

Mathematical modelling to prevent fistulas

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It is better to invest in measures that make it easier for women to visit a doctor during pregnancy than measures to repair birth injuries. This is the conclusion from two mathematicians at LiU, using Uganda as an example.

A [fistula](#) is a connection between the vagina and bladder or between the vagina and the rectum. It can arise in women during prolonged childbirth or as a result of violent rape. The connection causes incontinence, in which the patient cannot control either urine or feces, which in turn leads to several further [medical problems](#) and to major physical, mental and social suffering. The [medical care system](#) in Uganda is well-developed, particularly in metropolitan areas, but despite this the occurrence of fistulas during childbirth is among the highest in Africa. It has been calculated that between 1.63 and 2.25 percent of [women of childbearing age](#), 15-49 years, are affected.

Betty Nannyonga, postdoc at LiU who also works at Makerere University in Kampala, Uganda, and Martin Singull, associate professor in [mathematical statistics](#) at the Department of Mathematics at LiU, have published an article in the scientific journal *PLOS ONE* that demonstrates how the available resources can be put to best use.

"We have tried to construct a [mathematical model](#) to show how to prevent (obstetric) fistulas in women during prolonged childbirth. This is hugely important in a country such as Uganda," says Martin Singull.

The study analyzed data from the Uganda Demographic Health Survey 2016. This survey collected information from 18,506 women aged 15-49 years and living in 15 regions in Uganda. Some special clinics, known as "fistula camps," have been set up in recent years to provide surgery for affected women. Data from two of these, in different parts of the country, were also included in the study.

The research found that significantly fewer women have received surgery at the clinics than expected.

"Our results show that Uganda has a huge backlog of women who should be treated for fistula. In one of the regions we looked at, we found that

for each woman who had undergone an operation, at least eight more should have received care," says Betty Nannyonga.

The researchers have looked at the relationship between the resources required to provide surgery for the women after being injured and the corresponding resources used to give the women access to professional care during the pregnancy, which includes the availability of delivery by Cesarean section if required. Another chilling statistic that must be considered is that not only do the women suffer from fistula, but that the baby survives in only 9% of such cases.

The mathematical models demonstrate that the number of women who suffer from fistula decreases most rapidly if the resources are put into preventive maternity care, and making it possible for the women to give birth in hospital.

The authors point out, however, that several difficulties contribute to the relatively high occurrence of fistula.

"Even if professional healthcare and medical care are available in Uganda, most women do not enjoy good maternity care during their pregnancy. In some cases, this is because the distance to the healthcare providers is too far. Other reasons are the women do not have the money needed, or that they require permission from their husbands. It won't do any good to invest money in health centers if the women don't attend," says Betty Nannyonga.

The regions differ considerably in how they provide care. It is twice as likely that a woman in a town will see a doctor than it is for someone who lives in rural areas. Another factor is education: those with upper secondary education are twice as likely as those without, and having higher education than upper secondary increases the probability by a further factor of two. Social status also plays a major role: the

probability of seeing a doctor on some occasion during the pregnancy is directly linked to income.

One positive trend shown by the statistics is an increase in the fraction of [women](#) who receive professional care during the delivery itself (although the figures are for only those cases in which a child is born alive). This has risen from 37% in the period before 2001, to 42% in 2006, 58% in 2011 and 74% in 2016.

"Our results show that professional care and surgery by themselves cannot prevent all cases of fistula: other measures will be needed," concludes Betty Nannyonga.

More information: Betty Nannyonga et al. Modeling allocation of resources in prevention and control of obstetric fistula in Ugandan women, *PLOS ONE* (2020). [DOI: 10.1371/journal.pone.0238059](https://doi.org/10.1371/journal.pone.0238059)

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