to confirm our structure’s predicted negative refraction, using the interfaces of the photonic crystal in the $z$–$M$ direction. The electric field was kept parallel to the rods for all measurements and calculations; the horn antenna was oriented so that the incident waves make an angle of 45° with the normal of the $z$–$M$ interface. Our structure exhibits the maximum angular range of negative refraction at an operating frequency of 137 gigahertz (GHz). In simulations using the finite-difference time-domain method (FDTD), the incident gaussian beam width was set at 6 cm, which is equal to the width of the horn antenna.

The centre of the outgoing gaussian beam is shifted to the left of the centre of the incident gaussian beam (Fig. 1c), which corresponds to negative refraction. The negative index of refraction was determined to be $-1.94$, which is close to the theoretical value of $-2.06$ calculated by the FDTD method. For comparison, we repeated the measurements and simulations with a slab containing only polystyrene pellets, which has a refractive index of 1.46, and found the refracted beam to be on the right of the incident beam, corresponding to a positive index of 1.52 (Fig. 1d).

The advantage of negative refraction in the valence band is that there is no Bragg reflection; such reflections occur in higher bands of the photonic crystal, and we have a well-defined, single-beam propagation that is negatively refracted. Another advantage of operating in the valence band is that the transmission efficiency at this frequency is 63%, which is almost three orders of magnitude larger than the typical transmission efficiency in a left-handed material. The negative refraction effect that we describe depends only on the refractive index of the dielectric material and on the geometric factors used in two-dimensional photonic crystals. This effect can therefore also be observed at optical wavelengths, at which it is possible to obtain similar refractive indices by using transparent semiconductors.

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**Sexual contacts and epidemic thresholds**

Distributions of the number of sexual partners reported in surveys show a pronounced skew, with most people having had one or no partners in the past year and a small fraction having had many. Lijeros and colleagues infer from the results of a Swedish survey that there is a “scale-free” population distribution of sexual contacts, consistent with a preferential-attachment model, in which “the rich get richer” and epidemics are driven by extremely promiscuous individuals. Here we reanalyse the data from Sweden and from other countries, using more appropriate statistical tools. Our findings support the conventional wisdom that epidemic thresholds exist in these populations, and indicate that current public-health strategies to reduce the spread of HIV and other sexually transmitted infections do not need to be radically refocused.

An important epidemiological question for highly skewed partnership distributions is whether their variance is finite. As the reproduction number of a pathogen increases linearly with the variance in the level of sexual activity, populations with infinite variance lack epidemic thresholds. In these populations, a sexually transmitted infection could persist regardless of its transmissibility, and interventions such as vaccines or barrier contraceptives would be ineffective for eradicating it.

Lijeros et al. estimate the scaling exponent for Sweden by fitting a line to the apparently linear region of the upper tail of the logged sexual-contact distribution. This approach is not statistically appropriate, for several reasons. Inference based on the basis of the distribution’s extreme upper tail yields wildly increasing confidence intervals because there is little empirical information in this region (Fig. 1). Estimates of the scaling exponent are a source of further difficulties, including temporal confounding and censoring.

We take a more principled statistical approach, using a stochastic mechanism for the underlying preferential-attachment process. This yields a Yule distribution, and infinite variance when the single scaling parameter $\rho < 3$. (Details of the Yule model and the statistical estimation procedure are presented elsewhere.) We generalize the simple Yule model to allow for a mixture of distributions — a process for the lower tail, and a preferential-attachment-type process for the upper tail. Assuming the Yule form, we can estimate the model parameter using maximum

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assortative mixing and concurrency. The high stakes in the battle against HIV and AIDS call for a broad perspective.

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Figure 1 Interval estimates of the scaling parameter, \( k \), for the generalized Yule probability mass function for Swedish males and females. Data show the sensitivity of the 95% bootstrap confidence intervals to the upper tail of the partnership distribution, defined as \( \kappa > k_{\text{min}} \), where \( k \) is the number of sexual partners in the previous 12 months. For both males and females, the best-fitting model has \( k_{\text{min}} = 1 \). By contrast, Liljeros et al.\(^3\) used \( k_{\text{min}} = 5 \) for males and \( k_{\text{min}} = 4 \) for females. For these values, our estimates of parameter uncertainty are six times greater than the intervals reported by Liljeros et al.\(^1\).

likelihood, and base our model selection on the Bayesian information criterion.\(^9\)

The 95% bootstrap confidence-interval estimates of the scaling parameters fall above the infinite-variance range (females, 3.60–5.21; males, 3.01–3.63). Our results are similar when we analyse further data sets from Uganda and the United States (both based on representative samples with substantially higher response rates than in the Swedish survey). Thus, there seems to be consistent evidence that sexual-contact distributions are characterized by finite variance.\(^2\)

Our findings suggest that sexual-contact distributions, although strongly right-skewed, are characterized by finite variance. This implies that interventions aimed at reducing transmissibility have the potential to reduce the reproductive number of sexually transmitted infections below the epidemic threshold.

To justify using “radically different” prevention strategies for sexually transmitted infections, strong evidence is needed that current strategies will be ineffective. Results based on unverified mathematical assumptions about network structure do not come close to meeting this standard.\(^11\) Such data provide no new insight for epidemiology\(^14,15\), and conclusions drawn from them could jeopardize campaigns to eliminate sexually transmitted infections worldwide.

It has been suggested in the media that ‘eliminating’ highly promiscuous nodes could be more effective than reducing their probability of transmission, but this overlooks the remarkable progress in preventing mother-to-child infection, the difficulty in identifying highly active individuals, and the growing evidence of the importance of other behavioural patterns, such as differential