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REVIEW

Economic analysis of applying medical check-up mobile in Indonesia

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Abstract

Background: Work-related accidents and illnesses emphasise the importance of preventive measures in the workplace. While corporate health apps and workplace health promotion apps have potential benefits, their effectiveness requires further evaluation. **Objective:** The primary objective of this study is to enhance employee productivity and capture the indirect benefits associated with the use of mobile medical check-ups (MCUs), which have demonstrated superior efficacy compared to conventional approaches within office settings, particularly in Indonesia. **Method:** This study conducted a review, drawing data from reputable platforms such as PubMed, NEJM, government websites, and scholarly articles to perform pharmacoeconomic calculations. **Result:** The total cost of a conventional medical check-up (MCU) was determined to be USD 50.63, while the total cost of a mobile MCU was USD 31.54. The indirect benefit derived from a conventional MCU was USD 42.22, while the indirect benefit associated with a mobile MCU was Rp. USD 143.55. The incremental cost-effectiveness ratio (ICER) and quality-adjusted life year (QALY) values (Δ QALY = 0.6514) indicated the dominance of mobile MCUs. **Conclusion:** The findings suggest that mobile MCUs offer a more economical and effective approach to workplace health management in Indonesia, contributing to improved employee productivity and greater indirect economic benefits.

Introduction

Work-related accidents and illnesses remain a significant concern worldwide, impacting millions of individuals and causing thousands of fatalities daily. However, these statistics may underestimate the actual magnitude of the problem due to underreporting. Occupational diseases account for a substantial portion of worker fatalities, exhibiting a disproportionately high rate of accidents. Both younger and older workers face increased vulnerability, necessitating special attention as the ageing population grows in developed countries (ILO, 2023). Occupational diseases contribute significantly to work-related fatalities, with industrialised nations experiencing a greater percentage of work-related deaths than developing countries (Driscoll *et al.,* 2005; Takala *et al*., 2014). Nevertheless, countries with developing economies, such as Indonesia, also face substantial challenges in occupational health due to limited infrastructure, inadequate health surveillance, and a high prevalence of informal labour markets.

In Indonesia, the absence of sickness, particularly when prolonged, is a prevalent and costly issue. Occupational health practitioners play a critical role in preventing sickness absence, which can be attributed to various factors, including health conditions, work-related and personal aspects, individual characteristics, and labour market dynamics (Falkenberg *et al.,* 2009). The impact of work-related injuries and occupational diseases is evident, with Indonesia reporting thousands of work-related illnesses and injuries annually. This situation underscores the urgent need for preventive measures and enhanced occupational health strategies to mitigate the adverse effects of work-related illnesses on the workforce (Leigh, 2011). The economic burden of workplace illnesses is particularly concerning in

developing nations, where access to healthcare and awareness of occupational health may still be improving.

Medical check-ups (MCUs) provide a crucial opportunity for the early detection and prevention of health issues among employees. Routine screenings can help identify underlying medical conditions, such as hypertension, diabetes, or high cholesterol, which can impact employees' well-being and productivity. Early intervention and appropriate treatment can prevent these conditions from worsening, leading to improved health outcomes and reduced absenteeism (Cloeren *et al.,* 2014). A pragmatic randomised controlled trial has demonstrated the impact of preventive workplace health programs on employee absenteeism and medical service utilisation. One study found that such programmes, including MCUs, positively influence absenteeism rates and the use of medical services (Bertera, 1990). In Indonesia, where occupational health regulations are evolving, integrating MCU programs into workplace policies could provide significant benefits in maintaining workforce productivity.

To enhance employee satisfaction, reduce turnover rates, and support employee health, employers in Indonesia and other developing nations are exploring corporate health apps (De Korte *et al.,* 2018). These apps, initially introduced by employers and now being investigated by researchers, have shown potential benefits such as increased physical activity, improved productivity, and greater engagement (Jung & Cho, 2022). Many workplaces in Indonesia have also started adopting mobile health applications for workplace health promotion (WHP) due to their cost-effectiveness in supporting employee well-being. These apps aim to present individual check-up results, provide comparative analyses with normative data, and offer advice and resources for improving health outcomes. Challenges addressed by these apps include physical activity, nutrition, and mental health (Driscoll *et al.,* 2005; Takala *et al.,* 2014). Given Indonesia's large and diverse workforce, mobile-based occupational health initiatives could serve as scalable and adaptable solutions.

In occupational medicine, assessing earnings and income losses is crucial. Work-related injuries and illnesses can significantly affect an individual's earning capacity and household income, influencing their entire family's well-being. Understanding the relationships among health, work, and income is vital for developing comprehensive interventions that mitigate the financial impact of work-related health issues and promote a healthier, more resilient workforce. The severity of a disease is closely linked to work disability, making it imperative to adopt strategies that minimise long-term damage and reduce work disability. These approaches not only address economic burdens but also align with the growing demand for pharmacoeconomic evaluations, ultimately leading to increased workplace productivity and indirect benefits for individuals (Shanahan & Ahern, 2008).

This study aims to evaluate the direct medical costs and indirect benefits associated with the use of Medical Check-up Mobile (MCU-M) in Indonesia. The MCU-M has gained popularity as a preferred method compared to conventional approaches in office settings for fostering economic growth. This research focuses on estimating the effectiveness of MCU usage in the financial context of Indonesian companies and offices. The findings of this study are expected to provide valuable insights into enhancing profitability and productivity. Moreover, considering Indonesia's economic conditions, this analysis could be applicable to other developing nations with similar occupational health challenges and financial constraints. The adaptation of MCU-M in such settings offers a promising direction for improving workplace health while optimising economic efficiency.

Methods

Source of studies

To gather data for pharmacoeconomic calculations without any time restrictions, as long as the available values were deemed acceptable, the authors conducted searches in databases such as PubMed, NEJM, Medline, Current Contents, national journals, and government websites. As an initial step, these search strategies focused on keywords related to pharmacoeconomic analysis, including terms such as "*cost-minimisation analysis*", "*cost-effective analysis*", "*cost utility analysis*", "*occupational medicine*", "*medical check-up cost*", and "*human capital*".

The selection of studies was based on specific criteria. First, the authors considered studies that explicitly mentioned the use of MeSH in their titles or abstracts. Second, the authors included studies where economic analysis was the primary purpose or one of the primary purposes, while excluding editorials, methodological discussion papers, reviews, and letters. Finally, the studies had to evaluate interventions related to human health conditions.

Economic analysis

To evaluate health outcomes, the authors utilised all relevant information supporting the economic analysis

of medical check-up utilisation. The key criteria to be met included assessing direct medical costs and indirect benefits. This classification was based on two factors: (1) comparing the effectiveness and costs of at least two programs, and (2) the units used to measure and value health outcomes in the analysis. A cost-minimisation analysis (CMA) was used to compare the direct medical costs associated with different health programs to identify the program with the lowest cost. (CMAs) Cost-effectiveness analyses (CEAs) were considered when comparing the costs and health effects of two programs using natural units of measurement rather than monetary units. Cost-utility analyses (CUAs) were conducted to evaluate outcomes in quality-adjusted time periods. The authors also considered options such as determining the lowest expenditure through cost minimisation analysis using direct medical costs and human capital approaches. All values, prices, and costs used in this analysis refer to those applicable in Indonesia and may have similar relevance in countries with comparable conditions in other developing nations.

Results

The literature review yielded various data supporting the conduct of pharmacoeconomic analysis, and the availability of data determined the applicable economic analysis methods (Appendix A). Regarding direct medical costs, data were obtained on the costs of examinations, doctor visits for medical check-ups, and offline or online health consultations. For direct nonmedical costs, data were obtained on the value of employee absenteeism in a year. For indirect benefits, data included years of life saved, utility for each year of life, the percentage reduction in hospitalisation rates and mortality rates after using medical check-ups (MCU) and the MCU-M. The gathered data were further analysed and interpreted.

In this analysis, the focus is on identifying the most cost-effective option by minimising costs while maintaining comparable health outcomes. The CMA provides insights into the specific costs associated with the MCU-M, including expenses related to medical examinations, doctor visits, and consultations. By examining these costs in relation to the benefits gained, organisations can make informed decisions regarding the implementation of the MCU-M, aiming to optimise both financial resources and employee health outcomes. Through this analysis, the potential cost savings and cost-effectiveness of the MCU-M can be assessed, providing a foundation for evidence-based decision-making in healthcare management.

Based on the analysis results in Table I, there is a noticeable comparison of cost-effectiveness between the conventional MCU and MCU-M. In the traditional MCU, the total expenditure amounts to USD 50.46, consisting of laboratory check costs of USD 28.38 and the doctor's visit and consultation costs of USD 18.92.

Table I: CMA-cost minimisation analysis

	MCU cost (USD)	MCU-M cost (USD)
Laboratory check cost	28.38	28.38
Doctor’s visit fee	3.15	3.15
Consultation fee	18.92	3.15
Total	**50.46**	**34.69**

On the other hand, MCU-M has a total cost of USD 34.69, with laboratory check costs of USD 28.38 and the doctor's visit and consultation costs of USD 6.31. This results in a total cost difference of USD 15.77, representing a 31.25% reduction in cost. In terms of effectiveness, the use of MCU-M has proven to be beneficial, as patients can save USD 15.77 compared to a conventional MCU. The results of a literature study for the average salary of private employees in Indonesia are USD 185.72, with an average of 5-6 working days a week. Therefore, the authors use economic analysis data, which indicates an average daily salary of USD 8.44 and 22-23 working days in IDR per month, using the HCA model. Additionally, the data also suggest a decrease in the average value of lost productivity due to illness. In the absence of an MCU, the average patient is absent from work for 34 days per year, resulting in an average loss of productivity of USD 287.10. After undergoing conventional MCU, the average patient does not work for 29 days per year, with an average value of lost productivity amounting to USD 244.88. Furthermore, after using an MCU, the average patient does not work for 17 days per year, with an average lost productivity value of USD 143.55 (see Table II).

Table II: Human capital-productivity analysis

	Average number of patients unemployed per year (day)	Average value of lost productivity (USD)
Sick	34	287.10
Sick after MCU	29	244.88
Sick after MCU-M	17	143.55
Indirect Benefit per person after undergoing medical check-up = USD 42.22		
Indirect Benefit per person after using MCU-M = USD 143.55		

Based on these calculations, it can be concluded that there is a 14.69% decrease in the average value of lost productivity between patients without MCU and those who have undergone conventional MCU. Moreover, there was also a 41.38% decrease in the average value of lost productivity between patients after conventional MCU and patients after MCU-M. These analysis results indicate the potential of using MCU-M to optimise patient productivity and provide significant benefits in terms of cost reduction and efficiency improvement in healthcare services.

This enables companies to reduce costs associated with employee health examinations and consultations. Additionally, the use of MCU-M has a positive impact on employee productivity. The use of MCU-M resulted in a decrease in the number of sick leave days, with an average reduction from 34 days to 17 days.

The impact of implementing a combined MCU-M intervention can be observed through clinical outcomes among employees, who typically undergo either conventional MCU or no examinations at all. In this study, the authors used actual costs incurred for a single implementation of the intervention to derive assumptions about the clinical outcomes per unit. By utilising a database and estimating a cost-effective analysis model, the MCU-M intervention is expected to decrease indirect costs while achieving improved clinical outcomes.

The ACER (average cost-effective ratio) analysis, as presented in Table III, demonstrates that the MCU-M intervention is significantly more cost-effective in enhancing indirect benefits and reducing indirect costs associated with employee productivity. The ACER results indicate that to achieve one symptom-free or disease-free day, an employee utilising the MCU-M incurs USD 148.25, which is significantly lower than the USD 277.24 cost incurred by using a conventional MCU. Moreover, to attain a 1% reduction in hospitalisation and mortality, an employee would need to invest more, with the ACER for the mobile intervention being USD 439.11 for hospitalisation and USD 377.06 for mortality, in contrast to the conventional medical check-up costs, which are approximately twice as high at USD 764.50 and USD 574.03, respectively.

Table III: Cost-effectiveness analysis

	After using MCU	After using MCU-M
Cost (USD)	50.46	34.69
Disease-free days	182	234
% Decrease hospitalisation	66	79
% Decrease in death	87.9	92
ACER		
Disease-free days (USD)	277.24	148.25
% Decrease hospitalisation (USD)	764.50	439.11
% Decrease in death (USD)	574.03	377.06
ICER	**MCU-M is dominant**	

A cost-effectiveness grid was constructed to illustrate the potential alternative results in terms of cost and effectiveness (Figure 1). The results indicate that the incremental cost-effectiveness ratio (ICER) calculation is not required because sufficient information has been obtained to determine the cost-effectiveness relationship. It has been determined that MCU-M is more effective and less costly, making it the dominant choice. Based on the analysis, although MCU-M requires lower costs, it can provide greater clinical outcomes than the expenses needed to achieve one unit of indirect benefit. This is mainly due to the long-term cost savings in healthcare.

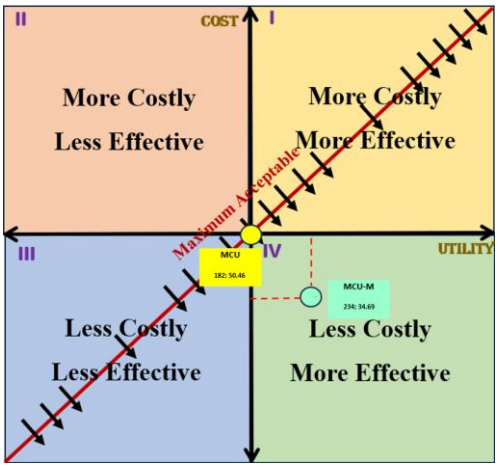

Figure 1: Cost-effectiveness grid of the MCU-M to MCU

In Table IV, data on the cost-utility analysis of the conventional MCU are presented, compared with the traditional MCU-M. The MCU conventional cost was Rp. USD 15.77, more than that of MCU-M, USD 50.46 versus USD 34.69, respectively, and produced an additional 0.6514 QALYs (1.4874–0.836); therefore, the incremental ratio was USD 24.21 per extra QALY.

Table IV: CUA- Cost utility analysis

	Cost (USD)	Years of life saved	Utility for each year of life	QALY
MCU	50.46	1.52	0.55	0.834
MCU-M	34.69	2.22	0.67	1.4874

Discussion

Integrating the MCU into an occupational health program offers a range of benefits that enhance productivity. Early detection and prevention of health issues, improved employee engagement, reduced healthcare costs, and enhanced workplace safety all contribute to a healthier and more productive work environment. Staying updated with current research and guidelines ensures the effectiveness and relevance of the occupational health program, ultimately leading to long-term success and growth. (Van Berkel et al., 2013).

Proactively identifying and addressing health issues through regular screenings leads to improved overall well-being and decreased absenteeism. These findings support the positive effects of workplace health programs incorporating the MCU on reducing employee absenteeism rates and the utilisation of medical services (Bertera, 1990). A comprehensive MCU demonstrates an employer's commitment to employee well-being, creating a positive work environment that fosters engagement, motivation, and job satisfaction.

The use of MCU-M as a future breakthrough in the field of healthcare is an eagerly anticipated development. In this digital era, the MCU-M provides individuals with easy access to obtain MCU results directly through their mobile devices. Through online consultation features, users can consult with medical professionals regarding their MCU results without having to visit healthcare centres physically. This not only improves efficiency but also enables easier and more convenient health screenings for individuals with busy work schedules. Additionally, the MCU-M also pays special attention to promoting better lifestyles, including monitoring dietary intake and recommending suitable physical activities. By emphasising preventive efforts, MCU-M offers individuals the opportunity to take preventive actions to avoid preventable health issues. Thus, MCU-M is an exciting innovation in the healthcare field and has the potential to provide significant benefits to individuals in maintaining their health.

Studies have evaluated the effectiveness of various app use cases in workplace health, including mobile health (mHealth) interventions such as physical activity trackers and wearables (Giddens *et al.,* 2017; Buckingham *et al.,* 2019; Lennefer *et al.,* 2020). These interventions have shown benefits such as flexibility, personalisation, real-time progress tracking, feedback, accessibility, sustained user engagement, and cost efficiency (Ly *et al.,* 2014; Nuryan Dehkordi *et al.,* 2017). They also enable employers to monitor working conditions and employee health for tailored interventions and improved work safety. However, further research is needed to evaluate the pharmacoeconomic outcomes and productivity-related behaviours following the use of these apps by employees (Junker *et al.,* 2023).

The cost-effectiveness of MCU-M compared to the conventional MCU is supported by the positive net benefit-to-cost value, indicating that the former is a more economically viable option. In this scenario, the threshold value of willingness to pay is set at USD 63.07, and the net benefit-to-cost ratio is USD 25.32. This signifies that the additional benefits gained from using the mobile platform outweigh the associated costs, making it a favourable choice for medical check-ups. The positive net benefit obtained in this study highlights the cost-effectiveness of MCU-M compared to conventional MCU. The additional benefits gained from utilising the mobile platform outweigh the associated costs, making MCU-M a favourable choice for medical check-ups. The integration of technology and healthcare has the potential to significantly improve access, efficiency, and cost-effectiveness in healthcare delivery.

Based on HCA analysis, the use of MCU-M has made a significant contribution to improving worker productivity and reducing stress levels, hospitalisations, deaths, and diseases. By providing easy and quick access to MCU information, providing

online consultations, and promoting better lifestyles, the MCU-M helps individuals take appropriate preventive measures to maintain their health. This enables companies to reduce costs associated with employee health examinations and consultations. Additionally, the use of MCU-M has a positive impact on employee productivity. The use of MCU-M resulted in a decrease in the number of sick leave days, with an average reduction from 34 days to 17 days.

In the workplace context, improved employee health and well-being have a positive impact on employee productivity by reducing sickness absences and increasing employee focus and energy levels. Moreover, by reducing stress levels and the risk of serious illnesses, MCU-M has the potential to decrease hospitalisation rates and deaths related to preventable health issues. Thus, the use of the MCU-M as a holistic and proactive approach to individual health maintenance can potentially provide tangible benefits in creating a healthier and more productive society.

The MCU-M not only provides health information to individuals but also provides specific steps to be taken next. This allows individuals to take appropriate actions based on their daily work schedules without sacrificing excessive time. With online consultation features and accessibility through the Android platform, the MCU-M has better potential for optimising healthcare services. Individuals can easily access the necessary information and advice to maintain their health by combining the convenience of digital technology with attention to busy modern lifestyles. Therefore, the use of MCU-M on the Android platform offers promising prospects for improving overall efficiency and effectiveness in healthcare services.

These estimates also compare favorably to cost-effectiveness studies of other lifestyle modifications following the use of MCU-M. The cost-effectiveness of the MCU-M intervention appears to be greater or at least comparable to lifestyle and health management interventions that can be facilitated. The cost estimates and assumptions incurred to obtain indirect benefits in relation to indirect medical costs depict the relationship between lifestyle modifications promoted by the MCU-M through its application to users. This indirect usage will impact employee health awareness through health guidance obtained from the examined MCU data. Although there is a high level of ambiguity and bias in the data assumptions regarding indirect benefits in specific unit terms within this study, it provides valuable information on the effectiveness of MCU-M compared to conventional approaches, resulting in improved access to healthcare and increased self-efficacy for employees.

It is important to note that while MCU-M appears to be the most cost-effective option, the precise measurement of the impact of lifestyle habits on clinical outcomes and indirect benefits for employees remains uncertain. The human capital approach has a significant influence on the success of MCU-M utilisation and overall health outcomes, which significantly affect the functioning of companies or offices. The selection of healthy workers and job productivity carried out over a year may determine the effectiveness of MCU-M usage by employees in achieving a reduction in absence, hospitalisation, and mortality rates that could harm the company.

The understanding of the relationship between productivity and the use of MCU-M from a pharmacoeconomic perspective is limited. The authors believe that prospective studies incorporating real estimations of the unit value of indirect benefits are necessary to determine the best program, specifically the MCU-M, in this context. The authors are concerned that various factors may influence the level of productivity perceived by employees, which is difficult to estimate due to the intangible nature of costs and benefits. Additionally, there is a scarcity of available data on the effectiveness of interventions for economic analysis.

Conclusion

The findings of this study highlight the significant economic advantages of implementing Medical Check-up Mobile (MCU-M) in Indonesia. By reducing direct medical costs and enhancing indirect benefits such as increased employee productivity and reduced absenteeism, MCU-M proves to be a cost-effective intervention. The pharmacoeconomic evaluation confirms that MCU-M is a superior alternative to conventional medical check-ups, demonstrating both financial and health-related benefits.

Furthermore, the adaptability of MCU-M extends beyond Indonesia, offering practical solutions for other developing nations with similar occupational health and economic conditions. The integration of MCU-M into workplace health policies can serve as a strategic initiative to foster economic growth, enhance workforce resilience, and promote a culture of preventive healthcare. Moving forward, continued research and policy support will be essential in maximising the impact of MCU-M and expanding its accessibility to a broader range of industries and sectors.

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Appendix A: Data value used in Pharmacoeconomic analysis

Aspect	Value	Reference
Value/cost of medical check-up per examination	USD 28.38	(Bakhrun & Hutahaean, 2021)
Medical check-ups in a year	1 time a year	(Bakhrun & Hutahaean, 2021)
Once in a lifetime MCU-M value/cost (long term use)	Free	(Junker *et al*., 2023)
Value/cost once the arrival of the doctor/health worker to carry out the examination	USD 3.15	(Alviandre *et al*., 2022)
Salary in a month in an industry/office	USD 140.69 – 183.75	(Frengky *et al*., 2020)
Average working days in a year	260(5 days/month)-312 days (6 days/month)	(Purnomo & Kurniawati, 2020)
Average patient salary per day	USD 8.43	(Alviandre *et al*., 2022)
Average number of days a patient is unable to work in a year due to various illnesses	34 days	(Stephan & Roesler, 2010)
Average number of days a patient is unable to work in a year due to various illnesses after a medical check-up	29 days	(Junker *et al*., 2023)
Average number of days a patient is unable to work in a year due to various illnesses after using the MCU-M	17 days	(Junker *et al*., 2023)
Average yearly chance of developing the disease	68%	(Stephan & Roesler, 2010)
Average probability of *hospitalisation* for the office	63%	(Stephan & Roesler, 2010)
Average probability of developing a disease within a year after a medical check-up	30%	(Ngo *et al*., 2021)
Average chance of developing a chronic disease within a year of running the MCU-M	10%	(Junker *et al*., 2023)
Average probability of *hospitalisation* after conducting a medical check-up	34%	(Ngo *et al*., 2021)
Average chance of *hospitalisation* after doing an MCU-M	21%	(Junker *et al*., 2023)
Die annually from disease	1.9 million/year or 25%/year	(Gandy *et al*., 2014)
Died after doing MCU	12.1%	(Ngo *et al*., 2021)
Died after doing MCU-M	8%	(Ngo *et al*., 2021)
Years of life saved MCU	1.52	(Trihandini, 2010)
Years of life saved MCU-M	2.22	(Trihandini, 2010)
Utility for each year of life saved MCU	0.55	(Trihandini, 2010)
Utility for each year of life saved MCU-M	0.67	(Trihandini, 2010)
Doctor consultation fees	18.92	(Ginanjar, 2017)
Online doctor consultation fees	3.15	(Ginanjar, 2017)