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Reducing risk factors in the workplace in low and middle-income countries

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Abstract

Objective

To reduce risk factors in workplace settings in low and middle-income countries

Design

Workplace interventions were utilized as part of the Community Interventions for Health (CIH) program, a non-randomised, controlled study undertaken in three communities in China, India and Mexico.

Sample

45 industrial, 82 health and 101 school workplace settings with a target population of 15,726. Two independent cross-sectional surveys of workers were conducted at baseline and follow-up, after 18-24 months of intervention activities.

Intervention

Culturally appropriate interventions to reduce tobacco use, increase physical activity and improve dietary intake were delivered in the intervention areas.

Results

12,136 adults completed surveys at baseline, and 9,786 at follow-up. In the intervention group, the prevalence of tobacco use reduced significantly in men (-6.0%, $p<0.001$) and the proportion eating five portions of fruit and vegetables daily increased (+6.9%, $p<0.001$) compared with the control group. There were no significant differences between the groups for changes in physical activity or prevalence of overweight.

Conclusions

Workplace interventions improved risk factors in China, India and Mexico.

Keywords

Non-communicable disease, workplace, community interventions, tobacco, physical activity, diet, obesity

Background

Cardiovascular disease, type 2 diabetes, chronic obstructive pulmonary disease and cancer, collectively known as non-communicable disease (NCD) are leading causes of mortality, causing almost two thirds of deaths worldwide (Lozano et al., 2012). Although these are commonly thought of as diseases of high income countries, four fifths of deaths caused by NCD occur in low and middle income countries (LMIC) (World Health Organisation, 2011). These premature deaths are preventable in almost one third of cases (World Health Organisation, 2011).

Workplace interventions targeting the three modifiable risk factors of tobacco use, physical inactivity and unhealthy diet can reduce the impact of non-communicable disease amongst those of working age, and can offer health promotion to those who have limited contact with health services outside the workplace. However, the majority of published evidence for the efficacy of workplace interventions comes from higher income countries, with very few studies from LMIC.

Tobacco cessation in the workplace

The evidence for tobacco reduction is mixed, with some studies showing that smoke-free policies in the workplace are linked with higher rates of smoking cessation, decreased second hand smoke (SHS), and a reduction in the number of cigarettes smoked by current smokers (Mozaffarian et al., 2012). Conversely, some studies (Baker et al., 2008; Cancelliere, Cassidy, Ammendolia, & Cote, 2011) and a systematic review have reported a lack of evidence for comprehensive attempts to reduce smoking in the workplace(Cahill & Lancaster, 2014), and that there is no evidence incentives and rewards are successful in reducing smoking in the workplace (Cahill & Perera, 2011). However, the most recent report (to the California legislature) states there is "clear and convincing" evidence that work-based wellness programs increase smoking cessation (California Health Benefits Review Program, 2013).

Smoking bans reduce exposure to SHS (Polanska, Hanke, & Konieczko, 2011a, 2011b), , and legislative smoking bans are particularly effective (Callinan, Clarke, Doherty, & Kelleher, 2010). Tobacco advertising increases the likelihood that young people will start smoking (Lovato, Watts, & Stead, 2011) and mass media can prevent the uptake of smoking (Brinn, Carson, Esterman, Chang, & Smith, 2010), showing that the media can be used for both positive and negative effects on smoking. Comprehensive multi-component methods to implement banning smoking are more effective than less comprehensive ones - such as posted warning and educational material (Serra, Bonfill, Pladevall, & Cabezas, 2008).

In LMIC there is limited evidence from uncontrolled, intervention studies to suggest that programs to stop smoking in the workplace are effective in India (Mishra et al., 2010; Pimple, Pednekar, Mazumdar, Goswami, & Shastri, 2012). One controlled study from India reported significant reduction in tobacco consumption in the multi-component, multi-level and multi-method intervention group compared with no change in the control group (Prabhakaran et al., 2009). In China, previous work has shown that smoke-free policies were more easily implemented in workplaces than other indoor public spaces (Wan et al., 2013). Banning, rather than restricting, smoking was more effective in reducing smoking prevalence in China (Gao, Zheng, Gao, Chapman, & Fu, 2011). However, in China, even when there are smoking bans in the workplace these are frequently ignored (Ma et al., 2010).

Diet and physical activity interventions in the work place

There are many randomised controlled trials of dietary and physical activity interventions in the workplace, although the report to the California legislature states the evidence for beneficial effects of workplace interventions on both physical activity and fruit and vegetable intake is ambiguous (California Health Benefits Review Program, 2013). However, a systematic review reported workplace health promotion results in moderate dietary improvement (Ni Mhurchu, Aston, & Jebb, 2010). In terms of obesity reduction, a meta-analysis showed that workplace nutrition and physical activity programs achieve modest improvements in weight (Anderson et al., 2009), and other studies have shown that a suite of dietary interventions (Christensen et al., 2011) and a weight loss program can reduce obesity (Morgan et al., 2011,

2012). Collaborative interventions reduce obesity and increase physical activity (Prestwich et al., 2012), and an exercise and nutrition program showed improvements in diet, exercise and weight (Thorndike et al., 2012). Although workplace cafeteria or vending machines labels and icons alone have little effect on improving diet, combining these with additional environmental changes have demonstrated improvements in adiposity measures (Mozaffarian et al., 2012).

Examples of interventions to improve physical activity include social support (Tamers et al., 2011), giving a pedometer to employees (Aittasalo, Rinne, Pasanen, Kukkonen-Harjula, & Vasankari, 2012; Gemson, Commisso, Fuente, Newman, & Benson, 2008), and active commuting and exercise training promote to physical activity and fitness (Vuillemin et al., 2011).

Impact of workplace programs on non-communicable disease

NCD and its associated absenteeism and loss of productivity in the workplace impose a heavy economic burden on employers and an equally heavy burden on the individual. A recent US survey of 94,000 workers across 14 major occupations reported that 77% of workers had a chronic health condition associated with NCD (asthma, cancer, depression, diabetes, heart attack, high blood pressure, high cholesterol or obesity) and that the annual costs related to lost productivity totaled $84 billion (Gallup, 2014). Poor health in the workplace is expensive and employers in the US spend $900 billion annually on health care (Gates & Brehm, 2010). A comprehensive investigation of the financial burden

on companies that employ smokers has calculated that the average cost per year for each smoker is $5,816 (Berman, Crane, Seiber, & Munur, 2014).

Workplace programs not only improve individual health, but have economic and productivity benefits for employers. A meta-analysis of workplace wellness programs reported that savings of $2.73 on absenteeism and $3.27 on medical costs are obtained for every dollar spent (Baicker, Cutler, & Song 2010). Systematic reviews have demonstrated that workplace health promotion can make employees more effective (Cancelliere et al., 2011), increase productivity by 1-2% and are cost effective in larger organisations (Jensen, 2011). However a recent systematic review found while non-randomised trials showed positive financial returns on worksite health promotion programs, randomised trials did not (van Dongen et al., 2011). The review concluded the apparent positive effects in non-randomised studies were likely to be due to selection bias so that control and intervention groups were not comparable and that baseline differences or confounders may explain the positive results. The value of workplace interventions is increasingly acknowledged by employers, and the National Healthy Workplace Program now has one hundred small, medium and large employers aiming to reduce chronic disease, promoting sustainable workplace health activities and supporting one-to-one business mentoring (Centers for Disease Control and Prevention, 2013).

Despite the reported wide-spread benefits of workplace interventions, there are concerns that financial incentives, especially in insurance-based health systems, may result in adverse shifts in costs and this may disadvantage workers in low socio-economic levels (Krisberg, 2013).

Strategies to combat NCDs

There are two strategies to combat NCD. The first, known as the high risk strategy, identifies individuals at high risk of developing NCD and targets these individuals with preventive measures and/or treatments. Targeting and treating individuals at high risk of NCD has been successful in disease prevention in high income countries (Luepker, 2008), but in LMIC this approach is not appropriate, as it is resource intensive (Capewell & Graham, 2010). Community approaches offer preventative interventions to the whole population, rather than to individuals and these population strategies are suitable for all countries, including LMIC. These comprehensive programs typically combine several approaches including legislative change, health education and community coalitions.

Population level interventions within workplaces have other advantages as they target all workers and negate the need to identify high-risk individuals, potentially improving the health of all, with a lower cost per worker. Kaiser Permanente, for example, has now adopted a population approach and based financial rewards on regional improvements rather than individual ones. This program, commenced in 2008,

has reported reductions in blood pressure (5%), cholesterol levels (7%) and smoking (12%) (Krisberg, 2013). It is likely that a combination of comprehensive (i.e. population) and high-risk interventions will prove to be the most promising approach, but there are few randomised controlled trials assessing this strategy (Pelletier, 2009).

In 2008, the Community Interventions for Health (CIH) program was initiated in selected communities in China, India and Mexico with the aim of applying a population strategy to reduce the risk of non-communicable disease by addressing the modifiable risk factors of tobacco use, unhealthy diet and physical inactivity.

In this paper it is hypothesised that workplace interventions will improve risk factors for NCD.

Methods

Design and sample

The Community Interventions for Health study was designed as a whole community, comparator group study incorporating action-orientated research to examine the prevalence and secular trends of risk factors for NCD. The full methodology for CIH has been reported previously (O'Connor Duffany et al., 2011). CIH took place in three different sites in Hangzhou city in China, Kerala in India and in Mexico City.

Each country site identified intervention and control areas with a population size between 150,000 and 200,000 people within selected communities and with similar demographic and socioeconomic characteristics. A community was defined as an administrative unit specific to the country setting e.g. delegacion in Mexico and panchayat in India. CIH was conducted in four main settings; health centers, workplaces, schools and the community at large. The data reported here relate to information collected from questionnaires administered to adults aged 18-64 years in the workplace sample.

Workplaces within each intervention and control sites of similar size and type of industry were identified, and questionnaires were administered to all workers aged 18-64 years in each workplace. The size of the sample was based on small predicted effect sizes (estimated at 4-6%) between the intervention and control group. Equal sizes of intervention and control groups were calculated and which were selected to be independent of each other and to have similar risk factor prevalence at baseline. Power analysis assumed two-sided 5% significance test of the null hypotheses that intervention and control groups experienced similar changes in the prevalence of NCD risk factors, and power was fixed at 80% for testing the alternative hypothesis that the intervention groups would exhibit a 4-6% greater change in risk factors. Current prevalence of the three risk factors was employed to give sample sizes for each risk factor and the largest sample size was selected across all

three risk factors. For the workplace 2,000 adults in each country site were calculated to be necessary at baseline and follow-up, comprising a total sample of 12,000 adults in the workplace.

Measures

Culturally sensitive interventions targeting the whole workforce in each selected workplace site were applied in the intervention area only. Specific, evidence-based interventions were selected for local application from a manual devised by the CIH international advisory group (Stevens, O'Connor, Wong, & et al, 2012), and are shown in Table 1. Strategies employed included health education, structural change and community mobilization. The interventions in this study included no smoking days and smoking bans in the workplace as well as incentives, but smoking bans also occurred in control areas..

The intervention stage lasted 18-24 months.

Data were collected from independent samples of individuals in workplace sites at baseline and follow-up after the 18-24 months intervention period by means of self-completed questionnaires. Data collected included age, gender, weight, height and information about general health, tobacco use, diet and physical activity. The CIH questionnaire was based on previously validated questionnaires including the

Global Adults Tobacco Survey (GATS) (World Health Organisation, 2007), WHO STEPwise approach to surveillance (STEPS) (World Health Organisation, 2008), and the International Physical Activity Questionnnaire (IPAQ) (Craig, Marshall, Sjöström, & et al, 2003).

Analytic strategy

Logistic regression was employed to determine differences between groups and time periods which allows for differences in baseline of risk factors. All variables were dichotomised into binary variables. For tobacco either current user or not, for fruit and vegetables and exercise either meeting current recommendations or not, for obesity and overweight either overweight/obese or not, for salt either taken or not. A logistic regression analysis was conducted with risk factors as dependent variables. Independent variables were time (baseline/follow-up, with baseline as reference category), education level, gender (male reference category) and age. A difference in differences (DiD) approach similar to that used by Vanderos et al (Vanderos, Hessel, Leone, & Avendana, 2013) was employed to determine the effect of the interventions.

Ethics

Ethical approval was obtained in each country site from appropriate institutional review boards.

Results

12,136 adults (from a population 15,726 employees) completed the baseline survey and 9,786 at follow-up (21,922 in total). There were minimal missing data for the logistic regression (<3%).

Baseline data are shown in Table 2. Significant differences were seen between control and intervention groups for gender, age and all risk factors except tobacco use at baseline. Differences between the groups at baseline and follow-up are shown in Table 3, and a summary of changes in the prevalence of NCD risk factors is shown in Figure 1. Finally Table 4 gives DiD odds ratios which shows the effects and significance values of intervention compared with control.

The proportion of men using tobacco at baseline was relatively high (31.8%), compared with only 3.9% of women. Although the prevalence of tobacco use amongst men decreased in both the intervention and control group by 6% and 2.6% respectively, DiD analysis showed that this decrease was significantly greater in the intervention group, $p<0.001$. Tobacco use increased slightly in women in both control and intervention areas, with no differences between the two groups.

Fruit and vegetable intake was low at baseline, the mean intake of fruit and vegetables was 2.7 portions/day, and less than 14% of the sample achieved the recommended 5 portions/day. The proportion meeting recommended intakes of fruit and vegetables increased in the

intervention group and decreased in the control group, and DiD analysis showed that this was a significant difference (6.9% v -1.5%, p<0.001). Despite interventions designed to reduce salt added at the table, salt intake appeared to increase in both groups although the increase was attenuated in the intervention group, which showed less of an increase compared to the control group (p=0.014).

Physical activity was relatively low at baseline, with only one third of the sample achieving recommended levels of activity. The proportions meeting recommendations increased in both groups during the study, with no significant difference between the groups.

In the intervention group, the proportion of women taking part in the study increased from 53.7% at baseline to 58.3% at follow-up, and this compares with fewer women in the control group (57.6% at baseline and 55.9% at follow-up). As a result of this, a higher level of obesity at follow-up would have been anticipated in the intervention group if there been no effect of the intervention. Although obesity did increase in the intervention group, there remained a significant DiD OR (p=0.014) in favour of intervention (Table 4) after allowing for gender, age and education.

Discussion

This study of community interventions within the workplace has shown small but significant positive changes in tobacco use by men, fruit and vegetable intake and salt intake over a relatively short time period, suggesting a good dose-response to the interventions. It is

impossible to identify which specific interventions were effective, and while this may be viewed as a limitation, the rationale of the study was to use multiple interventions in various settings to achieve the desired effect. Overall, It shows that multiple interventions can be successfully applied in the workplace across varying cultures and communities and can show positive outcomes.

Reductions in tobacco use amongst men in both the intervention and control groups suggest that there may have been a secular trend for tobacco cessation in the workplace, but this change was significantly greater in the intervention areas. The high levels of smoking reported in this study reflect cultural norms. In China for example, where levels of smoking were highest amongst men (42%), it is particularly challenging to reduce tobacco consumption when practices such as giving tobacco as gifts is common, and it is considered rude to refuse a cigarette if offered. Despite this, the multi component approach used in CIH, combining health education with enforcement of smoking bans showed a positive effect. As CIH was also implementing these strategies in schools, clinical centers and the wider community, this synergy may have impacted in the workplace to enhance the workplace interventions.

The dietary improvements noted in CIH, namely increased fruit and vegetable intake and reduction in salt intake, are consistent with systematic reviews that show workplace health promotion results in moderate dietary improvement (Christensen et al., 2011). Obesity also improved which could be attributed to workplace nutrition programs. The comprehensive approach adopted in CIH is more likely to be effective than using single strategies. For example, in the workplace restaurants in China, this study combined health education (displays of

posters about healthy eating and point of decision prompts), structural change (introduction of healthy options on the menu) and economic benefits (subsidising healthy options) to improve dietary intake. In India, where low intakes of fruit and vegetables are particularly apparent, vegetable seeds and fertilizer were distributed to workers and training on vegetable cultivation was provided. In this way, the positive impact may be taken outside of the workplace, as children may benefit from healthy vegetables grown by parents who received these in the workplace, .

There was no improvement in physical activity in this study, despite reports from the literature showing workplace interventions can increase physical activity (Morgan et al., 2011), and active commuting and exercise training promote physical activity and fitness (Baicker et al., 2010). The reasons for this are unclear, but there is some evidence that the majority of interventions for increasing physical activity were based on health education and point of decision prompts, with little in the way of structural change or provision of facilities for increasing physical activity. It is well-recognised that improving knowledge (health education) does not necessarily translate to behaviour change, and this may have been the case in this instance (Institute of Medicine, 2001).

Obesity, while increased more in the intervention compared with control group, having allowed for gender, age and education is improved in the intervention compared with the control group. This is consistent with the meta-analysis of Anderson et al noted above (Anderson et al., 2009) which showed workplace interventions can reduce obesity.

Strengths and limitations

The study is novel as it evaluates workplace interventions in LMIC and provides further evidence of the effectiveness of this approach in reducing risk factors for NCD. It demonstrates that multiple interventions including strategies such as health education, introducing policies, mandates and restrictions and effecting structural change are achievable and sustainable in LMIC. The study was successful in recruiting large numbers of subjects and showed positive results, despite the small dose and relatively short duration.

The limitations of this study include the fact that the results are based on self-completed questionnaires, which may lead to inaccurate data recording. In addition, matching the control and the intervention sites for social and demographic factors resulted in them being in close proximity and increasing the chance of contamination. Health education was widely disseminated throughout the intervention area, and it is likely that some workers from the control area were exposed to this.

The sample was unbalanced as more than half the sample were from the China site, and this is explained by the fact that the industries in China were larger and employed more staff. Importantly, the numbers recruited from both intervention and control areas were similar. There is also a large difference between sample numbers at baseline and follow-up, due to time constraints on data collection at follow-up, but again sample numbers from the intervention and control areas were similar.

CIH was not a true randomised study, but it did have a control group. While non-randomised studies have been criticised for showing possibly spurious positive results due to baseline differences in control versus intervention groups (van Dongen et al., 2011), in this study baseline differences were allowed for in a regression analysis and a difference in differences approach was taken so these results should be considered robust.

In conclusion, although the CIH study was not randomised at the individual level, it did have a control group and a rigorous methodology and offers further evidence that community based interventions can have an impact on risk factors in the workplace.

Competing interests

There are no competing interests.

Relevance for Public Health Nursing

Community interventions may take place in clinical areas, schools, workplaces or in other locations such as clubs and churches (including mosques, temple etc.). Nurses working in hospitals and clinics may facilitate such interventions but public health nurses are most able to effect change in the community at large. The impact of several interventions may through synergy be greater than the sum of the individual components. Nurses are the largest health workforce and are ideally placed to encourage healthy living through better diet, exercise and tobacco cessation both in secondary/tertiary care but even more so in primary care since a population approach is recommended and more members of the community will access primary care services.

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Table 1. Examples of evidence-based interventions to reduce risk factors for NCD in selected workplaces in China, India and Mexico

Strategy	*China*	*India*	*Mexico*
Health education	• *Developed and displayed posters about hazards of tobacco and passive smoking* • *Developed and displayed posters about health benefits of physical activity.* • *Developed and displayed posters about healthy eating.*	• *Developed and displayed posters about hazards of tobacco and passive smoking* • *Developed and displayed posters about health benefits* • *of physical activity.* • *Developed and displayed posters about healthy eating.*	• *Developed and displayed posters about hazards of tobacco* • *Collaborated with the local cookery school to train chefs in healthy cooking practices.*
Policies, mandates and restrictions	• *Developed and implemented tobacco-free policy* • *Developed and displayed No Smoking signs* • *Creation of special "tobacco police" who enforced smoke-free public spaces*	• *Developed and implemented tobacco-free policy* • *Developed and displayed No Tobacco signs* • *Displayed POD prompts by lifts and stairwells* • *Organised aerobic yoga*	• *Created marked walking paths around worksites*

Strategy	*China*	*India*	*Mexico*
	• *Displayed point of decision (POD) prompts by lifts and stairwells* • *Organised work-break exercises, sports competitions and mountain-climbing events.* • *Introduced healthy options to canteens* • *Displayed POD prompts in canteens and restaurants*	*sessions for workers.* • *Distributed vegetable seeds and fertilizer and provided training on vegetable cultivation* • *Displayed POD prompts in canteens and restaurants*	

Table 2. Baseline characteristics of workplace sample

	Control group (C) n=5,442	*Intervention group (I) n=6,694*	*Total n=12,136*	*p-value (I v C)*
Demographics:				
Age (mean, sd)	*36.6 (12.9)*	*38.3 (12.3)*	*37.6 (12.6)*	*<0.001*
Gender (%M)	*42.4*	*46.3*	*44.6*	*<0.001*
Risk factors:		*Prevalence (%)*		
Tobacco use:				
Male	*32.3*	*31.4*	*31.8*	*0.458*
Female	*3.6*	*4.1*	*3.9*	*0.304*
>30 mins/day moderate/ vigorous physical activity	*36.2*	*30.8*	*33.2*	*<0.001*
>5 portions fruit and vegetables/day	*11.4*	*15.8*	*13.9*	*<0.001*
Added salt at the table	*33.2*	*36.4*	*35.0*	*<0.001*
BMI > 25 kg/m2	*23.7*	*25.4*	*24.6*	*0.049*
BMI > 30 kg/m2	*7.4*	*6.3*	*6.8*	*0.036*
Assessed variables:				
BMI (kg/m2)	*23.6 (4.3)*	*23.8 (4.0)*	*23.7 (4.1)*	*0.142*
Fruit and vegetables (portions/day) mean (s.d.)	*2.5 (1.8)*	*2.8 (1.9)*	*2.7 (1.9)*	*<0.001*
Physical activity (MET/day) median (IQR)	*69 (377)*	*51 (274)*	*60 (309)*	*<0.001*

Table 3. NCD risk factors at baseline and follow-up in workplace sample

Risk factor	*Control group (c)*				*Intervention group (I)*				*I v C at follow-up*
	Baseline	*Follow-up*	*% Change*	*p-value*	*Baseline*	*Follow-up*	*% Change*	*p-value*	*p-value*
Dichotomous variables:									
Tobacco use:									
Male	*32.3*	*29.7*	*-2.6*	*0.077*	*31.4*	*25.4*	*-6.0*	*<0.001*	*0.002*
Female	*3.6*	*5.4*	*1.8*	*0.001*	*4.1*	*5.2*	*1.1*	*0.026*	*0.734*
>30 mins/day moderate/vigorous physical activity	*36.2*	*40.9*	*4.7*	*<0.001*	*30.8*	*38.6*	*7.8*	*<0.001*	*0.024*
>5 portions fruit and vegetables/day	*11.4*	*12.9*	*-1.5*	*0.031*	*15.8*	*22.7*	*6.9*	*<0.001*	*<0.001*
Added salt at the table	*33.2*	*44.2*	*11.0*	*<0.001*	*36.4*	*41.1*	*4.7*	*<0.001*	*0.002*
BMI >25 kg/m2	*23.7*	*26.6*	*2.9*	*0.002*	*25.4*	*29.1*	*3.7*	*<0.001*	*0.009*
BMI >30 kg/m2	*7.4*	*9.0*	*1.6*	*0.007*	*6.3*	*8.1*	*1.8*	*<0.001*	*0.148*
Assessed variables:									
BMI (kg/m2)	*23.6*	*24.2*	*0.6*	*<0.001*	*23.8*	*24.4*	*0.6*	*<0.001*	*0.089*

Fruit and vegetables (portions/day)	*2.5*	*2.8*	*0.3*	*<0.001*	*2.8*	*3.3*	*0.5*	*<0.001*	*<0.001*
Physical activity (MET/day)	*259*	*168*	*-91*	*<0.001*	*217*	*164*	*-53*	*<0.001*	*0.050*

Table 4. DiD odds ratio of risk factors from logistic regression

Risk factor	*Odds ratio*	*95% Confidence Intervals*	*p-value*
Tobacco use:	*0.794*	*0.691, 0.912*	*0.001*
Male	*0.921*	*0.724, 1.172*	*0.503*
Female			
>150 mins/week moderate/vigorous physical activity	*0.928*	*0.853, 1.009*	*0.078*
>5 portions fruit and vegetables/day	*1.975*	*1.767, 2.208*	*<0.001*
Salt added at the table	*0.901*	*0.830, 0.979*	*0.014*
BMI >25 kg/m2	*1.059*	*0.962, 1.166*	*0.242*
BMI > 30 kg/m2	*0.827*	*0.963, 0.014*	*0.014*
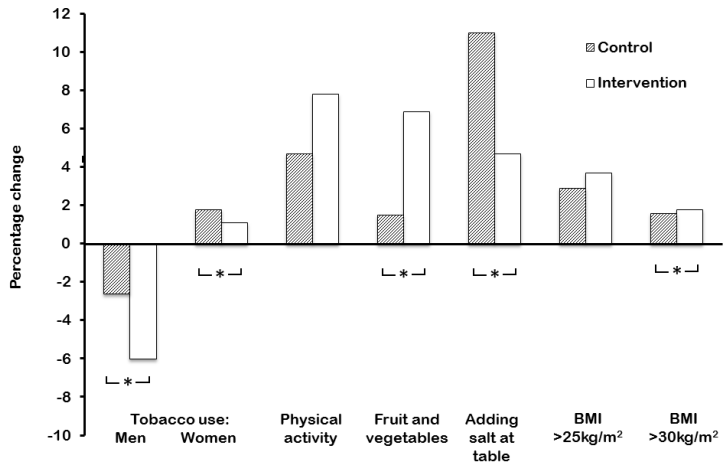
Fig 1. Percentage changes in prevalence of risk factors in control and intervention groups * Significant difference ($p<0.02$) in changes between control and intervention groups by DiD analysis