

The Mathematics of Concurrent Partnerships and HIV: A Commentary on Lurie and Rosenthal, 2009

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In their commentary “Concurrent Partnerships as a Driver of the HIV Epidemic in Sub-Saharan Africa? The Evidence is Limited” [1] Mark Lurie and Samantha Rosenthal call for more research on the role sexual partnership concurrency may play in the spread of sexually transmitted infections. Unfortunately this very sensible recommendation is undermined by a number of errors, beginning with the first sentence.¹

Evidence for the concurrency hypothesis rests on three bodies of research:

- 1) Empirical studies of the prevalence of concurrency in different populations.
- 2) Ethnographic studies suggesting that the concurrency hypothesis is plausible to many people in Africa.
- 3) Mathematical modeling studies demonstrating that high rates of concurrency can drive high rates of HIV transmission, even when overall numbers of partnerships are low.

Mah and Halperin [2, 3] address (1) and (2). I will therefore mainly address Lurie and Rosenthal’s discussion of the modeling studies here.

Lurie and Rosenthal’s critique of Morris and Kretzchmar’s mathematical models of concurrency suggests some misunderstanding. Morris and Kretzchmar [4] compare the spread of a hypothetical STI through sexual networks in which long term concurrency is relatively common to those in which serial monogamy predominates. Lurie and Rosenthal claim that the partnership duration parameters used by Morris and Kretzchmar, “may be unrealistic” because they produce partnerships with average durations of

6–7 months, rather than the 10 years observed in Uganda [5]. Increasing partnership duration would affect both monogamous and concurrent partnerships—and by trapping infection for longer times in monogamous pairings, this would likely increase, rather than decrease, the effect of concurrency.

While the transmission rates used by Morris and Kretzchmar are high, this does not affect the comparison between concurrency and serial monogamy, since both would be affected by changes in the transmission rate. What would make a difference is the early peak in infectivity [6]. This makes concurrency even more dangerous than long term serial monogamy because it guarantees another partner will be available during the short peak infection window [7]. Morris and Kretzschmar’s models do not include this, so one could argue they actually underestimate the relative effect of concurrency.

Lurie and Rosenthal also claim that Morris and Kretzchmar’s model “assumes that every partnership consists of one sex act per day, meaning that a person with four concurrent partners has sex with each of the four partners every day.” In fact, the fraction of people in the Morris and Kretzchmar model with more than one partner at a time was very low, and the fraction with more than two was extremely low, and the number with four partners vanishingly low. Eliminating them and extending the time between sex acts would have slowed down the epidemic, but would not substantially affect the comparison between serial monogamy and concurrency.

¹ “Sub-Saharan Africa contains only 3% of the global population,” the authors state, “but an alarming 68% of the world’s adults and children living with HIV/AIDS (UNAIDS 2007).” In fact, sub-Saharan Africa is home to 12.6% of the world’s population, not 3%. (World Population Prospects: 2008 Revision).

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By contrast, Lurie and Rosenthal cite the model presented by Doherty et al. [8] as the most up to date modeling study of concurrency. However, Doherty et al. did not attempt to distinguish the effects of concurrency from serial monogamy. Doherty et al. define the continuum of activity groups in their model population in such a way that concurrency and rates of partner acquisition both increase at the same time, so the effects of the two are almost completely confounded. They regress out the effect of partner acquisition to isolate the effects of concurrency, but because the two are so strongly correlated, this also removes most of the effect of concurrency. Doherty's model also assumes a very unusual population, in which 60% of subjects belong to the "high activity group" which has a maximum of 50 partners over 5 years. Such a large fraction of "high activity" individuals has never been recorded in any heterosexual population (other than sex workers). If such a population existed, the core group's behavior would dominate the outcome, and concurrency would not matter. In fact, this is the key point of the concurrency hypothesis: in the absence of such large core groups, concurrency is one of the few plausible explanations for the emergence of a generalized epidemic.

Lurie and Rosenthal state that the models of Morris and Kretzschmar "have frequently been cited as proof of the argument that concurrency drives the HIV epidemic." That is not correct. These models are often cited as "proof of concept"—the results demonstrate that small amounts of concurrency *can* have strikingly large effects—and they have been cited as strong evidence that concurrency is one among many drivers of the epidemic in heterosexual populations [9].

Lurie and Rosenthal also state that Epstein [10, 11] has, "gone so far as to accuse UNAIDS of failing to address concurrency in their recommended prevention interventions, and of *deliberately* covering up the evidence of the importance of concurrency." [Emphasis theirs.] In fact, Epstein demonstrates that UNAIDS made no mention of concurrency in its official literature on prevention until 2006, and that the agency failed to make public various reports showing partner reduction was the major behavioral change during the HIV decline in Uganda during the 1990s. These are not accusations, but facts.

Finally, Lurie and Rosenthal recommend that, for now, prevention programs should not be based on the concurrency hypothesis. But if we were to use the standard they propose, the only HIV prevention intervention we could implement now would be male circumcision. Many persons do become infected through long term relationships with a partner for whom concurrency is culturally normative. Explaining how this can happen could help reduce the confusion, shame and denial that has thwarted so many prevention and treatment programs for so long [11].

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