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Social norms, misperceptions, and mosquito net use: a population-based, cross-sectional study in rural Uganda

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Abstract

Background: Mosquito net use is an essential part of malaria prevention. Although previous research has shown that many people sleep under a mosquito net in endemic areas, it is unknown whether people underestimate how common it is to sleep under a net every night. Furthermore, perceived social norms about whether most others sleep under a mosquito net every night may contribute to personally sleeping under a net, given decades of research showing that people often mimic others' behaviours.

Methods: Population-based data were collected from 1669 adults across eight villages in one rural parish in south-western Uganda. Individuals' perception about whether most adults in their community sleep under a mosquito net every night was compared with whether daily mosquito net use was the actual norm in their community to identify the extent of norm misperception. The association between whether an individual perceived daily mosquito net use to be the norm and personal mosquito net use was assessed while adjusting for the ratio of nets:people in the household and other factors.

Results: Although the majority (65%) of participants reported sleeping under a mosquito net every night (and 75% did so among the 86% of people with at least one net), one-quarter of participants thought that most adults in their community did not sleep under a mosquito net every night. Another 8% were unsure how many nights per week most adults in their community sleep under a mosquito net. Participants who perceived that daily mosquito net use was the norm were 2.94 times more likely to report personally sleeping under a mosquito net every night (95% CI 2.09–4.14, $p < 0.001$) compared to participants who thought doing so was not normative, adjusting for other factors.

Conclusions: Results suggest an opportunity for anti-malarial interventions to reduce misperceptions about mosquito net use norms and emphasize the commonness of daily mosquito net use in malaria-endemic regions. If people correctly perceive most others to sleep under a net every night, then they may personally do so when possible and support others to do so too.

Keywords: Malaria, Bed net, ITN, Perceived norm, Descriptive norm, Social norms, Peer norm, Misperception, Uganda

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Background

Malaria is a leading cause of morbidity and mortality in the world. To prevent malaria transmission, the World Health Organization (WHO) recommends sleeping under a mosquito net on a daily basis for the 3.2 billion people worldwide who remain at risk of malaria [1]. Despite evidence that nets are effective in preventing malaria transmission and that most people have a net under which to sleep, some individuals still do not sleep under a mosquito net [2, 3].

Past research on protective behaviours and attitudes has found that many people underestimate the prevalence of a protective behaviour or attitude in a reference group and believe it to rarely occur or be held (i.e., they perceive a minority to do it or hold that belief) even when the protective behaviour or attitude is present among a majority in that reference group [4–9]. Likewise, people often overestimate the prevalence of risky behaviours and believe them to be common when they are not [10–21]. That is, perceived descriptive norms, which are the behaviours an individual believes to be the most common within a reference group [22], may not be actual descriptive norms (also known as collective norms), which are the behaviours actually engaged in by a majority of the reference group [23–26].

A similar phenomenon may occur with mosquito net use whereby people underestimate use among peers. For example, if people do not talk about sleeping habits with peers, then they may simply lack information about typical mosquito net use behaviour. Furthermore, if sleeping under a mosquito net is only discussed when someone has malaria symptoms, when mosquitoes have been noticed, or when there is a problem with a net, then using a mosquito net may seem less common than it is in reality. Similarly, local media (e.g., billboards, newspapers, television, radio) may disproportionately display or discuss people who are sick with malaria rather than people who are healthy, which also makes the protective behaviour seem less common. Thus, it is plausible that even in contexts where more than 50% of people sleep under a mosquito net every night, there may be many people who do not perceive this behaviour to be normative.

Conceptual framework

Humans have a tendency to follow the herd. Misperceiving a protective behaviour as uncommon when the behaviour actually is common is problematic if people's choices and actions are motivated by their perception of what is typical behaviour. Indeed, the classic sociological dictum suggests that: 'what is perceived as real is real in its consequences' [27]. In addition, decades of research in social psychology have demonstrated this conformity to social norms. People adopt behaviours even when the

behaviour goes against what an individual would otherwise do and conform to what they perceive is accepted by others [28–31]. In general, humans' desire to avoid being viewed as different or as an outcast and seek to avoid being socially sanctioned [32]. Thus, social norms, and more specifically, perceived social norms, may in part drive personally sleeping under a mosquito net every night.

The Theory of Planned Behaviour and the subsequent Integrated Behavioural Model conceptualize perceived norms (also labelled as subjective norms) as an important antecedent to intentions and behaviours [33–35]. Starting from these psychological frameworks, Social Norms Theory then applies a sociological lens to the role of social norms in predicting behaviour by identifying both perceived norms at the micro level (i.e., an individual's perceptions about typical behaviour among a reference group) and actual norms at a meso level (i.e., actual typical behaviour among reference groups) as potentially important predictors of attitudes and behaviours [23]. This theory emphasizes separate measurement of these social norm constructs to allow for identification of norm misperception and to be able to assess the extent to which perceived norms predict behaviour above and beyond the predictive contribution of actual norms. The Social Norms Approach applies this theory to behavioural research and intervention by calculating and describing the extent of norm misperceptions and then, assuming misperceptions exist, designing messages around positive actual norms as the basis of a social norms intervention to change misperceived norms and ultimately change attitudes and increase healthy or positive behaviour [23, 26, 36–38]. This intervention approach focuses on existing positive norms among a peer group or community as opposed to showing negative messages, which may make harmful behaviour seem more common than is true and inadvertently increase the harmful behaviour. Additional theoretical discussion from the communication discipline builds upon these theories by focusing on moderators of the relationship between perceived norms and personal attitudes and behaviour [24, 39–41].

A large body of observational studies on topics of public health importance provides empirical support for these theories and frameworks by finding strong associations between perceived norms and personal behaviour (e.g., see these reviews for some examples [42–44]). In addition, studies using longitudinal analyses, quasi-experimental designs, and randomized controlled trials have shown that changes in individuals' perceived norms about a variety of risky behaviours determine, at least in part, whether the individual personally engages in the behaviour [18, 21, 45–63]. Given this theoretical and empirical history, several recent review articles discuss

the importance of changing perceived social norms (i.e., correcting misperceived norms) to change behaviour and also discuss issues to consider as part of developing interventions that try to change perceived norms by directly or indirectly providing social norms messages based on actual norms [44, 64–67]. Moreover, social norms messaging has been utilized within recent behavioural science-based interventions as an effective form of social nudging [68].

Although most of this work has primarily been conducted in high-income countries, a few studies from sub-Saharan Africa have identified misperceptions of social norms and associations between norm perception and personal behaviour about HIV-prevention related behaviours [9, 69–72] and environmental-related attitudes and behaviours [73]. In addition, a few experimental studies on other topics in Africa have found that changes in perceived norms were associated with changes in personal behaviour [74–77]. However, no studies on mosquito net use have compared the gap between an individual's perception about whether daily mosquito net use was normative in a given population and the actual norm for mosquito net use in that population. If there are people who misperceive an existing positive mosquito net use norm, then an opportunity to correct the misperception is presented. And, if perception is associated with personal behavior, then intervening on individuals or a population to correct norm misperceptions might then increase daily mosquito net use among people who do not sleep under mosquito nets every night. In addition, people who sleep under a mosquito net for other reasons but who had misperceived the norm (and thus were 'carriers of the misperception') may feel more supported to continue engaging in the protective behaviour upon learning the true norm. They may also be less likely to spread incorrect assumptions about normative behaviour in their community during general conversation and support an overall climate of using mosquito nets.

Current study

In Uganda, the vast majority of households now own mosquito nets due to a nationwide campaign that was conducted in 2013–2014 to ensure universal free access to mosquito nets and provide a ratio of at least one net for every two people in a household [78]. Yet, ownership has not translated into consistent use: according to 2014–2015 nationally representative data, one-quarter of people in Uganda with at least one net at home report not having slept under it the previous night [79]. Thus, a cross-sectional, population-based study on social norms and mosquito net use was conducted in rural Uganda. The study aimed to (1) quantify the prevalence of people who misperceived the daily mosquito net use norm;

and, (2) determine the extent to which perception of the norm was associated with personal daily mosquito net use. It was hypothesized that a substantial amount of people would erroneously perceive that daily mosquito net use was not normative in their community despite most people sleeping under a mosquito net every night. The second hypothesis was that people who thought daily mosquito net use was normative would be much more likely to personally sleep under a mosquito net every night as compared to people who misperceived that most adults in their community did not do so.

Methods

Study population and procedure

The study was conducted in Nyakabare Parish, Mbarara District, a rural area of southwest Uganda. It is 20 km away from the nearest city, and is in a malaria-endemic region. The healthcare infrastructure is limited. Beginning in early 2011, the research team conducted a census enumeration of all adults (18 years+) who considered their permanent main household to be in the parish, which contained eight villages. The census was continually updated thereafter. For this population-based study, eligible participants were defined as all adults whose main household was within the parish. If there was more than one eligible adult in a household, then all such adults were eligible to participate in individual interviews.

Survey interview materials were iteratively translated and piloted from English to the local language and back to ensure accuracy and consistent word choice. The study team began contacting eligible participants in October 2011 for survey administration moving from village to village. Several well-trained research assistants who spoke the local language conducted one-on-one interviews lasting about an hour typically at the participant's home. By the end of the data collection period in August 2012, 1669 adults had been interviewed, 16 refused, and 62 could not be contacted (because the person was always away). The response rate was 96%.

Measures

Availability of mosquito nets in the household

All individual participants were first asked, "Does your household have a mosquito net that can be used while sleeping?" If the answer was yes, then further questions about mosquito net use were asked. Participants also reported the number of functional mosquito nets present in their household in response to the question, "In total, how many mosquito nets that can be used while sleeping do you have in your household?" as this factor is associated with use [80–84]. Combining this information with the total number of household members, a categorical variable representing the ratio of reported number

mosquito nets to the number of people in the household was created to indicate access to a mosquito net within one's household, with the following categories: 0 nets, ratio < 0.5, 0.5 to less than 1.0, 1.0 or greater.

Daily personal mosquito net use and the actual norm

If participants reported at least one mosquito net in their household, then participants were asked, "On average, how many nights per week do you sleep under a mosquito net?" A binary variable was created to capture whether a participant reported sleeping under a mosquito net seven nights per week. Given the population-based sample, the parish-wide prevalence of daily mosquito net use was calculated based on responses to the personal mosquito net use question. Daily mosquito net use was considered to be normative (i.e., to be the actual norm) if more than 50% of adults reported sleeping under a mosquito net seven nights per week.

Perceived norm for daily mosquito net use

To measure the perceived mosquito net use behaviour of most adults in their parish, participants were asked, "On average, how many nights per week do you think that most other people aged 18 years and older in your parish sleep under a mosquito net?" They could answer any digit from 0 to 7 or don't know/unsure. This question was informed by previously published studies on other health-related risk behaviours [38, 85]. Based on responses, a trichotomous variable was created to indicate whether participants (a) thought that most adults sleep under a mosquito net seven nights per week (that is, engaged in daily mosquito net use); (b) thought that most adults do not sleep under a mosquito net seven nights per week (that is, engaging in less than daily use); or, (c) were unsure about how often most adults sleep under a mosquito net. This variable was created because this study was substantively focused on norms around daily use due to the malaria-endemic context. Participants in the first category perceived daily mosquito net use to be normative. Accuracy of norm perception was determined by comparing an individual's perceived norm about daily net use in the parish to the actual norm about daily net use in the parish.

Other explanatory variables

Information on gender, age, marital status, education, household wealth, number of additional adults in the household (other than participant and spouse, if married), and number of children in the household was also collected because prior studies have identified associations between personal mosquito net use and these factors [83, 84, 86–92]. By including these variables, analyses could adjust for any potential confounding introduced by

these factors on the relationship between perception and behaviour.

Age (15 missing) was a continuous measure. Marital status was categorized as married or single/separated/widowed/divorced (1 missing). Education (32 missing) was defined as having completed (a) none, (b) primary school, (c) secondary school, or (d) postgraduate studies. The number of household adults and children were continuous variables (82 and 81 missing, respectively). A household asset index was created to indicate wealth, by conducting a principal components analysis on 26 household assets and housing characteristics (no missing data). The first principal component was retained to define the wealth index and then split it into quintiles [93]. Finally, season was recorded using a binary variable to capture any variation due to wet versus dry season (that is March/April/October/November vs other months).

Statistical analysis

The population is described and indicators of access to mosquito nets in the household are provided. Then, the prevalence of daily mosquito net use is shown across sub-groups as well as the percentage of people in each perception accuracy category across sub-groups. To test the relationship between perceived mosquito net use norm and personal use among people with at least one mosquito net in their household, we use a multivariable multilevel logistic regression model that accounts for the clustering of observations at the household level. Through this model, the log-odds of a participant reporting personal daily mosquito net use as a function of the participant's perceived norm about daily mosquito net use was estimated adjusting for the nets:people household ratio, gender, marital status, age, number of additional household adults, number of household children, education, household wealth, season, and village (as dummy variables). All significance tests are conservative as the data represented the entire population.

Results

Participant characteristics are presented in Table 1. More than 60% were under 40 years old, 58% were married, and 69% had completed primary education or less. The average number of adults per household was 1.8 (SD = 0.5). Eighty-six percent of participants personally reported having at least one mosquito net in their household. Overall, 68% of participants reported having enough mosquito nets in their household to indicate a ratio of one or more mosquito nets per every two people in their household (the national target). Forty percent of participants reported having three or more mosquito nets in their household.

Table 1 Prevalence of sleeping under a mosquito net among adults across eight villages in rural Uganda

Characteristics	n	%	% who sleep under a mosquito net every night	% who sleep under a mosquito net every night among people reporting at least one net in the household
Gender				
Male	913	54.7	61.7	77.2
Female	756	45.3	67.1	72.9
Age (years)				
Under 30	694	42.0	65.3	74.1
30–39	330	20.0	67.6	77.2
40–49	266	16.1	69.6	77.4
50–59	134	8.1	62.4	74.8
60–69	97	5.9	57.3	73.3
70–79	74	4.5	62.2	82.1
80 or more	59	3.6	42.1	64.9
Marital status				
Married	961	57.6	64.6	67.7
Single/divorced/separated	707	42.4	53.8	80.2
Education				
No education	276	16.9	56.6	73.7
Primary	847	51.7	64.6	75.2
Secondary	405	24.7	67.7	74.1
Postgraduate	109	6.7	74.3	86.2
Household asset quintile				
Lowest	273	16.4	55.3	73.3
2nd	316	18.9	64.2	74.4
3rd	327	19.6	70.8	80.4
4th	383	23.0	66.1	73.3
Highest	370	22.2	65.0	75.0
Ratio of nets:people in the household				
0 nets	235	14.1	0	n/a
< 0.5	291	17.4	54.5	54.5
0.5 to < 1.0	437	26.2	73.2	73.2
1.0 or greater	706	42.3	85.1	85.1

Daily mosquito net use among adults was the actual norm in this parish as 65% of all participants reported sleeping under a mosquito net every night. (This percentage incorporates participants who had no mosquito nets). Among participants reporting at least one mosquito net in the household, 75% reported sleeping under a net every night. Furthermore, sleeping under a mosquito net every night was also the actual norm for many sub-groups as 54–85% of people in different sociodemographic categories reported sleeping under a net every night (except for people aged 80 years or more and people without a net in the household) (Table 1). Even the majority of participants living in a household with fewer than one net for every two people (but at least one net in the household) reported sleeping under a mosquito net every night. Similarly, 57–81% of adults across each village reported doing so each night (Table 2).

Yet, 23% of participants erroneously thought that the majority of adults in their parish do not sleep under a mosquito net every night, and thus misperceived the norm. This level of norm misperception was consistent as 20–30% of participants across sociodemographic sub-categories believed that daily mosquito net use was not normative in the parish (Table 3).

For example, 24% of participants with zero nets in their household misperceived daily mosquito net use as uncommon in their parish as did 22% of participants in a household with a ratio of nets:people of 1.0 or greater. In addition, 8% of participants indicated not knowing how often adults in their parish sleep under a mosquito net. Thus, almost one-third of all participants did not realize that daily mosquito net use was the norm in their parish when combining participants who misperceived the norm with participants who were unsure about the norm.

Table 2 Prevalence of sleeping under a mosquito net every night across eight villages in rural Uganda

Village	n	%	Mean ratio of the number of mosquito nets per person in the household	% who sleep under a mosquito net every night	% who sleep under a mosquito net every night among people who reported at least one net in their household
1	230	13.8	0.75	56.5	71.0
2	263	15.8	0.86	65.7	76.8
3	209	12.5	0.98	80.9	87.6
4	214	12.8	0.77	56.6	68.6
5	153	9.2	0.98	73.0	79.9
6	237	14.2	0.76	62.9	71.0
7	146	8.8	0.81	63.2	72.8
8	217	13.0	0.63	61.3	74.3

Table 3 Prevalence of perceived norm accuracy about daily mosquito net use among adults in rural Uganda

Respondent characteristics	Accurate perception: % who thought that daily mosquito net use was normative in the parish	Erroneous perception: % who thought that daily mosquito net use was not normative in the parish	Did not know perception: % who insisted on not knowing how often people in their parish sleep under a mosquito net
Gender			
Male	67.6	23.8	8.6
Female	68.9	23.1	8.0
Age (years)			
Under 30	72.0	23.5	4.5
30–39	70.6	21.8	7.6
40–49	68.4	21.4	10.2
50–59	64.9	21.6	13.4
60–69	61.9	28.9	9.3
70–79	58.1	25.7	16.2
80 or more	45.8	28.8	25.4
Marital status			
Married	70.1	22.3	7.6
Single/divorced/separated	65.8	25.0	9.2
Education			
No education	63.0	21.0	15.9
Primary	68.0	24.7	7.3
Secondary	72.1	22.5	5.4
Postgraduate	70.6	22.9	6.4
Household asset quintile			
Lowest	61.5	24.9	13.6
2nd	72.8	21.2	6.0
3rd	68.2	23.9	8.0
4th	69.5	23.5	7.0
Highest	68.4	23.8	7.8
Ratio of nets:people in household			
0 nets	55.3	24.3	20.4
<0.5	64.6	29.6	5.8
0.5 to <1.0	72.3	21.1	6.6
1.0 or greater	71.7	22.1	6.2

Daily mosquito net use among adults was normative if more than 50% of participants in the parish personally reported sleeping under a mosquito net seven nights per week

Similarly, 17–38% across villages misperceived the norm (Table 4).

Excluding participants who reported zero nets in their household, a simple bivariate association showed that among participants who perceived daily mosquito net use as normative, 81% reported personally sleeping under a mosquito net seven nights per week. In contrast among participants who thought daily mosquito net use was

not normative, 61% reported personally sleeping under a mosquito net every night. Further, among participants who did not know their perception of the norm, 63% reported daily mosquito net use. Subsequent regression analyses found that an individual's perception about the normative mosquito net use behaviour had a statistically significant association with personal mosquito net use after adjusting for several other explanatory variables (Table 5). Participants who perceived daily use as normative in their parish were 2.94 times more likely (95% CI 2.09–4.14, $p < 0.001$) to sleep under a mosquito net every night compared to participants who perceived that most adults in their parish did not do so while adjusting for several other variables. Other factors that were associated with daily mosquito net use included the ratio of nets:people in the household, the number of children in the household, the number of additional adults in the household, being female, being married, and having post-graduate education. For example, compared to having access to fewer than one net for every two people in the household, having a ratio of '0.5 to < 1.0' nets per person in the household was associated with a 2.21 greater likelihood (95% CI 1.47–3.32, $p < 0.001$) of personally sleeping under a net every night. A supplemental analysis found similar estimates of the association between perception of the norm and personal use for both men and women.

Table 4 Prevalence of perceived norm accuracy about mosquito net use among adults in rural Uganda

Village	Accurate perception: % who thought that daily mosquito net use was normative in the parish	Erroneous perception: % who thought that daily mosquito net use was not normative in the parish	Did not know perception: % who insisted on not knowing how often people in their parish sleep under a mosquito net
1	70.4	23.5	6.1
2	70.3	22.1	7.6
3	76.6	17.2	6.2
4	62.6	19.6	17.8
5	56.9	37.9	5.2
6	72.2	20.3	7.6
7	58.9	32.9	8.2
8	71.4	21.7	6.9

Table 5 Odds ratios for personally sleeping under a mosquito net every night among adults in rural Uganda

	AOR	(95% CI)	p value
Perceived daily mosquito net use as normative	2.94	(2.09, 4.14)	< 0.001
Did not know perception	1.10	(0.60, 2.03)	0.760
Perceived daily mosquito net use as not normative	1.0	–	–
Nets:people in the household from 0.5 and < 1.0 (vs < 0.5)	2.21	(1.47, 3.32)	< 0.001
Nets:people in the household is 1.0 and greater (vs < 0.5)	4.48	(2.91, 6.90)	< 0.001
Female (vs male)	1.47	(1.09, 1.99)	0.012
Married (vs single)	1.87	(1.33, 2.63)	< 0.001
Age	1.00	(0.99, 1.01)	0.548
Number of children in the household	0.85	(0.78, 0.93)	< 0.001
Number of additional adults in the household	0.89	(0.81, 0.98)	0.023
Primary school (vs none)	0.97	(0.61, 1.56)	0.900
Secondary school (vs none)	1.18	(0.67, 2.09)	0.561
Postgraduate studies (vs none)	2.43	(1.06, 5.61)	0.037
2nd household wealth quintile (vs lowest)	1.09	(0.63, 1.87)	0.766
3rd household wealth quintile (vs lowest)	1.98	(1.11, 3.54)	0.021
4th household wealth quintile (vs lowest)	1.49	(0.86, 2.99)	0.158
Highest household wealth quintile (vs lowest)	1.65	(0.91, 1.38)	0.102
Rainy season	0.97	(0.67, 1.38)	0.848

Estimates were obtained using a multilevel logistic regression model that accounted for clustering of observations at the household level and also included dummy variables for village

Discussion

In this study, 23% of adults in a malaria-endemic region misperceived sleeping under a mosquito net every night as rarely occurring among most adults in their community even though most adults personally reported sleeping under a mosquito net every night. Moreover, 5–25% of adults (depending on the sociodemographic category) indicated that they did not know how many nights per week most adults in their parish slept under a mosquito net. This novel identification of misperceived norms about regular mosquito net use is similar to results demonstrating the discrepancy between actual and perceived behavioural norms from social norms studies on other health-related behaviours and attitudes [4–7, 10–21, 25, 26, 65, 94–96]. In addition, underestimating the normativity of a protective behaviour is similar to results about misperception of HIV testing norms within this same population in rural Uganda [9] and about HIV prevention behaviour in Tanzania and South Africa [69, 70, 72].

The second novel contribution of this study was finding that perceiving daily mosquito net use to be normative was a strong protective factor for personally sleeping under a mosquito net every night. The finding that the perceived norm is strongly associated with personal behaviour is consistent with results from studies on other topics [18, 21, 45–58, 84, 97, 98]. In follow-up research, it will be important to assess whether malaria-specific knowledge and perceptions of risk, and belief in the effectiveness of mosquito nets to prevent malaria, confound or modify the association between perception and behaviour [84, 99–104].

Intervention implications

The results of this study suggest that there is an opportunity to correct mosquito net use norm misperceptions by increasing adults' awareness of daily mosquito net use among peers. A social norms approach to doing so would first create messages about the positive actual behavioural norms about mosquito net use among specific reference groups in this context. Thus, example fact-based messages might be 'Most adults in this village sleep under a mosquito net every night' or 'Most single men in village X sleep under a mosquito net every night'. Highlighting the typical ratio of nets available for use within the household could also be a helpful message. For example, data from this study indicated that the ownership norm represented the national target; that is 'Most people in your village have access to at least one net for every two people in their household'. Emphasizing true protective norms (e.g., most people use nets in X village) rather than publicizing the problem (e.g., the number of people suffering from malaria in a community) will be more effective in bringing about the desired behaviour change [105,

106]. In addition, messages need to be credible, for example, created from recent local data [67, 106–108].

Interventions disseminating social norms messages have typically been implemented as community-wide social norms marketing campaigns, personalized normative feedback sessions, or facilitator-led small group discussions about actual norms and norm misperceptions [64]. However, the specific design of a social norms intervention should be tailored to the community setting. For example, a community-wide social norms marketing intervention in this kind of context could disseminate information on true behavioural norms about mosquito net use among specific reference groups using a variety of communication methods such as billboards, radio shows, education-entertainment, or SMS text-messages. Alternatively, local leaders or community health workers could provide information on actual norms about mosquito net use during local group meetings and engage in community-based dialogues about these norms. Separately, they could provide personalized normative feedback during one-on-one conversations. Although the delivery mode in a given context to a specific population should be assessed for feasibility and acceptability, a combination of communication approaches would likely be most impactful [109], especially as doing so increases frequency of, and thus exposure to, messaging.

This kind of intervention messaging may integrate well with other malaria-related behaviour change communication programmes [110]. Actual norms messaging could also increase the impact of structural anti-malaria interventions by creating a more informed population to target or with whom to operate. For example, messages about the commonness of net ownership and net use could be paired with a campaign to distribute free mosquito nets, potentially motivating more people to pick up and use a net regularly. These kinds of low-cost social norms-based interventions may have great utility in settings such as sub-Saharan Africa [111]. However, development of an intervention using a social norms approach to improve mosquito net use should account for other local factors that may influence personally sleeping under a net every night [112]. In addition, a norms-based intervention to increase mosquito net use should not be conducted alongside interventions that call attention to extreme cases of malaria or foster fear as they mute effects from any social norms messaging by implying that people are not using nets [106, 107, 113].

For individuals who misperceive the norm before a social norms intervention is implemented and who do not sleep under a mosquito net regularly, it is plausible that an intervention to correct misperceived norms may change their perception and therefore encourage them to conform to the normative behaviour and sleep under a

net every night given the association between perception and behaviour. In addition, individuals who misperceive the norm but who do sleep under a net every night for other reasons may feel more supported to continue doing so every night upon learning that their behaviour is actually normative. Finally, individuals accurately perceiving the norm before the intervention may feel additionally supported by a social norms intervention, and therefore encouraged to vocally reinforce to others the importance and commonness of sleeping under a mosquito net every night.

Study limitations

Interpretation of these findings is subject to limitations. First, the data are cross-sectional so causal direction between norm perception and personal behaviour cannot be determined. However, previous studies using longitudinal and experimental designs provide extensive evidence that change in an individual's perception of the norm has led to changes in personal behaviour for several health-related behaviours (as cited previously).

A second limitation is that data about personal mosquito net use are based on self-report. Although the rates reported in this study are similar to rates from past research [79], it is possible that reporting may have been influenced by social desirability bias (i.e., given the regular government campaigns) or by their perceptions of the norm (whether correctly perceived or incorrectly perceived). While the extent of mis-reporting is quantifiable and important, it is unclear whether the degree of mis-reporting could be significant enough to change the findings reported here. For example, a recent meta-analysis of studies comparing self-report and objective data found that people overestimated their mosquito net use by 13.6% [114]. Thus, even if 10–15% of participants in this study had incorrectly reported sleeping under a mosquito net seven nights per week when they actually sleep under a net less often, the majority of participants in this study would still be using a mosquito net every night. In that scenario, the actual norm would not have changed and norm misperception would still exist within this population. Moreover, as participants were asked how many nights they sleep under a mosquito net, mis-reports from participants who reported using a net less than seven nights per week but still over-estimated the number of nights they sleep under a mosquito net would not affect the results from this study as this study is discussing a binary norm about daily use. Finally, even if there were people whose under-reporting was driven by perceptions that others did not use nets, then the prevalence of actual use would be even greater and the extent of norm misperception found in this study would still exist.

Future research directions

Future research on mosquito net use norms would improve if objective monitoring methods were used to measure actual net use norms [101]. In addition, follow-up studies could assess the importance of norms about different social reference groups [115–118]. Inquiring about norms about “men your age in your village” or “women with young children” could perhaps show less norm misperception. However, although the potential association between perceived norms about proximal peers and personal behaviour may be stronger than the association between perceived norms about distal peers and personal behaviour, the extent of close peer norm misperception, and thus the possible extent of perceived peer norm correction would likely be less [26]. In contrast, even though the perceived norm about distal peers may be less influential, there is likely to be more norm misperception about distal peer groups [116]. This greater misperception thus allows for more potential change to occur in the perceived norm, and ultimately, perhaps, in personal behaviour. Relatedly, collecting network data could examine whether clustering of perceived norms about mosquito net use and actual use behaviours occurs within friendship networks or other kinds of networks [119]. Social network structure and the clustering of specific behaviour among close friends might make that behaviour seem more common overall than it actually is in the larger reference group [120].

Assessing social norms about a variety of behaviours related to mosquito net use when malaria vectors are most present, such as entry and exit of nets at night or the early morning, may also be worthwhile [121, 122]. Likewise, the power of perceptions about societal expectations around mosquito net use may also play a role. Injunctive norms, that is perceptions about what people ought to do, are distinct from behavioural descriptive norms and can exert their own direct influence or a modifying influence on the relationship between descriptive norms and personal behaviour [22, 24, 123].

Conclusions

There are two main findings from this population-based study on mosquito net use in rural Uganda. First, even though daily mosquito net use was reported by a majority of people in the targeted community, about a quarter of people misperceived daily use as not normative in this population, and another 8% did not know whether it was normative. Second, people who thought daily mosquito net use was normative among adults in their community were much more likely to report personally sleeping under a mosquito net every night.

The estimated association was statistically significant, large in magnitude, and robust. These findings suggest an opportunity for anti-malarial interventions to correct misperceived norms about daily mosquito net use in malaria-endemic regions. An increase in accurately perceiving this protective behaviour to be common and normative may help advance malaria prevention efforts in sub-Saharan Africa.

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Authors' contributions

JMP conceived of and designed the study. JMP and BK participated in the data collection. JMP wrote the first draft. JMP, PK, ST, BK, VB, ACT, NAC, and DRB participated in interpretation of the data and provided critical revisions. ACT, NAC, and DRB provided study oversight. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval for all study procedures was obtained from the Institutional Review Board at Harvard University, Yale University, Mbarara University of Science and Technology, and the Uganda National Council for Science and Technology and the Research Secretariat in the Office of the President in Uganda. Written informed consent to participate was obtained. Illiterate study participants were permitted to indicate consent with a thumbprint.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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References

- WHO. World Malaria Report. Geneva: World Health Organization; 2015. <https://www.who.int/malaria/publications/world-malaria-report-2015/report/en/>. Accessed 1 Oct 2018.
- Baume CA, Marin MC. Intra-household mosquito net use in Ethiopia, Ghana, Mali, Nigeria, Senegal, and Zambia: are nets being used? Who in the household uses them? *Am J Trop Med Hyg*. 2007;77:963–71.
- Pulford J, Hetzel MW, Bryant M, Siba PM, Mueller I. Reported reasons for not using a mosquito net when one is available: a review of the published literature. *Malar J*. 2011;10:83.
- Perkins JM, Perkins HW, Craig DW. Misperceiving a code of silence: peer support for telling authorities about weapons at school among middle school and high school students in the United States. *Youth Soc*. 2017. <https://doi.org/10.1177/0044118x17714808>.
- Litt DM, Lewis MA, Linkenbach JW, Lande G, Neighbors C. Normative misperceptions of peer seat belt use among high school students and their relationship to personal seat belt use. *Traffic Inj Prev*. 2014;15:748–52.
- Kroshus E, Garnett BR, Baugh CM, Calzo JP. Social norms theory and concussion education. *Health Educ Res*. 2015;30:1004–13.
- Scholly K, Katz AR, Gascoigne J, Holck PS. Using social norms theory to explain perceptions and sexual health behaviors of undergraduate college students: an exploratory study. *J Am Coll Health*. 2005;53:159–66.
- Dickie R, Rasmussen S, Cain R, Williams L, MacKay W. The effects of perceived social norms on handwashing behaviour in students. *Psychol Health Med*. 2017;23:154–9.
- Perkins JM, Nyakato VN, Kakuhikire B, Mbabazi PK, Perkins HW, Tsai AC, et al. Actual versus perceived HIV testing norms, and personal HIV testing uptake: a cross-sectional, population-based study in rural Uganda. *AIDS Behav*. 2018;22:616–28.
- Lewis MA, Litt DM, Crouce JM, Blayney JA, Gilmore AK. Underestimating protection and overestimating risk: examining descriptive normative perceptions and their association with drinking and sexual behaviors. *J Sex Res*. 2012;51:86–96.
- Perkins HW. Misperceptions of peer drinking norms in Canada: another look at the "reign of error" and its consequences among college students. *Addict Behav*. 2007;32:2645–56.
- Perkins HW, Craig DW. Student-athletes' misperceptions of male and female peer drinking norms: a multi-site investigation of the "Reign of Error". *J Coll Stud Dev*. 2012;53:367–82.
- Perkins HW, Haines MP, Rice R. Misperceiving the college drinking norm and related problems: a nationwide study of exposure to prevention information, perceived norms and student alcohol misuse. *J Stud Alcohol Drugs*. 2005;66:470–8.
- Paluck EL, Shepherd H. The salience of social referents: a field experiment on collective norms and harassment behavior in a school social network. *J Pers Soc Psychol*. 2012;103:899–915.
- Sanders A, Stogner J, Seibert J, Miller BL. Misperceptions of peer pill-popping: the prevalence, correlates, and effects of inaccurate assumptions about peer pharmaceutical misuse. *Subst Use Misuse*. 2014;49:813–23.
- Young JTN, Weerman FM. Delinquency as a consequence of misperception: overestimation of friends' delinquent behavior and mechanisms of social influence. *Soc Prob*. 2013;60:334–56.
- Kilmer JR, Walker DD, Lee CM, Palmer RS, Mallett KA, Fabiano P, et al. Misperceptions of college student marijuana use: implications for prevention. *J Stud Alcohol Drugs*. 2006;67:277–81.
- Neighbors C, Dillard AJ, Lewis MA, Bergstrom RL, Neil TA. Normative misperceptions and temporal precedence of perceived norms and drinking. *J Stud Alcohol Drugs*. 2006;67:290–9.
- Neighbors C, Walker DD, Mbilinyi LF, O'Rourke A, Edleson JL, Zegree J, et al. Normative misperceptions of abuse among perpetrators of intimate partner violence. *Violence Against Women*. 2010;16:370–86.
- Cunningham JA, Neighbors C, Wild TC, Humphreys K. Normative misperceptions about alcohol use in a general population sample

- of problem drinkers from a large metropolitan city. *Alcohol Alcohol*. 2012;47:63–6.
21. Reid AE, Aiken LS. Correcting injunctive norm misperceptions motivates behavior change: a randomized controlled sun protection intervention. *Health Psychol*. 2013;32:551–60.
 22. Cialdini RB, Reno RR, Kallgren CA. A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *J Pers Soc Psychol*. 1990;58:1015–26.
 23. Perkins HW, editor. The social norms approach to preventing school and college age substance abuse: a handbook for educators, counselors, and clinicians. San Francisco: Jossey-Bass; 2003.
 24. Lapinski MK, Rimal RN. An explication of social norms. *Commun Theory*. 2006;15:127–47.
 25. Perkins HW. Misperceptions of peer substance use among youth are real. *Addiction*. 2012;107:888–9.
 26. Perkins HW. Misperception is reality: the “Reign of Error” about peer risk behaviour norms among youth and young adults. In: Xenitidou M, Edmonds B, editors. The complexity of social norms. Computational social sciences. Berlin: Springer International Publishing; 2014. p. 11–36.
 27. Thomas WI, Thomas DS. The child in America. New York: Knopf; 1928.
 28. Asch SE. Studies of independence and conformity: a minority of one against a unanimous majority. *Psychol Monogr*. 1956;70:1–70.
 29. Sherif M. The psychology of social norms. New York: Harper; 1936.
 30. Sherif M. An experimental approach to the study of attitudes. *Sociometry*. 1937;1:90–8.
 31. Miller DT, Prentice DA. The construction of social norms and standards. *Social psychology: Handbook of basic principles*. New York, NY, US: Guilford Press; 1996. p. 799–829.
 32. Cialdini RB, Trost MR. Social influence: social norms, conformity and compliance. In: Gilbert DT, Fiske ST, Lindzey G, editors. The handbook of social psychology. 1 and 2. 4th ed. New York: McGraw-Hill; 1998. p. 151–92.
 33. Ajzen I, Fishbein M. Understanding attitudes and predicting social behavior. New Jersey: Prentice-Hall; 1980.
 34. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process*. 1991;50:179–211.
 35. Montano DE, Kasprzyk D. Theory of reasoned action, theory of planned behavior, and the integrated behavioral model. In: Glanz K, Rimer BK, Viswanath K, editors. Health behavior: theory, research and practice. 5th ed. San Francisco: Wiley; 2015. p. 95–124.
 36. Perkins HW, Berkowitz AD. Perceiving the community norms of alcohol use among students: some research implications for campus alcohol education programming. *Int J Addict*. 1986;21:961–76.
 37. Perkins HW. Scope of the problem: misperceptions of alcohol and drugs. *Catalyst*. 1995;1:1–2.
 38. Perkins HW. College student misperceptions of alcohol and other drug norms among peers: exploring causes, consequences, and implications for prevention programs. Designing alcohol and other drug prevention programs in higher education: bringing theory into practice. Newton: Higher Education Center for Alcohol and Other Drug Prevention; 1997. p. 177–206.
 39. Rimal RN, Real K. Understanding the influence of perceived norms on behaviors. *Commun Theory*. 2003;13:184–203.
 40. Rimal RN, Real K. How behaviors are influenced by perceived norms: a test of the theory of normative social behavior. *Commun Res*. 2005;32:389–414.
 41. Rimal RN, Lapinski MK. A re-explication of social norms, ten years later. *Commun Theory*. 2015;25:393–409.
 42. Chung A, Rimal R. Social norms: a review. *Rev Commun Res*. 2016;4:1–29.
 43. Reid AE, Cialdini RB, Aiken LS. Social norms and health behavior. In: Steptoe A, editor. Handbook of behavioral medicine: methods and applications. New York: Springer; 2010. p. 263–74.
 44. Perkins HW, Perkins JM. Using the social norms approach to promote health and reduce risk among college students. promoting behavioral health and reducing risk among college students. Abingdon: Routledge; 2018. p. 149–66.
 45. Pedersen ER, LaBrie JW, Hummer JF. Perceived behavioral alcohol norms predict drinking for college students while studying abroad. *J Stud Alcohol Drugs*. 2009;70:924–8.
 46. Lewis MA, Litt DM, Neighbors C. The chicken or the egg: examining temporal precedence among attitudes, injunctive norms, and college student drinking. *J Stud Alcohol Drugs*. 2015;76:594–601.
 47. Brooks-Russell A, Simons-Morton B, Haynie D, Farhat T, Wang J. Longitudinal relationship between drinking with peers, descriptive norms, and adolescent alcohol use. *Prev Sci*. 2014;15:497–505.
 48. DeJong W, Schneider SK, Towvim LG, Murphy MJ, Doerr EE, Simonson NR, et al. A multisite randomized trial of social norms marketing campaigns to reduce college student drinking. *J Stud Alcohol Drugs*. 2006;67:868–79.
 49. Haines MP, Spear SF. Changing the perception of the norm: a strategy to decrease binge drinking among college students. *J Am Coll Health*. 1996;45:134–40.
 50. Mattern JL, Neighbors C. Social norms campaigns: examining the relationship between changes in perceived norms and changes in drinking levels. *J Stud Alcohol Drugs*. 2004;65:489–93.
 51. Neighbors C, Larimer ME, Lewis MA. Targeting misperceptions of descriptive drinking norms: efficacy of a computer-delivered personalized normative feedback intervention. *J Consult Clin Psychol*. 2004;72:434–47.
 52. Perkins HW, Linkenbach JW, Lewis MA, Neighbors C. Effectiveness of social norms media marketing in reducing drinking and driving: a statewide campaign. *Addict Behav*. 2010;35:866–74.
 53. Perkins HW, Craig DW, Perkins JM. Using social norms to reduce bullying: a research intervention among adolescents in five middle schools. *Group Processes Intergroup Relations*. 2011;14:703–22.
 54. Turner J, Perkins HW, Bauerle J. Declining negative consequences related to alcohol misuse among students exposed to a social norms marketing intervention on a college campus. *J Am Coll Health*. 2008;57:85–94.
 55. Bewick BM, Trusler K, Mulhern B, Barkham M, Hill AJ. The feasibility and effectiveness of a web-based personalised feedback and social norms alcohol intervention in UK university students: a randomised control trial. *Addict Behav*. 2008;33:1192–8.
 56. LaBrie JW, Hummer JF, Neighbors C, Pedersen ER. Live interactive group-specific normative feedback reduces misperceptions and drinking in college students: a randomized cluster trial. *Psychol Addict Behav*. 2008;22:141–8.
 57. Neighbors C, Lewis MA, LaBrie J, DiBello AM, Young CM, Rinker DV, et al. A multisite randomized trial of normative feedback for heavy drinking: social comparison versus social comparison plus correction of normative misperceptions. *J Consult Clin Psychol*. 2016;84:238–47.
 58. Schultz PW, Messina A, Tronu G, Limas EF, Gupta R, Estrada M. Personalized normative feedback and the moderating role of personal norms: a field experiment to reduce residential water consumption. *Environ Behav*. 2016;48:686–710.
 59. Schultz PW, Nolan JM, Cialdini RB, Goldstein NJ, Griskevicius V. The constructive, destructive, and reconstructive power of social norms. *Psychol Sci*. 2007;18:429–34.
 60. Zapp D, Buelow R, Soutiea L, Berkowitz A, DeJong W. Exploring the potential campus-level impact of online universal sexual assault prevention education. *J Interpers Violence*. 2018. <https://doi.org/10.1007/0886260518762449>.
 61. Pedersen ER, Parast L, Marshall GN, Schell TL, Neighbors C. A randomized controlled trial of a web-based, personalized normative feedback alcohol intervention for young-adult veterans. *J Consult Clin Psychol*. 2017;85:459–70.
 62. Mulla MM, Witte TH, Richardson K, Hart W, Kassing FL, Coffey CA, et al. The causal influence of perceived social norms on intimate partner violence perpetration: converging cross-sectional, longitudinal, and experimental support for a social disinhibition model. *Pers Soc Psychol Bull*. 2018;45:652–68.
 63. Davey-Rothwell MA, Latkin CA, Tobin KE. Longitudinal analysis of the relationship between perceived norms and sharing injection paraphernalia. *AIDS Behav*. 2010;14:878–84.
 64. Miller DT, Prentice DA. Changing norms to change behavior. *Annu Rev Psychol*. 2016;67:339–61.
 65. Tankard ME, Paluck EL. Norm perception as a vehicle for social change. *Social Issues and Policy Review*. 2016;10:181–211.

66. Dempsey RC, McAlaney J, Bewick BM. A critical appraisal of the social norms approach as an interventional strategy for health-related behavior and attitude change. *Front Psychol*. 2018;9:2180.
67. Burchell K, Rettie R, Patel K. Marketing social norms: social marketing and the 'social norm approach'. *Journal of Consumer Behaviour*. 2013;12:1–9.
68. Sunstein CR. Nudging: a very short guide. *J Consum Policy*. 2014;37:583–8.
69. Carey KB, Scott-Sheldon LAJ, Carey MP, Cain D, Mlobeli R, Vermaak R, et al. Community norms for HIV risk behaviors among men in a South African township. *J Behav Med*. 2011;34:32–40.
70. Mulawa M, Yamanis TJ, Balvanz P, Kajula LJ, Maman S. Comparing perceptions with actual reports of close friend's HIV testing behavior among urban Tanzanian men. *AIDS Behav*. 2016;20:2014–22.
71. Eggers SM, Mathews C, Aarø LE, McClinton-Appollis T, Bos AER, de Vries H. Predicting primary and secondary abstinence among adolescent boys and girls in the Western Cape, South Africa. *AIDS Behav*. 2017;21:1417–28.
72. Hill LM, Moody J, Gottfredson NC, Kajula LJ, Pence BW, Go VF, et al. Peer norms moderate the association between mental health and sexual risk behaviors among young men living in Dar es Salaam, Tanzania. *Soc Sci Med*. 2018;196:77–85.
73. Bova CS, Halse SJ, Aswani S, Potts WM. Assessing a social norms approach for improving recreational fisheries compliance. *Fisheries Management Ecology*. 2017;24:117–25.
74. Blair G, Littman R, Paluck EL. Motivating the adoption of new community-minded behaviors: an empirical test in Nigeria. *Sci Adv*. 2019;5:eaa5175.
75. Paluck EL, Green DP. Deference, dissent, and dispute resolution: an experimental intervention using mass media to change norms and behavior in Rwanda. *Am Polit Sci Rev*. 2009;103:622–44.
76. Paluck EL. Reducing intergroup prejudice and conflict using the media: a field experiment in Rwanda. *J Pers Soc Psychol*. 2009;96:574.
77. Green DP, Wilke A, Cooper J. Countering violence against women at scale: a mass media experiment in rural Uganda. 2019. <https://www.poverty-action.org/sites/default/files/publications/GreenWilkeCooper2019.pdf>. Accessed 1 Apr 2019.
78. PMI. Protecting Ugandans from Malaria: Universal ITN Coverage Campaign. 2015. <https://www.pmi.gov/news/stories-from-the-field/stories-from-the-field—detail/protecting-ugandans-from-malaria-universal-itn-coverage-campaign>. Accessed 1 Apr 2019.
79. Statistics UBo, International I. Uganda Malaria Indicator Survey 2014–15. Kampala, Uganda, and Rockville, Maryland, USA: UBOS and ICF International 2015. <https://dhsprogram.com/pubs/pdf/mis21/mis21.pdf>. Accessed 15 Oct 2018.
80. Atieli HE, Zhou G, Afrane Y, Lee M-C, Mwanzo I, Githeko AK, et al. Insecticide-treated net (ITN) ownership, usage, and malaria transmission in the highlands of western Kenya. *Parasit Vectors*. 2011;4:113.
81. Macintyre K, Littrell M, Keating J, Hamainza B, Miller J, Eisele TP. Determinants of hanging and use of ITNs in the context of near universal coverage in Zambia. *Health Policy Plan*. 2011;27:316–25.
82. Batisso E, Habte T, Tesfaye G, Getachew D, Tekalegne A, Kilian A, et al. A stitch in time: a cross-sectional survey looking at long lasting insecticide-treated bed net ownership, utilization and attrition in SNNPR, Ethiopia. *Malar J*. 2012;11:183.
83. Graves PM, Ngondi JM, Hwang J, Getachew A, Gebre T, Mosher AW, et al. Factors associated with mosquito net use by individuals in households owning nets in Ethiopia. *Malar J*. 2011;10:354.
84. Storey JD, Babalola SO, Ricotta EE, Fox KA, Toso M, Lewicky N, et al. Associations between ideational variables and bed net use in Madagascar, Mali, and Nigeria. *BMC Public Health*. 2018;18:484.
85. Perkins HW, Meilman PW, Leichter JS, Cashin JR, Presley CA. Misperceptions of the norms for the frequency of alcohol and other drug use on college campuses. *J Am Coll Health*. 1999;47:253–8.
86. Macintyre K, Keating J, Okbaldt YB, Zerom M, Sosler S, Ghebremeskel T, et al. Rolling out insecticide treated nets in Eritrea: examining the determinants of possession and use in malarious zones during the rainy season. *Trop Med Int Health*. 2006;11:824–33.
87. Noor AM, Amin AA, Akhwale WS, Snow RW. Increasing coverage and decreasing inequity in insecticide-treated bed net use among rural Kenyan children. *PLoS Med*. 2007;4:e255.
88. Noor AM, Omumbo JA, Amin AA, Zurovac D, Snow RW. Wealth, mother's education and physical access as determinants of retail sector net use in rural Kenya. *Malar J*. 2006;5:5.
89. Garcia-Basteiro AL, Schwabe C, Aragon C, Baltazar G, Rehman AM, Matias A, et al. Determinants of bed net use in children under five and household bed net ownership on Bioko Island, Equatorial Guinea. *Malar J*. 2011;10:179.
90. Agyepong IA, Manderson L. Mosquito avoidance and bed net use in the greater Accra region, Ghana. *J Biosoc Sci*. 1999;31:79–92.
91. Krezanoski PJ, Comfort AB, Tsai AC, Bangsberg DR. Households with young children and use of freely distributed bednets in rural Madagascar. *Int Health*. 2014;6:29–34.
92. Ricotta E, Oppong S, Yukich JO, Briët OJT. Determinants of bed net use conditional on access in population surveys in Ghana. *Malar J*. 2019;18:63.
93. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. *Demography*. 2001;38:115–32.
94. Lally P, Bartle N, Wardle J. Social norms and diet in adolescents. *Appetite*. 2011;57:623–7.
95. Perkins JM, Perkins HW, Craig DW. Misperceptions of peer norms as a risk factor for sugar-sweetened beverage consumption among secondary school students. *J Am Diet Assoc*. 2010;110:1916–21.
96. Perkins JM, Perkins HW, Craig DW. Misperceived norms and personal sugar-sweetened beverage consumption and fruit and vegetable intake among students in the United States. *Appetite*. 2018;129:82–93.
97. Litt DM, Lewis MA, Rhew IC, Hodge KA, Kaysen DL. Reciprocal relationships over time between descriptive norms and alcohol use in young adult sexual minority women. *Psychol Addict Behav*. 2015;29:885–93.
98. Schultz PW. Changing behavior with normative feedback interventions: a field experiment on curbside recycling. *Basic Appl Soc Psych*. 1999;21:25–36.
99. Belay M, Dereessa W. Use of insecticide treated nets by pregnant women and associated factors in a pre-dominantly rural population in northern Ethiopia. *Trop Med Int Health*. 2008;13:1303–13.
100. Bernard J, Mtove G, Mandike R, Mtei F, Maxwell C, Reyburn H. Equity and coverage of insecticide-treated bed nets in an area of intense transmission of *Plasmodium falciparum* in Tanzania. *Malar J*. 2009;8:65.
101. Krezanoski PJ, Santorino D, Nambogo N, Campbell JI, Bangsberg DR. Maternal attitudes about objectively monitored bednet use in rural Uganda. *Malar Res Treat*. 2016. <https://doi.org/10.1155/2016/8727131>.
102. Birhanu Z, Abebe L, Sudhakar M, Dissanayake G, Yihdego Y, Alemayehu G, et al. Access to and use gaps of insecticide-treated nets among communities in Jimma Zone, southwestern Ethiopia: baseline results from malaria education interventions. *BMC Publ Health*. 2015;15:1304.
103. Nuwaha F. Factors influencing the use of bed nets in Mbarara municipality of Uganda. *Am J Trop Med Hyg*. 2001;65:877–82.
104. Kanyangarara M, Hamapumbu H, Mamin E, Lupiya J, Stevenson JC, Mharakurwa S, et al. Malaria knowledge and bed net use in three transmission settings in southern Africa. *Malar J*. 2018;17:41.
105. Cislighi B, Heise L. Theory and practice of social norms interventions: eight common pitfalls. *Global Health*. 2018;14:83.
106. Haines MP, Perkins HW, Rice RM, Barker G. A guide to marketing social norms for health promotion in schools and communities: National Social Norms Resource Center East Lansing; 2005.
107. Berkowitz AD. An overview of the social norms approach. Changing the culture of college drinking: a socially situated health communication campaign. New York: Hampton Press; 2005. p. 193–214.
108. Hummer JF, Davison GC. Examining the role of source credibility and reference group proximity on personalized normative feedback interventions for college student alcohol use: a randomized laboratory experiment. *Subst Use Misuse*. 2016. p. 1–15.
109. Perkins H, Craig DW. A multifaceted social norms approach to reduce high-risk drinking: lessons from Hobart and William Smith Colleges. Newton: The Higher Education Center for Alcohol and Other Drug Prevention and the U.S. Department of Education; 2002.
110. Koenker H, Keating J, Alilio M, Acosta A, Lynch M, Nafo-Traore F. Strategic roles for behaviour change communication in a changing malaria landscape. *Malar J*. 2014;13:1.

111. Ganz G, Neville FG, Ward CL. Applying behavioural science to issues of public health in South Africa: the case for social norms intervention. *South Afr J Sci*. 2017;113:1–5.
112. Cislighi B, Heise L. Using social norms theory for health promotion in low-income countries. *Health Promot Int*. 2018. <https://doi.org/10.1093/heapro/day017>.
113. McAlaney J, Bewick B, Hughes C. The international development of the 'Social Norms' approach to drug education and prevention. *Drugs*. 2011;18:81–9.
114. Krezanoski PJ, Bangsberg DR, Tsai AC. Quantifying bias in measuring insecticide-treated bednet use: meta-analysis of self-reported vs objectively measured adherence. *J Global Health*. 2018;8:010411.
115. Shibutani T. Reference groups as perspectives. *Am J Sociol*. 1955;60:562–9.
116. Larimer ME, Neighbors C, LaBrie JW, Atkins DC, Lewis MA, Lee CM, et al. Descriptive drinking norms: for whom does reference group matter? *J Stud Alcohol Drugs*. 2011;72:833–43.
117. Lewis MA, Neighbors C. Gender-specific misperceptions of college student drinking norms. *Psychol Addict Behav*. 2004;18:334–9.
118. Dams-O'Connor K, Martin JL, Martens MP. Social norms and alcohol consumption among intercollegiate athletes: the role of athlete and nonathlete reference groups. *Addict Behav*. 2007;32:2657–66.
119. Ernst KC, Ery S, Adusei C, Bell ML, Kessie DK, Biritwum-Nyarko A, et al. Reported bed net ownership and use in social contacts is associated with uptake of bed nets for malaria prevention in pregnant women in Ghana. *Malar J*. 2017;16:13.
120. Lerman K, Yan X, Wu X-Z. The "Majority Illusion" in social networks. *PLoS ONE*. 2016;11:e0147617.
121. Harvey SA, Lam Y, Martin NA, Olórtegui MP. Multiple entries and exits and other complex human patterns of insecticide-treated net use: a possible contributor to residual malaria transmission? *Malar J*. 2017;16:265.
122. Monroe A, Moore S, Koenker H, Lynch M, Ricotta E. Measuring and characterizing night time human behaviour as it relates to residual malaria transmission in sub-Saharan Africa: a review of the published literature. *Malar J*. 2019;18:6.
123. Reno RR, Cialdini RB, Kallgren CA. The transsituational influence of social norms. *J Pers Soc Psychol*. 1993;64:104.

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