



UNIVERSITI
TEKNOLOGI
MARA

Cawangan Kedah
Kampus Sungai Petani



e-PROCEEDINGS

of The 5th International Conference
on Computing, Mathematics and
Statistics (iCMS2021)

4-5 August 2021

Driving Research Towards Excellence



e-Proceedings of the 5th International Conference on Computing, Mathematics and Statistics (iCMS 2021)

Driving Research Towards Excellence

Editor-in-Chief: Norin Rahayu Shamsuddin

Editorial team:

Dr. Afida Ahamad
Dr. Norliana Mohd Najib
Dr. Nor Athirah Mohd Zin
Dr. Siti Nur Alwani Salleh
Kartini Kasim
Dr. Ida Normaya Mohd Nasir
Kamarul Ariffin Mansor

e-ISBN: 978-967-2948-12-4

DOI

Library of Congress Control Number:

Copyright © 2021 Universiti Teknologi MARA Kedah Branch

All right reserved, except for educational purposes with no commercial interests. No part of this publication may be reproduced, copied, stored in any retrieval system or transmitted in any form or any means, electronic or mechanical including photocopying, recording or otherwise, without prior permission from the Rector, Universiti Teknologi MARA Kedah Branch, Merbok Campus. 08400 Merbok, Kedah, Malaysia.

The views and opinions and technical recommendations expressed by the contributors are entirely their own and do not necessarily reflect the views of the editors, the Faculty or the University.

Publication by
Department of Mathematical Sciences
Faculty of Computer & Mathematical Sciences
UiTM Kedah

TABLE OF CONTENT

PART 1: MATHEMATICS

	Page
STATISTICAL ANALYSIS ON THE EFFECTIVENESS OF SHORT-TERM PROGRAMS DURING COVID-19 PANDEMIC: IN THE CASE OF PROGRAM BIJAK SIFIR 2020 <i>Nazihah Safie, Syerrina Zakaria, Siti Madhiah Abdul Malik, Nur Bani Ismail, Azwani Alias Ruwaidiah Idris</i>	1
RADIATIVE CASSON FLUID OVER A SLIPPERY VERTICAL RIGA PLATE WITH VISCOUS DISSIPATION AND BUOYANCY EFFECTS <i>Siti Khuzaimah Soid, Khadijah Abdul Hamid, Ma Nuramalina Nasero, NurNajah Nabila Abdul Aziz</i>	10
GAUSSIAN INTEGER SOLUTIONS OF THE DIOPHANTINE EQUATION $x^4 + y^4 = z^3$ FOR $x \neq y$ <i>Shahrina Ismail, Kamel Ariffin Mohd Atan and Diego Sejas Viscarra</i>	19
A SEMI ANALYTICAL ITERATIVE METHOD FOR SOLVING THE EMDEN-FOWLER EQUATIONS <i>Mat Salim Selamat, Mohd Najir Tokachil, Noor Aqila Burhanddin, Ika Suzieana Murad and Nur Farhana Razali</i>	28
ROTATING FLOW OF A NANOFUID PAST A NONLINEARLY SHRINKING SURFACE WITH FLUID SUCTION <i>Siti Nur Alwani Salleh, Norfifah Bachok and Nor Athirah Mohd Zin</i>	36
MODELING THE EFFECTIVENESS OF TEACHING BASIC NUMBERS THROUGH MINI TENNIS TRAINING USING MARKOV CHAIN <i>Rahela Abdul Rahim, Rahizam Abdul Rahim and Syahrul Ridhwan Morazuk</i>	46
PERFORMANCE OF MORTALITY RATES USING DEEP LEARNING APPROACH <i>Mohamad Hasif Azim and Saiful Izzuan Hussain</i>	53
UNSTEADY MHD CASSON FLUID FLOW IN A VERTICAL CYLINDER WITH POROSITY AND SLIP VELOCITY EFFECTS <i>Wan Faezah Wan Azmi, Ahmad Qushairi Mohamad, Lim Yeou Jiann and Sharidan Shafie</i>	60
DISJUNCTIVE PROGRAMMING - TABU SEARCH FOR JOB SHOP SCHEDULING PROBLEM <i>S. Z. Nordin, K.L. Wong, H.S. Pheng, H. F. S. Saipol and N.A.A. Husain</i>	68
FUZZY AHP AND ITS APPLICATION TO SUSTAINABLE ENERGY PLANNING DECISION PROBLEM <i>Liana Najib and Lazim Abdullah</i>	78
A CONSISTENCY TEST OF FUZZY ANALYTIC HIERARCHY PROCESS <i>Liana Najib and Lazim Abdullah</i>	89
FREE CONVECTION FLOW OF BRINKMAN TYPE FLUID THROUGH AN COSINE OSCILLATING PLATE <i>Siti Noramirah Ibrahim, Ahmad Qushairi Mohamad, Lim Yeou Jiann, Sharidan Shafie and Muhammad Najib Zakaria</i>	98

RADIATION EFFECT ON MHD FERROFLUID FLOW WITH RAMPED WALL TEMPERATURE AND ARBITRARY WALL SHEAR STRESS	106
<i>Nor Athirah Mohd Zin, Aaiza Gul, Siti Nur Alwani Salleh, Imran Ullah, Sharena Mohamad Isa, Lim Yeou Jiann and Sharidan Shafie</i>	

PART 2: STATISTICS

A REVIEW ON INDIVIDUAL RESERVING FOR NON-LIFE INSURANCE	117
<i>Kelly Chuah Khai Shin and Ang Siew Ling</i>	
STATISTICAL LEARNING OF AIR PASSENGER TRAFFIC AT THE MURTALA MUHAMMED INTERNATIONAL AIRPORT, NIGERIA	123
<i>Christopher Godwin Udomboso and Gabriel Olugbenga Ojo</i>	
ANALYSIS ON SMOKING CESSATION RATE AMONG PATIENTS IN HOSPITAL SULTAN ISMAIL, JOHOR	137
<i>Siti Mariam Norrulashikin, Ruzaini Zulhusni Puslan, Nur Arina Bazilah Kamisan and Siti Rohani Mohd Nor</i>	
EFFECT OF PARAMETERS ON THE COST OF MEMORY TYPE CHART	146
<i>Sakthiseswari Ganasan, You Huay Woon and Zainol Mustafa</i>	
EVALUATION OF PREDICTORS FOR THE DEVELOPMENT AND PROGRESSION OF DIABETIC RETINOPATHY AMONG DIABETES MELLITUS TYPE 2 PATIENTS	152
<i>Syafawati Ab Saad, Maz Jamilah Masnan, Karniza Khalid and Safwati Ibrahim</i>	
REGIONAL FREQUENCY ANALYSIS OF EXTREME PRECIPITATION IN PENINSULAR MALAYSIA	160
<i>Iszuanie Syafidza Che Ilias, Wan Zawiah Wan Zin and Abdul Aziz Jemain</i>	
EXPONENTIAL MODEL FOR SIMULATION DATA VIA MULTIPLE IMPUTATION IN THE PRESENT OF PARTLY INTERVAL-CENSORED DATA	173
<i>Salman Umer and Faiz Elfaki</i>	
THE FUTURE OF MALAYSIA'S AGRICULTURE SECTOR BY 2030	181
<i>Thanusha Palmira Thangarajah and Suzilah Ismail</i>	
MODELLING MALAYSIAN GOLD PRICES USING BOX-JENKINS APPROACH	186
<i>Isnewati Ab Malek, Dewi Nur Farhani Radin Nor Azam, Dinie Syazwani Badrul Aidi and Nur Syafiqah Sharim</i>	
WATER DEMAND PREDICTION USING MACHINE LEARNING: A REVIEW	192
<i>Norashikin Nasaruddin, Shahida Farhan Zakaria, Afida Ahmad, Ahmad Zia Ul-Saufie and Norazian Mohamaed Noor</i>	
DETECTION OF DIFFERENTIAL ITEM FUNCTIONING FOR THE NINE-QUESTIONS DEPRESSION RATING SCALE FOR THAI NORTH DIALECT	201
<i>Suttipong Kawilapat, Benchlak Maneeton, Narong Maneeton, Sukon Prasitwattanaseree, Thoranin Kongsuk, Suwanna Arunpongpaisal, Jintana Leejongpermpool, Supattra Sukhawaha and Patrinee Traisathit</i>	

ACCELERATED FAILURE TIME (AFT) MODEL FOR SIMULATION PARTLY INTERVAL-CENSORED DATA	210
<i>Ibrahim El Feky and Faiz Elfaki</i>	
MODELING OF INFLUENCE FACTORS PERCENTAGE OF GOVERNMENTS' RICE RECIPIENT FAMILIES BASED ON THE BEST FOURIER SERIES ESTIMATOR	217
<i>Chaerobby Fakhri Fauzaan Purwoko, Ayuning Dwis Cahyasari, Netha Aliffia and M. Fariz Fadillah Mardianto</i>	
CLUSTERING OF DISTRICTS AND CITIES IN INDONESIA BASED ON POVERTY INDICATORS USING THE K-MEANS METHOD	225
<i>Khoirun Niswatin, Christopher Andreas, Putri Fardha Asa OktaviaHans and M. Fariz Fadilah Mardianto</i>	
ANALYSIS OF THE EFFECT OF HOAX NEWS DEVELOPMENT IN INDONESIA USING STRUCTURAL EQUATION MODELING-PARTIAL LEAST SQUARE	233
<i>Christopher Andreas, Sakinah Priandi, Antonio Nikolas Manuel Bonar Simamora and M. Fariz Fadillah Mardianto</i>	
A COMPARATIVE STUDY OF MOVING AVERAGE AND ARIMA MODEL IN FORECASTING GOLD PRICE	241
<i>Arif Luqman Bin Khairil Annuar, Hang See Pheng, Siti Rohani Binti Mohd Nor and Thoo Ai Chin</i>	
CONFIDENCE INTERVAL ESTIMATION USING BOOTSTRAPPING METHODS AND MAXIMUM LIKELIHOOD ESTIMATE	249
<i>Siti Fairus Mokhtar, Zahayu Md Yusof and Hasimah Sapiri</i>	
DISTANCE-BASED FEATURE SELECTION FOR LOW-LEVEL DATA FUSION OF SENSOR DATA	256
<i>M. J. Masnan, N. I. Maha3, A. Y. M. Shakaf, A. Zakaria, N. A. Rahim and N. Subari</i>	
BANKRUPTCY MODEL OF UK PUBLIC SALES AND MAINTENANCE MOTOR VEHICLES FIRMS	264
<i>Asmahani Nayan, Amirah Hazwani Abd Rahim, Siti Shuhada Ishak, Mohd Rijal Ilias and Abd Razak Ahmad</i>	
INVESTIGATING THE EFFECT OF DIFFERENT SAMPLING METHODS ON IMBALANCED DATASETS USING BANKRUPTCY PREDICTION MODEL	271
<i>Amirah Hazwani Abdul Rahim, Nurazlina Abdul Rashid, Abd-Razak Ahmad and Norin Rahayu Shamsuddin</i>	
INVESTMENT IN MALAYSIA: FORECASTING STOCK MARKET USING TIME SERIES ANALYSIS	278
<i>Nuzlinda Abdul Rahman, Chen Yi Kit, Kevin Pang, Fauhatuz Zahroh Shaik Abdullah and Nur Sofiah Izani</i>	

PART 3: COMPUTER SCIENCE & INFORMATION TECHNOLOGY

- ANALYSIS OF THE PASSENGERS' LOYALTY AND SATISFACTION OF AIRASIA PASSENGERS USING CLASSIFICATION** 291
Ee Jian Pei, Chong Pui Lin and Nabilah Filzah Mohd Radzuan
- HARMONY SEARCH HYPER-HEURISTIC WITH DIFFERENT PITCH ADJUSTMENT OPERATOR FOR SCHEDULING PROBLEMS** 299
Khairul Anwar, Mohammed A.Awadallah and Mohammed Azmi Al-Betar
- A 1D EYE TISSUE MODEL TO MIMIC RETINAL BLOOD PERFUSION DURING RETINAL IMAGING PHOTOPLETHYSMOGRAPHY (IPPG) ASSESSMENT: A DIFFUSION APPROXIMATION – FINITE ELEMENT METHOD (FEM) APPROACH** 307
Harnani Hassan, Sukreen Hana Herman, Zulfakri Mohamad, Sijung Hu and Vincent M. Dwyer
- INFORMATION SECURITY CULTURE: A QUALITATIVE APPROACH ON MANAGEMENT SUPPORT** 325
Qamarul Nazrin Harun, Mohamad Noorman Masrek, Muhamad Ismail Pahmi and Mohamad Mustaqim Junoh
- APPLY MACHINE LEARNING TO PREDICT CARDIOVASCULAR RISK IN RURAL CLINICS FROM MEXICO** 335
Misael Zambrano-de la Torre, Maximiliano Guzmán-Fernández, Claudia Sifuentes-Gallardo, Hamurabi Gamboa-Rosales, Huizilopoztli Luna-García, Ernesto Sandoval-García, Ramiro Esquivel-Felix and Héctor Durán-Muñoz
- ASSESSING THE RELATIONSHIP BETWEEN STUDENTS' LEARNING STYLES AND MATHEMATICS CRITICAL THINKING ABILITY IN A 'CLUSTER SCHOOL'** 343
Salimah Ahmad, Asyura Abd Nassir, Nor Habibah Tarmuji, Khairul Firhan Yusob and Nor Azizah Yacob
- STUDENTS' LEISURE WEEKEND ACTIVITIES DURING MOVEMENT CONTROL ORDER: UİTM PAHANG SHARING EXPERIENCE** 351
Syafıza Saila Samsudin, Noor Izyan Mohamad Adnan, Nik Muhammad Farhan Hakim Nik Badrul Alam, Siti Rosiah Mohamed and Nazihah Ismail
- DYNAMICS SIMULATION APPROACH IN MODEL DEVELOPMENT OF UNSOLD NEW RESIDENTIAL HOUSING IN JOHOR** 363
Lok Lee Wen and Hasimah Sapiri
- WORD PROBLEM SOLVING SKILLS AS DETERMINANT OF MATHEMATICS PERFORMANCE FOR NON-MATH MAJOR STUDENTS** 371
Shahida Farhan Zakaria, Norashikin Nasaruddin, Mas Aida Abd Rahim, Fazillah Bosli and Kor Liew Kee
- ANALYSIS REVIEW ON CHALLENGES AND SOLUTIONS TO COMPUTER PROGRAMMING TEACHING AND LEARNING** 378
Noor Hasnita Abdul Talib and Jasmin Ilyani Ahmad

PART 4: OTHERS

- ANALYSIS OF CLAIM RATIO, RISK-BASED CAPITAL AND VALUE-ADDED INTELLECTUAL CAPITAL: A COMPARISON BETWEEN FAMILY AND GENERAL TAKAFUL OPERATORS IN MALAYSIA** 387
Nur Amalina Syafiqa Kamaruddin, Norizarina Ishak, Siti Raihana Hamzah, Nurfadhlina Abdul Halim and Ahmad Fadhly Nurullah Rasade
- THE IMPACT OF GEOMAGNETIC STORMS ON THE OCCURRENCES OF EARTHQUAKES FROM 1994 TO 2017 USING THE GENERALIZED LINEAR MIXED MODELS** 396
N. A. Mohamed, N. H. Ismail, N. S. Majid and N. Ahmad
- BIBLIOMETRIC ANALYSIS ON BITCOIN 2015-2020** 405
Nurazlina Abdul Rashid, Fazillah Bosli, Amirah Hazwani Abdul Rahim, Kartini Kasim and Fathiyah Ahmad@Ahmad Jali
- GENDER DIFFERENCE IN EATING AND DIETARY HABITS AMONG UNIVERSITY STUDENTS** 413
Fazillah Bosli, Siti Fairus Mokhtar, Noor Hafizah Zainal Aznam, Juaini Jamaludin and Wan Siti Esah Che Hussain
- MATHEMATICS ANXIETY: A BIBLIOMETRIX ANALYSIS** 420
Kartini Kasim, Hamidah Muhd Irpan, Noorazilah Ibrahim, Nurazlina Abdul Rashid and Anis Mardiana Ahmad
- PREDICTION OF BIOCHEMICAL OXYGEN DEMAND IN MEXICAN SURFACE WATERS USING MACHINE LEARNING** 428
Maximiliano Guzmán-Fernández, Misael Zambrano-de la Torre, Claudia Sifuentes-Gallardo, Oscar Cruz-Dominguez, Carlos Bautista-Capetillo, Juan Badillo-de Loera, Efrén González Ramírez and Héctor Durán-Muñoz

EVALUATION OF PREDICTORS FOR THE DEVELOPMENT AND PROGRESSION OF DIABETIC RETINOPATHY AMONG DIABETES MELLITUS TYPE 2 PATIENTS

Syafawati Ab Saad¹, Maz Jamilah Masnan^{2,3}, Karniza Khalid⁴, Safwati Ibrahim⁵

^{1,2,5}Faculty of Applied & Human Sciences, Institute of Engineering Mathematics, Universiti Malaysia Perlis, Kampus Alam UniMAP, Pauh Putra, 02600 Arau, Perlis, Malaysia

³Centre of Excellence for Social Innovation and Sustainability, Universiti Malaysia Perlis, Kampus Alam UniMAP, Pauh Putra, 02600 Arau, Perlis, Malaysia

⁴Ministry of Health Malaysia, Clinical Research Centre, Hospital Tuanku Fauziah, Jalan Tun Abd Razak, 01000 Kangar, Perlis, Malaysia

(¹syafawatisaad@unimap.edu.my, ^{2,3}mazjamilah@unimap.edu.my, ⁴karniza.khalid@moh.gov.my, ⁵safwati@unimap.edu.my)

Diabetic retinopathy is one of the microvascular complications caused by prolonged uncontrolled diabetes. It is believed that diabetic retinopathy correlates with certain predictors and risk factors that might worsen the disease, eventually causing visual loss and blindness among diabetes patients. There are some predictors and risk factors that attribute to the development and progression of diabetic retinopathy, such as the duration of diabetes and HbA1c trends. This study aims to evaluate the predictors and risk factors associated with the development and/or progression of diabetic retinopathy. Retrospective data were collected from a single healthcare facility in the northwest of Peninsular Malaysia. Patients included in this study were those with type 2 diabetes mellitus diagnosed with diabetic retinopathy. The total number of patients involved in this study were 197, where 161 of them were newly diagnosed or with progressive diabetic retinopathy. The characteristics of diabetes patients with complication of diabetic retinopathy were described through descriptive statistics. Characteristics include demographics data such as age, gender, race and clinical data such as HbA1c readings HbA1c, estimated glomerular filtration rate (eGFR), urea and haemoglobin concentration (Hb). The results show that 7 predictors and risk factors are significant to the development and progression of diabetic retinopathy among diabetes patients. By using multinomial logistic regression, this study offers better understanding of the significant predictors and risk factors related to diabetic retinopathy.

Keywords: diabetic retinopathy, predictors, multinomial logistic regression

1. Introduction

Diabetic retinopathy is a microvascular complication caused by prolonged uncontrolled diabetes mellitus which may cause significant disability including blindness. The prevalence of diabetic retinopathy worldwide ranges from 6.8% to 44.4% in patients with diabetes mellitus. Globally, the number of people with diabetic retinopathy were estimated to grow from 126.6 million in 2010 to 191.0 million by 2030 if remedial action is not taken (Romero-Aroca et al., 2012; Zhang et al., 2018). However, in Malaysia the prevalence of diabetic retinopathy has been reported to increase from 44.1% to 48.6% (Ali et al., 2016). The prevalence of diabetic retinopathy in Malaysia is comprised of 12.3% of type 1 and another 22.3% of type 2 diabetes mellitus. Diabetic retinopathy refers to all the vascular changes in the retina occurring from the disease detected from ophthalmologic evaluation, risking visual impairment and blindness among patients with diabetes (Altomare et al., 2018). According to the International Clinical Diabetic Retinopathy, diabetic retinopathy is categorized by six stages; (i) no retinopathy, (ii) mild non-proliferative diabetic retinopathy (NPDR), (iii) moderate NPDR, (iv) severe NPDR, (v) proliferative diabetic retinopathy (PDR) and (vi) advanced diabetic eye disease (ADED)(Goh, 2008).

From past studies, predictors and risk factors that are commonly associated to the progression of diabetic retinopathy includes the duration of diabetes, age, gender, HbA1c and hypertension (Kim et al., 2014; Liu et al., 2017; Ali et al., 2016; Rudnisky et al., 2017; Yau et al., 2012). In addition, there

are clinical predictors which can be significant to the development of diabetic retinopathy. Common clinical predictors that may affect the progression of diabetic retinopathy are glycosylated haemoglobin trends (HbA1c), systolic and diastolic blood pressure, serum creatinine and urea (Fong et al., 2004). Synonymously, Lee et al. (2014), Kotlarsky et al. (2015) and Tsao et al. (2018) agreed that blood glucose control as measured by HbA1c, insulin treatment, glucose levels and serum creatinine could also impact the progression of diabetic retinopathy. However, the testing on the significance of these predictors varied from one study to another.

Diabetes patients with diabetic retinopathy can be divided into three groups. Group 1 include diabetes patients who were diagnosed with diabetes without obvious clinical findings of diabetic retinopathy (show development). Unfortunately, some of them may have developed occult signs of early diabetic retinopathy. While Group 2 consists of diabetes patients who were diagnosed with diabetic retinopathy and remain in the same stage for a certain period of time until the current follow-up, and Group 3 involves diabetes patients who were diagnosed with diabetic retinopathy at certain stage for a period of time but progressively worsen over time during the current follow-up (show progression). Thus, the purpose of this study is to evaluate the predictors and risk factors associated to the development or progression of diabetic retinopathy among Group 1 and Group 3. However, for the descriptive statistics, analysis will involve all the three groups.

2. Study Design

This is a retrospective study involving patients with diabetes mellitus type 2 (T2DM) from a single healthcare centre located in the northwest of Peninsular Malaysia. A total of 197 diabetes patients were included in this study. The characteristics of patients selected in this study were; diabetes patients who were diagnosed with diabetic retinopathy, on follow-up treatment in the respective healthcare centre from their first clinic visit, up to the year 2020. Predictors and risk factors evaluated in this study are age, gender, ethnicity, duration of T2DM, duration of diabetic retinopathy, diabetic nephropathy, hypertension, dyslipidaemia, HbA1c, estimated glomerular filtration rate (eGFR), urea and haemoglobin concentration (Hb). The details and clinical data for every patient were obtained from their medical card, which was recorded by trained and credentialed personnel, with prior review by experienced ophthalmologists at the Ophthalmologist Clinic.

3. Statistical Analysis

Evaluation for significant predictors and risk factors for this study was implemented by modelling the multinomial logistic regression model using the predictors and risk factors involved in the study. Multinomial logistic regression is an extension of binary logistic regression that allows more than two categories of dependent variable. Commonly, multinomial logistic regression model is applied for classification in medical, education, transportation, physiological, mathematical finance and engineering area. Multinomial logistic is also known as the polytomous or multiclass logistic regression method. In order to make sure valid results are obtained from the model, all the six assumptions of the model including, (i) the dependent variable i.e. stages of diabetic retinopathy should be measured at the nominal level, (ii) the model has one or more independent variables i.e. predictors and risk factors that are continuous, ordinal or nominal, (iii) the model has independence of observations and the stages of diabetic retinopathy should have mutually exclusive and exhaustive categories, (iv) there should be no multicollinearity among the predictors and risk factors, (v) there needs to be a linear relationship between any continuous predictors and risk factors, and the logit transformation of the stages of diabetic retinopathy, and (vi) there should be no outliers for the scale or continuous variables. Multinomial logistic regression model is presented as:

$$\text{logit}(Y_{DR}) = \ln \left[\frac{P(Y_{DR} = j | X)}{P(Y_{DR} = J | X)} \right] = \beta_{j0} + \beta_{j1}X_1 + \beta_{j2}X_2 + \dots + \beta_{jk}X_k \quad (1)$$

where $j=1,2,\dots,J-1$ is a logit equation and J represents the categories of the reference outcome. Y_{DR} includes the categorical predictors which represent the stages of diabetic retinopathy (no diabetic retinopathy (stage 0), mild NPDR (stage 1), moderate NPDR (stage 2), severe NPDR (stage 3), PDR (stage 4) and ADED (stage 5); $Y = 0,1,2,3,4,5$). X refers to the predictors and risk factors associated with diabetic retinopathy, while k denotes the number of predictors and risk factors for diabetic retinopathy, where X_1, X_2, \dots, X_k can either be continuous or categorical predictors (replaced by dummy variables) and risk factors. Predictors and risk factors in this study include age, gender, ethnicity, duration of T2DM, duration of diabetic retinopathy, diabetic nephropathy, hypertension, dyslipidaemia, HbA1c, eGFR, Urea and Hb. β_{jk} is the logit coefficient providing information on how great a change in the logit is made by a one-unit increase of the value of k -th predictors. This study used R Studio Packages to perform the respective statistical analyses.

4. Result and Discussion

For this study, progression of diabetic retinopathy refers to diabetes patients in Group 1 and Group 3, while diabetes patients in Group 2 shows no progression. Figure 1 shows the composition of diabetes patients according to the age group. Among diabetes patients in Group 1 and 3, the blue bars indicate that most number of patients with the age group from 50 to 89 years are among those who have higher potential of showing diabetic retinopathy progression. Compared to the red bars that reflect diabetes patients in Group 2, the number of patients with age 60 to 69 shows no progression in diabetic retinopathy. While Figure 2 illustrates that the number of male and female diabetes patients are similar regardless whether patients are in Group 1, 2 or 3.

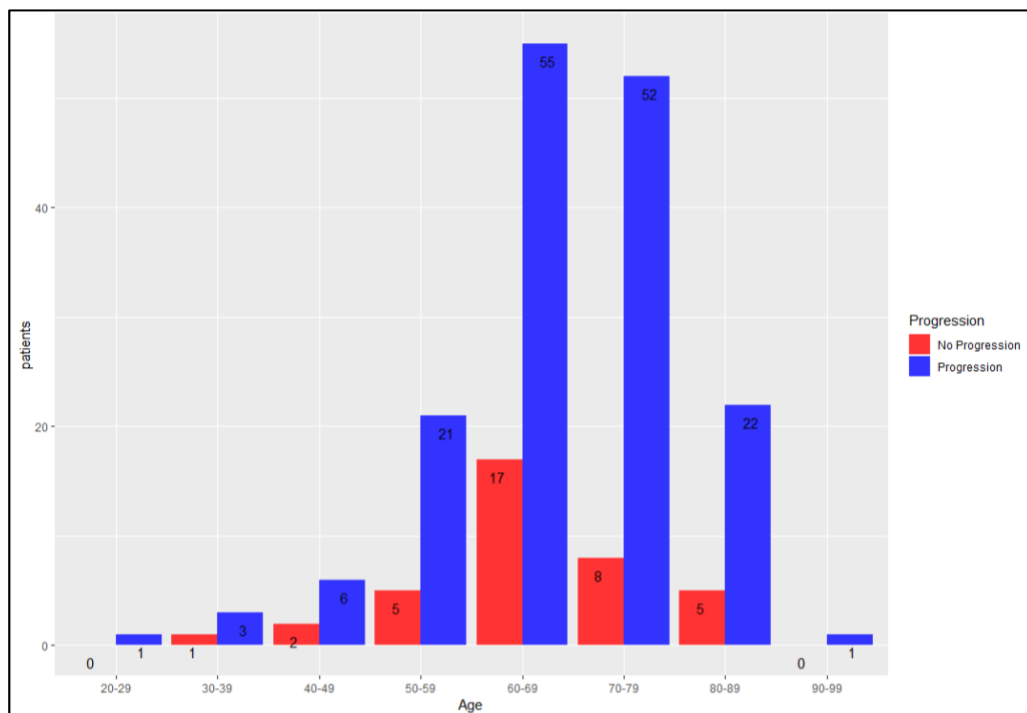


Figure 1: Comparison between diabetes patients with no progression and with progression status according to patients' age group.

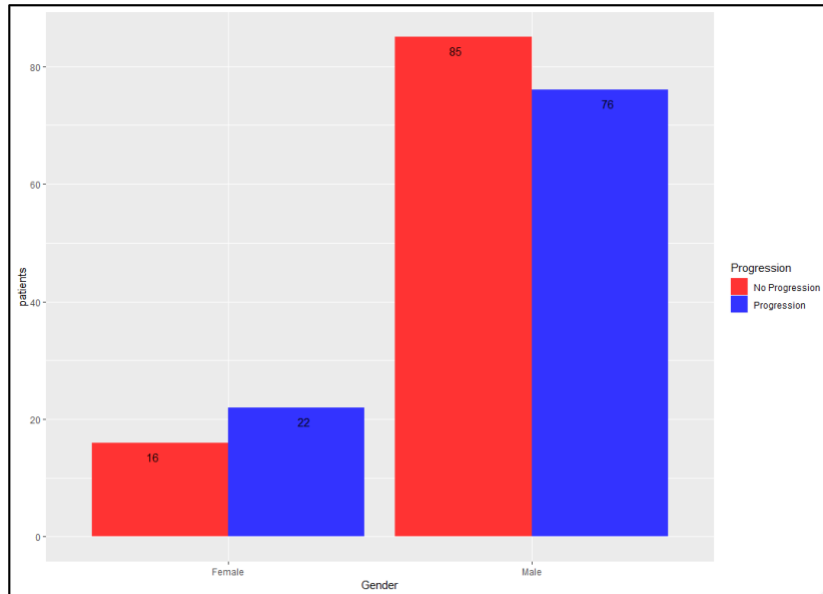


Figure 2: Comparison between no progression and with progression status according to gender.

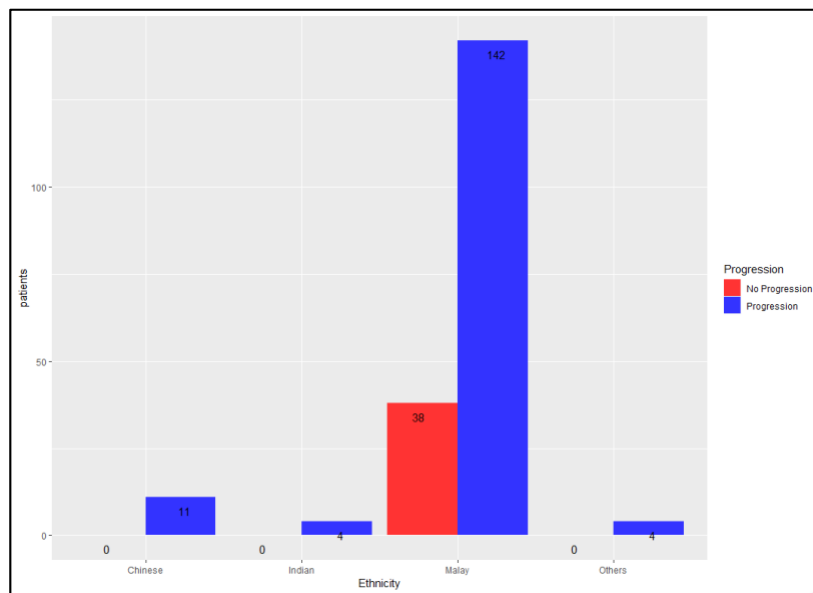


Figure 3: Comparison between no progression and with progression status according to ethnicity

Figure 3 demonstrates the ethnicity of diabetes patients involved in the study. Malay diabetes patients show the highest number of patients experiencing progressive diabetic retinopathy. Similar observation was also noted for diabetes patients with no progression. Based on the data, mostly Malay patients are among the majority who come for follow up at the Ophthalmologist Clinic.

Figure 4(a) refers to the stages for diabetes patients when first diagnosed with diabetic retinopathy, while Figure 4(b) refers to the same diabetes patients when diagnosed with diabetic retinopathy during the current follow up. Based on Figure 4(a), diabetes patients with stage 0 are those who have higher potential to develop diabetic retinopathy. This means that if a patient in Group 1 have not yet diagnosed with diabetic retinopathy, he/she may develop to other stage of diabetic retinopathy after certain period of time. For example, a patient could present with no diabetic retinopathy initially, however may progressed directly to stage 2 (mild NPDR) or stage 3 (moderate NPDR). Figure 4(b) shows the increasing number of diabetes patients who have shown some stage progression. For example, about 118 diabetes patients who were first diagnosed with stage 0 have shown progression to stage 1, 10 patients have developed to stage 2, 11 patients developed to stage 3, and 15 patients developed to stage 4. Also, from Figure 4(b) one patients has shown progression

from stage 4 to 5. Compared with no progression case for stages at diagnosis during the current follow up, the number of patients with no progression is higher for stage 2 (mild NPDR) and onwards.

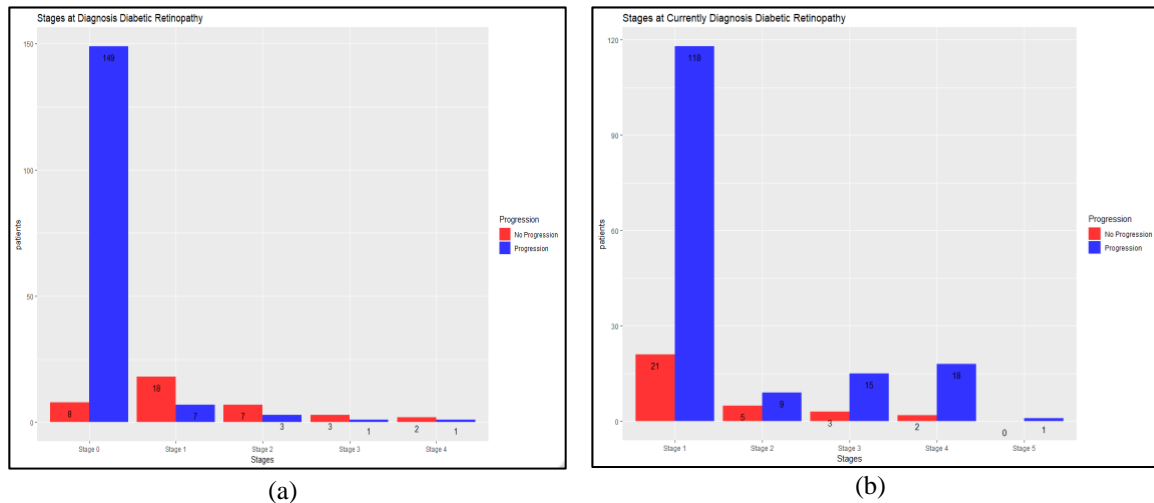


Figure 4: Comparison between the (a) developed stages at diagnosis of diabetic retinopathy and (b) stages diabetic retinopathy at current follow up.

4.1 Comparison of Demographic and Clinical Data between Patients with and without Development or Progression of Diabetic Retinopathy

As mentioned earlier, this study includes three groups of patients; Group 1 includes diabetes patients who were diagnosed with diabetes but not yet diagnosed with diabetic retinopathy (show development), Group 2 refers to diabetes patients who were diagnosed with diabetic retinopathy and remain in the same stage for a certain period of time until the current follow-up, and Group 3 involves diabetes patients who were diagnosed with diabetic retinopathy at certain stage for a period of time but worsen to other stage during the current follow-up (show progression). A total of 197 patients with diabetes, 81.7% were patients from Group 1 and 3, while 18.3% from Group 2. From Table 1, the mean age for both groups is similar (67 years). However, the duration of diabetes, HbA1c, eGFR, urea and HB readings baseline for patients in Group 1 and 3 is higher than the readings for Group 3.

In addition, Table 1 shows the descriptive statistics and the significant predictors and risk factors for diabetes patients in Group 1 and 3 based on the evaluation using multinomial logistic regression model. These significant predictors and risk factors were tested based on the small p -value (<0.001). From 11 predictors evaluated, 7 predictors were found significant. Age, gender, duration of T2DM, duration diabetic retinopathy, HbA1c, eGFR, and urea are significant predictors for the development and progression of diabetic retinopathy. Some of these findings were found to be similar with the previous studies. Many studies have shown that duration of diabetes and gender are significant (Cardoso et al., 2017; Haider et al., 2020; Kaewput et al., 2019; Ali et al., 2016; Rudnisky et al., 2017). While for the clinical data (HbA1c, eGFR and urea) some of studies agreed that HbA1c greatly influenced the progression of diabetic retinopathy (Cardoso et al., 2017; Euswas et al., 2021; Rudnisky et al., 2017). This study highlights that eGFR and urea as new significant predictors to the progression of diabetic retinopathy among Group 1 and 3. This new finding are less discussed in the previous studies may be due to its effect to diabetic retinopathy.

Table 1: Characteristics of diabetic patients according to development or progression of diabetic retinopathy or without development or progression of diabetic retinopathy. (Group 1 - diabetes patients who were diagnosed with diabetes without obvious clinical findings of diabetic retinopathy (show development), Group 2 - diabetes patients who were diagnosed with diabetic retinopathy and remain in the same stage for a certain period of time until the current follow-up and Group 3 - diabetes patients who were diagnosed with diabetic retinopathy at certain stage for a period of time but progressively worsen over time during the current follow-up (show progression)). Values are proportions and means (standard deviations).

Characteristics	All Patients (n=197)	Group 1 & 3 Patients with Development/Progression of Diabetic Retinopathy (n=161)	Group 2 Patients without Development/Progression of Diabetic Retinopathy (n=36)	P-value
Age	67.33 (10.99)	67.68 (11.02)	67.78 (11.02)	<0.001
Gender				<0.001
Male	0.52	0.53	0.42	
Female	0.48	0.47	0.58	
Ethnicity				0.9636
Malay	0.89	0.88	1.00	
Chinese	0.05	0.07		
India	0.03	0.01		
Others	0.02	0.01		
Duration of T2DM	12.66 (5.03)	13.31 (5.00)	12.52 (5.05)	<0.001
Duration Diabetic Retinopathy	6.02 (3.45)	6.79 (3.99)	5.96 (3.38)	<0.001
Diabetic Nephropathy	1.00	0.82	0.18	0.4392
Hypertension	0.99	0.82	0.18	0.576
Dyslipidaemia	0.89	0.91	0.20	0.6231
HbA1c	8.64 (2.47)	9.41 (2.50)	8.54 (2.47)	<0.001
eGFR	59.45 (25.34)	59.78 (25.37)	54.54 (23.47)	<0.001
Urea	7.04 (3.77)	7.82 (3.93)	7.44 (3.94)	<0.001
Hb	11.46 (2.01)	11.34 (2.00)	11.89 (1.97)	0.8069

5. Conclusion

This study found that age, gender, duration of T2DM, duration of diabetic retinopathy, HbA1c, eGFR and urea are significant to the progression of diabetic retinopathy. Overall, this results suggest that for high risk diabetic retinopathy patients, these predictors could potentially influence to the development of severe stage of diabetic retinopathy. Therefore, to avoid rapid progression of stages in diabetic retinopathy among diabetes patients, these significant predictors and risk factors need to be given attention to prevent serious microvascular complications.

Ethical Clearance

This study was registered with the National Medical Research Register of the Ministry of Health, Malaysia (NMRR-19-3896-47105) and received ethical clearance from the Medical Research and Ethics Committee (MREC) of the Ministry of Health Malaysia (KKM/NIHSEC/P20-376).

Acknowledgment

The authors would like to thank the Director General of Health Malaysia for his permission to publish this paper. The authors also gratefully acknowledge to Doctor Muhamad Ruzaini Abd Hamid from Department of Ophthalmology, Hospital Tuanku Fauziah, Perlis and Doctor Noorhafini Abdul Sukur from Department of Internal Medicine, Hospital Tuanku Fauziah, Perlis for their support to this study.

References

- Altomare, F., Kherani, A., and Lovshin, J. (2018). Retinopathy. *Canadian Journal of Diabetes*, 42: S210–S216.
- Cardoso, C. R. L., Leite, N. C., Dib, E., and Salles, G. F. (2017). Predictors of Development and Progression of Retinopathy in Patients with Type 2 Diabetes: Importance of Blood Pressure Parameters. *Scientific Reports*, 7(1):1–10.
- Euswas, N., Phonnopparat, N., Morasert, K., Thakhampaeng, P., Kaewsanit, A., Mungthin, M., and Sakboonyarat, B. (2021). National trends in the prevalence of diabetic retinopathy among Thai patients with type 2 diabetes and its associated factors from 2014 to 2018. *PLoS ONE*, 16(1): 1–14.
- Fong, D. S., Aiello, L., Gardner, T. W., King, G. L., Blankenship, G., Cavallerano, J. D., and Klein, R. (2004). Retinopathy in Diabetes. *Diabetes Care*, 27(SUPPL. 1): s84-s87
- Goh, P. P. (2008). Status of Diabetic Retinopathy Among Diabetics Registered to the Diabetic Eye Registry, National Eye Database 2007. *Med J. Malaysia*, 63(SUPPL. C):24–28.
- Haider, S., Sadiq, S. N., Lufumpa, E., Sihre, H., Tallouzi, M., Moore, D. J., and Price, M. J. (2020). Predictors for diabetic retinopathy progression - Findings from nominal group technique and Evidence review. *BMJ Open Ophthalmology*, 5(1). <https://doi.org/10.1136/bmjophth-2020-000579>
- Kaewput, W., Thongprayoon, C., Rangsin, R., Ruangkanhanasetr, P., Mao, M. A., & Cheungpasitporn, W. (2019). Associations of renal function with diabetic retinopathy and visual impairment in type 2 diabetes: A multicenter nationwide cross-sectional study. *World Journal of Nephrology*, 8(2):33–43.
- Kim, Y. J., Kim, J. G., Lee, J. Y., Lee, K. S., Joe, S. G., Park, J. Y., and Yoon, Y. H. (2014). Development and progression of diabetic retinopathy and associated risk factors in Korean patients with type 2 diabetes: The experience of a tertiary center. *Journal of Korean Medical Science*, 29(12):1699–1705.
- Liu, Y., Yang, J., Tao, L., Lv, H., Jiang, X., Zhang, M., and Li, X. (2017). Risk factors of diabetic retinopathy and sight-threatening diabetic retinopathy: A cross-sectional study of 13 473 patients with type 2 diabetes mellitus in mainland China. *BMJ Open*, 7(9):1–11. <https://doi.org/10.1177/0009922814528280>
- Mohd Ali, M. H., Draman, N., Mohamed, W. M. I. W., Yaakub, A., & Embong, Z. (2016). Predictors of proliferative diabetic retinopathy among patients with type 2 diabetes mellitus in Malaysia as detected by fundus photography. *Journal of Taibah University Medical Sciences*, 11(4), 353–358.
- Romero-Aroca, P., Baget-Bernaldiz, M., Reyes-Torres, J., Fernandez-Ballart, J., Plana-Gil, N., Mendez-Marin, I., and Pareja-Rios, A. (2012). Relationship between diabetic retinopathy, microalbuminuria and overt nephropathy, and twenty-year incidence follow-up of a sample of

type 1 diabetic patients. *Journal of Diabetes and Its Complications*, 26(6):506–512.

Rudnisky, C. J., Wong, B. K., Virani, H., and Tennant, M. T. S. (2017a). Risk factors for progression of diabetic retinopathy in Alberta First Nations communities. *Canadian Journal of Ophthalmology/Journal Canadien d'ophtalmologie*, 52(1): S19–S29.

Rudnisky, C. J., Wong, B. K., Virani, H., and Tennant, M. T. S. (2017b). Risk factors for progression of diabetic retinopathy in Alberta First Nations communities. *Canadian Journal of Ophthalmology*, 52(1):S19–S29.

Yau, J. W. Y., Rogers, S. L., Kawasaki, R., Lamoureux, E. L., Kowalski, J. W., Bek, T., and Wong, T. Y. (2012). Global prevalence and major risk factors of diabetic retinopathy. *Diabetes Care*, 35(3):556–564.

Zhang, J., Wang, Y., Li, L., Zhang, R., Guo, R., Li, H., and Teng, G. (2018). Diabetic retinopathy may predict the renal outcomes of patients with diabetic nephropathy. *Renal Failure*, 40(1), 243–251.



**20
21** **ICMS**
INTERNATIONAL CONFERENCE ON COMPUTING,
MATHEMATICS AND STATISTICS

e ISBN 978-967-2948-12-4



9 7 8 9 6 7 2 9 4 8 1 2 4