DIRECT MEDICAL COSTS OFISCHAEMIC HEART DISEASEIN A TERTIARY HOSPITAL IN MALAYSIA

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Background &objectives: Ischaemic heart disease (IHD)is a major contributor to the total death from non-communicable diseases in Malaysia, therefore is associated with substantial economic burden to the healthcare sector. This study aimed to determine the direct medical costs ofmanaging ischaemic heart disease and its associated factors in a tertiary hospital in Malaysia.

Methods: A retrospective study utilising secondary data from Casemix Unit, UKMMC was conducted among patients hospitalised for myocardial infarction (MI) and angina pectoris in 2018. The direct medical cost was measured from the healthcare provider perspective,using the tariff (sum of costs incurred per patient) provided in casemix data based on step-down costing approach. Associated factors which influenced direct medical costs were determined, such as gender, age group, comorbidities, cardiovascular-related procedures, and disease severity.

Results:A total of 1317 patients were recruited into the study.The majority of admissions were attributable to angina pectoris (62.2%), while the remaining 37.8% patients were hospitalised due to MI. The total direct medical costs of treating IHD in 2018 was higher for angina patients (MYR 2,101,169.71) compared to MI patients (MYR 2,053,757.36). However, the average costs of treating MI patients were higher (MYR 4,124.01) compared to angina patients (MYR 2,565.53). The factors which influenced direct costs included older age, multiple comorbidities, type of cardiovascular-related procedures, length of stay, and severity of illness.

Conclusion: Direct medical cost of IHD in 2018 incurred by UKMMC was substantial. Direct costs are highest in MI-related cases, which in most cases are associated with longer length of stay and a more complex medical intervention.Preventive measures and strategies to minimise direct costs should be targeted to address the major cost drivers as highlighted in this study.

Keywords: angina, ischaemic heart disease, direct cost, economic burden, myocardial infarct

INTRODUCTION

Cardiovascular diseases (CVD) are recognised as the leading cause of morbidity and mortality globally[1].In Malaysia, CVD are the highest contributor of the estimated 73% of total death fromnon-communicable diseases[2], whichis considered a significant public health concern in this country. A subset of CVD is ischaemic heart disease (IHD) or also known as coronary heart disease (CHD), which is a sequalae of atherosclerotic changes in the coronary arteriesresulting in ischaemia. Consequently, this results in clinical manifestations such as stable angina or the more life-threatening acute coronary syndromesthat can manifest as either unstable angina, myocardial infarction (MI) or even sudden cardiac death[3]. Anepidemiological update by the American Heart Association reported that 15.5 million people who are younger than 20 years old were diagnosed with coronary heart disease in the United States[4]. In European countries, CVD accounted for 45% of deaths, with IHD being the highest contributor of deaths (20%) in both men and women[5]. Based onthese staggering figures, it is anticipated that the costs for treating IHD are projected to increase up to $366 billion in the future by year 2035 in the United States alone[6].Meanwhile, the National Health Service in the United Kingdom allocated more than £30 billion per year for more than 5 million of its population living with CVD[7].

In the era where the prevalence of IHDis expected to rise due to a shift in epidemiolocal patterns because of aging population worldwide, similarly the costs of treating IHD are expected to consume a massive portion of healthcare provider's limited budget.Hospitalisations resulting from IHD or acute coronary syndromes are therefore anticipated to exhaust a substantial amount of healthcare expenditure, typically because a large portion of patients with this condition require diagnostic procedure such as coronary angiography and/or coronary interventions.

In Malaysia, previous studies have investigated the basic epidemiology, risk factors, assessment, and management of IHD among the local population[8-11], however very little has been explored about the direct medical costs of IHD. Therefore, this current study aimed to determine the direct medical costs of IHD patients admitted toa tertiary hospital in Malaysia, who were diagnosed either with angina or myocardial infarction.

MATERIAL AND METHODS

This was aretrospective study utilising in-patient's hospitalisation data for 2018, obtained from the Casemix Unit in a tertiary hospital in Malaysia, known as the Universiti Kebangsaan Malaysia Medical Centre (UKMMC). Casemix data utilised comprisedof inpatient data of subjects who were hospitalised due to either myocardial infarction

or angina,based on the International Classification of Diseases 10th revision (ICD-10) coding system. The Casemix system usesa tool developed by the United Nations University International Institute for Global Health (UNU-IIGH) and the National University of Malaysia (UKM) which was based on step-down costing method. Variables included in the casemix data are age, gender, length of stay, main diagnosis, comorbidities, complications, and discharge status. We also determined the common coronary procedures underwent by the patients during hospitalisation.

Ethical approval was obtained from the Universiti Kebangsaan Malaysia Research and Ethics Committee (JEP-2019-227). For patient recruitment, universal sampling method was adopted, whereby all patients with ICD-10 codes of I20, I21, I22, I25 (ischaemic heart disease) recorded in the casemix database were recruited in this study. Patients were included if they were males or females aged 18 years and above andwere hospitalised due to IHD such as angina pectoris (both stable and unstable) or myocardial infarction (MI). Subjects were also included if they had concomitant hyperlipidaemia (ICD-10 code E78) at admission or even prior to index hospitalisation. Patients who were younger than 18 years old or diagnosed with non-specific chest pain other than angina or myocardial infarct were excluded from the study.

Total costs for hospitalisations due to angina pectoris and MI were estimated by using the costs or tariff included in the casemix data. Thecasemix system recorded the costs for hospitalisation of each patient using the step-down costing method, starting from the total hospital expenditure based on different cost centres. In order to derive the casemixtariff, the hospital expenditure was initially allocated to three main cost centres; namely the overhead cost centre (for example, administration costs, utilities and costs of consumables) , intermediate cost centre (such as laboratory, radiological tests, operating theatres and pharmacy costs) and final cost centres (such as wards involved in treating hospitalised patients)[12]. These stages lead to the derivation of the final unit cost, which is essentially the cost of hospitalisation per-patient per-day. Subsequently, when multiplied with the patient's individual length of stay (LOS) in the hospital, the cost per admission is obtained. In this study, the direct medical costs of patients admitted with IHD were calculated for the year 2018.

Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 25 software. The independent data was tested for a normality test using Shapiro-Wilk test. Data which were not normally distributed was tested using non-parametric test including Kruskal Wallis and Mann-Whitney U test. All results were expressed as mean cost (Standard Deviation, SD). A value of $p<0.05$ is set as limit to be significant.

RESULTS

A total of 1317 patients with IHD in 2018 were included in the study, with the mean age being 62 years. Demographic and clinical parameters of the study population are highlighted further in Table 1. Mostsubjects were admitted to the hospital with angina pectoris (62.2%), while the remaining were associated with MI (37.5%).The range of LOS (days) for each subgroup of patients (angina pectoris and MI) was illustrated in Figure 1. A vast majority of angina pectoris patients stayed less than 5 days (90%). For MI patients, almost half (49.8%) stayed less than five days, however almost similar proportion of them stayed between 5-14 days (45.2%). The total direct costs of treating IHD events in 2018 in UKMMC was higher (Figure 2) for patients with angina (MYR 2,101,169.71) compared to the direct costs of treating MI patients (MYR 2,053,757.36). However, the average cost of treating MI patients was higher (MYR 4,124.01), compared to patients with angina (Figure 3). Figure 4 showed the LOS for the subjects stratified into three groups. For angina patients, a vast majority stayed less than 5 days (90%), and only 0.7% stayed more than 14 days. For MI patients, 49.8% stayed less than 5 days, 45.2% stayed between 5 and 14 days, and only a small fraction (5%) stayed longer than 14 days.

Table 1: Demographic and clinical parameters of study population

	al (n= 1317)
	ó)
n age, years (SD)	(12.49)
der	
e	(65.9)
ale	(34.1)
erlipidaemia	
	(26.73)
	(73.27)
aemic Heart Disease (IHD) status,	
gina pectoris	(62.2)
ocardial Infarction	(37.8)
er comorbidities	
e II Diabetes mellitus (T2DM)	(19.29)
ertension	(20.05)
onic renal disease (CKD)	.68)
)M &Hypertension	(24.07)
)M, Hypertension& CKD	3.80)
ertension& CKD	1.29)
)M & CKD	0.91)
	(28.85)
n length of stay (LOS), days (SD)	± 3.2
S (angina pectoris)	± 1.9
S (MI)	± 3.4
erity of angina pectoris	
l	(47.74)
lerate	(32.48)
ere	(19.78)
erity of myocardial infarction	
l	(27.51)
lerate	(26.7)
ere	(45.78)

IHD, Ischaemic heart disease; T2DM, Type 2 diabetes mellitus; CKD, chronic renal disease

Figure 1: Frequency (%) of patients with ischemic heart disease admitted to UKMMC in 2018 based on length of stay (LOS)
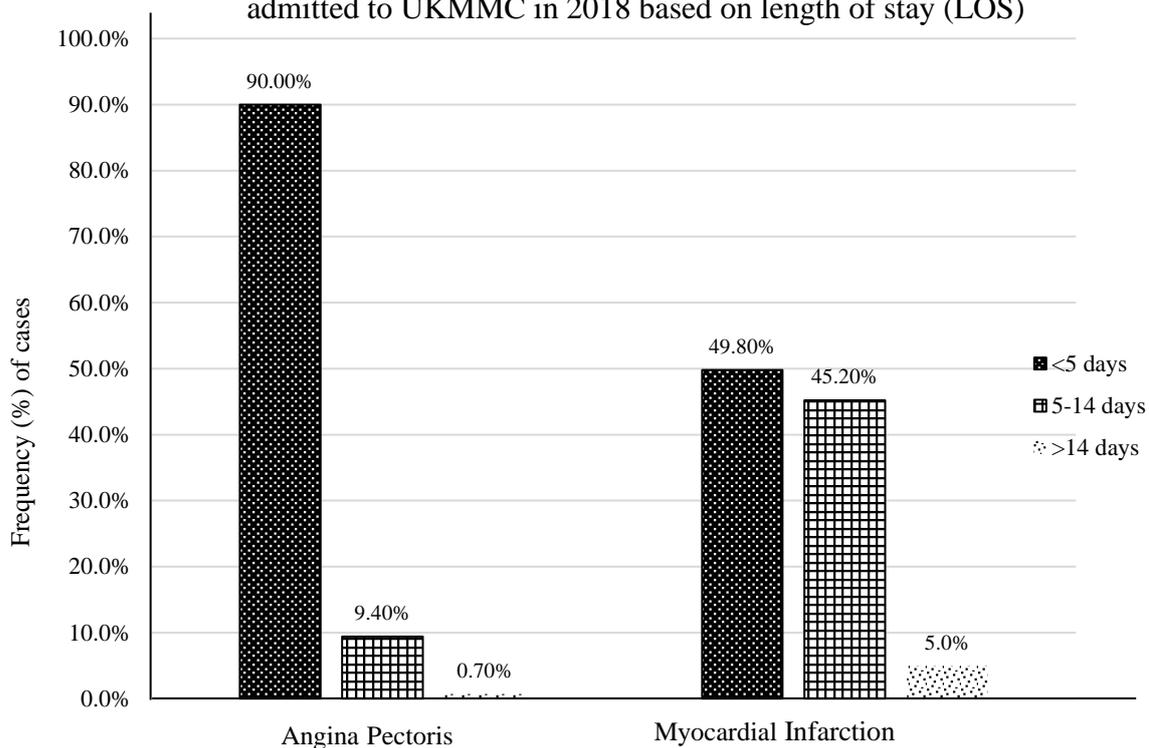

Figure 2: Total direct cost for patients with IHD admitted to UKMMC in 2018
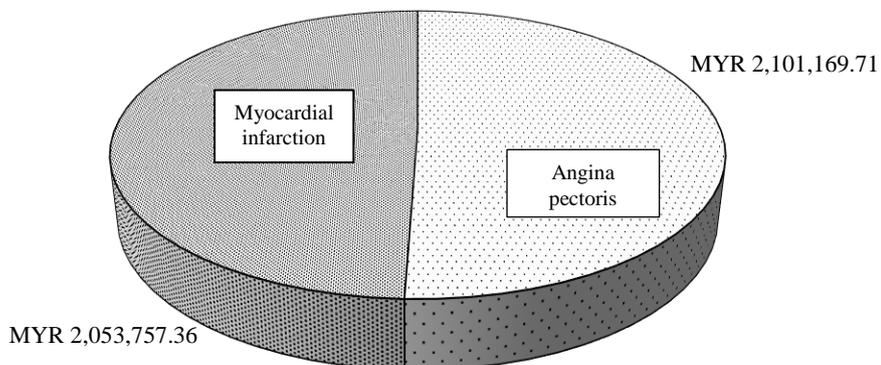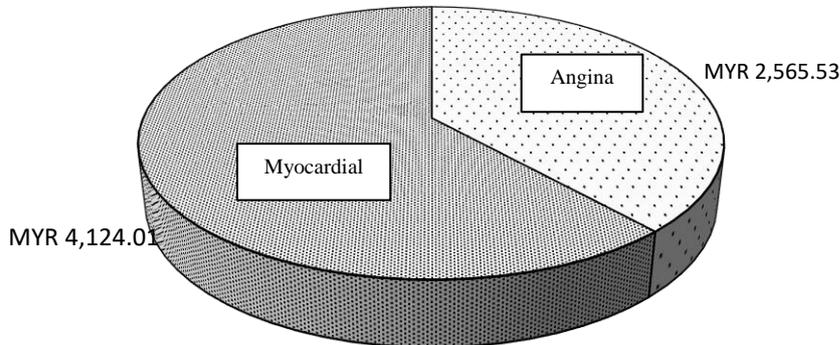
Figure 3: Average direct medical cost for all patients with
IHD admitted to UKMMC in 2018

Factors affecting the direct medical costs of IHD in UKMMC were analysed. There was a significant difference between direct cost and gender (p<0.001), whereby male patients had higher mean costs (MYR 2458.32).There was a similar trend seen with age, whereby patients who were above 40 years old had significantly higher mean cost (MYR 2376.12) compared to subjects who were less than 40 years of age (MYR 1965.18). In terms of LOS, patientswith angina pectoris and MI who stayed longer than 14 days, significantly consumed the highest mean direct costs (MYR 3354.81 and MYR 7098.34 respectively). For angina patients' LOS, there was a 76% increment in mean costs when patients who stayed the longest (more than 14 days) was compared with those who stayed less than 5 days. The cost further increased by 80% for MI patients who stayed more than 14 days when compared with patients who stayed less than 5 days. This was also true for severity, in which severe forms of angina pectoris and MI consumed the highest mean direct costs (MYR 3593.62 and MYR 6211.43 respectively). Patients with three combined comorbidities significantly consumed the highest mean costs (MYR 6200.42) as opposed to other recorded comorbidities (p<0.001). Direct mean costs for cardiovascular-related procedures were also significantly affected by the types of procedure underwent (p<0.001).For angina pectoris patients, PTCA with 3 drug-eluting stents consumed the highest mean cost (MYR 5461.21), meanwhile for MI patients, those who underwent coronary artery bypass grafting (CABG) of 3 arteries had highest mean cost (MYR 12900.21).

Table 2: Analysis of the factors affecting direct medical costs of IHD in UKMMC

	n cost (MYR)	idard deviation, SD (R)	ilue
ider			.001[a]
e	3.32	1.87	
ale	2.59	2.98	
group			0.001[a]
s than 40 years old	5.18	1.14	
re than 40 years old	5.18	0.73	
gth of stay			.001[b]
ina pectoris			
lays	3.22	4.52	
days	0.10	7.90	
days	4.81	0.54	
cardial infarction			
lays	2.12	1.90	
days	01.46	3.52	
days	3.34	1.53	
rity			:001[b]
ina pectoris			
l	1.52	39	
lerate	7.33	5.27	
re	3.62	3.62	

ocardial infarction			
d	5.63	5.81	
derate	5.90	5.43	
ere	1.43	2.00	
norbidities			
)M	1.29	2.12	
ertension	3.01	40	
D	).33	7.01	
)M + Hypertension	).24	1.14	
ertension + CKD	1.81	7.17	.001[b]
)M + CKD	).90	7.43	
)M + Hypertension + D	).42	5.69	
	5.08	).82	
diovascular-related procedures			
ina pectoris			
'A (drug)	3.16	).00	
'A (drug) + 2 stents	1.09	).11	
'A (drug) + 3 stents	1.21	5.06	.001[b]
'A (non-drug)	3.00	).72	
'A (non-drug) + 2 stents	1.90	2.23	
procedures	).73	44	
ocardial infarction			
3G of 3 arteries	)0.21	).13	
'A (drug)	1.34	7.00	
'A (drug) + 2 stents	3.09	1.72	.001
'A (drug) + 3 stents	1.52	7.40	
'A (non-drug)	3.12	1.06	
'A (non-drug) + 2 stents	).12	3.65	
'A (non-drug) + 3 stents	).49	3.08	
procedures	).91	5.06	

T2DM, Type 2 diabetes mellitus; CKD, chronic kidney disease; CABG, coronary artery bypass graft; PTCA, percutaneous transluminal coronary angioplasty.

[a] Mann-Whitney U test

[b] Kruskal-Wallis test

DISCUSSION

In our study population, the mean age of study subjects was 62.1 years.This finding is almost similar to another study that determined the direct costs of IHD in Brazil, which reported the mean age for their study population was 61 years old[13]. Similarly, another previous study reported the mean age for men subjects who were admitted for acute coronary syndromes was 65.8 years[14]. However, our sample population's age was slightly older compared to the Malaysian average for acute coronary syndromes (myocardial infarction or unstable angina) as reported by the National Cardiovascular Disease database - acute coronary syndrome (NCVD-ACS) registry[15]. Based on the NCVD-ACS registry, males who were admitted for acute coronary syndromes (ACS) hada mean age which ranged between 55.13 to 59.29 years old. The older mean age for IHD patients in our study cohort could be explained by the fact that our nation is experiencing a shift towards aging population, which shows that Malaysians in general, are having increased longevity. The majority of the subjects in this study were males (65.9%), and most of them suffered from angina pectoris (62.2%). This was in agreement with previous studies which reported that the majority of IHD patients recruited into their studies were also predominantly males (72.3%)[14, 16, 17]. Male predominance proved that male sex is indeed a non-modifiable risk factor for IHD[18]. The mean length of stay (LOS) for all subjects was 4.9 ± 3.2 days, with the average LOS for MI being longer (6.9 ± 3.4 days) compared to the LOS for angina patients (3.8 ± 1.9 days). This finding was consistent with another study investigating the cost of acute MI in Malaysia, Philippines, and Indonesia, which reported that the average LOS for mild, moderate and severe MI in Malaysia was 5.8, 7.5 and 9.2 days respectively[19]. Although our study did not report the average LOS for MI patients based on severity, however,our average LOS reported did not vary significantly from the average LOS described by this prior study. An earlier study conducted in UKMMC in 2011 has also reported almost similar mean LOS for acute ST-elevated MI (STEMI), which was 5.6 days[20].Angina patients tend to be hospitalised for a shorter duration, and this finding was consistent with a study from France, which reported that the mean LOS for unstable angina patients were much shorter (4.9 days) as

compared to 6.9 days for ST-elevation MI (STEMI) and 6.6 days for non-ST elevation MI (NSTEMI)[14]. A prior study also highlighted that patients with unstable angina was mainly hospitalised between 2-6 days (51.13%), with a mean LOS of 2.14 days[21]. This is not surprising, becausegenerally angina patients are less likely to experience more severe disease and have reduced possibility of undergoing in-hospital procedures compared to patients with MI.

The total direct medical costs of IHD in our study population was higher in patients with MI (MYR 2,053,757.36) compared to angina patients (MYR 2,101,169.71). Similarly, the average direct costs increased by 61% for MI patients when compared to subjects with angina pectoris (MYR 4,124.01 versus MYR 2,565.53 respectively). An earlier local study investigating the cost for acute ST-elevated MI (STEMI) in the same hospital has reported that the costs for treating STEMI in 2009 based on step-down costing ranged between MYR 1,789.26 to MYR 4,771.36[20], which did not vary significantly from our average direct cost for MI cases.Our finding was consistent with another study which determined that myocardial infarction was associated with the highest incremental costs following a cardiovascular event[22].This study also recorded similar findings in terms of comparative costs between MI and unstable angina, whereby the incremental costs for MI were significantly higher than unstable angina in the first 6 months for both first and second event cohorts. This can be explained most likely because MI patients tend to present to the hospital with more serious symptoms that need complex treatments and most often are associated with revascularisation procedures, hence needing longer LOS. In agreement with this, our cohort of MI patients also had significantly higher rates for longer hospitalisations compared to the angina subjects, whereby a higher number of MI subjects stayed between 5-14 days (35.8%) and more than 14 days (4.3%) when compared to their angina counterparts. Contrastingly, unstable angina could result in a higher direct costs compared to MI, as highlighted by Schlatter et al. (2017)[13]. In the particular study, it was noted that unstable angina patients had higher re-hospitalisation rates (over 30%) during the first year of follow-up[13].Although our study only looked at the direct medical costs for year 2018 only, the direct costs for angina patients in our cohort could show a variable trend if a few years' data were included, as follow-up rates and rehospitalisation costs could have impacted on the overall costs.

The direct medical costs for IHD in this study was driven mainly by several factors, such as gender, LOS, severity of illness, the presence of comorbid conditions and cardiovascular-related procedures(Table 2). The direct medical costs increased by approximately 21% in patients who were more than 40 years old (although not statistically significant) andwas higher for male patients. Our finding is consistent with another study which observed a similar trend of coronary heart disease costs; wherebyolder age and male gender were associated with higher mean costs[23]. The association between age and higher costs of IHD was most likely explained by increased presence of comorbid conditions in the subjects as age increased. An earlier study also reported that male gender was significantly associated with higher direct medical costs for Chinese patients with acute coronary syndromes[24]. The severity of illness was another important cost driver in this study. The casemix system has categorised IHD patients who were hospitalised in 2018 into three different categories: mild, moderate, and severe cases. Direct costs were strongly associated with disease severity: mild cases of both MI and angina pectoris were associated with significantly lowest direct costs (MYR 3455.63 and MYR 2001.52 respectively), followed by moderate and severe cases. This could be because the more severe the illness, the more likely the patient to be associated with multiple comorbidities and they were more likely to need multiple diagnostic procedures and treatments, hence the longer the hospitalisations.

Our study revealed that multiple comorbidities incurred a higher direct cost. Patients without any comorbid conditions had 66% lower direct cost compared to patients with type 2 diabetes mellitus, hypertension, and chronic kidney disease. The average costs were much lower when fewer comorbid conditions were present. Several prior studies also reported similar trends in the association between direct costs and comorbid illnesses[13, 24, 25].There was a significant correlation between direct medical cost and cardiovascular-related procedures for both patients with angina pectoris and myocardial infarction. In patients with angina pectoris, those who underwent percutaneous transluminal coronary angioplasty (PTCA) with insertion of 3 drug eluting stents have the highest medical costs (MYR 5461.21). For those with MI, the highest cost was recorded for patients who underwent coronary artery bypass graft (CABG) of 3 arteries (RM12900.21) followed by PTCA with insertion of 3 drug eluting stents (MYR 7021.52). This is in accordancea prior study which stated that revascularization was associated with the highest incremental costs[22]. Other previous studies similarly reported identical findings, whereby coronary procedures such as CABG and PTCA incurred a significant massive increase in direct costs[26, 27].

Some limitations of this study should be mentioned. As this study involveda retrospective analysis of direct medical costs from only a single centre and based on one year's data, the generalisability of this study to the general Malaysian population may be limited. Since this was a retrospective study utilising secondary data from the casemix database, there is a possibility in which disease coding may not completely reflect the real clinical scenario of hospitalised subjects. We have carefully included selected ICD-10 codes which were most likely to be associated with IHD (I20, I21, I22, I25), however these codes might not be inclusive of all IHD patients admitted in 2018. Since this was an analysis of cost for one whole year (2018), direct medical costs of IHD patients may be under-represented since possible re-hospitalisations in subsequent years were not considered. Indirect costs related to IHD were not calculated in this study, therefore the overall magnitude of illness for IHD patients in UKMMC could not be determined.

CONCLUSION

This study showed that the direct medical costs for IHD in UKMMC for year 2018 were substantial, and were primarily influenced by gender, age, length of stay, presence of comorbid illness, disease severity and cardiovascular-related procedures underwent by the subjects. However, further studies investigating the factors influencing direct costs of IHD can be conducted, especially highlighting different components of costs involved, such as the use of IHD medications for the cohort of patients. Such findings might assist the clinicians in decision-making for the management of IHD subjects, specifically to reduce costs of disease for IHD.

ACKNOWLEDGEMENT

CONFLICTS OF INTEREST

Nil.

AUTHORS' CONTRIBUTIONS

NM and SSwas involved in the concept and planning of the research. NNAZA, MPM, REME, ASAH, ASMJ performed initial literature search, undertook data collection for this study, calculated the experimental data, performed the analysis, and interpreted the results. NNAZA, MPM, REME, ASAH, ASMJ drafted and edited the manuscript. NM and SS reviewed the overall results and revised the manuscript. All authors took part in giving critical revision of the final manuscript.

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