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Evaluation of health education interventions on Chinese factory workers' knowledge, practices, and behaviors related to infectious disease

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ABSTRACT

Background: Workplaces are a common location for infectious disease transmission among adults. To provide recommendations regarding appropriate health promotion programs, we evaluated the impact of three different interventions on factory workers.
Methods: In a prospective intervention study carried out from October 2012 to June 2013, three factories were selected and each was assigned a different intervention method (i.e. self-study group, manager training group and interactional group discussion group). Participants were scored on their knowledge, behavior, and hygienic practices related to infectious disease prevention both before and after the intervention.
Results: A total of 1154 participants completed the survey before the intervention and 1111 completed the survey after. The sum infectious disease knowledge score in the manager training group was higher after the intervention (9.09/12) than before (8.63/12, $t = 4.47$, $p < 0.05$). There was no significant difference in sum infectious disease knowledge score pre and post intervention for both the self-study group and the interactional group discussion.
Conclusions: Overall, change in health behaviors and hygiene practices were not as affected compared to changes in knowledge after interventions related to infectious disease health promotion. Training managers who then interact with workers may be an effective and efficient way of educating workers on health issues.

Introduction

Adults spend a large proportion of their life within workplaces [1]: approximately 19–25% of human-to-human contacts for an adult are within the workplace, and 34% of these contacts involve some form of physical interaction [2]. Given this close and often regular contact with other individuals, employees can be exposed to respiratory and gastrointestinal infections through a variety of mechanisms including through infected colleagues coughing, sneezing, and touching fomites [3]. As a result, infectious diseases can be seamlessly transmitted from cases to susceptible individuals within the workplace [4]. Preventing the transmission of disease within workplaces benefits employees' health; infectious diseases like influenza and diarrhea are the some of the main causes of illness and absenteeism among workers [5–7]. In summary, reduced transmission of infectious agents can promote productivity and reduce economic costs within the workplace [8,9].

Globally, many workplaces seek to improve healthy behaviors among workers, although many of these efforts have primarily targeted cardiovascular disease and other chronic diseases through programs that promote healthy eating and reduce physical inactivity [1]. Many studies evaluating health education interventions about infectious diseases have been carried out in schools [10,11]. Studies have also evaluated hand hygiene programs [12,13], influenza policies [2], and vaccine promotion programs [14], but less is known about the effectiveness of a comprehensive program

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targeting a range of infectious diseases, even though certain behaviors (hand washing, staying home when sick, knowing when to see a doctor) can prevent transmission of a wide range of diseases transmitted through a range of modalities.

Additionally, workplaces represent an important setting for health interventions because a large number of outbreaks, including of diarrhea and influenza, have recently been reported in these locations [15–17]. Knowledge of infectious diseases and personal hygiene practices could improve the health of workers and assist with control of such outbreaks. Work sites are an important venue for efforts to reduce the impact of infectious diseases through health promotion, which can influence the health-related knowledge and behaviors of large numbers of people [18]. Most workplaces have the infrastructure for providing training to their workforce, and they often have the financial incentive – through reducing absenteeism – to do so. However, there is controversy on how to best implement educational programs.

Traditionally, population-level interventions targeting health education are carried out through activities such as providing promotional materials and posters, organizing lectures, and instituting training. Understanding what types of activities are most likely to lead to better hygienic behaviors among workers can lead to the development of effective health promotion protocols within workplaces. In this study, we tested three different health interventions in workplace sites comprising self-study, manager training, and interactional group discussion. Self-study is a traditional health education method. However, previous research has shown that supervisors in the workplace can play a significant role in health promotion among their subordinates [19–21]. Workplace leaders' support has demonstrated beneficial effects on worker health [22–24]. This results from health-promoting educational interventions being followed more closely by workers and by generating greater worker motivation when supervisors worked with them [25,26]. Interactional group discussion is a new form of health intervention involving an expert facilitator leading worker discussions on the topic of interest. This methodology has been used in studies of psychotherapeutic technique and prescribing behavior [27]. In this study, we applied three different health education intervention on factory workers in Tianjin China, and we examined how well they improved knowledge and self-reported behaviors and hygienic practices in order to assess the most appropriate health education method for use in workplaces.

Materials and methods

Population and sampling

This was a prospective intervention study comparing different health education methods. This study was conducted over a 9-month period from October 2012 to June 2013.

Three of the 19 factories within the Port Free Trade Zone of Tianjin, China, were randomly selected and assigned to one of the intervention groups. The self-study group was located at an electric circuits company which had 890 workers, the manager training group was at a dairy producer which had 1171 workers, and the interactional group discussion occurred at a automotive patterns company which had 1182 workers. Workers present at work on the day of recruitment were chosen by convenience sample in each factory at the end of a work day, and were enrolled after obtaining written informed consent for the self-study group and the interactional group discussion. For the manager training group, all 20 managers at the diary producer received training on infectious diseases every three months and were required to train other workers in their department at the end of a work day.

The sample size was established based on a pilot study among workers in one of selected three factories. In a questionnaire with 12 questions about knowledge of infectious diseases (the same set of questions was later used in the main study), prevalence of infectious disease knowledge before an intervention was found to be about 75% among the tested workers. The following equation was used, assuming an allowable error of 4.5% and a level of significance $\alpha = 0.05$:

$$n = \mu_\alpha{}^2 \times \pi \times (1 - \pi) / \delta^2$$

n is the sample size, $\mu_\alpha = 1.96$, $\pi = 0.75$, $\delta = 0.7 \times 0.045 = 0.0315$.

Four hundred workers were required for each intervention group. Allowing for 2.5% non-response, the number of workers needed in each group was 410. In total, the target sample size across the three intervention groups was 1230 participants.

In the final analysis, we used a t-test for summary scores. A post-hoc power calculation revealed that, at a significance level of $\alpha = 0.05$ and with a two-sided test, a sample size of 410 would have 81.6% power to detect a hypothetical, small effect size (of 0.2).

Questionnaire design

A questionnaire was structured with three sections: infectious disease knowledge, personal hygienic practices and health protection behaviors among participants. The same questionnaire was administered to each participant in face-to-face interviews by Tianjin CDC staff at the start of the study and after a 9-month interval in which 3 rounds of the same intervention were carried out in each of the three sites.

Summary scores were created for each domain (infectious disease knowledge, behavior, and hygiene practices). For the sections on knowledge related to infectious diseases and health protection behavior, each correct response was given a score of one. The total maximum score was 12 for the knowledge section, and 15 for the health behavior section. For the section on personal hygiene practices, some items asked about positive behaviors (like washing hands before eating) and some items asked about negative behaviors (like eating foods with dirty hands). For the positive behaviors, the responses were coded as 1 for "never," 2 for "sometimes," and 3 for "every time." For the negative behaviors, the responses were coded as 3 for "never," 2 for "sometimes," and 1 for "often." The maximum total score in the personal hygiene section was 24.

A pilot study was carried out in one of the selected factories to validate the questionnaire. The Cronbach's α was 0.8319, indicating high reliability in a test-retest. And the Kappa statistic of the questionnaire items was 0.7 or higher. In a confirmatory factor analysis, the items loaded onto three constructs which were consistent with the three parts to the structured questionnaire (Kaiser-Meyer-Olkin Measure = 0.746, $P < 0.05$).

Intervention activities

The research team consisted of seven health educators, who were trained on the objectives of the study, the health education interventions to be used, questionnaire administration, and field monitoring to ensure the quality of the interventions. The same information on infectious diseases was transcribed into the formats for the three interventions (a pamphlet, electronic presentation slides, or discussion topics).

Over the 9-month study period, interventions were delivered 3 times at 3-month intervals. In the self-study group, 410 workers in the first factory were asked to learn about the prevention of infectious diseases on their own; different pamphlets related to infectious diseases were distributed to these workers every three months. The researchers did not offer any other health education.

Table 1
Distribution of sociodemographic characteristics of respondents in three intervention groups, Tianjin, China, 2012–13.

	Manager training group				Self-study group				Interactional group discussion			
	Pre (n = 363)	Post (n = 362)	χ^2	*P*	Pre (n = 406)	Post (n = 339)	χ^2	*P*	Pre (n = 385)	Post (n = 410)	χ^2	*P*
Sex			0.01	0.91			0.21	0.64			0.06	0.80
Male	180 (50%)	181 (50%)			257 (63%)	209 (62%)			294 (76%)	310 (76%)		
Female	183 (50%)	181 (50%)			149 (37%)	130 (38%)			91 (24%)	100 (24%)		
Age			3.91	0.05			0.10	0.32			0.30	0.59
≤29 years	263 (73%)	273 (75%)			319 (79%)	255 (75%)			262 (68%)	275 (67%)		
30–39 years	50 (14%)	65 (18%)			61 (15%)	59 (17%)			46 (12%)	44 (11%)		
≥40 years	49 (14%)	24 (7%)			26 (6%)	25 (7%)			77 (20%)	91 (22%)		
Education			7.34	0.06			0.96	0.81			4.28	0.23
≤Primary school	14 (4%)	8 (2%)			9 (2%)	9 (3%)			19 (5%)	27 (7%)		
Middle school	56 (15%)	36 (10%)			109 (27%)	84 (25%)			42 (11%)	57 (14%)		
Vocational	50 (14%)	60 (17%)			194 (48%)	159 (47%)			43 (11%)	54 (13%)		
College	243 (67%)	258 (71%)			94 (23%)	87 (26%)			281 (73%)	272 (66%)		

In the manager training group, managers in the second factory received training on infectious diseases every three months consisting of 1-h lectures. The managers were required to train 410 workers after each lecture by means of email or 1-h lecture, as decided by the factory management.

In the interactional group discussion, 10 health educators sat together with the 410 workers in the third factory, and discussed some topics about infectious diseases, once every three months. The workers were encouraged to ask questions about the chosen topics, and health educators gave explanations as necessary.

Data analysis

The data were entered into Epidata, and analyzed using the Statistical Package for Social Sciences Software (SPSS 19.0). Differences in sociodemographic characteristics, and changes in the proportion of behaviors from before an intervention to after, were tested with a chi squared test. The Kruskal Wallis test was used to examine differences before and after the intervention for personal hygiene practices. A Student's t-test was used to compare the differences of knowledge scores and behavior scores before and after the intervention. We did not collect personally identifiable information and so were unable to link participants before and after the intervention and use a paired t-test, potentially overstating the significance of our results.

Ethical approval

The study was approved by Ethical Committee of Tianjin Centers for Disease Control and Prevention. The workers who participated in this study gave written informed consent.

Results

We attempted to reach 410 individuals in each of the 3 intervention arms, for a total sample size of 1230. A total of 1154 participants completed the survey before the intervention for a response rate of 94%: 363 people in the manager training group (47 refused), 406 in the self-study group (4 refused), and 385 in the interactional group discussion (25 refused). After the intervention, a total of 1111 workers were surveyed: 362 in the manager training group, 339 in the self-study group, and 410 in the interactional group discussion. Table 1 shows the socio demographic characteristics of the participants before and after intervention. The age, sex and education levels of the participants before and after the intervention for all three groups had no statistically significant differences.

Change in knowledge about infectious diseases

Table 2 shows the changes in the participants' infectious diseases knowledge. Before the intervention, a majority of individuals were able to name three kinds of common infectious diseases, knew that diarrhea had high incidence in summer, were aware that eradicating household pests could prevent infectious disease, knew that washing hands could prevent intestinal diseases, knew about hepatitis B vaccination, and knew that vaccines could prevent infectious diseases. However, fewer participants knew that influenza could be spread through the respiratory tract (14% in manager training group) and that humans cannot get rabies by washing a wound (7%). After the intervention in the manager training group, there was a statistically significant increase in the proportion of individuals who were aware of 4 items: knowing three kinds of common infectious diseases, knowing diarrhea has high incidence in summer, knowing that eradicating household pests can prevent infectious disease, and knowing vaccination is the best method to prevent hepatitis B. The mean score of infectious disease knowledge increased from 8.63 items correct to 9.09 items correct before and after the intervention in the manager training group. There was no significant increase in the proportion of individuals who answered an item correctly or in overall knowledge score in the self-study group. In the interactional group discussion, significantly more individuals knew that humans will not get rabies from washing a dog bite wound after the intervention, but the overall knowledge score did not significantly change.

Changes in personal hygiene practices

Table 3 shows changes in personal hygiene practices after the interventions. Overall, before the intervention, instances of washing hands was reported to be high. For instance, in the manager training group, 90% reported washing hands after work, 94% after using the toilet, and 85% before eating. Prevalence of unhealthy behaviors was low—16% ate food with dirty hands often, 28% rubbed eyes often, 17% drank unboiled water often, 19% ate raw cold food often, and 8% spit often. In the manager training group, there was a significant improvement in the proportion of individuals reporting washing hands before eating and a decrease in the proportion of individuals eating food with dirty hands. Otherwise, we did not observe a statistically significant change in the proportion of other individual hygiene practices or in overall score after the intervention.

Changes in self-protective behavior

The proportion of individuals engaging in healthy behaviors was relatively high, but greater for respiratory illness than enteric

Table 2
Change in knowledge about infectious diseases after an intervention, Tianjin, China, 2012–13.

	Manager training group		Self-study group		Interactional group discussion	
	Pre (n = 363)	Post (n = 362)	Pre (n = 406)	Post (n = 339)	Pre (n = 385)	Post (n = 410)
Know three kinds of common infectious disease	276 (76%)	307 (85%)[a]	398 (98%)	335 (99%)	290 (75%)	317 (77%)
All infectious diseases are spread by humans	83 (23%)	65 (18%)	47 (12%)	38 (11%)	58 (15%)	81 (20%)
Diarrhea has high incidence in summer	263 (72%)	311 (86%)[a]	322 (79%)	275 (81%)	284 (74%)	323 (79%)
Eradicating household pests can prevent infectious disease	339 (93%)	350 (97%)[a]	395 (97%)	333 (96%)	354 (92%)	389 (95%)
Influenza means a cold	90 (25%)	67 (19%)	59 (14%)	46 (14%)	99 (26%)	108 (26%)
Washing hands can prevent intestinal disease	322 (89%)	336 (93%)	382 (94%)	321 (95%)	335 (87%)	369 (90%)
Influenza is spread by respiratory tract	49 (14%)	57 (16%)	19 (5%)	14 (4%)	51 (13%)	61 (15%)
Humans will not get rabies from washing a dog bite wound	25 (7%)	25 (7%)	5 (1%)	3 (1%)	34 (8%)	57 (14%)[a]
Bacillary dysentery is transmitted through fecal-oral route	178 (49%)	204 (56%)	195 (48%)	152 (45%)	238 (62%)	236 (57%)
Vaccination is the best method to prevent hepatitis B	260 (72%)	295 (81%)[a]	304 (75%)	258 (76%)	275 (71%)	300 (73%)
Vaccination can prevent infectious disease	338 (93%)	344 (95%)	398 (98%)	332 (98%)	359 (93%)	369 (90%)
Mice can spread epidemic hemorrhagic fever	151 (42%)	133 (37%)	141 (35%)	123 (36%)	17 (30%)	137 (33%)
Sum infectious disease knowledge score (mean)	8.63	9.09[b]	9.02	9.06	8.55	8.54

[a] Difference between pre and post test is $P < 0.05$ from χ^2 test.
[b] Difference between pre and post test is $P < 0.05$ from a Student's t-test.

Table 3
Changes in personnel hygiene practices after an intervention, Tianjin, China, 2012–13.

		Manager training group		Self-study group		Interactional group discussion	
		Pre (n = 363)	Post (n = 362)	Pre (n = 406)	Post (n = 339)	Pre (n = 385)	Post (n = 410)
Wash hands after work	Every time	328 (90%)	335 (93%)	336 (83%)	282 (83%)	329 (86%)	352 (86%)
	Sometimes	33 (9%)	26 (7%)	70 (17%)	57 (17%)	51 (13%)	52 (13%)
	Never	2 (1%)	1 (0%)	0	0	5 (1%)	6 (1%)
Wash hands after toilet	Every time	342 (94%)	349 (96%)	392 (97%)	330 (97%)	360 (93.5%)	379 (92.4%)
	Sometimes	20 (6%)	12 (3%)	14 (3%)	9 (3%)	22 (5.7%)	27 (6.6%)
	Never	1 (0%)	1 (0%)	0	0	3 (0.8%)	4 (1.0%)
Wash hands before eating	Every time	309 (85%)	327 (90%)[a]	376 (93%)	313 (92%)	319 (83%)	349 (85%)
	Sometimes	52 (14%)	33 (9%)	29 (7%)	25 (7%)	59 (15%)	52 (13%)
	Never	2 (1%)	2 (1%)	1 (0%)	1 (0%)	7 (2%)	9 (2%)
Eat food with dirty hands	Often	59 (16%)	38 (11%)[a]	18 (4%)	17 (5%)	60 (16%)	70 (17%)
	Sometimes	168 (46%)	174 (48%)	198 (49%)	154 (45%)	210 (54%)	198 (48%)
	Never	136 (38%)	150 (41%)	190 (47%)	168 (50%)	115 (30%)	142 (35%)
Rub eyes	Often	103 (28%)	88 (24%)	89 (22%)	68 (20%)	113 (29%)	113 (28%)
	Sometimes	193 (53%)	216 (60%)	238 (59%)	201 (59%)	206 (54%)	201 (49%)
	Never	67 (19%)	58 (16%)	79 (19%)	70 (21%)	66 (17%)	96 (23%)
Drink unboiled water	Often	61 (17%)	54 (15%)	69 (23%)	59 (17%)	72 (19%)	87 (21%)
	Sometimes	130 (36%)	120 (33%)	122 (40%)	88 (26%)	140 (36%)	129 (32%)
	Never	172 (47%)	188 (52%)	215 (70%)	192 (57%)	173 (45%)	194 (47%)
Eat raw cold food	Often	69 (19%)	68 (19%)	53 (13%)	42 (12%)	75 (19%)	99 (24%)
	Sometimes	212 (58%)	218 (60%)	238 (59%)	191 (56%)	245 (64%)	236 (58%)
	Never	82 (23%)	76 (21%)	115 (28%)	106 (31%)	65 (17%)	75 (18%)
Spit	Often	28 (8%)	18 (5%)	5 (1%)	4 (1%)	34 (9%)	41 (10%)
	Sometimes	67 (18%)	68 (19%)	87 (22%)	69 (20%)	124 (32%)	135 (33%)
	Never	328 (90%)	335 (93%)	336 (83%)	282 (83%)	329 (86%)	352 (86%)
Sum personal hygiene score (mean)		19.80	20.11	20.39	20.53	19.34	19.40

[a] Difference between pre and post test is $P < 0.05$ from Kruskal–Wallis test.

illness (Table 4). For instance, the vast majority of participants avoided close contact with colleagues who had respiratory illness (82% in the manager training group), but only about half (53% in manager training group) did for colleagues who had enteric illness. Most individuals stated they would stay at home with a respiratory illness (79%) or a enteric illness (82%). In the manager training group, after the intervention there was a significant increase in the number of people who would wear a mask (65%–74%) and open windows (95%–98%), and there was an increase from 53% to 61% in the proportion of individuals who would avoid close contact with a colleague who had an enteric illness. There was also an increase from 85% to 92% in the proportion of individuals who would decrease activities in public places if they themselves had a respiratory illness. There was not a significant increase in the prevalence of stated behaviors after the self-study group or interactional group discussion. Additionally, overall behavior scores did not change before and after the intervention for any intervention group.

Discussion

Workplaces are a common location for adults to have physical contact with other persons and have a potential for exposure to infectious diseases. Workplace health education intervention programs to reduce infectious disease risk have the potential to improve health status and alter behaviors among factory employees [28]. It is yet undetermined which approach is most effective for successful health education in infectious diseases and personal hygiene practices, particularly in the context of the workplace [29]. Our study evaluated the change in knowledge and behavior with three different intervention methods.

Scores in the manager training group improved more often than in any other intervention group. This suggests that providing supervisors with infectious diseases knowledge as was done in the manager training group would be an effective means of improving infectious diseases-related health among factory workers. Previous studies showed that supervisors have a positive effect for promoting mental health [30,31]. No study had previously used

Table 4
Change in behaviors after an intervention, Tianjin, China, 2012-13.

	Manager training group		Self-study group		Interactional group discussion	
	Pre (n = 363)	Post (n = 362)	Pre (n = 406)	Post (n = 339)	Pre (n = 385)	Post (n = 410)
If colleague has respiratory illness						
Avoid close contact	296 (82%)	313 (86%)	334 (82%)	283 (83%)	305 (79%)	325 (79%)
Wear a mask	236 (65%)	269 (74%)[a]	203 (50%)	178 (53%)	234 (61%)	269 (66%)
Avoid contact with polluted places	239 (66%)	246 (68%)	237 (58%)	205 (60%)	238 (62%)	275 (67%)
Wash hands after contact	338 (93%)	344 (95%)	371 (91%)	320 (94%)	340 (88%)	369 (90%)
Open windows	343 (95%)	355 (98%)[a]	379 (93%)	317 (94%)	359 (93%)	379 (92%)
If colleague has enteric illness						
Avoid close contact	193 (53%)	222 (61%)[a]	185 (46%)	167 (49%)	202 (52%)	230 (56%)
Avoid contact with polluted places	214 (59%)	220 (61%)	208 (51%)	184 (54%)	222 (58%)	242 (59%)
Wash hands after contact	289 (80%)	303 (84%)	294 (72%)	248 (73%)	268 (70%)	288 (70%)
If oneself has respiratory illness						
Stay at home	288 (79%)	295 (81%)	331 (82%)	277 (82%)	295 (77%)	330 (80%)
Wear a mask	261 (72%)	276 (76%)	229 (56%)	198 (58%)	253 (66%)	286 (70%)
Decrease activities in public places	307 (85%)	334 (92%)[a]	367 (90%)	310 (91%)	337 (88%)	359 (88%)
Visit doctor in a timely manner	333 (92%)	337 (93%)	372 (92%)	309 (91%)	328 (85%)	351 (86%)
If oneself has enteric illness						
Stay at home	296 (82%)	300 (83%)	327 (81%)	277 (82%)	299 (78%)	334 (81%)
Decrease activities in public places	296 (82%)	306 (85%)	349 (86%)	296 (87%)	322 (84%)	342 (83%)
Visit doctor in a timely manner	327 (90%)	339 (94%)	364 (90%)	304 (90%)	331 (86%)	353 (86%)
Sum behavior score (mean)	11.90	12.14	11.21	11.42	11.25	11.54

[a] Difference between pre and post test is $P < 0.05$ from χ^2 test.

this approach in infectious diseases. This study first educated the supervisors, who then trained the workers, thus improving the infectious diseases knowledge among workers. This effect results from the key role supervisors play within their factory [32]: workers more readily accept infectious diseases knowledge from their managers. However, the behavior change in personal hygiene practices seemed ineffective in the manager training group. It has appeared more difficult to change the actual behavioral even though the knowledge was improved after the intervention. We note that employees may be more receptive to educational information directly from their manager because of the established relationship between both parties.

The group of participants in the manager training group had some socioeconomic differences from the other groups. For one, there was a higher proportion of college-educated participants in this group than in the other groups. Health promotion activities typically are more effective in individuals with a higher socioeconomic status, especially if these health interventions rely on voluntary behavioral change [33], such as in this study. In contrast, long-lasting change, regardless of socioeconomic gradient, follows regulatory changes or the use of incentives [33]. Therefore, although it is difficult for us to dissociate socioeconomic status from the success of different intervention strategies in this study, we suggest that health promotion activities in occupational settings be used in combination with development of employee regulations, for instance in formulating guidelines for employees reporting to work while sick.

Additionally, participants in the manager training group could have received information by written email or oral communication in a lecture. An oral lecture involves the opportunity for attendees to actively ask questions and receive verbal responses to their own and others' questions, and it also represent a delivery modality where managers can more easily insure that workers are in attendance. Active worker engagement and attendance are harder to measure when relying solely on written emails, and the effectiveness of email is heavily dependent on the manner in which the health promotion material is presented. Health literacy – "the accessing, understanding, and use of information to make health decisions" [34] – can be related to an individual's educational background and their past experiences in the medical world [34]. Therefore, the potential impact of email-based interventions is affected by the socioeconomic characteristics of the target audience which must then be weighed against the greater costs of in-person lectures which typically take up more time for both managers and workers. Future studies should evaluate the cost-effectiveness of one strategy over the other.

The study also showed that the knowledge and behavior scores did not change among individuals with the interactional group discussion. Interactional group discussion has been used in studies on psychotherapeutic technique [35,36], on the use of injections [27], and on sanitation use [29], but it had not been previously used to alter personal hygiene practices. This study showed that the method was not effective in the field of infectious diseases, even though other studies proved the approach can change behavior [27]. While one-to-one intervention was carried out in those earlier studies, in our study the intervention was conducted on larger groups of participants. This suggests that the method of interactional group discussion may be more effective among smaller groups of individuals, although fewer health educators per employee can increase the cost of this intervention substantially.

The workers in the self-study group were given leaflets, which is a traditional method of health education [37]. The self-study group showed no evidence of any change in knowledge or behavior in this study. This may have resulted from reluctance on the part of the workers to read the pamphlets, or a lack of time to carefully assimilate the information. Numerous factors can influence the effectiveness of health education [38].

Strengths and limitations

There are several strengths and limitations to this study. The three factor sites had employees with different socioeconomic characteristics (including age, sex, and education level), which could possibly influence baseline knowledge, behavior, and hygiene practices, and which could influence their receptivity to learning. Although the three sites had their intervention randomly selected, we were unable to eliminate confounding by these characteristics within our analysis. Future studies within a socioeconomically homogeneous workforce could test the effectiveness of different interventions to eliminate this source of bias. By sampling three factories, we were able to obtains more diverse grouping of participants, although certain cultural factors may limit the gen-

eralizability of these findings beyond China. Although this study examined self-reported hygienic practices, future studies should also examine actual behavioral changes in the workplaces (for instance, hand washing before or after eating or the prevalence of presenteeism—the situation where a sick individual will still come into work).

Conclusions

The study used three different methods to intervene on the knowledge and hygiene practices related to infectious diseases among factory workers. The results showed that manager training had the best intervention efficacy in knowledge of infectious diseases, compared to self-study and interactional group discussion. However, there were no changes in practices related to infectious diseases. The manager training method may be used in the health education of workers in the future instead of traditional methods.

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Competing interests

None declared.

Ethical approval

Not required.

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