Attribution of reductions in malaria prevalence in Dar es Salaam, Tanzania

Authors' reply

We thank Mathieu Maheu-Giroux and Marcia Castro for their Correspondence about our Article.[1] Regarding concerns about the stepped-wedge design of the larviciding scale-up in our study, we agree and also note that scale-up was not randomised, but rather introduced earliest to the best-prepared wards. However, such compromises are normal and healthy in pragmatic assessments of effectiveness under realistic programmatic conditions, rather than efficacy under artificially controlled experimental conditions. As acknowledged in the discussion and emphasised in the title, we also agree that evidence for window screening impact is purely observational, and that long-overdue, cluster-randomised, experimentally controlled analyses of well developed delivery practices for both these supplementary vector control measures are urgently needed.[1]

However, we disagree with the view that our attributions of intervention effects are haphazard and that potential confounders were "arbitrarily disregarded". In our Article,[1] factors such as bed nets, antimalarial drugs, and household-level screening were all considered in the analysis, with relevant effect sizes reported and discussed in detail. Although major shifts in vector population composition were observed in rural Tanzania around the time of the first mass distributions for insecticide-treated nets in 2008,[2,3] no equivalent changes were observed in Dar es Salaam over the same period, because the city was given lowest priority in both national campaigns so coverage remained low until 2010.[4] Although a slight upward trend in net usage coincided with the downward trend in human malaria prevalence in Dar es Salaam, and artemisinin-based therapies also came into use, uptake of both measures was far too low to plausibly account for such massive reductions of malaria burden.[1]

The only interventions for which substantive upward coverage trends were observed over the study period were larviciding and window screening. Together, these two intervention scale-ups were associated with prevalence reductions equivalent to those accounted for with a simple, unattributed empirical time trend.[1] As detailed in the methods, we did account for temporal autocorrelation when fitting these models.[1] Indeed, our models that included a simple empirical time trend as per previous studies[5,6] essentially reproduced the previous results, notably the modest effect size estimates for larviciding. The major issue therefore seems to be that fitting an unattributed empirical time trend may have spuriously assimilated the effects of both observed intervention scale-up processes.[1] Underestimating effect sizes may be as dangerous as overestimating them, and regression dilution bias inherently exacerbates risk of underestimation.

Notably, the entomological secondary outcomes and explanatory variables clearly and independently implicated window screening as the most important, obvious, and parsimonious explanation for the remarkable decline in malaria prevalence.[1] Substantial reductions of mosquito population density were associated with scale-up of both larviciding and window screens. Effect sizes for different taxonomic groups of mosquitoes were fully consistent with those attributed to the same two interventions for the epidemiological data. Crucially, the effect sizes for window screening were greatest for the most efficient malaria vectors with the greatest preference for human hosts, and therefore the greatest dependence upon accessing human blood. It is difficult to envision how changes in demography, socioeconomic status, or any intervention other than a personal protection measure like window screens could cause such behaviour-dependent effects on mosquito populations.

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