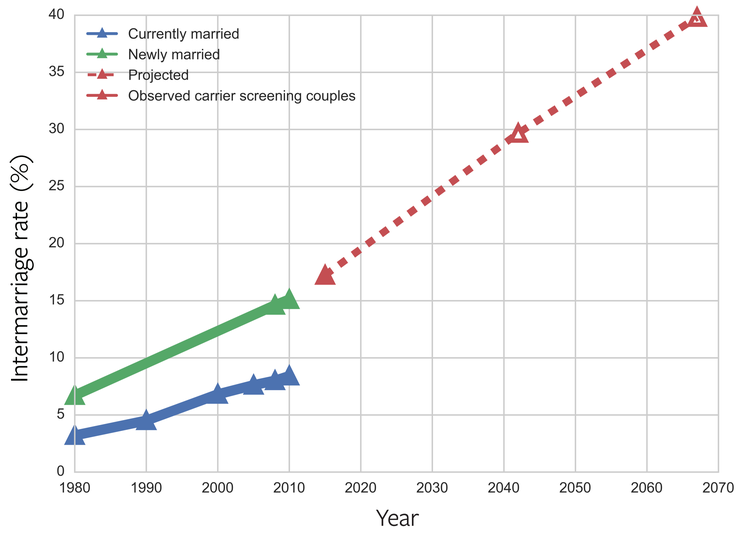
Results

Breakdown of carrier screening couples by ethnicity



The rise of intermarriage rates

Across varying ethnicities in the US population, 17.2% choose reproductive partners of a different ethnic background. Our data comes from couples taking carrier screening tests for reproductive planning purposes and is consistent with the intermarriage trend among newly married couples in the US population. If we assume that coupling continues to follow current trends, we predict that intermarriage rates in 2060 will approach 40%.



Intermarriage rates with predictions. Coupling patterns simulated forward two generations assuming each generation is 27 years (typical range is 22 - 32yr)[3].

Deviation from random mating model across ethnicities

The rise in intermarriage is not uniform across the population and demonstrates clear patterns influenced by sex and ethnicity. Compared to random mating, all ethnicities couple within their self-identified ethnicity more than expected, but some ethnicities have a stronger preference than others. For example, 'Black's are 6 times more likely than 'White's to partner within their self-identified group. The asymmetry of the heat map also suggests that sexes behave differently.

Deviation of actual number of couples from expected number of couples under random mating model. This heatmap is annotated with ln (actual/expected). People prefer to marry within their ethnicity, but some ethnicities prefer more than others.

Sex bias in exogamy

Looking closer at the sex bias, 'Asian' women are more likely to partner with men outside of their self-reported ethnic group than are 'Asian' men. By comparison, 'White' or 'Black' men are more likely to partner with women outside of their self-reported ethnic group than are 'White' or 'Black' women. The table below highlights the propensity for males and females of various ethnicities to partner outside of their self-identified category.

Ethnicity	Likelihood to couple outside of ethnicity
Asian	**Women** are **2.39** times more likely than men
White	**Men** are **1.74** times more likely than women
Black	**Men** are **1.70** times more likely than women
Hispanic	**Women** are **1.18** times more likely than men

Propensity to couple outside ethnicity for males vs females.

Conclusion

While the majority of individuals are still coupling within their self-identified ethnic group, the trend towards partnering outside of one's ethnic group is increasing. In our cohort, 17.2% of couples chose partners outside of their self-reported ethnicity. We also observe non-uniformity in coupling patterns across different ethnicities and sexes. The implications of this trend for clinical genetics practice should be considered, as medical guidelines for genetic screening are based on self-reported ethnicity. This practice will become increasingly difficult to rely upon as the US population continues to diversify.

REFERENCES 1. Taylor, et al. Pew Research Center. The Rise of Intermarriage **2.** Kaseniit et al. A Comparison of Self-Reported Ethnicity and Genetic Ancestry, NSGC 2016 **3.** https://en.wikipedia.org/wiki/Generation_time

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