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VALUE IN HEALTH

Costs and Benefits of Influenza Vaccination and Work Productivity in a Colombian Company from the Employer's Perspective

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ABSTRACT

Objectives: This study was designed to evaluate the effects of an employee influenza vaccination campaign, measured in terms of health and economic benefits.

Methods: Colombian bank employees volunteered to take part in this prospective observational study involving two groups: vaccinated and nonvaccinated. Socioeconomic and health status information, including influenza-like symptoms, sick leave, and postvaccination adverse events, were collected via questionnaires. Cost–benefit analyses were performed to determine whether the employer would save money overall by paying for the vaccination program.

Results: Between October 2000 and May 2001, 424 vaccinated subjects and 335 nonvaccinated subjects volunteered to join the study. Cumulative incidence of influenza-like illness (ILI) was lower among vaccinated (14.6%) than nonvaccinated subjects (39.4%). Fever was the most common ILI symptom (93% of all reported ILI). Absence rates because of ILI were similar in the two groups (2.59%–2.69%). Assuming that employees with ILI who continue to work have reduced effectiveness (30%–70% of normal) the employer can save US$6.4 to US$25.8 per vaccinated employee based on labor costs alone. This saving increases to US$89.3 to US$237.8 when operating income is also considered. Sensitivity analyses indicate that the vaccination program will be cost saving for vaccination coverage above 20% and ILI rates above 10%.

Conclusions: Among the studied volunteers, ILI has significant impact on work productivity in terms of indirect costs. Implementing an influenza vaccination program would reduce the burden of ILI and save substantial amounts of money for the company.

Keywords: cost–benefit, influenza, occupational health, vaccination.

Introduction

Influenza is an acute, febrile illness that primarily affects the respiratory tract. The disease is characterized by fever (38–40°C), headaches, myalgia, sore throat, and inflammation [1]. It is a seasonal disease, affecting northern, temperate zones during winter and the tropics during the rainy season [1].

Influenza is commonly misconceived to be an inconvenient infection rather than a potentially lethal hazard. Nevertheless, the elderly and patients with underlying chronic medical conditions such as chronic pulmonary or cardiovascular disorders, metabolic disorders, hemoglobinopathies, or immunosuppression are at risk of influenza with a high risk of potential complications including heart failure, pneumonia, respiratory insufficiency, and even death. An estimated 20,000 to 50,000 people died perepidemic year as a result of influenza in the United States according to surveys performed from 1972 to 1973 through 1980 to 1981 [2].

The potential benefits of vaccination against influenza have been documented extensively since the 1940s [1]. The Advisory Committee on Immunization Practices (ACIP) recommends vaccination against influenza in numerous countries worldwide [3].

Influenza causes a dramatic increase in work absenteeism and disease burden among otherwise healthy adults during peak levels of influenza and influenza-infected individuals who attend work are often less productive than normal [4–9]. For exam-

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ple, in the United States, between 1971 and 1978, approximately US$764 million per year was lost because of absenteeism resulting from influenza epidemics [6]. These losses are not caused by severe illness in people from high-risk groups, but by uncomplicated illness in otherwise healthy, productive adults. Almost half of reported losses resulted from illness in workers aged 25 to 44 years [6,10].

Annual influenza vaccination campaigns for the workforce at the start of an influenza season might reduce the financial losses that result from influenza, but the campaigns themselves have costs that need to be met. For example, an employer implementing such a campaign would need to purchase the vaccine, employ health-care staff to run the campaign, and then accept lost productivity while the workforce was being vaccinated and during any subsequent absence caused by vaccine-related adverse events. Thus, the economic costs of uncontrolled influenza in the workforce must be compared with the costs of implementing influenza vaccination programs.

Several studies of the costs and benefits of annual influenza vaccination programs have demonstrated their economic benefits to profit-driven companies. A recent review of 11 health economic studies between 1979 and 2000 revealed that eight showed clear benefits of vaccinating the workforce [11]. Failure to show any benefit was linked to high vaccination costs, low levels of influenza, or short duration of sick leave. In reviewed studies where cost benefits were found they mostly resulted from indirect cost savings (CS) such as losses arising from absenteeism or low levels of production while at work [11]. In fact, such indirect costs are the most important considerations for the benefits of such vaccination programs [11,12]. Other health economic analyses have shown benefits of vaccination programs where influenza rates among the workforce are as low as 2% and that vaccination of the healthy working population aged 18 to 50 years against influenza in a variety of settings is cost-effective during most influenza seasons [13,14]. These findings have been confirmed in randomized, double blind, and placebo-controlled trials of influenza vaccination of healthy working adults [4,11]. Vaccination against influenza has also been shown to reduce absenteeism significantly [15]. The American Center for Disease Control and Prevention (CDC) has shown that the benefits of vaccination of healthy people less than 65 years old are optimized if a vaccine strain is chosen that matches the strain responsible for disease outbreaks in that year [3]. Elsewhere, health economic modeling has been used to indicate the pricing of a novel, nasal delivery system for an influenza vaccine, to enable programs using this system to break even financially [16].

The majority of these published studies have measured the effects of vaccination in northern, temperate climates. Few studies have been implemented in tropical countries such as Colombia where influenza circulation is perceived to be moderate. It is important to evaluate the potential health and economic benefits of vaccination against influenza in these countries.

The study described here evaluates the economic impact of an influenza vaccination program in a Colombian banking company. The primary objective of this study was to determine whether vaccination against influenza decreases the rate of influenza-like illness (ILI) and levels of absenteeism and how vaccination affects the financial losses associated with ILI in healthy adults in an occupational setting. The secondary objective was to determine whether the indirect financial benefits of the vaccination program outweigh the overall costs.

Methods

This nonrandomized, prospective, and observational study was conducted among the workforce of a bank in Bogota, Colombia between October 2000 and May 2001. The study was designed to evaluate the economic benefits of vaccination from the point of view of the employer exclusively.

The bank's entire workforce ($N = 2598$) was asked to participate in the study via the company's internal information services—Internet, fax, notice boards, and newspapers. To be eligible, employees had to be in full-time employment, aged 18 to 64, not be at high risk of complications as a result of influenza, not to have been diagnosed with influenza in the previous 3 months nor already vaccinated against influenza during winter 2000. A total of 834 employees were eligible and willing to participate to the study. Questionnaires were completed by 827 but 68 had to be excluded, resulting in a final sample size of 759.

Completed questionnaires provided demographic data, medical history, and employment-specific data, including the number of people, including children, living in each household and the employee's education, level of responsibility within the workplace, and any underlying chronic medical conditions considered to be at-risk factors for influenza. Preliminary data were collected at the appointment during which vaccine was administered (vaccinated group) or by mail (nonvaccinated group). These data included an analysis of the employees' own perception of their health status, obtained using an analog scale, 0 to 10, where 0 is worst possible health and 10 is normal. Subjects estimated their ability to perform their usual activities using a similar scale, with 0 corresponding to an inability to perform their usual activities and 10 corresponding to an unhindered ability to perform usual activities.

An annual vaccination program was established with vaccination occurring during the first week of October: vaccinated subjects received one dose of an inactivated, split influenza vaccine (IMOVAX®, Aventis Pasteur, Lyon, France) as an intramuscular injection in the leg or upper arm. The program was organized and implemented internally, involving occupational nurses employed in the occupational health department. Thus, the timeframe of intervention was 1 week whereas the analytical horizon—follow-up and measurement of vaccination's costs and benefits—was from October to May.

The vaccinated group reported any adverse events within 7 days postvaccination, including associated treatments or sick leave. During the entire study period—8 months—all subjects completed monthly questionnaires administered by telephone. Occurrence of ILI was noted, defined as the occurrence of a febrile illness of at least 2 days' duration having at least one systemic symptom—fever, chills, and myalgia—and at least one respiratory-tract symptom—rhinorrhoea, sore throat, cough, and hoarseness. Adverse events—fever, tiredness, muscle aches, headache, and allergic reaction; and pain, redness, itchiness, and swelling at the vaccination site—were recorded during the 7 days after vaccination.

Health economic analysis and statistics. The percentage (%) effectiveness of vaccination was calculated using the equation:

$$\% \text{ effectiveness} = [(\%\text{ILI in nonvaccinated group}) - (\%\text{ ILI in vaccinated group})]/(\%\text{ ILI in the nonvaccinated group}).$$

Qualitative and quantitative data from the two groups were compared using analysis of variance (ANOVA) or nonparametric tests (Mann–Whitney Wilcoxon for the comparison of two data sets or Kruskal–Wallis for comparison of more than two data sets) if ANOVA conditions could not be applied. Qualitative variables were compared using chi-square tests or Fisher exact tests if conditions for chi-square tests could not be respected. Cochran–Mantel–Haenszel tests were used for comparisons with adjustments for defined factors. Association between two quantitative variables was estimated by using the Pearson linear correlation coefficient or Spearman when Pearson's condition could not be applied.

The cost–benefit evaluation of the vaccination program was performed from the perspective of the employer, focusing on the direct vaccination program costs including the costs of vaccines, materials, and cost of administration, indirect costs of the vaccination program including the cost of time for the employees to get the vaccine and the indirect cost of adverse events in terms of productivity, indirect costs of ILI including sick leave, either with or without temporary replacement of the employee, and the cost of productivity lost in case of employees working while sick (Table 1). The financial costs of these outcomes to the employer were estimated by considering salaries as well as the loss of income caused by the employee's absence or illness. Both

Table 1 Sources and calculations for economic evaluation data

Economic evaluation items	Economic calculation (including operating income)
Direct vaccination program costs	
Costs of vaccines and materials	Purchasing prices
Costs of administration of vaccines by occupational health nurse	Time × hourly labor costs
Indirect vaccination program costs	
Cost of average time lost by vaccinated employees during administration	Time (20 min) × (hourly labor costs + individual hourly operating income)
Cost of working days lost due to adverse events	Time × (daily labor costs + daily individual operating income)
Indirect ILI costs	
Cost of sick leaves due to ILI when the employees are not replaced	Number of days × (daily labor costs + daily individual operating income)
Cost of decreased productivity due to ILI episodes	Number of days × % of reduced effectiveness × (daily labor costs + daily individual operating income)
Indirect vaccination program benefits (not vaccinated vs. vaccinated)	
Avoided cost of sick leaves due to ILI when the employees are not replaced	Number of days × (daily labor costs + daily individual operating income)
Avoided cost of decreased productivity due to ILI episodes	Number of days × % of reduced effectiveness × (daily labor costs + daily individual operating income)

the employer and contracted Health Maintenance Organizations (HMOs) are responsible for meeting the labor costs for absent employees. In this case, the employer pays 100% of the costs for the first 3 days of absence and for each subsequent day the company pays 33% and the contracted HMO pays 67% of the costs. Nevertheless, the employer ultimately bears these costs through the annual contract with the HMO, so full salary costs were included in these calculations.

Two scenarios have been considered:

- The base case that includes salaries plus operating income (OI); and
- The low case scenario that considers salaries alone.

The net financial benefit of the vaccination program, in the form of the CS was calculated using formula:

CS = (cost of ILI in nonvaccinated employees) – (cost of ILI in vaccinated employees + cost of vaccination program)

The net benefit per vaccinated employee is calculated by dividing the overall net benefit by the number of vaccinated employees.

Employees with ILI who attend work are likely to be less efficient. Cost–benefit analyses were performed taking into account three levels of such reduced efficiency—70% (H1), 50% (H2), and 30% (H3) [12,13]. Finally, replacement costs were not applied because no replacement occurs for absence below 20 consecutive days in this bank, which did not happen in the study.

Results

This health economic study of the benefits to the employer of an influenza-vaccination program was performed using staff of a Colombian bank which at the time of the study had a total workforce of 2598 employees, 827 of whom volunteered to take part in the study. Of these, 92% (759/827) completed the full follow-up period, 424 of whom were vaccinated (56%) and 335 were not vaccinated (44%). During the entire follow-up period questionnaire completion was always greater than 96% in the vaccinated group and greater than 99% in the nonvaccinated group.

The two groups were similar in terms of sex and marital status (Table 2). Nevertheless, there were significant differences between the two groups. The mean age of the nonvaccinated group was significantly lower than that of the vaccinated group ($P = 0.001$). This difference was unlikely to be of clinical significance and was only detectable because of the large sample size increasing the sensitivity of the ANOVA test. Vaccinated subjects tended to live in more populous households ($P < 0.0001$) with more children than did the nonvaccinated group ($P < 0.01$) and their levels of education and workplace responsibility tended to be lower than those of the nonvaccinated group ($P < 0.001$). These data were confirmed by multivariate analyses of the two

Table 2 Comparisons of baseline information about the two study groups

	Vaccinated	Nonvaccinated	*P* value
Age, mean (±SD)	33.3 (±7.6)	31.7 (±6.0)	0.001
Sex, F/M	52%/48%	48%/52%	NS
Marital status, married/single or divorced	54%/46%	50%/50%	NS
Number of people living in the household, mean (± SD)	4.0 (±2.1)	3.4 (±1.2)	<0.0001
Households with children	35%	23%	<0.01
Highest education level			<0.001
Secondary	14%	3%	
University	72%	86%	
Other	14%	11%	
Main workplace responsibility			<0.0001
Operations	55%	32%	
Middle management	10%	11%	
Support	29%	49%	
Executive management	6%	8%	
Smoking status			
Currently	25%	25%	NS
In past	14%	11%	
Sick leaves in the past 6 months	29%	16%	<0.0001
Chronic medical conditions			
Any disease	14%	10%	<0.05
Asthma	3.5%	4.1%	NS
Bronchitis	3.08%	3.8%	NS
Heart disease	2.38%	1.2%	NS
Previous influenza vaccination in the past	74%	38%	<0.0001

Table 3 Multivariate analysis showed differences between the two groups

	Vaccinated profile	Nonvaccinated profile
Age	40–45 years	30–35 years
Responsibility level	Operations or support responsibilities	Support responsibilities
Salary level (SMLV)	Less than 4 times SMLV	4–10 times SMLV
Education level	Secondary	University

SMLV, Annual Legal Minimum Salary Value decided by the National Government yearly. In 2002, SMLV = 309.000 Colombian Pesos.

groups (Table 3). Subjects in the vaccinated group had taken significantly more sick leave in the 6 months preceding the study than had the nonvaccinated group ($P < 0.0001$) and were more likely to have a chronic medical condition ($P < 0.05$). Significantly more people choosing to be vaccinated in this study had previously been vaccinated compared to those choosing not to be vaccinated ($P < 0.0001$).

At the start of the study all participants considered themselves to have good health. Overall, the health status of the vaccinated group measured 8.8 (± 1.1) compared to 9.0 (± 0.6) in the nonvaccinated group. It is noteworthy that the vaccinated group generally considered themselves to have slightly but significantly lower health status ($P < 0.05$) than the nonvaccinated group immediately before vaccination. Both the vaccinated [9.3 (± 0.8)] and nonvaccinated [9.1 (± 0.7)] groups considered themselves able to perform their usual activities without difficulty.

Postvaccination adverse events were recorded for 7 days after vaccination. Of the 424 vaccinated employees, 2.6% (11/424) reported local or systemic adverse events, the most frequent being sore throat, fever, chills, cough, and muscle aches. Pain was declared only three times.

ILI Frequency

In the following analyses the data for one vaccinated employee reporting an ILI episode were excluded. This employee was absent for 26 days and the illness was subsequently identified as pneumonia.

One hundred and ninety-three subjects reported a total of 221 ILI episodes. In the vaccinated group a total of 63 episodes were reported by 61 people and in the nonvaccinated group a total of 158 episodes were reported by 132 people. Overall, the cumulative incidence of ILI was 14.6% in the vaccinated group and 39.4% in the nonvaccinated group. Thus, vaccination significantly reduced ILI ($P < 0.0001$). More unvaccinated subjects (20.45%, 27/132) than vaccinated subjects (3.27%, 2/61) reported two or more ILI episodes (Table 4).

Table 4 Occurrence of ILI episodes among vaccinated and nonvaccinated groups

n ILI attacks	Vaccinated *n* (%)	Nonvaccinated *n* (%)	Total *N* (%)
0	363 (85.6)	203 (60.6)	565 (74.4)
1	59 (13.9)	107 (31.9)	167 (22.0)
2	2 (0.5)	24 (7.2)	26 (3.4)
3	0 (0.0)	1 (0.3)	1 (0.1)
Total	424 (100)	335 (100)	759 (100)

ILI attack rates were 15.09% in the vaccinated group and 47.16% in the nonvaccinated group. From these data, effectiveness rates for the vaccination program were 68.5% based on the attack rates and 63% based on the cumulative incidence.

Information about ILI symptoms was available for 216 of the 221 episodes. ILI symptoms were generally comparable in the two groups although fever, the most reported symptom, occurred less often among the vaccinated group (85%) than among the unvaccinated group (95%) (Table 5).

Figure 1 shows incidence of ILI episodes during the 32-week follow-up period and demonstrates four distinct periods:

1. Weeks 1 to 8: the number of ILI episodes was similar between the two groups.
2. Weeks 8 to 13: there were approximately 10 times more ILI episodes in the nonvaccinated group than in the vaccinated group.
3. Weeks 13 to 23: ILI was scarce.
4. Weeks 23 to 32: 89.8% (53/59) of reported ILI occurred in the nonvaccinated group.

A similar pattern was observed for ILI-related fever (data not shown).

Table 5 Distribution of reported ILI symptoms

Symptoms	Vaccinated *n* (%)	Nonvaccinated *n* (%)	Total *N* (%)
All ILI episodes	61 (100)	155 (100)	216 (100)
Fever	52 (85)	144 (95)	200 (93)
Chills	54 (88)	148 (95)	202 (94)
Muscle aches	59 (97)	151 (97)	210 (97)
Runny nose	59 (97)	151 (97)	210 (97)
Sore throat	59 (97)	151 (97)	210 (97)
Cough	59 (97)	139 (90)	198 (92)
Hoarse voice	59 (97)	136 (88)	195 (90)

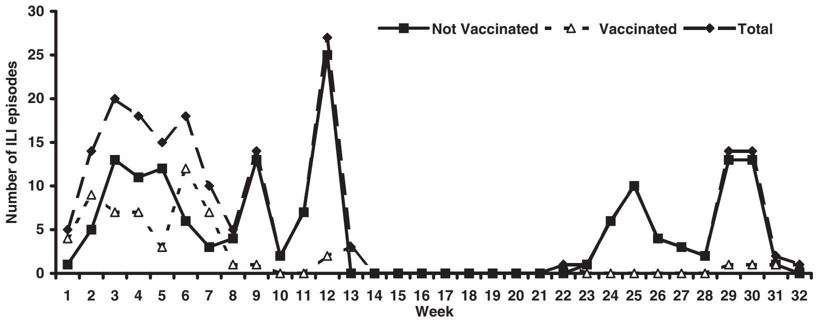

Figure 1 Occurrence of ILI episodes during the study period. The numbers of ILI episodes per week are shown for the nonvaccinated ($n = 335$) and vaccinated ($n = 423$) groups and for the whole study population. Clear reductions in the incidence of ILI are seen between weeks 8 and 13 and between weeks 23 and 32. Overall, most cases of ILI occurred in the nonvaccinated group.

Because of the differences between the two study groups shown in Table 2, logistic regression was performed to adjust for factors—smoking status, number of people in the household, presence of children in the household, absenteeism during the past 6 months—that may have affected the risk of ILI in either group. Chi-square (Cochran–Mantel–Haenszel) tests were all significant thereby proving that reduced incidence of ILI among vaccinated subjects is genuinely related to vaccination status despite differences between other characteristics of the two groups (data not shown).

Absenteeism/Sick Leave

During the study period 19 employees took sick leave because of ILI, 10 vaccinated and 9 nonvaccinated. In total, 19 working days were lost among vaccinated and 17 among nonvaccinated employees. Overall, the absence rate because of ILI symptoms was 2.59% in the vaccinated group and 2.69% in the nonvaccinated group.

A total of 327 days were occupied with ILI and recovery in the vaccinated group (mean: 5.64 ± 3.7 days per ILI episode) and 519 days in the unvaccinated group (mean: 3.48 ± 1.5 days per ILI episode). The number of absentee employees who were replaced during sick leave was negligible.

Presenteeism was calculated based on the total number of days before each group felt better while attending work—282 days in the vaccinated group and 502 days in the nonvaccinated group. The number of days used to calculate reduced productivity during presenteeism was obtained by subtracting the total number of sick leave days from the total number of days with ILI.

Economic Evaluation

The cost–benefit evaluation, performed from the company's perspective, focused on direct business costs—direct medical costs were not borne by the company—and indirect benefits of the influenza vaccination program. Based on the financial data provided by the bank, the average individual daily OI was US$387 per employee per day and the average daily salary was estimated to be US$58 per day. The total cost of the vaccine program including the cost of vaccines and administration costs—materials and nurses hired to perform vaccination—was US$2624 (i.e., US$6.2 per employee) and the total cost of employees' time away from work to receive vaccination was estimated to be US$513 based on salaries and US$3422 taking into account individual OI losses. The overall cost of postvaccination adverse events was approximately US$3932 including loss of productivity because of both absenteeism and temporary inefficiency at work. In addition to these costs, the effects of reduced productivity in both vaccinated and unvaccinated groups because of ILI was calculated based on three levels of productivity—70% (H1), 50% (H2), and 30% (H3) of normal. The results of these calculations are shown in Tables 6 and 7. When labor costs alone are considered, vaccinating employees against influenza saves US$6 to US$25 per vaccinated employee (Table 6). Nevertheless, absent employees or employees operating below their usual level of performance will contribute less OI to the company and when these income losses are considered vaccination against influenza will save between US$89 and US$237 per vaccinated employee.

Sensitivity analyses were performed to determine

Table 6 Vaccination program costs and savings per employee arising from vaccination—labor costs only

	Total cost of absenteeism, presenteeism and vaccination—labor costs only		
	H1*	H2†	H3‡
Vaccinated ($n = 424$)	9604.53	12,882.50	16,160.47
Nonvaccinated ($n = 335$)	9740.91	15,576.16	21,411.41
Cost saving per employee	6.43	16.11	25.80

*H1: productivity rate with ILI symptoms = 70%.
†H2: productivity rate with ILI symptoms = 50%.
‡H3: productivity rate with ILI symptoms = 30%.

Table 7 Vaccination program costs and savings per employee arising from vaccination—labor costs plus operating income

	Total cost of absenteeism, presenteeism and vaccination—labor costs plus operating income		
	H1*	H2†	H3‡
Vaccinated (*n* = 424)	56,656.22	81,787.50	106,918.78
Nonvaccinated (*n* = 335)	74,680.88	119,418.12	164,155.36
Cost saving per employee	89.30	163.58	237.85

*H1: productivity rate with ILI symptoms = 70%.
†H2: productivity rate with ILI symptoms = 50%.
‡H3: productivity rate with ILI symptoms = 30%.

the effects of vaccination coverage or levels of ILI in the unvaccinated workforce on the CS (Fig. 2). These sensitivity analyses were performed for each of the three levels of productivity described above. Depending on productivity, vaccination is cost effective when 1 to 2 employees out of 10 are vaccinated, i.e., 10% to 20% coverage (Fig. 2a). Analysis of the sensitivity of savings to levels of ILI showed that vaccination has financial benefits when ILI rates among unvaccinated employees exceed 0.1, i.e., 10% (Fig. 2b).

Conclusions

The value of influenza vaccination in groups at risk of severe complications from influenza infection, the elderly and those with underlying chronic medical conditions, is widely acknowledged and vaccination also reduces morbidity caused by influenza in healthy adults [4,6,7,14,17–21]. Nevertheless, the economic benefits of vaccination are generally not recognized in areas of moderate influenza circulation such as tropical regions. The present study was performed to determine whether an employee vaccination program is an attractive option for employers seeking to reduce the financial losses associated with absenteeism and decreased work productivity during the influenza season. The study monitored rates of ILI and absenteeism in vaccinated and nonvaccinated people employed in a Colombian bank.

ILI episodes had significant impact on work productivity even when the number of occasions of sick leave remained low. ILI rates were lower in the vaccinated group (cumulative incidence of 14.6%) than in the nonvaccinated group (cumulative incidence of 39.4%). Nonvaccinated employees were three times more likely than vaccinated employees to experience at least one ILI episode. This study demonstrates that an employee vaccination program is effective—effectiveness rate of 68%—and safe. Postvaccination adverse effects were reported by just 2.6% of the vaccinated group, which is low compared to published data (6.2% to 63.8%) [4,6,19]. Nevertheless, Wilde et al. [7] reported no absences resulting from vaccine-related adverse events and apart from mild pain and swelling, no significant adverse events were related to the influenza vaccine. Therefore, although the low incidence of vaccine-related adverse events could be due to under-reporting by subjects this could be a genuinely low rate of adverse events.

This pragmatic observational study involved volunteer subjects because a randomized, controlled trial was inappropriate for an analysis of general use of the vaccine. Nevertheless, statistical adjustment to account for possible exposure factors was essential to ensure that the two cohorts were statistically comparable. The only factor associated with different ILI rates between the two groups was vaccination status.

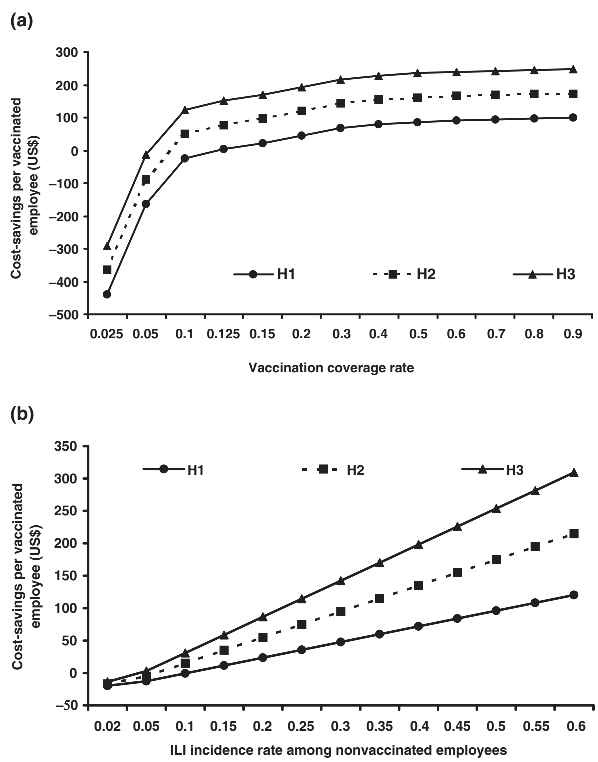

Figure 2 Impact of vaccination coverage rate (a) or rate of ILI among nonvaccinated employees (b) on annual total cost-savings. Total savings resulting from an employee vaccination program were calculated based on (a) vaccination coverage (up to 9 out of 10 employees vaccinated) or (b) ILI occurring in up to 6 out of 10 nonvaccinated employees. These calculations were performed taking into account the reduced productivity resulting from people being at work when ill. Three productivity rates were considered: 70% (H1), 50% (H2), and 30% (H3) of normal.

In this study, very low absenteeism rates were reported. Only one case of long-term sick leave—26 days—was reported and this individual was subsequently confirmed to be suffering from pneumonia. Also, the bank operated a "no replacement policy" for sick leave of less than 20 days duration. The probable effect of this policy would be to underestimate the impact of ILI among sick employees who continued working—so-called presenteeism. Also, the presence of sick colleagues in the workplace would increase levels of ILI contagiousness and increase ILI attack rates in the study population. Despite these circumstances, the vaccination demonstrated a high level of effectiveness (68%).

The influenza season in South America is different from that in North America so different strains of influenza virus might be involved in these geographically distinct regions and most effective vaccination might require vaccines with different viral strains [17]. Nevertheless, Brazilian Grupo Regional de Obseração da Grippe (GROG) and unpublished epidemiological surveys of the São Paulo city area report epidemiological data similar to the results of surveys performed in North America and Europe. Therefore, Burckel et al. considered it reasonable to apply data from the Americas to Brazil [17]. The results of the current study can also be assumed to be similar to those reported in North America and Europe.

When all study conditions are considered (sample size, influenza circulation, matching of circulating influenza strains, and the ones contained in the vaccine) and assumptions made concerning reduced productivity rates, the CS per vaccinated employee in this study varied between US$89 (70% efficiency) and US$237 (30% efficiency) when both labor costs and OI are considered. Even when OI is excluded from the analysis, savings of up to US$25 per employee are made in addition to the health benefits of vaccination. Clearly, the total amount saved by the company will be greater if more employees are vaccinated and the more ILI that is prevented, as demonstrated by the sensitivity analyses shown in Figure 2. These figures were calculated using a mean salary for each employee, rather than using actual salaries. Although it is expected that actual salaries might affect the amount saved [16] we agree with Postma et al. [11] that using different salary levels might lead to ethically unacceptable behavior such as only vaccinating those employees earning a salary that leads to CS.

The results of this study demonstrate the potentially significant economic benefits of the employee vaccination program especially when the study conditions are taken into account—not all bank employees were involved in the study, there was only a mild outbreak of influenza during the study period, optimistic hypotheses of lost productivity were considered; effectiveness at work could be considered much lower when ill. Additionally, the sensitivity analysis showed that possible expansion of influenza vaccination to most of the company would lead to substantial cost savings for the employer, even with conservative assumptions. Knowing the impact that vaccination coverage rate has on the return on investment, substantial effort should be made to communicate and persuade employees to be vaccinated to maximize both the health and financial benefits of the program.

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