ORIGINAL RESEARCH ARTICLE

General hygiene, sexual risk behaviour and HIV prevalence in truck drivers from Andhra Pradesh, South India: implications for prevention interventions

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Summary: The relationships between hygiene, sexual behaviour and HIV infection are poorly understood. We examine these relationships in Indian truck drivers, a group at high risk for HIV infection. Truck drivers ($n = 189$) were recruited into an integrated HIV and hygiene Information Motivation (IM) programme. Sociodemographic characteristics, sexual and hygiene behaviour and HIV prevalence were determined. Multivariate logistic regression and linear generalized estimating equation models were utilized. At baseline, 2.1% of drivers were HIV infected and 34% who reported having contact with female sex workers (FSWs) had contact within the previous six months. Those who washed their hands postdefecation were less likely to report genital symptoms (OR 0.02; $P = 0.01$) and have sex with an FSW (OR [odds ratio] 0.21; $P = 0.05$). After an IM intervention, there were no changes in sexual risk-taking behaviour (coefficient -0.15 to -0.02; $P = 0.13–0.75$); however, hygiene behaviour improved from baseline (coefficient 0.09–0.31; $P < 0.01$ to $P = 0.03$). Personal hygiene habits, like handwashing, seem to be a modifiable behaviour after a modest intervention, whereas HIV risk-taking behaviour was not. The association between hygiene and HIV risk-taking suggests the need for further evaluation of the relationship and that of other hygiene practices in high-risk men in India.

Keywords: HIV, hygiene, prevention intervention, truck drivers, India

INTRODUCTION

It is estimated that there are approximately five million truck drivers on the roads in India.[1] All research studies examining HIV or sexually transmitted infection (STI) prevalence of truck drivers in India have been cross-sectional in nature.[2–4] Several unpublished reports of truck drivers sampled from roadside stop areas and trucker unions suggest an HIV prevalence of 4–11%,[5,6] 11–31 times higher than the HIV prevalence in the general Indian adult population.[7,8] Sentinel surveillance conducted by the high HIV burden Indian State of Andhra Pradesh[9] (population 83 million) has included all the subpopulations thought to be at high risk for HIV and STIs, but has not included truck drivers,[10] although preliminary data suggest that they are at increased risk for HIV and other STIs.[11] Thus, there is need for increased efforts to maintain and create novel HIV prevention programmes that are specific for this mobile population.[12] One recent study examined truck drivers' sexual behaviour over time as part of an Information Motivation Behavioural change intervention with only modest benefit recorded by self-report, and participants were not tested for HIV.[13]

There is increased interest in examining the relationship between general hygiene and HIV or other STIs in high-risk subpopulations.[14–18] For example, bathing, frequency of changing underwear and number of individuals sharing a bathroom, have suggested associations with prevalent HIV infection[15]; however, this particular analysis did not control for other important covariates such as concurrent sexual partnering or use of condoms. There is also some evidence of an association between penile hygiene and HIV infection[19] and other STIs.[20–22] Causality has yet to be determined; however, results from circumcision studies confirm that the absence of foreskin and thus the subpreputial space decreases the risk of HIV acquisition.[23–25] Moreover, while there have been several studies demonstrating mixed associations of both general and vaginal hygiene and BV,[26–28] HIV[29–31] and other STIs,[32] there have been no studies to date on the relationship between general hygiene and HIV risk-taking behavior. Additionally,

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most studies suggest that a relationship between STI acquisition and penile hygiene has not taken into account the potential relationship between hygiene behaviours and other high-risk behaviours.[15,22] We sought to determine the relationship between general hygiene and HIV risk-taking behaviour in truck drivers and the potential effect of an Information Motivation (IM) intervention on these behaviours. If a strong relationship is found between these behaviours, hygiene interventions could potentially serve as new HIV bio-behavioural prevention interventions or as adjuncts to current behavioural interventions. If a link between hygiene and HIV risk-taking behaviours or HIV infection is not found, general hygiene remains an important prevention measure[33] for opportunistic[34–36] and non-opportunistic[37–39] infectious diseases in high-risk populations in India, where the vast majority who are infected are unaware of their HIV status.

METHODS

Study population and site

Truck drivers recruited into the study were at least 18 years in age, fluent Hindi or Telugu speakers and employed or contracted by Gati Limited, one of the largest transport companies in India.[40] Truck drivers were recruited by study staff directly from Gati's main depot centre in Bowenpally, just outside of Hyderabad, the capital of Andhra Pradesh.

A physician and three counsellors with 10 years experience working with high-risk populations and HIV in this region were provided by the partnering International Center for Human Health Advancement (ICHHA). Prior to initiation of the study, all staff received extensive training over five days for standardization of the IM component. This included didactics on HIV and hygiene information and counselling protocols, as well as role-playing among counsellors and truck driver volunteers. Protocols were approved by the Institutional Review Boards at MediCiti Hospital, The Miriam Hospital and the University of Chicago.

Procedures

All study visits included a structured interviewer administered quantitative survey, followed by a 60 minute IM component, HIV pretest counselling, a physical exam and blood draw. After subjects met inclusion criteria and were consented, they were brought to the sound-proof, private counselling room located on the Gati premises. The survey and intervention were conducted there by the counsellor, and physical exam and blood draw in another area of the compound by the physician. All participants were tested for HIV-1 and HIV-2 using three sequential ELISAs (Genscreen HIV 1/2, Bio-Rad; Detect HIV, Adaltis; HIV Tri-Dot, Biotech Inc.) in accordance with national guidelines. Any study participants found to be HIV infected during or after the study period were offered treatment and follow-up by ICHHA, including antiretrovirals if indicated, with costs covered by Gati Limited and other private donors.

Participants were instructed by study staff to return for two additional study visits, one six months after the baseline visit and one six months after the second visit for a total of three study visits. In order to simulate potential application of future sustainable workplace HIV and hygiene prevention programmes in this setting, passive follow-up was conducted. There was neither active outreach nor a reminder given by staff other than for subjects who returned to the clinic area for other unrelated study concerns. Monetary reward for participation was not offered as part of this study. Because of high attrition for the second and third follow-up visits, company docking records were reviewed to examine concordance between clinic hours and docking schedules. Additionally, company and truck vendor employee rosters were reviewed by study staff to determine truck driver turnover among full-time and contracted drivers at the beginning and end of the recruitment period.

Survey

The survey instrument was based on HIV risk factor surveys used by our group previously[41] and was utilized primarily to assess changes in HIV risk-taking behaviour and hygiene practices. The majority of behavioural outcome items included responses 'yes', 'no' and 'unknown' to account for cross-cultural differences in subjective responses to larger Likert type scales.[42] Areas covered included sociodemographics, sexual behaviour and partnering patterns, HIV and STI transmission knowledge and assessment of personal hygiene practices. Personal hygiene practices included evaluation of washing hands and foods prior to consumption, washing hands postdefecation, assessment of frequently used potable water sources and type of toilet used and accessibility to it.

Intervention

From 2005 to 2007, a once-a-week workplace intervention was established at the Gati Limited truck depot outside of Hyderabad. The intervention incorporated information and motivation theory components from the Information-Motivation-Behavioural Skills approach to HIV prevention[43] to provide a uniquely integrative HIV and hygiene behavioural intervention. The information component of the intervention included an introduction to germ theory principles, setting the stage for hygiene and HIV transmission teaching. General hygiene information included discussion of five behavioural areas: cross-contamination, personal hygiene, household hygiene, temperature control and control of unsafe foods.[44] These were discussed within the infectious disease context of communicable disease prevention through sanitary practices. HIV information included previously tested HIV transmission and prevention teachings and materials used in previous studies in rural parts of the state.[41] Examining individual perceptions of risk and dispelling potential false assertions about risk and transmission were also a part of this exercise. Counsellors were trained specifically to integrate HIV prevention and hygiene improvement teaching, but were, however, also instructed to emphasize that HIV transmission cannot be prevented solely by improvements in general hygiene.

The semistructured motivation component of the intervention included individualized counselling on current HIV risk-taking behaviours, potential HIV preventive practices and exploring mechanisms to improve hygiene behaviours. This component was based upon the Theory for Reasoned Action.[45] Motivational counselling utilized subjects' personal examples as well as hypothetical decisions made by peers to explore attitudes, prevention norms and locus of control. Examples included exploring potential methods of preventing

HIV transmission to one's wife and children, and assuring hands are clean before ingestion of food in order to prevent missed days at work due to illness.

Analyses

The final analytical sample included all recruited males who reported having had sex at least once and who had complete data on all hygiene, outcome and control variables ($n = 189$). All statistical analyses were performed using STATA version 8.0 (StataSoft Corp., Austen, TX, USA). For all statistical tests, variables were considered significant at the $P < 0.05$ level.

Multivariate logistic regression models were utilized to predict determinants of each hygiene behaviour. Both bivariate and multivariate associations between hygiene behaviour variables and sexual behaviour outcomes were examined. Multivariate logistic regressions were performed with the hygiene behaviour of interest on each sexual behaviour outcome, controlling for age, income, marital status, number of children, urban residence, education, time spent away from home, other sexual behaviours and HIV knowledge.

Longitudinal analyses were conducted to evaluate the effects of the intervention during the first clinic visit on subsequent personal hygiene behaviour and sexual behaviour outcomes on the subset of individuals with follow-up visit data. Mean sample values were compared from the first visit to those from the second visit using *t*-tests. Linear probability models were generated using generalized estimating equations that captured data from all available follow-up visits. These multivariate models assessed the effect of visit number on outcome variables, while controlling for age, education, number of children and time away from home in the past year.

RESULTS

Baseline characteristics

Of the 235 truck drivers recruited into the study, 189 reported having sex at least once and had complete data on the HIV behavioural and hygiene variables, as well as control variables. Table 1 presents baseline sociodemographic characteristics for the analytical sample. With regards to HIV risk factors, 29.1% of truck drivers reported having sex with a commercial sex worker in their lifetime with nearly a third of those (11.1% of total sample) having sex with a commercial sex worker within the last six months. About 59.1% of men who had visited a female sex worker (FSW) reported 'always' using a condom with commercial sex workers in the past six months. At baseline, 2.1% of the sample was found to be HIV-infected, with 3.2% reporting a previous STI diagnosis and 8.5% reporting genital symptoms (burning urination, genital discharge, or genital ulcers/sores) in the past 12 months. Personal hygiene characteristics were generally reported at high levels among the population with 93.1% of the sample reporting washing of hands prior to eating, 94.7% reporting washing vegetables prior to consumption and 96.3% reporting washing hands postdefecation. These three variables were moderately correlated with one another (Crohnbach's $\alpha = 0.47$) and made into a scale to measure general hygiene.

Table 1 **Participant baseline characteristics ($n = 189$)**

	Mean	Standard deviation	Percent
Demographic characteristics			
Current age (years)	31.2	6.4	
Number of children	1.5	1.4	
Income (hundreds of rupees/ month)	36.8 ($88)	15.6 ($37)	
Currently married			87.3
Residential location			
Village/rural area			49.2
Education			
Incomplete primary or none			14.3
Complete primary			16.4
Complete secondary			62.4
Postsecondary			6.9
Time spent away from home in past year			
None			49.2
Less than 1 month			37.0
Between 1 and 6 months			2.6
More than 6 months			11.1
Sexual behaviour			
Number of partners in past 12 months	1.5	2.1	
Ever visited a female sex worker			29.1
Visited a female sex worker in the past 6 months			11.6
Used a condom at last sex with regular partner: all men			19.1
Used a condom at last sex with regular partner: married men			10.9
Used a condom at last sex with regular partner: unmarried men			75.0
Engaged in sex with a male partner in the past 6 months			0.5
Alcohol use			
Daily/more than twice weekly			43.4
Health and hygiene behaviour			
Washes fruits and vegetables prior to consumption			94.7
Washes hands before eating or preparing food			93.1
Washes hands after defecation			96.3
Has heard of 'germ theory'			6.3
Boils water before drinking			1.1
Health outcomes			
HIV-positive			2.1
Reports previous STI diagnosis			3.2
Any genital symptoms in the past 12 months (burning, discharge, ulceration)			8.5
			8.5

STI = sexually transmitted infections

Hygiene predictors and association of hygiene with HIV risk

Baseline subject characteristics associated with general hygiene can be found in Table 2. Truck drivers with lower income were less likely to wash hands prior to cooking (OR 0.97; $P = 0.04$) and postdefecation (OR 0.94; $P = 0.01$); however, this relationship was not found between income and washing vegetables before eating (OR 0.97; $P = 0.31$). Truck drivers who were married, however, were more likely to wash vegetables before eating (OR 11.8; $P = 0.02$) when compared with unmarried truck drivers. At baseline, truck drivers whose primary residence was in an urban area were more likely to wash vegetables before eating (OR 14.6; $P = 0.02$) and more likely to have heard of the germ theory (OR 15.15; $P = 0.01$) but demonstrated no difference in washing of hands prior to eating or

Table 2 **Predictors of hygiene variables*** ($n = 189$)

	Washes hands before cooking			Washes hands postdefecation			Washes fruits/vegetables before eating			Has heard of germ theory		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Demographic characteristics												
Current age (years)	1.00	0.88–1.14	0.94	1.19	0.89–1.59	0.23	1.04	0.89–1.21	0.60	1.01	0.89–1.15	0.84
Income (100s of rupees/month)	0.97	0.94–1.00	0.04	0.94	0.90–0.98	0.01	0.97	0.92–1.02	0.21	0.97	0.93–1.02	0.31
Currently married	1.74	0.31–9.83	0.53	2.56	0.30–21.69	0.39	11.78	1.61–86.38	0.01	1.56	0.21–11.37	0.66
Number of children	1.18	0.62–2.22	0.62	1.23	0.42–3.61	0.71	0.58	0.30–1.16	0.10	0.54	0.27–1.04	0.07
Residential location												
Urban residence	0.49	0.13–1.84	0.13	1.02	0.17–6.11	0.99	14.63	1.54–138.7	0.02	15.15	1.82–125.9	0.01
Education												
Education level (ordinal)	0.91	0.53–1.54	0.53	1.11	0.46–2.65	0.82	0.78	0.37–1.64	0.51	1.32	0.65–2.68	0.44
Time spent away from home in the past year												
Time away from home (ordinal)	0.64	0.38–1.09	0.38	1.25	0.48–3.22	0.65	0.84	0.37–1.90	0.68	0.55	0.21–1.43	0.22
Alcohol use												
frequent alcohol use	0.80	0.23–2.76	0.23	2.80	0.41–19.38	0.30	2.13	0.45–10.14	0.34	1.12	0.31–4.08	0.87
HIV knowledge												
HIV knowledge count	0.96	0.79–1.17	0.68	0.93	0.69–1.26	0.66	0.94	0.75–1.16	0.55	1.14	0.92–1.42	0.24

*Adjusted odds ratios; OR = odds ratios; CI = confidence interval

postdefecation. There was no relationship between education or HIV knowledge and general hygiene behaviour.

In bivariate analyses, multiple hygiene variables were associated with either HIV infection or HIV risk behaviour (Table 3). The hygiene variables that were associated with sexual risk-taking or HIV infection consistently demonstrated a relationship in the same direction: better hygiene related to decreased risk behaviour or correlates with HIV infection. In multivariate regression analysis, after adjusting for covariates significant at the 10% level in bivariate analysis, washing hands postdefecation was significantly associated only with reporting one of four genital symptoms (OR 0.02; $P = 0.01$). Washing vegetables before eating was also negatively associated with ever having sex with an FSW (OR 0.21; $P = 0.05$).

Loss to follow-up

During the two-year study period, there were 92 half-days of clinic operation. High attrition was seen at the second follow-up visit, as only 22 of the 143 sexually active subjects eligible for follow-up actually reported for the second study visit (15.4%). A comparison of the truck drivers who were lost to follow-up to those who presented for the second study visit did not demonstrate any differences in HIV risk-taking behaviour, genitourinary symptoms or time away from home. However, those who did not follow-up were more likely to have a lower monthly income (Rs. 3600 vs. Rs. 4100; $P = 0.04$). Review of company records comparing truck number to date of docking at the centre demonstrated that 17.3% of the truck/truck driver pairs did not dock 0–2 days before clinic operation over the two-year period. Additionally, 46% of drivers initially enrolled in the study were no longer employed by the company or the vendors contracted by the company at the end of the study period. The majority of the drivers in this category, 38% of the total, were drivers working for vendors who held contracts with the company.

Hygiene and HIV risk behaviour over time

There were no incident HIV infections over the follow-up period (Table 4). Additionally, there was no change in correlates of HIV risk behaviour when compared with baseline for report of genital symptoms, FSW in the last six months, condom use and number of sex partners in the last six months (coefficient -0.15 to -0.02; $P = 0.13$–0.75). This negative finding is in contrast to the significant changes in hygiene practices over time. All individual and scale level hygiene measurements demonstrated improvement from baseline (coefficient 0.09–0.31; $P < 0.01$ to $P = 0.03$).

DISCUSSION

This study was unique in examining sexual behaviour in high-risk Indian men in the context of other hygienic practices. The use of a workplace prevention intervention, a focus on hand and food washing hygiene as opposed to penile hygiene and longitudinal follow-up of this mobile population were distinguishing features of this study. There were multiple inverse associations between washing-related hygiene behaviours and risk practices increasing the likelihood of HIV infection, with two correlates of HIV infection – STI symptoms, and contact with FSW, remaining significant after multivariate analyses. Finally, an integrated HIV and hygiene IM intervention resulted in improvement in personal hygiene behaviour, but no changes in HIV risk-taking behaviour.

The finding that a one or two session information and motivation session did little to alter HIV risk-taking behaviour is consistent with previous findings.[13] Cognitive interventions have not been successful in some other at-risk male populations.[46] Behavioural interventions based on information and motivation may need multiple sessions over time to have an impact,[47] which may not be feasible or cost-effective in areas with limited resources or with highly mobile populations, and may not be robust in a population where unprotected sex is the norm, and awareness of HIV risk is low. Behavioural interventions, however, might be designed to address the role of alcohol use and sexual risk-taking among truckers, given the frequency of use.[48] Additionally, our findings that changes in behaviour related to hygiene may be affected after a one or two session IM programme could be useful if hygiene, and perhaps genital hygiene behaviour, is found to be related to risk of HIV infection. Our future work will attempt to develop skills building and other culturally appropriate interventions for this population.

Table 3 **Relationship between hygiene and outcome variables**[*†]

	HIV-positive						STI symptoms						FSW ever						FSW in the past 6 months					
	Bivariate				Multivariate		Bivariate				Multivariate		Bivariate				Multivariate		Bivariate				Multivariate	
	Mean for negative outcome	Mean for positive outcome	*t*-Statistics[‡]	*P*	OR	*P*	Mean for negative outcome	Mean for positive outcome	*t*-Statistics	*P*	OR	*P*	Mean for negative outcome	Mean for positive outcome	*t* statistics	*P*	OR	*P*	Mean for negative outcome	Mean for positive outcome	*t*-Statistics	*P*	OR	*P*
Hygiene variable																								
Washes hands before eating	0.93	1.00	0.55	0.58	n/a	n/a	0.95	0.69	4.19	<0.01	0.41	0.39	0.95	0.87	2.05	0.04	0.38	0.15	0.95	0.82	2.25	0.03	0.38	0.24
Washes hands post defecation	0.97	0.75	2.29	0.02	0.18	0.19	0.98	0.75	4.99	<0.01	0.02	0.01	0.98	0.91	2.54	0.01	0.21	0.12	0.96	0.95	0.22	0.82	1.69	0.66
Washes fruits/ vegetables before eating	0.95	0.75	1.78	0.08	0.28	0.32	0.95	0.88	1.34	0.18	0.59	0.79	0.98	0.87	2.98	<0.01	0.21	0.05	0.96	0.86	1.87	0.06	0.32	0.23
Has heard of germ theory	0.06	0.25	1.55	0.12	4.99	0.20	0.06	0.06	0.02	0.99	1.01	0.99	0.06	0.07	0.33	0.74	1.39	0.65	0.07	0.05	0.37	0.71	0.23	0.24
Hygiene count	2.85	2.50	1.48	0.14	0.87	0.85	2.89	2.31	5.01	<0.01	0.44	0.20	2.92	2.65	3.62	<0.01	0.52	0.09	2.87	2.64	2.21	0.03	0.53	0.13
	Used condom with regular partner						**Always uses condoms with FSWs**[§]						**Multiple sex partners**											
Hygiene variable																								
Washes hands before eating	0.95	0.83	2.61	0.01	0.30	0.14	0.89	0.77	0.69	0.50	0.42	0.48	0.94	0.86	1.60	0.11	1.39	0.76						
Washes hands post defecation	0.98	0.89	2.65	0.01	0.35	0.26	1.00	0.93	0.82	0.42	n/a	n/a	0.97	0.90	2.07	0.04	0.39	0.368						
Washes fruits/ vegetables before eating	0.97	0.86	2.59	0.01	0.42	0.33	0.89	0.85	0.27	0.79	0.69	0.78	0.97	0.83	3.19	<0.01	0.33	0.224						
Has heard of germ theory	0.07	0.06	0.21	0.83	0.28	0.27	0.00	0.08	0.82	0.42	n/a	n/a	0.06	0.07	0.13	0.90	1.08	0.943						
Hygiene count	2.90	2.58	3.80	0.00	0.50	0.10	2.78	2.54	0.75	0.46	0.74	0.63	2.89	2.59	3.27	<0.01	0.67	0.38						

[*]All first visits
[†]$n = 189$
[‡]All *t*-Statistics are absolute
[§]$n = 22$ for this outcome
STI = sexually transmitted infections; FSW = female sex workers

Table 4 **Comparison of HIV risk factors, knowledge and hygiene at follow-up visits compared with baseline ($n = 50$)**

	Bivariate		Multivariate*	
Outcome	**Coefficient**	***P***	**Coefficient**	***P***
Risk factor				
HIV-positive	n/a	n/a	n/a	n/a
Any genital symptoms	−0.03	0.32	−0.05	0.13
FSW visit in last 6 months†	−0.04	0.52	−0.06	0.34
Used condom with last partner†	−0.02	0.77	−0.02	0.75
Number of partners‡	−0.15	0.75	−0.27	0.58
Percent answering question correctly				
Prevent HIV transmission by using a condom?	0.17	0.03	0.19	0.03
HIV be transmitted by sharing food?	0.11	0.16	0.11	0.20
HIV be transmitted by shaking hands?	0.06	0.56	0.08	0.45
HIV be transmitted via injections?	0.04	0.48	0.06	0.35
HIV be transmitted via blood transfusions?	0.10	0.14	0.12	0.11
Protect against HIV transmission by having only one sex partner?	0.13	0.09	0.15	0.07
Healthy-looking person have HIV?	−0.13	0.09	−0.11	0.18
Cure for HIV?	0.21	0.04	0.19	0.07
Pregnant women transmit HIV to their babies?	0.18	0.01	0.18	0.02
Total HIV knowledge count	0.81	0.09	0.87	0.10
Hygiene				
Washes hands before eating	0.09	0.07	0.11	0.03
Washes hands postdefecation	0.06	0.14	0.09	0.03
Washes fruits/vegetables before eating	0.06	0.14	0.10	0.01
Heard of 'germ theory'	0.19	0.02	0.21	0.02
Hygiene count	0.21	0.01	0.30	<0.01

Positive correlation designates positive association between variable of interest and follow-up visit
*This model controls for age, education, number of children and time away from home
†$n = 49$
‡$n = 48$
FSW = female sex workers

More information is needed on what the specific hygiene practices and behaviours are that men at risk for HIV infection practice, although some prior associations between penile hygiene practices and HIV infection have been documented.[15,22] A study in Kisumu, Kenya reported a large protective effect against genital ulcer disease in those who cleansed the penis less than one hour after intercourse. The analytical model, however, did not control for high-risk sexual behaviour that might have confounded the relationship and affected the outcome.[22] For postcoital cleansing (one component of hygiene), the timing, type of cleansing, high variability of cleansing traits and substance used to clean are all poorly understood in this and other populations of uncircumcised men.[49] Surprisingly, there have been no studies of improving precoital genital hygiene and the effect of HIV infection. Determining whether viral or other unmeasured bacterial pathogens decrease the level of barrier protection in the foreskin, or perhaps increased inflammation from bacterial overgrowth allows for additional targets for HIV would be needed to develop a potential biological prevention product.

A question that remains is whether improved hygiene behaviour is causally related to decreases in HIV or STIs, or whether these behaviours are a more proximate measure of HIV/STI infection and are in fact related to other HIV risk-taking behaviours. A biologically plausible explanation can certainly be made for the relationship of penile hygiene and HIV or STI acquisition. However, it is difficult to explain this type of causality in the relationship between washing hands and HIV or STI acquisition. Washing hands, especially postdefecation, may be associated with other hygiene behaviours such as bathing or washing in the subpreputial area, which have been shown to be associated with less risk of HIV infection; however, this potential relationship was not explored as part of this study. It is also possible that these practices are associated with other HIV preventive practices that are also hygienic, such as avoiding FSWs, using condoms and avoiding multiple partners.

A major limitation of this study was the high loss to follow-up of truck drivers and limits the interpretation of the IM intervention. We determined that poor follow-up was primarily due to changes in employer and lack of congruency between delivery and clinic times. Despite this, there were no major differences between the participants that followed up with those that did not. Newer methods currently used for retention of this highly mobile population, such as cell phone contact and counselling, monthly meetings with lorry associations and coordination with other truck driver service providers in the state, were not used at the time of this study. Additionally, testing for STIs in this population may have been a more useful outcome measure given the lower than expected prevalence of HIV infection found in this study. A population-based study in a district in the state where this study was conducted demonstrated HSV-2 and *Treponema pallidum* seroprevalence rates of 8.2% and 7.3%, respectively, among truck drivers (Lalit Dandona, personal communication).

Overall, these study results (1) add to the growing evidence of a potential relationship in the chain between hygiene behaviour and HIV or STI prevalence and (2) suggest that hygiene behaviour may be modifiable to a greater extent than sexual risk-taking behaviour. The potential ease in modifying hygiene behaviours compared with sexual behaviour, the potential difficulties implementing circumcision as an HIV prevention strategy in India and the potential for improvements in hygiene to help with preventing other communicable diseases in those who are HIV infected make an integrated hygiene programme a potential prevention intervention worthy of future investigation.

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REFERENCES

1 Steinbrook R. HIV in India – a complex epidemic. *N Engl J Med* 2007;**356**: 1089–93
2 Gawande AV, Vasudeo ND, Zodpey SP, Khandait DW. Sexually transmitted infections in long distance truck drivers. *J Commun Dis* 2000;**32**:212–5

3 Singh YN, Malaviya AN. Long distance truck drivers in India: HIV infection and their possible role in disseminating HIV into rural areas. *Int J STD AIDS* 1994;**5**:137–8
4 Manjunath JV, Thappa DM, Jaisankar TJ. Sexually transmitted diseases and sexual lifestyles of long-distance truck drivers: a clinico-epidemiologic study in south India. *Int J STD AIDS* 2002;**13**:612–7
5 Family Health International/Development Fund for International Development. Prevalence of sexually transmitted infections and HIV among long distance inter-city truck drivers and helpers of eastern India: impact assessment for HIV/STI prevention programmes. 2000. See [http://www.fhi.org/NR/rdonlyres/e3qubwscviczjtqqnsjcjpok43cui5ggz2ov3a3o2wplgq45zusqlm7r3c43pylbzrtluf7qd6fftn/HighwayEastern.pdf] (last checked 9 April 2007)
6 Family Health International/Development Fund for International Development. Prevalence of sexually transmitted infections and HIV among long distance inter-city truck drivers and helpers of northern India: impact assessment for HIV/STI prevention programmes. 2000. See [http://www.fhi.org/NR/rdonlyres/epyfmkvc5ppf5tzy4s7m4ddynf7w4mzkujegzd4hvckjtidvdofvbu6qiih2y7kkwxjjifw2ht7rbl/PrevalenceofSexuallyTransm.pdf] (last checked 12 April 2007)
7 *2.5 Million People Living with HIV in India.* Geneva: UNAIDS, 2007. See [http://www.unaids.org.in/new/displaymore.asp?subitemkey=669&itemid=466&subchnm=&subchkey=0&chname=Events] (last checked 21 September 2007)
8 *Statement on HIV Prevalence Estimates in India. Geneva.* Geneva: UNAIDS, 2007. See [http://www.unaids.org.in/new/EventsAndActivities_2-5MillionPeopleInIndiaLivingWithHIV_Statement.pdf] (last checked 21 September 2007)
9 Steinbrook R. HIV in India–a downsized epidemic. *N Engl J Med* 2008;**358**:107–9
10 *HIV/AIDS Epidemiological Surveillance & Estimation Report for the Year 2005*. New Delhi: Ministry of Health and Family Welfare, Government of India, 2006. See [http://www.nacoonline.org/fnlapil06rprt.pdf]
11 Chandrasekaran P, Dallabetta G, Loo V, Rao S, Gayle H, Alexander A. Containing HIV/AIDS in India: the unfinished agenda. *Lancet Infect Dis* 2006;**6**:508–21
12 Schneider JA. Novel HIV prevention strategies: the case for Andhra Pradesh. *Ind J Med Microbiol* 2008;**26**:1–4
13 Cornman DH, Schmiege SJ, Bryan A, Joseph Benziger T, Fisher JD. An information-motivation-behavioral skills (IMB) model-based HIV prevention intervention for truck drivers in India. *Soc Sci Med* 2007;**64**:1572–84
14 O'Farrell N. Soap and water prophylaxis for limiting genital ulcer disease and HIV-1 infection in men in sub-Saharan Africa. *Genitourin Med* 1993;**69**:297–300
15 Meier AS, Bukusi EA, Cohen CR, Holmes KK. Independent association of hygiene, socioeconomic status, and circumcision with reduced risk of HIV infection among Kenyan men. *J Acquir Immune Defic Syndr* 2006;**43**:117–8
16 Steele MS, Bukusi E, Cohen CR, Shell-Duncan BA, Holmes KK. Male genital hygiene beliefs and practices in Nairobi, Kenya. *Sex Transm Infect* 2004;**80**:471–6
17 Short RV. New ways of preventing HIV infection: thinking simply, simply thinking. *Phil Trans R Soc Lond B Biol Sci* 2006;**361**:811–20
18 Short RV. The HIV/AIDS pandemic: new ways of preventing infection in men. *Reprod Fertil Dev* 2004;**16**:555–9
19 O'Farrell N, Morison L, Moodley P, *et al.* Association between HIV and subpreputial penile wetness in uncircumcised men in South Africa. *J Acquir Immune Defic Syndr* 2006;**43**:69–77
20 O'Farrell N, Quigley M, Fox P. Association between the intact foreskin and inferior standards of male genital hygiene behaviour: a cross-sectional study. *Int J STD AIDS* 2005;**16**:556–9
21 van De Wijgert JH, Mason PR, Gwanzura L, *et al.* Intravaginal practices, vaginal flora disturbances, and acquisition of sexually transmitted diseases in Zimbabwean women. *J Infect Dis* 2000;**181**:587–94
22 Mehta SD, Moses S, Ndinya-Achola JO, Agot K, Maclean I, Bailey RC. Identification of novel risks for nonulcerative sexually transmitted infections among young men in Kisumu, Kenya. *Sex Transm Dis* 2007;**34**:892–9
23 Auvert B, Taljaard D, Lagarde E, Sobngwi-Tambekou J, Sitta R, Puren A. Randomized, controlled intervention trial of male circumcision for reduction of HIV infection risk: the ANRS 1265 Trial. *PLoS Med* 2005;**2**:e298
24 Bailey RC, Moses S, Parker CB, *et al.* Male circumcision for HIV prevention in young men in Kisumu, Kenya: a randomised controlled trial. *Lancet* 2007;**369**:643–56
25 Gray RH, Kigozi G, Serwadda D, *et al.* Male circumcision for HIV prevention in men in Rakai, Uganda: a randomised trial. *Lancet* 2007;**369**:657–66
26 Hassan WM, Lavreys L, Chohan V, *et al.* Associations between intravaginal practices and bacterial vaginosis in Kenyan female sex workers without symptoms of vaginal infections. *Sex Transm Dis* 2007;**34**:384–8
27 Bukusi EA, Cohen CR, Meier AS, *et al.* Bacterial vaginosis: risk factors among Kenyan women and their male partners. *Sex Transm Dis* 2006;**33**:361–7
28 Demba E, Morison L, van der Loeff MS, *et al.* Bacterial vaginosis, vaginal flora patterns and vaginal hygiene practices in patients presenting with vaginal discharge syndrome in The Gambia, West Africa. *BMC Infect Dis* 2005;**5**:12
29 Myer L, Denny L, De Souza M, Barone MA, Wright TC Jr, Kuhn L. Intravaginal practices, HIV and other sexually transmitted diseases among South African women. *Sex Transm Dis* 2004;**31**:174–9
30 Myer L, Kuhn L, Stein ZA, Wright TC Jr, Denny L. Intravaginal practices, bacterial vaginosis, and women's susceptibility to HIV infection: epidemiological evidence and biological mechanisms. *Lancet Infect Dis* 2005;**5**:786–94
31 Myer L, Denny L, de Souza M, Wright TC Jr, Kuhn L. Distinguishing the temporal association between women's intravaginal practices and risk of human immunodeficiency virus infection: a prospective study of South African women. *Am J Epidemiol* 2006;**163**:552–60
32 Reed BD, Ford K, Wirawan DN. The Bali STD/AIDS study: association between vaginal hygiene practices and STDs among sex workers. *Sex Transm Infect* 2001;**77**:46–52
33 Potgieter N, Koekemoer R, Jagals P. A pilot assessment of water, sanitation, hygiene and home-based care services for people living with HIV/AIDS in rural and peri-urban communities in South Africa. *Water Sci Technol* 2007;**56**:125–31
34 Dwivedi KK, Prasad G, Saini S, Mahajan S, Lal S, Baveja UK. Enteric opportunistic parasites among HIV infected individuals: associated risk factors and immune status. *Jpn J Infect Dis* 2007;**60**:76–81
35 Heathcock R, McLauchlin J, Newton LH, *et al.* Survey of food safety awareness among HIV positive individuals. *AIDS Care* 1998;**10**:237–41
36 Bryan RT. Microsporidiosis as an AIDS-related opportunistic infection. *Clin Infect Dis* 1995;**21**:S62–65
37 Lule JR, Mermin J, Ekwaru JP, *et al.* Effect of home-based water chlorination and safe storage on diarrhea among persons with human immunodeficiency virus in Uganda. *Am J Trop Med Hyg* 2005;**73**:926–33
38 Biswas D, Hazarika NC, Hazarika D, Mahanta J. Prevalence of communicable disease among restaurant workers along a highway in Assam, India. *Southeast Asian J Trop Med Public Health* 1999;**30**:539–41
39 Angulo FJ, Swerdlow DL. Bacterial enteric infections in persons infected with human immunodeficiency virus. *Clin Infect Dis* 1995;**21**:S84–93
40 http://www.gati.com/ (last checked 6 February 2008)
41 Schneider JA, Saluja GS, Oruganti G, *et al.* HIV infection dynamics in rural Andhra Pradesh south India: A sexual-network analysis exploratory study. *AIDS Care* 2007;**19**:1171–6
42 Heine SJLD, Peng K, Greenholtz. What's wrong with cross cultural comparisons of subjective Likert scales? *J Person Social Psychol* 2002;**82**:903–18
43 Fisher J, Fisher WA. In: *Emerging Theories in Health Promotion Practice and Research: Strategies for Improving Public Health*. San Francisco, CA: Jossey Bass Publishers, 2002
44 Leite LH, Waissmann W, Veggi AB. Reliability of a questionnaire to assess food safety knowledge, perceptions, and practices among outpatients with human immunodeficiency virus. *Cad Saude Publica* 2007;**23**:971–6
45 Hale JL, Householder BJ, Greene KL. The theory of reasoned action. In: Dillard JP, Pfau M, eds. *The persuation handbook: Developments in theory and practice*. Thousand Oaks, CA, Sage, 2003:259–86
46 Koblin B, Chesney M, Coates T. Effects of a behavioural intervention to reduce acquisition of HIV infection among men who have sex with men: the EXPLORE randomised controlled study. *Lancet* 2004;**364**:41–50
47 Institute of Medicine. In: Ruiz MS, Gable AB, Kaplan EH, Stoto MA, Fineberg HV, Trussell J, eds. *No Time to Lose: Getting More from HIV Prevention*. Washington, DC: National Academy Press, 2001
48 Sivaram S, Johnson S, Bentley ME, *et al.* Exploring "wine shops" as a venue for HIV prevention interventions in urban India. *J Urban Health* 2007;**84**:563–76
49 Makumbi F, Gray RH, Wawer M, *et al.* Male postcoital penile cleansing and the risk of HIV-acquisition in uncircumised men, Rakai district, Uganda. Paper presented at Fourth IAS Conference on HIV Pathogenesis, Treatment and Prevention, Sydney, 2007

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