Characteristics and prosthesis usage of amputees attending Medical Rehabilitation services in Malaysia

Halimah Hana A Karim, MBCHB[1], Chern Phei Ming, M.Rehab.Med[1,2]

[1]Clinical Research Centre, Hospital Rehabilitasi Cheras, [2]Rehabilitation Medicine Department, Hospital Rehabilitasi Cheras

ABSTRACT

Introduction: Increasing numbers of limb amputation are performed globally and in Malaysia due to the rise of complications because of Diabetes Mellitus (DM). Limb amputation influences many aspects of an individual's life, and prosthesis restoration is one of the primary rehabilitation goals to help amputees resume daily activities. As limited information is available in Malaysia, this study aims to determine the socio-demographic, clinical characteristics and prosthesis usage among the amputees.

Methods: A cross-sectional study using self-developed survey form was conducted at 13 Medical Rehabilitation Clinics in Malaysia among 541 upper and lower limb amputees of any duration and cause.

Results: The study population had a mean age of 54 years. Majority were males, Malays, married and had completed secondary school. About 70% of amputations were performed due to DM complications and at transtibial level. Fifty-eight percent of unilateral lower limb amputees were using prosthesis with a mean (standard deviation) of 6.48 (±4.55) hours per day. Time since amputation was the true factor associated with prosthesis usage. Longer hours of prosthesis use per day was positively correlated with longer interval after prosthesis restoration (r=0.467).

Conclusion: Higher aetiology of DM and lower prosthesis usage among amputees may be because of high prevalence of DM in Malaysia. The prosthesis usage and hours of use per day were low compared to the international reports, which may be influenced by sampling location and time since amputation. Nevertheless, this is a novel multicentre study on the characteristics and prosthesis usage of amputees. Hopefully, this research will assist to support, facilitate and promote prosthesis rehabilitation in Malaysia.

KEYWORDS:
Amputation, prostheses, rehabilitation

INTRODUCTION

Approximately 200-500 million amputations are performed annually worldwide resulting in significant number of people living with limb loss. In the United States of America (USA) alone it was estimated that 1.6 million people were living with limb loss in 2005 and is expected to double to 3.2 million by 2025.[1] Age, gender, race and aetiology has been shown to have a significant role in limb loss.[1] The main aetiologies are Diabetes Mellitus (DM), Peripheral Vascular Disease (PVD) and trauma. In a developed country like the USA, there is an equal representation of trauma and vascular causes[2] while in developing countries like Nigeria and Iran, trauma is the leading cause.[3,4] A recent study on the trend of limb amputations reported amputation secondary to DM complications are on the rise and transtibial amputation as the most common amputation level.[1] However, there is a lack of published information on limb amputation in Malaysia. The available data are scarce and less representative of the Malaysian amputees. A single-centre study in Malaysia reported DM as the leading cause comprising 63% of total amputations.[5] The projection on increasing Malaysian DM prevalence to 31.3% in 2025[6] may contribute to increasing number of amputees in Malaysia.

Limb amputation is a physical disability which impairs body structures and results in limitation to daily activities. It influences multiple aspects of an individual's life such as mobility, body image, psychosocial and self-care activities.[7] The use of a lower limb prosthesis has been shown to improve mobility, independence, cosmesis and quality of life after amputation.[8] Thus, prosthesis restoration is one of the primary rehabilitation goals after amputation to help resume activities of daily life.[2] According to World Health Organization (WHO), 0.5% of the population of a developing country has a disability that will require a prosthesis or orthosis.[9] This prediction suggests that around 160,000 of Malaysia's current population of 32.58 million[10] will need prosthetic or orthotic devices. A single-region study of 37 lower-limb amputees in Malaysia reported only 58% of prosthesis usage.[8] Amputation level, employment, marital status, amputation cause and phantom limb pain has been shown to be associated with optimum prosthesis usage in international studies.[11]

The limited literature on amputation and prosthesis usage coupled with increasing DM prevalence in Malaysia demands a need for a clear representation of the Malaysian amputee population. This study was conducted to determine the socio-demographic background, clinical characteristics and prosthesis usage among amputees in Malaysia and the factors associated with prosthesis usage.

MATERIALS AND METHODS

A cross-sectional study of adult amputees attending Medical Rehabilitation Clinics in thirteen tertiary Ministry of Health hospitals from different states in Malaysia was conducted.

This article was accepted: 22 June 2020
Corresponding Author: Halimah Hana A Karim
Email: halimahana@gmail.com

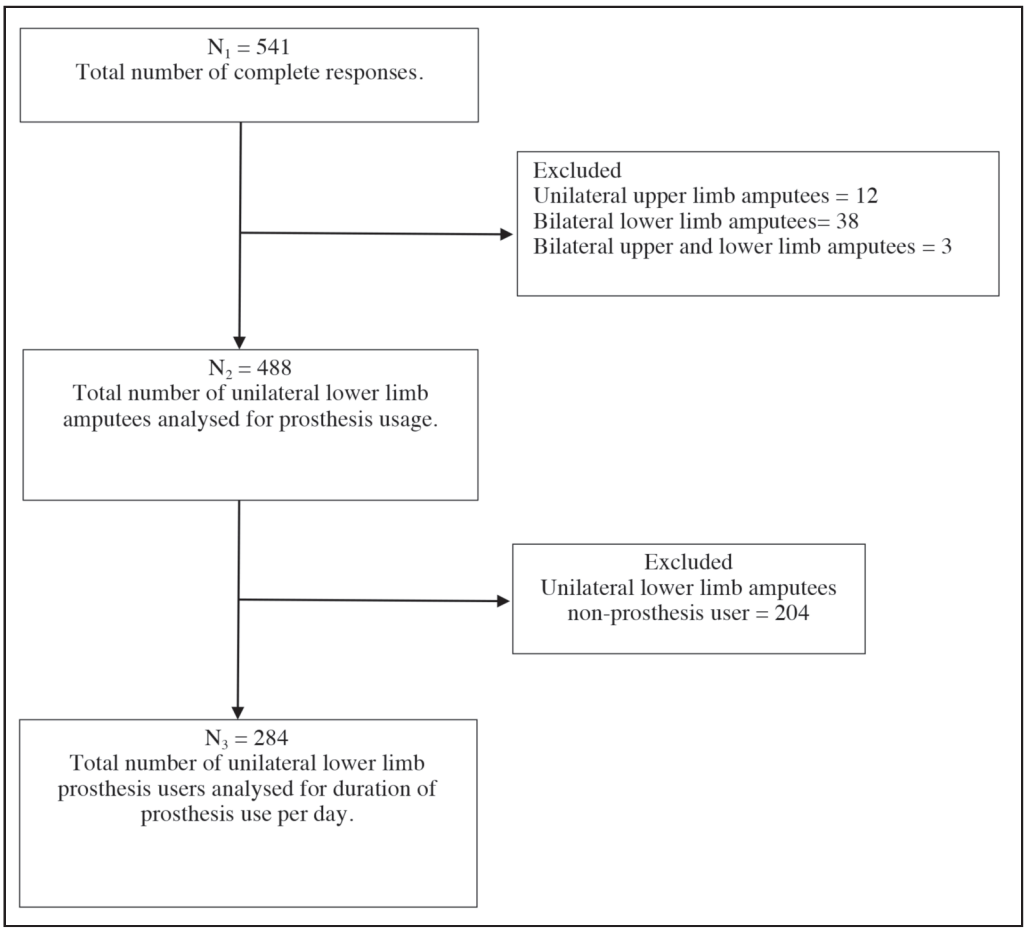

Fig. 1: The number of subjects used in the analysis of characteristics (N_1), prosthesis usage (N_2) and prosthesis use per day (N_3).

This study was registered with National Medical Research Registry (NMRR ID: 18-1609-41362) and obtained ethical clearance from the Ministry of Health's Medical Research Ethics Committee. Data was collected for three months at each site from August 2018 to July 2019. The hospitals involved were Hospital Rehabilitasi Cheras, Hospital Melaka, Hospital Pulau Pinang, Hospital Queen Elizabeth, Hospital Raja Perempuan Zainab II, Hospital Raja Permaisuri Bainun, Hospital Serdang, Hospital Sultan Ismail, Hospital Sultanah Bahiyah, Hospital Sultanah Nur Zahirah, Hospital Tengku Ampuan Rahimah, Hospital Tuanku Jaafar and Hospital Umum Sarawak.

Amputees were recruited during their medical rehabilitation clinic follow-ups. The inclusion criteria were patients with either upper or lower limb amputation of any duration and cause, age 18-year-old and above and able to understand written English or Bahasa Melayu. Amputees who were illiterate or had cognitive impairment were excluded. Informed consent was taken from all participants.

Participants were required to answer a self-developed survey form pertaining socio-demographic, medical, amputation and prosthesis-related information. For prosthesis usage, participants were asked "Are you currently using prosthesis?" with option of 'Yes' or 'No' as the answers. For duration of prosthesis use, they were asked, "On average, how many hours per day are you wearing your prosthesis?". Participants spent 15 to 20 minutes answering the survey questions which were collected by trained Site Investigators and returned to the Principal Investigator.

A total of 541 complete responses were returned for data entry and analysis. The total study population was analysed for their socio-demographic, medical and amputation characteristics. 488 subjects with unilateral lower limb amputations were analysed for their prosthesis usage. 284 unilateral lower limb prosthesis users were analysed for duration of prosthesis use per day. The number of subjects included and excluded at each analysis is shown in Figure I. Data was manually entered into Microsoft Excel before data cleaning. Data analyses was performed using IBM SPSS Statistics for Windows Version 20.0. Descriptive statistics was presented as frequencies and percentage. Numerical data was presented as means and standard deviations for normally distributed data and in medians and interquartile ranges for skewed data. The analysis of return to employment was performed on subjects that were employed prior to amputation. Analysis of prosthesis usage in normally distributed continuous variables were performed using Independent T-Test and One-way Anova. While analysis of prosthesis usage in non-normally distributed continuous variables were performed using Mann-Whitney Test or Kruskal-Wallis test. Categorical variables were analysed

Table I: The socio-demographic, medical and amputation characteristics of study population

Variables	Frequency (n) N1 = 541	Percentage (%)
Age, years		
<40	74	13.7
40-59	271	50.1
≥60	196	36.2
Gender		
Male	391	72.3
Female	150	27.7
Ethnicity		
Malay	350	64.7
Chinese	56	10.4
Indian	81	15.0
Other*	54	10.0
Marital status		
Single or divorced	143	26.4
Married	398	73.6
Highest education received		
None and Primary school	139	25.7
Secondary school	314	58.0
Higher education	88	16.3
Return to employment†		
Yes	112	27.9
No	290	72.1
Co-existing DM		
Yes	412	76.2
No	129	35.8
Amputation aetiology		
DM	380	70.2
Trauma	95	17.6
Tumour	42	7.8
Vascular without DM	15	2.8
Congenital	9	1.7
Time since amputation		
<1 year	189	34.9
1-3 years	173	32.0
3-5 years	74	13.7
>5 years	105	19.4
Amputation Level		
Upper Limb	12	2.2
Transfemoral and hip disarticulation	131	24.2
Transtibial and knee disarticulation	345	63.8
Partial foot and ankle disarticulation	12	2.2
Bilateral lower limb	38	7
Bilateral upper and lower limb	3	0.6
Presence of phantom limb sensation		
Yes	233	43.1
No	308	56.9
Presence of phantom limb pain		
Yes	235	43.4
No	306	56.6
Prosthesis Usage		
Yes	312	57.7
No	229	42.3

*Others (ethnicity) refers to indigenous Bumiputra other than Malays and non-Malaysians.
†Return to employment was analysed for subjects that were employed prior to amputation. (N=402)

using Chi-Square Test or Fisher's Exact Test. The true factor associated with prosthesis usage was determined using Multiple Logistic Regression.

Correlation between hours of prosthesis use per day with time since amputation and time since prosthesis restoration was performed using Spearman's correlation. All probability values were two-sided, and a level of significance of less than 0.05 (p-value<0.05) was considered as statistically significant.

RESULTS

The socio-demographic, medical and amputation characteristics of the whole study population are presented in Table I. The study population had mean age of 54 (±12.93) years with age range between 19 and 90 years old. Seventy-two percent were males and 64% Malays. Seventy-three percent were married and had received at least secondary school education. Around a third (27.9%) had returned to employment. While 76% of the total population had co-

Table II: The prosthesis usage of study population with unilateral lower limb amputation according to their socio-demographic, medical and amputation characteristics

Variables	Total n (%)	Prosthesis Usage, n (%)		p-value
	N2 = 488	Yes (n=284)	No (n=204)	
Age (years)				
<40	63 (12.9)	44 (69.8)	19 (30.2)	0.108
40-59	243 (49.8)	134 (55.1)	109 (44.9)	
>59	182 (37.3)	106 (58.2)	76 (41.8)	
Gender				
Male	350 (71.7)	217 (62.0)	133 (38.0)	0.007
Female	138 (28.3)	67 (48.6)	71 (51.4)	
Ethnicity				
Malay	319 (65.4)	172 (53.9)	147 (46.1)	0.053
Chinese	50 (10.2)	31 (62.0)	19 (38.0)	
Indian	68 (13.9)	45 (66.2)	23 (33.8)	
Others*	51 (10.5)	36 (70.6)	15 (29.4)	
Marital status				
Single or divorced	128 (26.2)	68 (53.1)	60 (46.9)	0.176
Married	360 (73.8)	216 (60.0)	144 (40.0)	
Highest education received				
None and Primary School	130 (26.6)	65 (50.0)	65 (50.0)	0.038
Secondary School	281 (57.6)	167 (59.4)	114 (40.6)	
Higher Education	77 15.8)	52 (67.5)	25 (32.5)	
Return to employment‡				
Yes	96 (26.7)	66 (68.8)	30 (31.2)	0.079
No	263 (73.3)	154 (58.6)	109 (41.4)	
Co-existing DM				
Yes	373 (76.4)	200 (53.6)	173 (46.4)	<0.001
No	115 (23.6)	84 (73.0)	31 (27.0)	
Amputation aetiology				
DM	345 (70.7)	181 (52.5)	164 (47.5)	< 0.001
Trauma	85 (17.4)	66 (77.6)	19 (22.4)	
Tumour	39 (8.0)	21 (53.8)	18 (46.2)	
Vascular without DM	13 (2.7)	11 (84.6)	2 (15.4)	
Congenital	6 (1.2)	5 (83.3)	1 (16.7)	
Time since amputation (years)				
<1	177 (36.2)	38 (21.5)	139 (78.5)	<0.001
1-3	158 (32.3)	111 (70.3)	47 (29.7)	
3-5	62 (12.7)	50 (80.6)	12 (19.4)	
>5	91 (18.6)	85 (93.4)	6 (6.6)	
Amputation Level				
Transfemoral and hip disarticulation	131 (26.8)	75 (57.3)	56 (42.7)	0.803
Transtibial and knee disarticulation	345 (70.7)	203 (58.8)	142 (41.2)	
Partial foot and ankle disarticulation	12 (2.5)	6 (50.0)	6 (50.0)	
Presence of phantom limb sensation				
No	278 (57.0)	170(61.3)	108 (38.7)	0.128
Yes	210 (43.0)	114 (54.3)	96 (45.7)	
Presence of phantom limb pain				
No	276 (56.3)	161 (58.3)	115 (41.7)	0.944
Yes	212 (43.7)	123 (58.0)	89 (42.0)	

*Others (ethnicity) refers to indigenous Bumiputras other than Malays, and non-Malaysians.
‡Return to employment was analysed for unilateral lower limb amputees who were employed prior to amputation. (N=359).

Table III: The true factor associated with prosthesis usage using Multiple Logistic Regression in Enter Method

Variable	Prosthesis Usage n (%)		Crude OR (CI)	p-value
	Yes (n=284)	No (n=204)		
Time since amputation (years)				
<1	38 (21.5)	139 (78.5)	ref.	<0.001
1-3	111 (70.3)	47 (29.7)	8.445 (5.210, 13.688)	
3-5	50 (80.6)	12 (19.4)	14.577 (7.407, 28.690)	
>5	85 (93.4)	6 (6.6)	27.982 (13.376, 58.537)	

CI= Confidence Interval
OR= Odds Ratio (95% Confidence Interval)

Table IV: Prosthesis usage of unilateral lower limb amputees according to amputation and prosthesis restoration time and the correlation analysis between hours of use per day with time since amputation and prosthesis restoration time

Variable	Total n (%) N3=284	Usage per day (hours)		Time since amputation/ prosthesis restoration (years)			
		Mean	SD	Mean	SD	r	p-value
Time since amputation (years)				4.73	6.181	0.382	<0.001
<1	38 (13.4)	4.74	3.825				
1-3	111 (39.1)	4.98	3.775				
3-5	50 (17.6)	7.48	5.14				
>5	85 (29.9)	8.62	4.429				
Time since prosthesis restoration (years)				3.61	5.715	0.467	<0.001
<1	128 (45.1)	4.52	3.535				
1-3	58 (20.4)	6.69	4.333				
3-5	39 (13.7)	8.82	4.914				
>5	59 (20.8)	8.97	4.567				

Note: Correlation analysis performed using Spearman's correlation test (r).

existing DM and 70% of amputation aetiology was due to DM. The most common amputation level was transtibial amputation, and 43% of subjects reported phantom limb sensation and pain.

The analysis of prosthesis usage among subjects with unilateral lower limb amputation is shown in Table II. The prosthesis usage was 58%. The mean age of prosthesis users and non-users were 53.62 (±13.62) and 55.59 (±11.71) years. Significantly more prosthesis usage was reported among males and those who had higher education level. Significantly lower prosthesis usage was found among subjects with duration of amputation less than one year and DM (as co-existing disease or aetiology). The presence of phantom limb sensation and pain did not affect the usage of prosthesis.

The Multiple Logistic Regression analysis of prosthesis usage is shown in Table III. When adjusted with other variables, the time since amputation had significant effect towards prosthesis usage. Those who were amputated for 1 to 3 years were eight times more likely to use prosthesis compared to those who were amputated less than 1 year.

The mean of prosthesis use per day among unilateral lower limb amputees was 6.48 (±4.549) hours. The mean hours of prosthesis use per day increased as time since amputation and prosthesis restoration increased as presented in Table IV. A stronger positive correlation was shown between hours of prosthesis use per day with time since prosthesis restoration compared to time since amputation as shown in Table IV.

DISCUSSION

A predominance of male gender and Malay ethnicity found in this study is consistent with other studies in Malaysia.[5,8,12] Our mean age of 54 is similar to other Malaysian studies[5,13] but older age than study populations in Thailand, Ireland and India with ages ranging from 43 to 47.[7,14,15] This may be due to our method of sampling in medical rehabilitation clinics as compared to prosthetic-fitting centres in the studies elsewhere.

Seventy percent of amputation was a result of DM which were comparable to the 63-72% range that was reported in other Malaysian studies.[5,13] Compared to International studies, aetiology of DM in the Malaysian amputee is double the proportion in Nigeria,[3] three times the proportion in India[14] and five times the proportion in Thailand.[7] Our population also showed 17% of amputation due to trauma which is half the proportion in Nigeria[3] and the US,[16] and a third of the proportion in Brazil[17] and India.[14] These findings reflects the high prevalence of DM in Malaysia which is 18.3% among adults[18] compared to 7% to 8% in the USA and the African countries.[19] However, our results could also be due to the sampling location.

Fifty-eight percent of prosthesis usage found in our study was similar to another Malaysian study.[8] This rate is comparatively low to the reported rate of 66% in India,[14] 83% in Nigeria,[3] and 80-90% in the USA.[2] This may be contributed by the high percentage of our study population being amputated less than one year compared to only 12% in the USA study.[2] However, our results also demonstrated significant increase of prosthesis usage to 80% among those amputated more than three years. Thus, the difference in time since amputation could possibly explain our low prosthesis usage. Nevertheless, our overall 58% of prosthesis usage still needs to be acted upon considering the projection of increasing number of amputees in Malaysia.

Our overall rate of return to employment is 27.9% which is lower than the range of 32% to 48% reported by other Malaysian and international studies.[5,8,14,16] This may be due to the fact that one third of our study population were above 60 years of age which is the normal retirement age in Malaysia. Studies have shown that amputees regained employment as time passed[20] and prosthesis rehabilitation increased the likelihood of returning to employment.[11] Thus, increasing access and prescription of prosthesis will possibly improve the employment rate of our amputees.

An average of 6.48 hours per day of prosthesis usage was about half the duration of 10 to 13 hours as reported by others.[2,11,14] This could have been contributed because of the older age of our study population which has been reported as

a barrier to successful prosthesis use.[21] Another study conducted among subjects with unilateral lower limb amputation due to DM or PVD discussed that the hours of walking with prosthesis is negatively associated with older age.[22] In addition, our higher rate of DM cause of amputation may be a contributing factor. A study by Pezzin et al., reported that the frequency of prosthesis use was lowest among persons with dysvascular amputations as compared to other causes of amputation. Dysvascular cause in their study included subjects who reported DM as reason for amputation.[2] Their study results also showed that shorter timing to prosthesis restoration is associated with higher frequency of prosthesis use after controlled for multiple demographic and amputation characteristics.[2] Similarly, our correlation analysis showed the importance of early prosthesis restoration. On top of that, early restoration has shown to provide many physical and psychological advantage.[21]

LIMITATIONS

There may be some limitations in this study. Firstly, the data are all self-reported and thus liable to recall and information bias. Secondly, subjects were recruited from medical rehabilitation clinics in the Ministry of Health hospitals, therefore may not capture amputees attending other facilities and the whole spectrum of amputees in Malaysia. This may contribute to the vast difference in the number of amputees by different amputation levels seen in this study. Finally, the proportion of amputees restored with prosthesis does not necessarily equate to successful and functional prosthesis usage. A further standardised functional assessment needs to be conducted to obtain thorough understanding of prosthesis usage. Nevertheless, this study may represent a diverse geographical amputee population encompassing 13 states in Malaysia.

CONCLUSION

In summary, this is a novel multicentre Malaysian study on amputee characteristics and prosthesis usage. A total of 58% of unilateral lower limb amputees were using prosthesis with average of 6.48 (±4.549) hours per day. This suboptimal rate of prosthesis usage raises concerns about lost opportunities for ideal prosthesis rehabilitation. Our findings will hopefully provide information in planning for management and intervention towards amputee population in Malaysia. This research also offers insight into factors associated with prosthesis usage and encourage advancement of prosthesis rehabilitation. A collective effort is needed to look into our prosthesis service to better equip Malaysians with the increasing amputee population in the future.

ACKNOWLEDGEMENTS

The authors would like to thank the Director General of Health Malaysia for permission to publish this paper. Special thanks to all Heads of Rehabilitation Department of the participating hospitals.

The authors declare that they have no conflict of interest.
This study is not funded by any organisation

REFERENCES

1. Varma P, Stineman MG, Dillingham TR. Epidemiology of limb loss. Phys Med Rehabil Clin N Am 2014; 25(1): 1-8.
2. Pezzin LE, Dillingham TR, MacKenzie EJ, Ephraim P, Rossbach P. Use and satisfaction with prosthetic limb devices and related services. Arch Phys Med Rehabil 2004; 85(5): 723-9.
3. Adegoke BO, Kehinde AO, Akosile CO, Oyeyemi AL. Quality of life of Nigerians with unilateral lower limb amputation. Disabil CBR Incl Dev 2013; 23(4): 76-89.
4. Sabzi Sarvestani A, Taheri Azam A. Amputation: a ten-year survey. Trauma Mon 2013; 18(3): 126-9.
5. Htwe O, Suganthini S, Lee KX, Siti Maryam AH, HadiFadhil MS, Kumaragu S, et al. Quality of life among lower limb amputees treated at the tertiary hospital, Malaysia. International Medical Journal 2015; 22(3): 171-4.
6. Ministry of Health Malaysia. National Strategic Plan for Non-Communicable Disease (NSP-NCD) 2016-2025.
7. Dajpratham P, Tantiniramai S, Lukkanapichonchut P. Health Related Quality of life among the Thai people with unilateral lower limb amputation. J Med Assoc Thai 2011; 94(2): 250-5
8. Razak MMA, Tauhid MZ, Yasin NF, Hanapiah FA. Quality of life among lower limb amputees in Malaysia. Procedia - Soc Behav Sci 2016; 222: 450-7.
9. World Health Organization. guidelines for training personnel in developing countries for prosthetics and orthotics services; 2004.
10. Department of Statistics Malaysia Official Portal. https://www.dosm.gov.my/v1/index.php?r=column/cone&menu_id=dDM2enNvM09oTGtQemZPVzRTWENmZz09. Accessed June 08, 2020.
11. Raichle KA, Hanley MA, Molton I, Kadel NJ, Campbell K, Phelps E, et al. Prosthesis use in persons with lower- and upper-limb amputation. J Rehabil Res Dev 2008; 45(7): 961-72.
12. Mohd Yusof N, Che Ahmad A, Fadzli Sulong A, Jazlan Mohd Adnan M, Abdul Rahman J, Musa R. Quality of life of diabetes amputees following major and minor lower limb amputations. Med J Malaysia 2019; 74 (1); 25-9.
13. Iqbal M, Mohamed S, Mohamad M. Depression and its associated factors among lower limb amputees at Hospital Kuala Lumpur and Hospital Sultanah Bahiyah: A Cross Sectional Study. J Depress Anxiety 2019; 8(2); 1-9.
14. Sinha R, van den Heuvel WJ, Arokiasamy P. Factors affecting quality of life in lower limb amputees. Prosthet Orthot Int 2011; 35(1): 90-6.
15. Gallagher P, Maclachlan M. The trinity amputation and prosthesis experience scales and quality of life in people with lower-limb amputation. Arch Phys Med Rehabil 2004; 85 (5);730-736.
16. Amtmann D, Morgan SJ, Kim J, Hafner BJ. Health-related profiles of people with lower limb loss. Arch Phys Med Rehabil 2015; 96(8): 1474-83.
17. Da Silva R, Rizzo JG, Barbosa PJ, Filho G, Ramos V, Deans S. Physical activity and quality of life of amputees in southern Brazil. Prosthet Orthot Int 2011; 35(4): 432-8.
18. Ministry of Health, National Health and Morbidity Survey 2019, Non-Communicable Diseases Healthcare Demand; http://iku.gov.my/images/IKU/Document/REPORT/NHMS2019/Fact_Sheet_NHMS_2019-English.pdf. Accessed June 8, 2020
19. World Health Organization. Global Report on Diabetes; 2017. https://www.who.int/diabetes/global-report/en/. Accessed June 2, 2020.
20. Fisher K, Hanspal RS, Marks L. Return to work after lower limb amputation. Int J Rehabil Res 2003; 26(26): 51-6.
21. Resnik L, Borgia M. Predicting prosthetic prescription after major lower-limb amputation. J Rehabil Res Dev 2015; 52(6): 641-52.
22. Webster JB, Hakimi KN, Williams RM, Turner AP, Norvell DC, Czerniecki JM. Prosthetic fitting, use, and satisfaction following lower-limb amputation: A prospective study. J Rehabil Res Dev 2012; 49(10): 1493-1504.