Clustering of lifestyle risk factors in employees: A quasi-experimental study in Sousse, Tunisia.

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Abstract

Background:

A better understanding of the prevalence and clustering patterns of multiple lifestyle-related health factors may support efforts to handle efficiently chronic diseases, reduce their incidence and improve overall health outcomes. This study aimed to evaluate the effectiveness of a three-year based intervention in the workplace on clustering of non-communicable diseases' risk factors.

Methods:

We based our study on a quasi-experimental intervention study (pre and post assessments with intervention and control groups) between 2010 and 2014 in two districts in the governorate of Sousse. The evaluation before and after the intervention focused on the attitudes and behaviors of participants. The intervention program team conducted several actions for the employees at the workplace focusing on physical activity, healthy diet promotion and smoking cessation.

Results:

In the intervention group, participants who had no risk factor increased significantly from 5.9% to 10.3% ($p<0.001$) but not significantly in the control group from 9.5% to 12.5 ($p=0.064$). Those who had only one risk factor increased significantly from 24.8% to 29.2% ($p=0.03$) in the intervention group but decreased in the control group from 32.2% to 28.8% ($p=0.14$). Furthermore, the proportion of employees who had 4 risk factors increased in the control group significantly, from 3.3% to 6.8% ($p<10^{-3}$).

Conclusion:

The positive co-variation represents one novel approach in which effective action on one handled behavior increases the odds of effective change on a second targeted behavior. Hence, the concept of intervening simultaneously on multiple risk behaviors might be a focus of attention as a means of preventing chronic diseases.

Keywords: intervention studies, workplace, chronic diseases, risk factors, prevention and control.

1. Introduction

Non-communicable diseases (NCDs) which include mainly cardiovascular diseases, cancers, diabetes and chronic respiratory diseases are the number one cause of death and disability in the world (1). In Tunisia, 57.8% of people in 2013 died from chronic diseases including 29.1% who died from cardiovascular diseases, 16.8% from cancer, 8.5% from diabetes and 1.5% from chronic respiratory diseases (2). Chronic disease morbidity and mortality is strongly associated with behaviors, or factors influenced by behavior, that may be characterized as modifiable, lifestyle-related health risk factors (3). Programs vary largely in objectives, content, organization, cost, and setting. Some are simple and inexpensive (4), some focus on a single risk factor such as obesity (5), smoking (4), or blood pressure (6) while others target multiple behavioral objectives. These modifiable lifestyle-related health risk factors tend to cluster among themselves, (7,8) increasing the likelihood that individuals are dealing with multiple health risk factors at a given time. A combination of two or more risk factors is usually associated with a higher increased risk of cardiovascular diseases or cancer than can be expected on the basis of the sum of the separate effects (9,10). There is a potential synergistic effect of multiple healthy lifestyle factors on the risk of chronic conditions and health outcomes (11,12). Therefore, an increased understanding of the prevalence and clustering patterns of multiple lifestyle-related health factors may support efforts to reduce incidence of disease, management of existing chronic disease, and improve overall health outcomes. If a combination is more prevalent than can be expected on the basis of the prevalence of the separate risk factors it is called "clustering." Previous studies on clustering have particularly reported on biological risk factors (13–15), and not on lifestyle risk factors. There are, however, indications that lifestyle factors cluster (16,17). Insight into clustering of lifestyle risk factors is important because this can be used in developing prevention strategies. Worksite health programs have been discussed frequently in recent years as a means for promoting behavior change in the general population. Since most adults spend over a third of their waking hours at the workplace, the worksite is believed to provide good opportunities to attempt to influence employee behavior. Consequently, it is targeted by many health promotion programs (18) to prevent from chronic diseases.

In this context, the present study aimed to evaluate the effectiveness of a three-year based intervention in the workplace on clustering of NCDs risk factors among workers.

2. Materials and methods

2.1. Study design

We based our study on a quasi-experimental intervention study in two districts in the governorate of Sousse (19). The first district that has served for the intervention group was represented by workplaces located in delegations of Sousse Jawhara and Sousse Erriadh. The district of control was located in the delegation of Msaken. We carried out an evaluation before intervention (pre-assessment) in 2009-2010. It focused on the attitudes and behaviors of the participants in relation to the various studied risk factors that were represented by diet, physical activity and smoking for both groups. The evaluation of these parameters was made at the end of the intervention (post-assessment) in both groups in 2013-2014.

2.2. Study population

Three enterprises were selected by convenience to be part of the intervention group (Epi d'Or, TEXMED, UATS) and 3 enterprises relatively similar in terms of size and gender composition in the control group (STIP, AAF, FITLEC). All employees of the selected companies were included in the data collection.

The sample size calculation on a type 1 error of $\alpha = 5\%$, a type 2 error of $\beta = 20\%$ and a change in the prevalence of various factors risk (smoking, unhealthy diet, lack of physical activity, obesity, arterial hypertension) of 6% between the pre- and post-intervention. For this, we needed 2,000 employees. The pre- and post-intervention assessments concerned two independent samples in both groups.

2.3. Data collection

For data collection, we used a pretested and standardized questionnaire administered to the participants by interview with trained medical doctors at the worksite. It allowed us to collect the following information: Socio-demographic characteristics, professional characteristics as well as eating habits, physical activity habits and tobacco use habits. The same questionnaire was administered by interview at the pre- and post-intervention assessments. We also collected biometric data such as height and weight. The weight was measured to the nearest 0.1 kg using a portable electronic scale. The height, in standing position was measured in participants with bare feet to the nearest 0.5 cm. Blood pressure was measured twice at rest using an arm electronic sphygmomanometer.

2.4. Variables definitions

To assess the unhealthy dietary behavior we used the variable less than five fruits and vegetables daily consumption. The recommended level of physical activity was used as defined by WHO adults (20), then physical inactivity is defined as adults aged 18–64 who do less than 150 minutes of moderate-intensity aerobic physical activity throughout the week or do less than 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity. Definition of smoker: we asked participants, "Do you currently smoke any tobacco products, such as cigarettes, cigars, or pipes?" Smokers were the participants who responded yes to this question.

Definition of overweight and obesity: Body Mass Index (BMI) in kg/m^2 was calculated by the ratio of weight to the square of the height.

Definition of hypertension: an average of the two measurements greater than or equal to 140 mmHg for systolic blood pressure and / or 90 mmHg for diastolic blood pressure (21).

2.5. Intervention program

The intervention program (19) during three years (from September 2010 until September 2013), consisted of several actions for the employees at workplace days (the projection of an education film for employees and interactive education sessions with the occupational physician, workshops animation, an open sensitization days in workplaces) focusing on the three main NCDs risk factors (smoking, physical activity, diet).

2.6. Data analyses

Statistical analysis was performed using the SPSS 10.0 software. We used chi square test to compare percentages and Student t test to compare means in independent groups with 0.05 as significance level for the different used tests.

2.7. Ethical considerations

Protocol, data collection forms, the questionnaire and the manual of investigation methods were approved by the University Hospital Farhat Hached of Sousse's ethics committee. We asked for authorizations from the Ministry of Health, the governor of the city of Sousse, and the group of Occupational Health of Sousse. An informed consent was obtained from the participants before the beginning of the intervention program. The intervention program consisted of interactive education actions which had no damage on the integrity of the participants. At the end of the program and after the completion of the post intervention assessment, we started the same health education program for the control group as a delayed intervention.

3. Results

3.1. Description of the studied population:

A total of 1775 employees were enrolled at the pre-assessment to participate in the intervention program with a response rate of 74.6%. Of these employees, 914 belonged to the intervention group (response rate=76.7%) and 861 to the control group (response rate=74.6%). At the post-assessment we enrolled 2113 employees to participate with a response rate of 71.9%. Of these employees, 1098 belonged to the intervention group (response rate=67.5%) and 1015 to the control group (response rate=77.5%). The mean age of the employees at the pre- and post-assessment were respectively 32.25 ± 8.11 years and 33.86 ± 8.10 among the intervention group, 35.40 ± 8.79 years and 38.90 ± 8.77 years among the control group. More than half of the study subjects were males in the two groups and at pre- and post-assessment. The studied population was composed mostly of workers without significant difference at the pre-assessment and the post-assessment in the intervention group (p= 0.69) whereas there was a significant difference in the control group (p=0.016). (Table 1)

3.2. Evolution of the participants' risk factors:

Overall, the intervention group had a significant improvement in the daily insufficient intake of fruits and vegetables (p=0.04), in the prevalence of hypertension (p=0.018) and in the physical activity level (p<10-3). Whereas, we noticed in the control group a non-significant decrease in the lack of fruit and vegetable (p= 0.57), a significant increase in the prevalence of hypertension (p<10-3) and a significant improvement in the level of physical activity ($p<10^{-3}$). Regarding the prevalence of obesity and tobacco use, there was respectively a significant increase and a non-significant decrease both in the intervention and the control groups. The total score of risk factors was calculated for each participant. The mean number of risk factors decreased significantly among employees participating in the intervention program from 1.99±1.00 to 1.81±1.05 ($p<10^{-3}$), while in the control group we observed a non-significant increase from 1.72±0.97 to 1.78±1.11. (Table 1)

Table 1: Characteristics of the Study Population in the intervention and the control group at pre- and post-assessment.

Characteristic	**Intervention group n (%) or Mean ±SD**		**p-value**	**Control group n (%) or Mean ±SD**		**p-value**
	Pre-assessment	Post-assessment		Pre-assessment	Post-assessment	
Mean age (SD)	32.25 (8.11)	33.86 (8.10)	$<10^{-3}$	35.40 (8.79)	38.90 (8.77)	$<10^{-3}$
Gender						
Men	591 (64.7)	719 (65.5)	0.70	508(59.0)	623 (61.4)	0.29
Women	323 (35.3)	379 (34.5)		353 (41.0)	392 (38.6)	
Marital status						
Single	438 (48.5)	387 (35.3)		238 (33.5)	252 (25.1)	
Divorced or widowed	18 (2.0)	11 (1.0)	$<10^{-3}$	9 (1.1)	16 (1.6)	$<10^{-3}$
Married	447 (49.5)	698 (63.7)		553 (65.4)	741 (73.4)	
Occupation						
Worker	669 (74.6)	818 (75.3)	0.69	698 (84.9)	760 (80.6)	0.016
Office stuff	228 (25.4)	269 (24.7)		124 (15.1)	183 (19.4)	
Lifestyle habits						
Current smoker	350 (39.2)	410 (37.5)	0.43	250 (31.7)	308 (30.6)	0.62
Little physical activity	642 (71.7)	679 (62.1)	$<10^{-3}$	577 (68.8)	568 (57.1)	$<10^{-3}$
Servings of fruits and vegetables<5 portions per day	466 (52.5)	513 (47.9)	0.04	323 (39.1)	372 (37.8)	0.57
BMI≥30 kg/m²	134 (15.0)	225(20.6)	0.01	161 (19.6)	274 (27.3)	$<10^{-3}$
Hypertension	163 (18.1)	156 (14.2)	0.018	126 (15.0)	263 (26.0)	$<10^{-3}$
Mean of risk factors (SD)	1.99 (1.00)	1.81 (1.05)	$<10^{-3}$	1.72 (0.97)	1.78 (1.11)	0.234

3.3. Evolution of clusters of multiple risk factors:

Table 2 lists the possible combinations of all five risk factors. The proportion of participants in the intervention group who had no risk factor increased significantly from 5.9% to 10.3% (p<0.001), while in the control group it increased, but not significantly. Those, who have only one risk factor increased in the intervention group, but decreased in the control group. This pattern was noticed particularly among those who had only smoking or obesity as a risk factor. At baseline, the most prevalent number of risk factors was two both in the intervention and control group. However, it decreased significantly in the intervention group, from 40% to 34.5% of the employees respectively in pre-assessment and post-assessment. On the one hand, the combination of being physically inactive and eating less than five servings of fruits and vegetables per day was by far the most common in both two groups, but on the other hand it decreased significantly only in the control group from 16.1% to 10.7% respectively at pre- and post-assessment (p=0.001). Regarding the clusters which were composed of at least three risk factors, we observed a significant decrease of two clusters which were the grouping of tobacco use, physical inactivity, hypertension and the grouping of tobacco use, physical inactivity, unhealthy diet, and hypertension in the intervention group. Nevertheless, this pattern was not observed in the control group. On the other hand, the proportion of employees who had four risk factors increased in the control group significantly from 3.3% to 6.8% (Table 2) which was observed significantly between the workers from 2.6% in pre-assessment to 6.5% in post-assessment (Table 3).

Table 2. Clustering of risk factors of chronic diseases

S	PI	UD	Ob	AHT	Intervention group n (%)		p	Control group n (%)		p
					Pre-assessment	Post-assessment		Pre-assessment	Post-assessment	
0	- -	-	-	-	49 (5.9)	109 (10.3)	$<10^{-3}$	68 (9.5)	119 (12.5)	0.064
1					206 (24.8)	307 (29.2)	0.03	229 (32.2)	273 (28.8)	0.14
	+ -	-	-	-	39 (4.7)	92 (8.7)	$<10^{-3}$	39 (5.4)	56 (5.9)	0.62
	- +	-	-	-	116 (14.0)	118 (11.2)	0.06	118 (16.5)	113 (11.9)	0.008
	- -	+	-	-	36 (4.3)	51 (4.8)	0.66	42 (5.9)	42 (4.4)	0.176
	- -	-	+	-	7 (0.8)	31 (2.9)	0.001	20 (2.8)	36 (3.8)	0.27
	- -	-	-	+	8 (0.9)	15 (1.4)	0.24	10 (1.4)	26 (2.7)	0.064
2					332 (40.0)	362 (34.5)	0.014	267 (37.5)	316 (33.3)	0.07
	+ +	-	-	-	71 (8.6)	70 (6.6)	0.1	75 (10.5)	45 (4.7)	$<10^{-3}$

	+	-	+	-	-	43 (5.1)	40 (3.8)	0.18	7 (0.9)	20 (2.1)	0.04
	+	-	-	+	-	3 (0.3)	3 (0.2)	0.79	6 (0.8)	12 (1.2)	0.525
	+	-	-	-	+	8 (0.9)	8 (0.7)	0.65	5 (0.7)	24 (2.5)	0.004
	-	+	+	-	-	141 (17.0)	157 (14.9)	0.2	115 (16.1)	102 (10.7)	0.001
	-	+	-	+	-	25 (3.0)	42 (4.0)	0.22	23 (3.2)	46 (4.8)	0.12
	-	+	-	-	+	22 (2.6)	16 (1.5)	0.08	17 (2.3)	20 (2.1)	0.84
	-	-	+	+	-	3 (0.3)	8 (0.7)	0.32	8 (1.1)	16 (1.6)	0.42
	-	-	+	-	+	12 (1.4)	11 (1.0)	0.32	5 (0.7)	13 (1.3)	0.25
	-	-	-	+	+	4 (0.4)	7 (0.6)	0.75	6 (0.8)	18 (1.9)	0.07
3						189 (22.8)	218 (20.7)	0.26	123 (17.2)	174 (18.3)	0.55
	+	+	+	-	-	96 (11.5)	107 (10.2)	0.37	34 (4.7)	38 (4.0)	0.531
	-	+	+	+	-	22 (2.6)	41 (3.9)	0.13	24 (3.3)	32 (3.3)	0.96
	-	-	+	+	+	3 (0.3)	5 (0.4)	0.9	3 (0.4)	3 (0.3)	0.95
	+	-	+	-	+	5 (0.6)	5 (0.4)	0.72	3 (0.4)	10 (1.0)	0.2
	+	-	-	+	+	2 (0.2)	8 (0.7)	0.32	1 (0.1)	10 (1.0)	0.073
	-	+	-	+	+	11 (1.3)	11 (1.0)	0.44	9 (1.2)	35 (3.6)	0.003
	+	-	+	+	-	5 (0.6)	8 (0.7)	0.86	3 (0.4)	1 (0.1)	0.42
	+	+	-	+	-	7 (0.8)	8 (0.7)	0.65	21 (2.9)	8 (0.8)	10^{-3}
	-	+	+	-	+	21 (2.5)	20 (1.9)	0.35	14 (1.9)	20 (2.1)	0.83
	+	+	-	-	+	17 (2.0)	5 (0.4)	$<10^{-3}$	11 (1.5)	17 (1.7)	0.82
4						52 (6.2)	53 (4.9)	0.21	24 (3.3)	65 (6.8)	10^{-3}
	-	+	+	+	+	15 (1.8)	11 (1.0)	0.1	4 (0.5)	16 (1.6)	0.05
	+	-	+	+	+	2 (0.2)	1 (0.1)	0.83	0 (0.0)	3 (0.3)	0.35
	+	+	-	+	+	1 (0.1)	6 (0.5)	0.34	8 (1.1)	11 (1.1)	0.89
	+	+	+	-	+	19 (2.2)	11 (1.0)	0.03	6 (0.8)	18 (1.9)	0.07
	+	+	+	+	-	9 (1.0)	16 (1.5)	0.28	5 (0.7)	9 (0.9)	0.58
	+	+	+	+	+	6 (0.7)	8 (0.7)	0.88	1 (0.1)	8 (0.8)	0.11

S: Smoking, PI: Physical Inactivity, UD: Unhealthy Diet, Ob: Obesity, AHT: Arterial Hypertension

Table 3. Clustering of risk factors for chronic diseases among office stuff and workers

Number of lifestyle risk factors	**Intervention group (%)**						**Control group (%)**					
	Office stuff			Workers			Office stuff			Workers		
	Pre	Post	p	Pre	Post	p	Pre	Post	p	Pre	Post	p
0	7.5	12.2	NS	5.5	9.8	0.003	9.1	12.1	NS	9.1	11.7	NS
1	25.1	26.5	NS	24.8	29.8	0.03	31.3	29.7	NS	33.9	28.3	0.029
2	34.7	33.1	NS	41.5	35.1	0.01	28.3	29.1	NS	38.2	34.1	NS
3	25.1	19.6	NS	22.2	21.3	NS	22.2	23	NS	16.2	18.4	NS
4	6.5	6.1	NS	5.3	3.6	NS	8.1	5.5	NS	2.6	6.5	$<10^{-3}$
5	1	2.4	NS	0.6	0.3	NS	1	0.6	-	0	1	0.04

4. Discussion

Our study aimed to investigate the influence of a three-year intervention program in the workplace on clustering evolution of five major lifestyle risk factors among the employees of Sousse, Tunisia. Globally, more than 70% of Tunisian employees have at least two of the five chronic diseases' risk factors we considered, and 29% had three. The clustered risk factors were important compared to the results found in the 2001 National Health Interview Survey, which provided an up to-date of multiple risk factor prevalence and clustering in the U.S. population (22). Employees in the intervention group decreased the number of risk factors while those who have only one risk factor considerably increased. These findings undoubtedly could be explained by the effectiveness of the intervention which gave rise to the segregation of multiple risk factors. Although the smokers' proportion decreased, but those who had only smoking as risk factor increased underlying the fact that people who have multiple risk factors are more motivated, more aware and could respond better to intervention programs. It was established that a majority of smokers (70%) desire to quit, but only 3% - 5% actually succeed in quitting (23). The workers were unable to break away from the tobacco habit because of the addiction and low tolerance towards the withdrawal symptoms associated with the process of quitting (24). Moreover, it is necessary to take into account the health and safety conditions, which are key features of the social-contextual environment in which workers make behavioral choices (25). We found that the proportion of participants who had no risk factor was 10.3% and 12.5% and those who had four or more, was between 4.5% and 6.8% respectively in the intervention and the control group at post-

assessment. Berrigan et al (26) found 6% of U.S. adults were physically active, nonsmokers, having healthy levels of fat in the diet, without alcohol intake and with adequate consumption of fruits and vegetables, and about 5% with five risk factors. These two extreme patterns of health behavior provide challenges for public health research and opportunities to promote change in more than one risk factor.

Many previous studies of multiple health behaviors have emphasized clusters or patterns of unhealthy behaviors and their socio-demographic characteristics in adult population (27,28), but fewer studies in the public health literature have focused on people who meet the criteria for a healthy lifestyle (26) and the effect of the intervention study on these clusters. In our study, adherence to all five recommendations increased among office staff, but it was more significant in workers.

One of our main findings was that the rate of employees who had two or more risk factors was decreased in the intervention group, opposed to an increase in the rate of employees in the control group. These results clearly illustrate the need to adopt a new paradigm of research in order to produce greater effect on public health with the minimum health care costs.

A growing literature describes several attempts to carry out a population-wide change of multiple lifestyle risk factors and demonstrates its feasibility and its potential efficacy (29). Moreover, multiple unhealthy behaviors often are present concurrently. Hence, it is important to investigate the clustering of lifestyle risk factors because of the possible synergistic health effects. In fact, knowing the tendency of clustering of risk factors and targeting the change of multiple health behaviors is the leading approach to prevent effectively chronic diseases (30). There is some evidence that combinations of lifestyle risk factors are more detrimental to people's health than can be expected from the added individual effects alone (9,12,31), suggesting that the health effects of lifestyle risk factors are multiplicative rather than additive. Because of the potentially synergistic effects, interventions on multiple risk factors promise to improve substantially an individual's health profile more effectively than targeting single behavioral risk factor (32–34). The finding that multiple risk factors are the norm in adult population provides strong support for multiple-behavior interventions as opposed to single-behavior interventions (32,34,35). Multiple-behavior interventions may not only have a much greater impact on public health than single-behavior interventions (32), they may also be more effective and efficient at achieving these goals as well (33). On the other hand, the workplace presents a suitable environment to prevent multiple risk factors where it could be advantageous to both employees and employers (36). A top priority for workplace health promotion is to improve physical work environments to comply with laws, regulations, and standards (37). At the workplace, the active participation of employees and stakeholders in decision making, problem solving, and assessment is indispensable for implementing and sustaining workplace health promotion projects (38,39). These participatory interventions could increase motivation, self-efficacy, confidence and employees' adherence to the project with the purpose to reduce multiple risk factors.

Limit:

In recent years, a number of studies have reported the clustering of different lifestyle risk factors. However, it is difficult to compare these studies as they focus on combinations of lifestyle risk factors, use

different measures and cutoff points, concern different study populations, and use different analytic techniques. It should be mentioned that the common practice of dichotomizing health behavior variables may have implications for the findings (40). Furthermore, the study relied on self-reports of the different health behaviors, which may be subject to social desirability answering. As we used a quasi-experimental design, we recognize that we could not affirm that risk factors change and evolution was due to our intervention. Indeed, structural and environmental changes in the workplace can improve and enhance the effect of the intervention to promote healthy lifestyles, even though these actions were limited and it seems that it is also the case in many other international interventions (41). On the other hand, smokers who participated in the intervention program and who stopped smoking could gain weight (42).

5. Conclusion

Intervening on two or more risk behaviors simultaneously could be more efficient than intervening on them separately. The positive co-variation represents one novel approach in which effective action on one handled behavior increases the odds of effective change on a second targeted behavior. The concept of intervening simultaneously on multiple risk behaviors might be a focus of attention as a means of preventing chronic diseases.

Conflicts of interest: none declared

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