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Original Article

Workplace influenza vaccination in private hospital setting: a cost-benefit analysis

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ABSTRACT

Background: Influenza illness causes several disruptions to the workforce. The absenteeism that often ensues has economic implications for employers. This study aimed to estimate the cost-benefit of influenza vaccination in a healthcare setting from the employer's perspective.
Methods: A cross-sectional questionnaire survey was conducted in a private hospital in 2018–2019 comparing voluntary vaccinated with non-vaccinated employees with influenza vaccine. The analyses were made based on self-reporting on absenteeism and presenteeism from Influenza-like illnesses (ILIs). The costs incurred, both direct and indirect costs, were included in the study. A cost-benefit analysis was performed by measuring the cost of the vaccination program. The costs of absenteeism and reduced productivity were calculated using 3 hypothesised levels of effectiveness in the following percentage of productivity of 30%, 50%, and 70%. The costs were also calculated based on four scenarios: with and without operating income and with and without replacement. The benefits of the influenza vaccination from the employer's perspective were analysed. The benefit to cost ratio was determined.
Results: A total of four hundred and twenty-one respondents participated. The influenza vaccination rate was 63.0%. The rate of ILI of 38.1% was significantly lower among vaccinated. The ILI-related absenteeism reported was also significantly lower amongst vaccinated employees at 30% compared to 70% non-vaccinated. Employers could save up to USD 18.95 per vaccinated employee when only labour cost was included or 54.0% of cost savings. The cost-saving rose to USD 155.56 when the operating income per employee was also included. The benefit to cost ratio confirmed that the net cost-benefit gained from the vaccination was more than the net cost of vaccination.
Conclusions: Influenza vaccination for working adults was cost-saving and cost-beneficial when translated into financial investments for the employer. A workplace vaccination demonstrates a significant cost-benefit strategy to be applied in any institutional setting.

Keywords: Influenza vaccination; Workplace; Influenza-Like illness; Absenteeism; Cost-benefit

Competing interests
The authors declare that have no competing interests.

Author contributions
Conceptualization: Tohiar MAH, Aizuddin AN, Tan KL; Data curation: Tohiar MAH, Jaafar S; Formal analysis: Jaafar S; Writing - original draft: Tohiar MAH, Jaafar S, Aizuddin AN; Writing - review & editing: Jaafar S, Abd Rahim AS.

BACKGROUND

Influenza vaccination remains the best control measure for prevention since it provides substantial protection from influenza illness and its potential complication.[1,2] The impact of influenza affects health and poses an economic burden due to its ease of spread.[3] The economic implications ascribed to the infection can be reflected by the increased number of outpatient clinics visits, hospitalisation, cost of medical expenses, and loss of productivity from missed workdays.[4]

Rolfes *et al.* reported that influenza vaccination has helped prevent about 1.6–6.7 million illnesses, 790,000–3.1 million outpatient medical visits, 39,000–87,000 hospitalisations, and 3,000–10,000 respiratory and circulatory deaths during each season, during the past 6 influenza seasons (2010–2011 to 2015–2016 in the US.[5]

Cost-benefit analysis on influenza vaccination conducted by Morales et al.[6] amongst employees in a Colombian Bank found that the employer can save up to USD 25.8 per vaccinated employee based on labour cost alone. The savings increased up to USD 237.8 per vaccinated employee when the operating income was included. Colamesta et al.,[7] in their study in Italy, found that loss of productivity was equal to €297.06 for vaccinated employees versus a higher €517.22 for unvaccinated.[7] Similarly, a prospective workplace study in the petrochemical company in Malaysia conducted in 2001 and published in 2006 evaluating the health and economic benefits of the workplace vaccination program, showed that vaccination had a clear impact on ILI rates.[8] The employer could save up to USD 53.0 per vaccinated employee when only labour cost was considered, and the saving tremendously rose to USD 899.7 when the operating income was included. From the cost-benefit perspective, which refers to the health benefits translated into financial benefits for the employer, vaccination will lead to significant cost savings, outweighing the costs of the vaccination program.[9-11]

There has been an increasing trend of influenza cases in the workplace. It will have an impact on the disease burden and consequentially the productivity of the employees and economic burden, which will significantly affect an organisation's profits.[12,13]

The year 2030 will mark the intended achievement of Sustainable Developmental Goals (SDG) or Global Goals, part of the United Nations Resolution set in 2015. Goal number 8 is to 'promote sustainable economic growth, full and productive employment and decent work for all; remains the main challenge worldwide.[14] The health of workers and occupational safety pose a serious threat, especially any illness that can potentially cause pandemic threats such as influenza infection. The coronavirus pandemic in 2020 has proven to cause profound impact and changes to the global economy.

In 2018, the world Global Domestic Products (GDP) per capita growth rate (a hallmark for economic growth) was reported to be at 2.0%, mainly driven by solid progress in Eastern and Southeast Asia.[15] The World Bank reported in 2019 that the growth dropped to 1.5%. The International Monetary Fund (IMF) initially forecasted GDP growth worldwide to increase to 3.5% in 2020. However, due to the current coronavirus pandemic, the expected decline in economic growth is 4.2%.[16]

Several studies have shown a strong relationship between influenza infection and absenteeism and presenteeism, resulting in lowered workplace productivity.[12,17-19]

In the US, the Centre for Disease Control and Prevention, National Institute for Occupational Safety and Health analysed the prevalence of sick days during the peak season of influenza. The report concluded that absenteeism during the influenza season of 2017–2018 increased sharply from 1.7% starting in October and peak up to 3.0% during the January period. In addition, the data captured the prevalence of absenteeism was high among male workers between 45–64 years of age and those who work in management, business, financial, maintenance and production.[20]

The concept of presenteeism, which is defined as "ill and still work," is getting much more attention nowadays. Unlike absenteeism, it is not always apparent as one cannot tell how much the illness or other medical conditions are overshadowing someone's performance in the workplace.[21] Certain professions like healthcare workers are likely to report having presenteeism, and this is due to common factors such as heavy workloads, working schedules in shifts, and difficulties in finding a replacement.[22,23] McKevitt et al.[24] reported that 88.0% of employees and 85.0% of healthcare workers worked while being sick.

Bloom et al.,[25] in his paper, discussed that vaccines had been undervalued and proposed that economic evaluations be conducted to reflect their total value. Several studies have demonstrated the economic benefits of annual influenza vaccination. Preaud et al.,[26] in their study, generated a model to evaluate the public health benefits and economic importance of influenza vaccination in five recommended target age groups of the European Union. Their study showed that with 44.4% vaccination coverage, it could prevent on average 1.6–2.1 million cases of influenza illness, 453,000–656,000 hospitalisation and 252,000–372,000 deaths. With 75% target vaccination coverage, the cost averted for influenza-related illnesses would be increased by an additional €190–226 million annually, with 883,800 to 1,015,000 lost days of work would be prevented annually.[26]

Influenza vaccine is widely available in Malaysia; however, it is not funded in the National Immunization Program. The current Malaysian Guidelines on adult immunisation recommended the vaccination to the following target groups; healthcare workers, persons with a high risk of developing complications from influenza infection (persons 50 years or older, persons age 18–49 years with one or more medical conditions, pregnant women), persons living in specific institutional settings and those performing religious pilgrimages. In Malaysia, research on economic analysis on workplace influenza vaccination has not been widely studied. The previous study was conducted by Samad and colleagues in 2001[8] in a petrochemical industry almost two decades ago. This present study is a follow-up to examine the cost-benefit of influenza vaccination in a healthcare workplace to assess the changes in the value and trend.

METHODS

Study design

The study adopted a cross-sectional survey in a private hospital setting. The selection of eligible participants was made using the cluster purposive sampling method. The employee was selected across the various departments divided proportionately using the employee register as the sampling frame. The chosen participants include full-time clinical and non-clinical employees who were in employment between January 2018 and June 2019. Questionnaires were distributed to each team and collected by the head of departments. The questionnaires

gathered demographics, including sex, age, educational level, vaccination status, medical history, and responsibility in the workplace. Data were anonymised for analysis.

Influenza-like illness (ILI) is defined as the occurrence of a respiratory illness of at least two days duration, having at least one systemic symptom (fever, chills, myalgia) and at least one respiratory tract symptom (rhinorrhoea, sore throat, cough, hoarseness).[8] The above definition for ILI was used instead of the global World Health Organisation (WHO) definition (acute respiratory illness with a fever of temperature ≥ 38°C and cough with onset within the last ten days) since the latter definition is usually used for surveillance of influenza cases. This working definition was used for this study. All vaccinated employees from this study had been vaccinated using 2017/2018 inactivated quadrivalent influenza vaccine. Vaccinated employees were required to report a history of side effects (fever, tiredness, allergy reaction, pain and swelling over injection site) within the one week of post-vaccination. A point to note this study was conducted in 2019 before the coronavirus disease-19 pandemic began.

Cost analysis

The cost evaluation of this study was performed from the perspective of the employer. The costs were converted in USD with the rate of USD 1.00 equal to Ringgit Malaysia RM 4.19, as an average for December 2018.[27] The costs calculation employed both the step-down and bottom-up costing methods shown in **Table 1**. Data on cost for this study has been extracted from the finance department of the study premise. The costs incurred that were included in the study were both direct and indirect costs. The direct cost includes vaccines and materials and the cost of nursing employees in the Health Screening Unit involved with the vaccination. The indirect costs were the average time lost by vaccinated employees during the vaccination process and the costs of working days due to vaccination's adverse events or side effects. These costs were calculated based on an average per employee.

For the base value calculation, the following parameters were used; the hospital's total number of 712 employees at the time of study period, the number of working days per month for 26 days, and a total of 8 hours of a working day. The base value came to an average salary cost per employee; per month amounting to USD 766.66 per day was USD 29.49, per hour was USD 3.68, and per minute was USD 0.06.

The daily operating cost per employee was USD 166.66, and the average cost of locum and overtime per employee per day was USD 2.56.

The vaccine effectiveness measurements in this study were reflected by the reduction in ILI and absenteeism rate. The costs related to ILI, such as sick leave and reduced productivity, were calculated using three hypothesised levels of effectiveness at work while suffering the effects of ILI in the following percentage of productivity 70%, 50%, and 30%.[28,29] This vaccination effectiveness was then calculated in monetary terms. The calculation and iterations are shown in **Table 2**.

The following final formula (Equation 1) was used to calculate the economic benefit of the vaccination program:

$$\text{Cost of ILI in Non-vaccinated Employees}) - (\text{Cost of ILI in Vaccinated Employees} + \text{Cost of Vaccination Program}) \quad (1)$$

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Table 1. Costing analysis

Cost extracted from finance department of study premise	Monetarisation
A. Direct vaccination program costs	
Costs of vaccines and materials	Purchasing Prices per Vaccine USD 7.16
Costs of employee at Health Screening Unit	Time (min) × Labour Cost per Minute
	18 minutes × Salary per Minute per Employee USD 0.06
B. Indirect vaccination program costs	
Cost of average time lost by vaccinated employees during the administration	Time (min) × Labour Cost per Minute
	18 minutes × Salary per Minute per Employee USD 0.06
Cost of working days lost due to adverse events	Time × Daily Labour Cost (no employee reporting having side effects)
C. Indirect ILI costs (excluding impact on operating income[a])	
Cost of sick leave due to ILI when the employees are not replaced	Number of Sick Day Leaves × Daily Labour Cost
	Number of Sick Day Leaves × Daily Salary per Employee USD 29.49
Cost of sick leave due to ILI when the employees are replaced	Number of Sick Day Leaves × (Daily Labour Cost of Absent Employees + Daily Labour Cost of Internal[b] or External[c] Replacement)
	Number of Sick Day Leaves × (Daily Salary per Employee USD 29.49 + Daily Overtime and Locum per Employee USD 2.56)
Cost of decreased productivity[d] due to ILI episodes	Number of Days Decreased Productivity × (% Reduced Effectiveness in Productivity) × Daily Labour Costs
	Number of Days Decreased Productivity × (30%/50%/70%) × Daily Salary per Employee USD 29.49
D. Indirect ILI costs (including impact on operating income)	
Cost of sick leave due to ILI when the employees are not replaced	Number of Sick Day Leaves × (Daily Labour Cost of Absent Employees + Daily Operating Income per Employees)
	Number of Sick Day Leaves × (Daily Salary per Employee USD 29.49 + Daily Operating Income per Employee [a]USD 166.66)
Cost of sick leave due to ILI when the employees are replaced	Number of Sick Day Leaves × (Daily Labour Cost of Absent Employees + Daily Labour Cost of Internal or External Replacement)
	Number of Sick Day Leaves × (Daily Salary per Employee USD 29.49 + Daily Overtime and Locum per Employee USD 2.56)
Cost of decreased productivity due to ILI episodes	Number of Days Decreased Productivity × (% Reduced Effectiveness in Productivity) × (Daily Labour Cost + Daily Operating Income per Employees)
	Number of Days Decreased Productivity × (30%/50%/70%) × (Daily Salary per Employee USD 29.49 + Daily Operating Income per Employee [a]USD 166.66)

ILI: influenza-like illness.
[a]Operating income: The operating income is calculated by subtracting the cost of sales, selling and administrative expenses to the company's turnover. The finance department of this study premise provided the data figure on the total operating income. Total operating income for the year was divided as an average per month, per working days and later divided by total employees, which gives the daily operating income USD 166.66.
[b]Internal replacement: Referring to the company's own employees who replace the duty of the other employees who was absent from work due to ILI. This usually apply to employees who works on shift basis being replaced whenever they out of their duty. The replacement will be duly reimbursed by the hospital administration.
[c]External replacement: Referring to employees who were not directly hired by the company.
[d]Reduce productivity: Measuring effects of presenteeism using three hypothesised[31,32] level of effectiveness while suffering the effects of ILI: P1 30% productivity, P2 50% productivity, P3 70% productivity of a full day work.

Table 2. Total numbers of working days lost in vaccinated and non-vaccinated

Number of working days lost	Vaccinated		Non-vaccinated		Total days
	No of staff	Cumulated days	No of staff	Cumulated days	
5 days	5	25	22	110	135
4 days	1	4	5	20	24
3 days	0	0	7	21	21
2 days	1	2	5	10	12
1 day	11	11	3	3	14
Total	18	42	42	164	206

RESULTS

A total of 421 respondents participated in this study (**Table 3**). Although the analysis was not statistically significant, females were predominant (63.7%) and vaccinated. The mid-age groups in the prime employment age between 25 to 54 years of age represented the majority (82.4%) of the respondents, with (63.4%) were vaccinated. The educational background of respondents was mainly from the tertiary level, the colleges and universities making up to

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Table 3. Respondents' demographic

Variables	Vaccinated (n = 265)	Non-vaccinated (n = 156)	Total (n = 421)	*p*-value[a]
Sex				0.460
Male	45 (59.2)	31 (40.8)	76 (18.1)	
Female	220 (63.7)	125 (36.3)	345 (81.9)	
Age group (years)				0.850
15–24	39 (60.0)	26 (40.0)	65 (15.4)	
25–54	220 (63.4)	127 (36.6)	347 (82.4)	
55–64	6 (66.7)	3 (33.3)	9 (2.1)	
Education				0.007
Secondary	87 (70.7)	36 (29.3)	123 (29.2)	
College	94 (67.6)	45 (32.4)	139 (33.0)	
University	78 (52.0)	72 (48.0)	150 (35.6)	
Others	6 (66.7)	3 (33.3)	9 (2.1)	
Ethnicity				0.210
Malay	241 (62.6)	144 (37.4)	385 (91.4)	
Indian	20 (69.0)	9 (31.0)	29 (6.9)	
Chinese	4 (80.0)	1 (20.0)	5 (1.2)	
Others	0 (0.0)	2 (100.0)	2 (0.5)	
Marital status				0.530
Single	82 (64.6)	45 (35.4)	127 (30.2)	
Married	178 (61.8)	110 (38.2)	288 (68.4)	
Widowed	5 (83.3)	1 (16.7)	6 (1.4)	
Job description				0.001
Clinical	176 (72.7)	66 (27.3)	242 (57.5)	
Non-Clinical	89 (49.7)	90 (50.3)	179 (42.5)	

Values are presented as number of patients (%).
[a]χ^2 test applied with significant level < 0.05.

about (68.6%), and more than half were vaccinated with a significant level of $p = 0.007$. The other predominant characteristics of the respondents were of Malay ethnicity, married, and with a clinical background.

The study found that ILI was present amongst 118 (28.0%) respondents within the study period. The rate of ILI was significantly lower among vaccinated at 17.0% than non-vaccinated, which was 47%. The overall rate of ILI amongst those vaccinated was also much lower (38.1%) than the non-vaccinated (61.9%) and was statistically significant (**Table 4**).

Based on the responses by the study samples, the majority of those who contracted the disease recalled that they had only one episode of ILI within the study period. It was apparent that those vaccinated had lesser reports of absenteeism (30.0%) and presenteeism (46.5%)

Table 4. ILI prevalence, absenteeism and presenteeism amongst vaccinated and non-vaccinated

Variables	Vaccinated	Not vaccinated	Total	*p*-value[a]
ILI after vaccination or in 2018				0.001
Yes	45 (38.1)	73 (61.9)	118 (28.03)	
No	220 (72.6)	83 (27.4)	303 (71.97)	
Working status				0.001
Absenteeism				
Yes	18 (30.0)	42 (70.0)	60 (14.2)	
Presenteeism				
Yes	27 (46.5)	31 (53.5)	58 (13.8)	
Working				
Yes	220 (72.6)	83 (27.4)	303 (72.0)	

Values are presented as number of patients (%).
ILI: influenza-like illness.
[a]χ^2 test applied with significant level < 0.05.

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compared to those non-vaccinated, and the analysis was also statistically significant. Respondents who reported absenteeism due to ILI was calculated based on the total days of the medical certificate given by the doctor. The study also showed that 72.6% of those vaccinated were working compared to 27.4% of non-vaccinated.

In **Table 2**, the total numbers of working days lost, between one to 5 days, among vaccinated and non-vaccinated employees were calculated based on reported numbers of sick-day leaves given by the treating doctor from each employee. The accumulated days lost among vaccinated employees were much lower at 42 days compared to 164 days among non-vaccinated.

The cost analysis was conducted as follows: firstly, the cost of the vaccination program was calculated. Separately, costs implicated by absenteeism and presenteeism with and without replacement were calculated by measuring the total working days lost and productivity days lost reported by each employee (**Table 2**). Anticipated productivity loss due to ILI symptoms was hypothesised at three levels of productivity rate at 30% (P1), 50% (P2), and 70% (P3) and was then calculated accordingly. As the analysis was done from the employers' perspective, costs borne by the sick employees for any investigations and consultation visits or hospitalisation were not considered. Cost savings per vaccinated and non-vaccinated employee were also calculated. From the analysis, it could be projected that the employer has the potential savings of about USD 18.95 (**Table 2**) at hypothesised productivity loss of 30% per vaccinated employee when labour cost only was considered. But it can rise to a more significant savings of USD 155.56 per vaccinated employee when operating income without replacement was included at hypothesised productivity loss of 30% per vaccinated employee.

In **Tables 5** and **6**, the operating income and with and without replacement have been analysed for each table. The benefit-cost ratio for both tables showed a value greater than one, except when the replacement was included (**Table 6**) as the operating income will not be affected when the employees were replaced. This study demonstrated that vaccination

Table 5. Cost calculation on the impact of ILI and influenza vaccination program - cost exclude operating income

	Cost of vaccination program	Cost of absenteeism and presenteeism[a]		
		P1 (30%)	P2 (50%)	P3 (70%)
No Replacement				
Total cost of vaccinated employees	2,483.42	1,477.29	1,636.52	1,795.75
Total cost of non-vaccinated employees	0.00	5,110.06	5,292.88	5,475.70
Cost per vaccinated employee	9.37	5.57	6.18	6.78
Cost per non-vaccinated employee	0.00	32.76	33.93	35.10
Cost saving per vaccinated employee		17.81	18.38	18.95
Benefit to cost ratio[b]		1.90	1.96	2.02
Replacement				
Total cost of vaccinated employees	2,483.42	1,584.98	1,744.21	1,903.44
Total cost of non-vaccinated employees	0.00	5,530.57	5,713.39	5,896.20
Cost per vaccinated employee	9.37	5.98	6.58	7.18
Cost per non-vaccinated employee	0.00	35.45	36.62	37.80
Cost saving per vaccinated employee		20.10	20.67	21.24
Benefit to cost ratio[b]		2.14	2.21	2.27

The calculation was made both without and with associated cost replacing employees that are absent because of ILI.
ILI: influenza-like illness.
[a]P1 measuring effects of presenteeism using three hypothesized levels of effectiveness while suffering the effects of ILI: 30% productivity, P2 measuring effects of presenteeism using three hypothesized levels of effectiveness while suffering the effects of ILI: 50% productivity, P3 measuring effects of presenteeism using three hypothesized level of effectiveness while suffering the effects of ILI: 70% productivity.
[b]Benefit cost ratio is measured by calculating the Net Benefit, which is represented in the monetary unit. From this study, the benefit to cost ratio is measured by identifying the component involved: Net-cost of benefit gained from the Influenza Vaccination Program – Net Cost of Influenza Vaccination Program. Where Positive Net Cost is considered Cost Beneficial and Negative Net Cost is Less beneficial. The benefit-cost ratio summarises the overall value for the progrcost incurred on the vaccination program calculated as: Net Cost-Benefit/Net Cost Program: Where ratio > 1 is Cost Beneficial.

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Table 6. Cost calculation on the impact of ILI and influenza vaccination programme - cost includes operating income

	Cost of vaccination program	Cost of absenteeism and presenteeism[a]		
		P1 (30%)	P2 (50%)	P3 (70%)
No Replacement				
Total cost of vaccinated employees	5,795.88	8,527.19	8,719.76	8,912.32
Total cost of non-vaccinated employees	0.00	32,493.03	32,709.18	32,925.33
Cost per vaccinated employee	21.87	32.18	32.90	33.63
Cost per non-vaccinated employee	0.00	208.29	209.67	211.06
Cost saving per vaccinated employee		154.24	154.90	155.56
Benefit to cost ratio[b]		7.05	7.08	7.11
Replacement				
Total cost of vaccinated employees	5,795.88	1,634.98	1,827.54	2,020.10
Total cost of non-vaccinated employees	0.00	5,580.57	5,796.72	6,012.87
Cost per vaccinated employee	21.87	6.17	6.90	7.62
Cost per non-vaccinated employee	0.00	35.77	37.16	38.54
Cost saving per vaccinated employee		7.73	8.39	9.05
Benefit to cost ratio[b]		0.35	0.38	0.41

The calculation was made both without and with associated cost replacing employees that are absent because of ILI.
ILI: influenza-like illness.
[a]P1 measuring effects of presenteeism using three hypothesized levels of effectiveness while suffering the effects of ILI: 30% productivity, P2 measuring effects of presenteeism using three hypothesized levels of effectiveness while suffering the effects of ILI: 50% productivity, P3 measuring effects of presenteeism using three hypothesized level of effectiveness while suffering the effects of ILI: 70% productivity.
[b]Benefit cost ratio is measured by calculating the Net Benefit, which is represented in the monetary unit. From this study, the benefit to cost ratio is measured by identifying the component involved: Net-cost of benefit gained from the Influenza Vaccination Program – Net Cost of Influenza Vaccination Program. Where Positive Net Cost is considered Cost Beneficial and Negative Net Cost is Less beneficial. The benefit-cost ratio summarises the overall value for the progrcost incurred on the vaccination program calculated as: Net Cost-Benefit/Net Cost Program: Where ratio > 1 is Cost Beneficial.

was financially beneficial with a positive cost-benefit ratio. It showed that the influenza vaccination was cost-beneficial as the net cost of benefit gained is more than the net cost of vaccination (positive net-cost).

DISCUSSION

There have been numerous studies on the potential benefits of vaccinating specific target groups and high-risk groups, including the elderly, chronic medical illness, and pregnancy, which may develop severe complications from influenza infection. However, only a few recognised the potential benefits of vaccinating working adults, which does contribute to cost-saving not only the employee but also the employer.[30]

A study done in Russia in 2011 by At'kov et al.[31] found that the attack rate for ILI was 3.4 times lower among vaccinated subjects at 6.8% than among unvaccinated at 23.2%. Nearer to home for local comparison, Samad et al.,[8] in 2006; reported that the ILI rate among the vaccinated group was almost close to At'Kov about 3.7 times with 8.1% in the vaccinated group compared to 30.3% with non-vaccinated subjects. Both these findings were higher than this present study which recorded only 2.8 times lower in vaccinated respondents, 17.0% vaccinated and 47.0% unvaccinated. Although both were done in Malaysia, the difference in the rate with the study by Samad et al.[8] could be explained by the differences in study design and the sample population studied. Samad et al.[8] have conducted a cohort study with a large sample size among petrochemical companies with a different cost structure than this study's premise. Another possible related factor was the circulating influenza virus strains during these periods in which the studies were conducted and the types of vaccines used.

In this study, the total sick days' leaves (absenteeism) were higher among the non-vaccinated group than the vaccinated group and were statistically significant. Vaccinated employees

reported 40.0% ILI-related absenteeism compared to 57.5% by non-vaccinated employees, with an absenteeism rate of 0.16 days per employee and 1.05 days per employee, respectively, which translated to 6.5 times higher absenteeism rate amongst the non-vaccinated. Similar findings were reported in the same study by Samad et al.[8] with a significantly lower sick leave duration in the vaccinated group than in the non-vaccinated group (3 ± 0.98 vs. 4.22 ± 1.39 days) with a significant *p*-value of < 0.001. Similar to Ferro et al.,[32] his study in Italy found that the monthly mean days of sick leave per employee were significantly lower among the vaccinated than the unvaccinated during non-influenza and flu 0.328 days/person vs. 0.752 days/person ($p = 0.022$, respectively). Overall, all the studies described have shown that vaccination significantly reduced the sick leave and absenteeism days and the number of employees affected.

Vaccination can lead to significant cost savings per vaccinated employee when only labour cost was considered but increased when operating income is factored in. The present study demonstrated that vaccination was financially beneficial with a positive cost-benefit ratio.

This study implied that if this private healthcare institution invests USD 11,563.40 (Equation 2) to vaccinate all employees (n = 716), the ROI can reach up to 54% (Equation 3) (USD 13,568.20; Equation 4) in averting the indirect cost of absenteeism (when only labour cost with no replacement was included). Equations included the following factors: Number of All Employees (E, n = 716), Cost of Absenteeism and Presenteeism per Vaccinated Employee ($Cost_{APVA}$; USD 6.78), Cost of Vaccination Program per Employee ($Cost_{VPE}$; USD 9.37), and Cost of Absenteeism and Presenteeism per Non-vaccinated Employee ($Cost_{APNVE}$; USD 35.10).

$$(Cost_{APVA} + Cost_{VPE}) \times E = (USD\ 6.78 + USD\ 9.37) \times 716 \quad (2)$$

$$\{(Cost_{APNVE} \times E) - [(Cost_{APVA} + Cost_{VPE}) \times E)]\}/(Cost_{APNVE} \times E) \times 100$$
$$= \{(USD\ 35.10 \times 716) - [(USD\ 6.78 + USD\ 9.37) \times 716]\}/(USD\ 35.10 \times 716) \times 100 \quad (3)$$

$$(Cost_{APNVE} \times E) - [(Cost_{APVA} + Cost_{VPE}) \times E]$$
$$= (USD\ 35.10 \times 716) - [(USD\ 6.78 + USD\ 9.37) \times 716] \quad (4)$$

The ROI may significantly increase to USD 111,380.96 (73.7%), averting indirect absenteeism if operating income without replacement was included. Comparing the cost savings between the cost of vaccination with the cost of absenteeism and presenteeism, this hospital could save 54.0% to 73.7% (**Table 6**).

Compared with the study done by Samad et al.,[8] this study had a higher cost saving of USD 53.00 per employee (labour cost) and USD 899.70 if it also included operating cost. Ferro et al.[32] found similar findings in their study. The monthly mean cost for absenteeism per employee was significantly lower for vaccinated (€236) versus (€563) for unvaccinated subjects, giving the company a significant savings of €19,674.[30] At'kov et al.,[31] reported that the annual cost savings per vaccinated employee ranged from €2.13 to €5.43 depending on the productivity rate.[29] He added that at the company level, with a 50% vaccination coverage rate among employees, the yearly global cost savings would be between €1.2 million and €3 million.[29]

What is clear from several studies is that there were savings to the institutions when employees were vaccinated due to reduced absenteeism. However, the savings showed differences across locations, period conducted, study design used, the prevailing virus strain

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and the types of vaccine used. These studies demonstrated that the influenza vaccination was effective and cost-saving at individual and institution levels, albeit at the country level.

As this study was conducted during a short period of three months, it has the following limitations: i) Only one episode of ILI sickness and related ILI sick days leave during the whole one-year time frame from each sample population was taken for analysis. There might be many more days that may not have been captured. ii) The survey was based on respondent's memory of their experience of having ILI within one year. They may have forgotten the details of those events. This limitation may affect this study's overall cost calculation, where the cost reflected here can be the tip of the iceberg. By analysing more ILI episodes from the respondents, the indirect cost may be higher, potentially giving higher savings than was calculated in this study. Although there was a significant difference in the salary scale for each job category, this study used the average amount between categories. It was not weighted for ease of calculation. This limitation will also affect the cost calculation, where the exact cost on each category of employees may contribute to much more cost and higher savings to the employer.

CONCLUSIONS

This present study illustrated that the ILI rate at the workplace was much lower among the vaccinated group than the non-vaccinated group. The vaccination was able to reduce ILI and absenteeism. There were significant cost benefits and savings to the workers and workplace in implementing the vaccination programme. As recommended by WHO, there is a requirement of higher commitment by the hospital management to provide free vaccination for all employees.

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