**'Black Henna' and the Epidemic of para-Phenylenediamine Sensitization: Mapping the Potential for Extreme Sensitization to Oxidative Hair Dye**

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Any person who has a 'black henna', the popular temporary tattoo created by ornamenting skin with paste containing 15% to 80% para-phenylenediamine, is at risk of a severe allergic reaction to oxidative hair dye. The number and severity of these reactions is increasing, and have included hospitalization and death. Many of the extreme reactions are caused by sensitization from unusual levels of para-phenylenediamine in 'black henna' temporary tattoos, the time the 'black henna' paste is left on the skin, the size of the area painted with 'black henna'. These may be complicated by the age of the client at first exposure. The para-phenylenediamine sensitization rate in children has risen to 8% in 2004, and 16% in 2015 according to a broad study presented to the British Association of Dermatologists' Annual Conference in 2015 (1).

The allergic reactions to oxidative hair dye following a 'black henna' temporary tattoo are especially severe because of the high levels of para-phenylenediamine painted onto skin and the extent and duration of the application. In the Kligman (3) sensitization test, a patch of 10% para-phenylenediamine sensitized 100% of subjects in five applications or fewer. Tests of 'black henna' paste in areas of tourism have been found to be from 15% to 80% para-phenylenediamine (4) (5). These high concentrations of para-phenylenediamine 'black henna' are left on the skin a minimum of twenty minutes, and the applications are frequently very large, imitating large permanent ink tattoos. This increases the dose-time sensitization curve, resulting in extreme levels of subsequent allergic reactions. In some instances where there have been a number of people exposed at the same time to the same 'black henna', then examined by a health department, 50% of subjects were sensitized by the first application of 'black henna' (6).

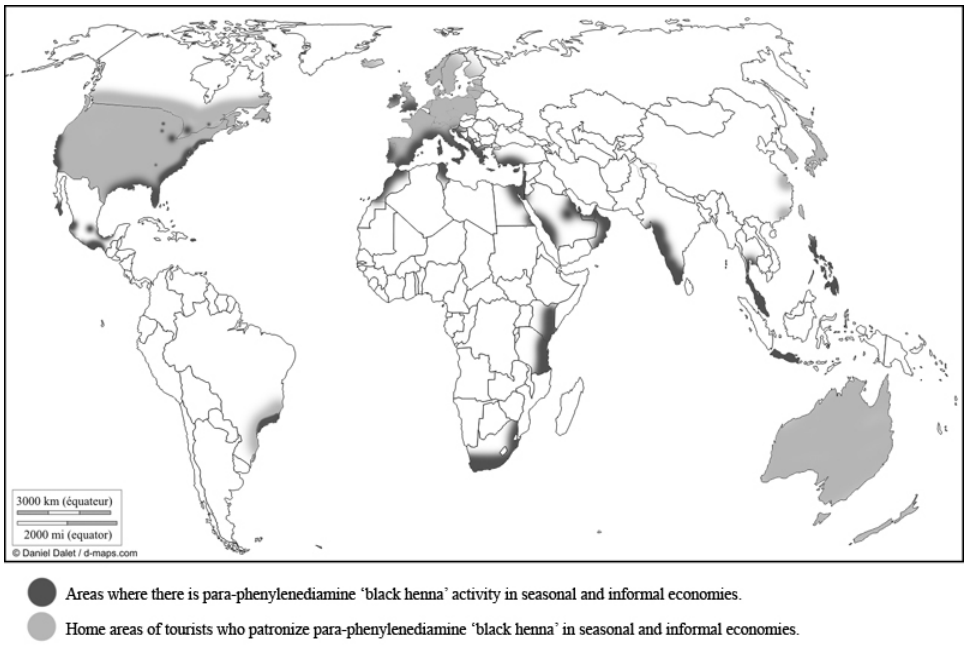


**Figure 1: Areas where para-phenylenediamine skin painting is common in informal economies of tourism, and the areas to which their patrons return**

Figure 1 shows the areas of seasonal and informal economies where ornamenting skin with para-phenylenediamine 'black henna' is done to emulate 'tribal' tattooing styles as well as traditional henna body art patterns, and the areas to which the sensitized tourists return. There may be more males than

females sensitized by these applications, as larger skin decorations are intended to emulate permanent, masculine tattoos. Many of these people were sensitized as children.

Consumer warning labels on packaging may be insufficient to prevent injuries; many people were sensitized as young children on vacation, and they do not recall the event (2). Others believe that they were painted with henna, a safe, natural, and traditional body art rather than a high concentration of para-phenylenediamine. Cultural groups have been sensitized through 'black henna' replacing or augmenting traditional henna in social and religious celebrations.

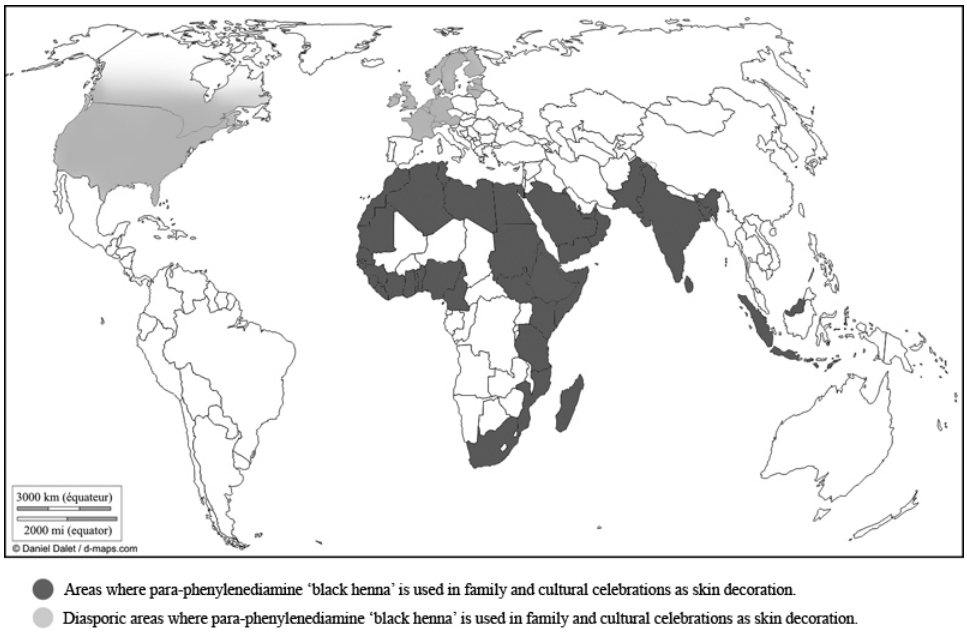


**Figure 2: Areas where women use para-phenylenediamine 'black henna' to ornament skin for weddings, Eids, and other religious and cultural celebrations, and areas of diasporic communities where the practice is continued.**

Para-phenylenediamine has been used to decorate skin in cultural celebrations for twenty to forty years in areas of East Africa, the Arabian Peninsula and South Asia, and more recently in diaspora. The sensitized population is largely female, with multiple exposures of 20% to 60% para-phenylenediamine skin painting, each being applied with paste in contact with skin for a duration of twenty or thirty minutes. The awareness of the risk of skin reaction is not absent, but women's preference for fast, convenient, fashionable black skin art prevails over the estimation of risk. The practice, though not done before the 1970's, has been embedded in many communities for long enough that it is considered part of the culture.

Based on my doctoral research (7), I estimate that as of 2013, there have been 140,625,000 people severely sensitized to para-phenylenediamine in areas of tourism by 2013, and that the number continues to increase by 9,375,000 each year. Many of these were children sensitized between 1997 and 2015, who will be a rising demographic of sensitized adults seeking to mask gray hair from 2010 to 2040. A far larger number of women are sensitized to para-phenylenediamine through cultural use every year in cultures where safe, traditional henna was formerly used to celebrate marriage and religious holidays, now replaced by fast, as black stains considered more modern and fashionable. Attempts by governments to ban 'black henna' have largely been ineffective as the desire for fast, black temporary tattoos continues, and the patrons either do not know the risk, don't think they will be affected, or don't consider the risk of injury to be significant. Enforcement of bans has rarely succeeded because of the availability of para-phenylenediamine and 'black henna' and the seasonal, informal economies of the practitioners.

People who have been exposed to 'black henna' should not be assumed to be sensitized to only para-phenylenediamine; cross sensitizations to multiple coal tar derivative chemicals in oxidative hair dye and

other products are common (8). Traditional patch testing may be insufficient to establish sensitization as reactions may occur as late as thirty days after exposure, and patch tests themselves may result in severe reactions. For highly sensitized persons, a complete departure from all coal-tar derivatives is necessary.
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