**Journal of Public Health Sciences**
Vol. 5, No. 03, pp. 862-876
journal.iistr.org/index.php/JPHS
DOI: 10.56741/IISTR.jphs.002310

# Association of Sociodemographic Factors with Health Protocol Compliance and Metabolic Profile Among Patients with Diabetic Retinopathy

**[1]Yuliana Rahmah Retnaningrum*, [1]Yuniati, [1]Nur Khoma Fatmawati, [1]Endang Sawitri, [1]Amalia Aswin, [1]Rudi Saputra**
Corresponding Author: *yulianakaltim@gmail.com
[1] Mulawarman University, Samarinda, Indonesia

ARTICLE INFO

**Article history**
Received 11 May 2026
Revised 14 September 2026
Accepted 24 September 2026

ABSTRACT

Diabetic retinopathy is a major microvascular complication of diabetes mellitus and is closely related to metabolic disturbances and sociodemographic factors. This study aimed to analyze the association between sociodemographic characteristics, health protocol compliance, and metabolic profile parameters among patients with diabetic retinopathy. An analytical observational study with a cross-sectional design was conducted among 45 diabetic retinopathy patients at two hospitals in Samarinda, Indonesia, during November 2020. Sociodemographic data, serological status, mask types, health protocol compliance scores, and metabolic profile parameters were collected. Female participants slightly predominated (53.3%), and most participants were aged <60 years (71.1%). Educational level was significantly associated with health protocol compliance score ($p = 0.008$), with higher educational attainment related to better health protocol compliance. Age was significantly associated with HbA1c ($p = 0.006$), FBG ($p = 0.008$), and 2hPPBG ($p = 0.045$). Occupation was significantly associated with TC/HDL ($p = 0.008$) and LDL/HDL ratios ($p = 0.019$), while gender was associated with the TC/HDL ratio ($p = 0.048$). No significant associations were identified between serological status or mask types and metabolic profile parameters. These findings suggest that sociodemographic characteristics, particularly educational level, age, and occupation, may be associated with differences in health behavior and metabolic profiles among patients with diabetic retinopathy.

**Keywords**
Diabetic Retinopathy
Health Protocol Compliance
Metabolic Profile
Sociodemographic Factors

This is an open-access article under the CC–BY-SA license.

## Introduction

Diabetes mellitus (DM) remains one of the most significant global public health challenges, with rapidly increasing prevalence and substantial long-term complications. A recent global analysis reported that approximately 12% of adults worldwide were living with diabetes, while a considerable proportion remained undiagnosed. The prevalence of diabetes continues to rise, particularly in low- and middle-income countries, contributing to increased morbidity, mortality, and healthcare burden [1], [2].

Diabetic retinopathy (DR) is one of the most common microvascular complications of diabetes and represents a leading cause of visual impairment and blindness among working-age adults worldwide. Recent global estimates demonstrated a continuous increase in the number of individuals experiencing vision impairment due to DR between 2000 and 2020 [1], [3]. In addition, a systematic review conducted in 2024 reported a high prevalence of DR among patients with diabetes and emphasized the growing epidemiological burden of DR globally [4].

Poor glycemic control remains one of the major risk factors associated with the development and progression of DR. Hemoglobin A1c (HbA1c), fasting blood glucose (FBG), and 2-hour postprandial blood glucose (2hPPBG) are commonly used indicators to evaluate metabolic control in diabetic patients. Several recent studies have demonstrated that elevated HbA1c levels are significantly associated with increased severity of DR [5], [6]. Furthermore, lipid abnormalities, including elevated low-density lipoprotein (LDL), triglycerides (TG), and atherogenic lipid ratios such as TG/HDL and LDL/HDL ratios, have also been implicated in retinal vascular damage and worsening diabetic complications [7], [8].

In addition to metabolic factors, sociodemographic characteristics may be associated with differences in health-related behaviors and clinical outcomes among patients with diabetes. Age, gender, educational level, and occupation have been reported to affect diabetes management, health literacy, treatment adherence, and healthcare utilization. Higher educational attainment has been associated with better adherence to DR screening and preventive health behaviors [9]. Similarly, occupational and socioeconomic factors may contribute to differences in lifestyle, physical activity, dietary patterns, and metabolic profiles among patients with chronic diseases [9], [10].

During the COVID-19 pandemic, adherence to health protocols such as mask use, hand hygiene, and physical distancing became particularly important among patients with chronic

diseases, including DM, due to their increased vulnerability to severe infection outcomes. However, health protocol compliance may vary according to sociodemographic and clinical characteristics. Patients with better educational backgrounds and health literacy may demonstrate higher health protocol compliance with preventive measures [11]–[13]. Nevertheless, limited studies have explored the relationship between sociodemographic factors, metabolic profile, and health protocol compliance specifically among patients with DR.

Because this study was conducted during the COVID-19 pandemic, COVID-19-related variables were also considered as contextual factors reflecting the health and healthcare environment in which patients with DR managed their disease. Serological status and mask type were not considered direct determinants of DR or metabolic control. Rather, these variables were included to describe pandemic-related circumstances and to explore whether indicators of COVID-19 exposure or preventive behavior were associated with health protocol compliance or metabolic profile. This contextual approach was intended to provide a more complete description of the behavioral and metabolic characteristics of patients with DR during the pandemic, while recognizing that the primary focus of the study remained the relationship between sociodemographic characteristics, health protocol compliance, and metabolic parameters.

Considering the increasing burden of DR and the importance of both metabolic control and preventive health behaviors, this study aimed to analyze the association of sociodemographic factors with health protocol compliance and metabolic profile among patients with DR. Understanding these associations may provide useful information for informing targeted educational and preventive strategies aimed at supporting health behaviors and metabolic outcomes among patients with DR.

## Material and Methods

This study employed an analytical observational design with a cross-sectional approach. The study was conducted at two hospitals in Samarinda, Indonesia, namely SMEC Eye Hospital Samarinda and Siaga Al-Munawwarah Hospital. Data collection was carried out in November 2020. The study population consisted of patients diagnosed with DR who visited the ophthalmology outpatient clinics during the study period. Total sampling was applied by including all eligible patients who attended the clinics in November 2020. Patients with incomplete clinical or laboratory data were excluded from the analysis.

Sociodemographic variables collected included gender, age, educational level, and occupation. Educational level was categorized into low (no formal education-junior high school), medium (senior high school), and high (diploma-doctoral degree). Occupation was classified as unemployed, informal occupation, or formal occupation. Clinical and laboratory data included FBG, 2hPPBG, total cholesterol (TC), high-density lipoprotein (HDL), LDL, TG,

urea (Ur), creatinine (Cr), and HbA1c. Lipid ratios, including the LDL/HDL ratio, TG/HDL ratio, and total cholesterol/HDL ratio, were also calculated. In addition, the urea-to-creatinine ratio was analyzed.

COVID-19 transmission-related characteristics and health protocol compliance was assessed using a structured questionnaire adapted from guidelines issued by the Ministry of Health of the Republic of Indonesia and the World Health Organization (WHO) [14]–[17]. The questionnaire consisted of 14 items divided into two domains: COVID-19 transmission-related characteristics (items 1–5) and health protocol compliance (items 6–14). The transmission-related domain assessed symptoms, history of close contact with COVID-19 patients, previous rapid or swab testing, and history of confirmed COVID-19. The health protocol compliance domain assessed mask use, appropriate mask use, physical distancing, disinfection of frequently touched objects, hand hygiene, carrying hand sanitizer, avoiding touching the face, increased handwashing frequency, and implementation of the six-step handwashing technique. The nine health protocol compliance items were scored using three response options: “always”, “sometimes”, and “never”. The total health protocol compliance score ranged from 9 to 27, with higher scores indicating better health protocol compliance.

COVID-19 serological status was assessed using IgM and IgG antibody results and categorized as seropositive or seronegative. Types of masks used by participants were additionally categorized into non-medical masks, medical-based masks, and combined mask use. Data analysis was performed using IBM SPSS Statistics Version 25. Descriptive analysis was used to summarize participant characteristics and study variables. Numerical variables were presented as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages.

COVID-19 serological status and mask type were included as contextual pandemic-related variables because the study was conducted during the COVID-19 pandemic. Serological status was used to describe evidence of previous or recent exposure based on the available IgM/IgG testing, while mask type was used as an indicator of preventive health behavior. These variables were exploratory and were not considered primary determinants of DR or metabolic control. Their inclusion was intended to assess whether pandemic-related exposure and preventive behavior were associated with health protocol compliance or metabolic profile during the study period.

Normality testing was performed using the Shapiro-Wilk test. Variables with normal distribution were analyzed using the independent t-test for comparisons between two groups and one-way ANOVA for comparisons involving more than two groups. Variables that were not normally distributed were analyzed using non-parametric statistical tests. The Mann-Whitney U test was used to compare two independent groups, while the Kruskal-Wallis test was used

for comparisons involving more than two groups. Given the number of statistical comparisons, analyses of associations between sociodemographic factors and metabolic parameters were considered exploratory. A p-value of <0.05 was considered statistically significant. This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Mulawarman University under Ethical Clearance Number 69/KEPK-FK/V/2020. All data were collected and analyzed confidentially in accordance with research ethics principles.

## Results and Discussions

Table 1 presents the baseline characteristics of patients with DR included in this study. Female participants slightly predominated, accounting for 53.3% of the study population, while males represented 46.7%. Most participants were younger than 60 years old (71.1%), indicating that DR was more frequently observed among middle-aged adults in this population. Regarding educational attainment, participants with low and high education levels each accounted for 40.0% of the sample, whereas only 20.0% had a medium educational level. More than half of the participants were unemployed (51.1%), while 35.6% had formal occupations and 13.3% worked in informal sectors.

Most participants were seronegative for COVID-19 antibodies (86.7%), with only 13.3% categorized as seropositive. Non-medical masks were the most commonly used type of mask (60.0%), followed by combined mask use (22.2%) and medical-grade masks (17.8%). The mean health protocol compliance score was 21.0±2.6, indicating generally good compliance with health protocols among participants.

**Table 1.** Sociodemographic characteristics, serological status, mask types, and health protocol compliance score of patients with DR (n = 45).

| Variables | Characteristics | Number | Percentage (%) | Cumulative Percentage (%) |
|---|---|---|---|---|
| Gender | Male | 21 | 46.7 | 46.7 |
| | Female | 24 | 53.3 | 100.0 |
| Age (years) | <60 | 32 | 71.1 | 71.1 |
| | ≥60 | 13 | 28.9 | 100.0 |
| Education Level | Low | 18 | 40.0 | 40.0 |
| | Medium | 9 | 20.0 | 60.0 |
| | High | 18 | 40.0 | 100.0 |
| Occupation | Unemployed | 23 | 51.1 | 51.1 |
| | Informal Occupation | 6 | 13.3 | 64.4 |
| | Formal Occupation | 16 | 35.6 | 100.0 |
| Serological Status | Seropositive | 6 | 13.3 | 13.3 |
| | Seronegative | 39 | 86.7 | 100.0 |
| Types of Masks | Non-Medical Mask | 27 | 60.0 | 60.0 |
| | Medical-Based Mask | 8 | 17.8 | 77.8 |
| | Combined Mask | 10 | 22.2 | 100.0 |
| Health Protocol Compliance Score | | | 21.0±2.6 | |

The metabolic characteristics of the study participants are presented in Table 2. The mean TC level was 227.0±65.3 mg/dL, while the mean LDL level was 150.4±63.8 mg/dL,

indicating relatively elevated lipid levels among participants. The mean HDL level was 43.3±12.2 mg/dL and the mean TG level was 138.3±63.3 mg/dL. Lipid ratio analysis showed mean TC/HDL, LDL/HDL, and TG/HDL ratios of 5.6±2.2, 3.8±2.0, and 3.6±2.2, respectively. These findings suggest the presence of unfavorable lipid profiles that may contribute to vascular complications in DR patients.

Renal function parameters demonstrated a mean Ur level of 31.2±15.2 mg/dL and Cr level of 1.1±0.6 mg/dL, with a mean Ur/Cr ratio of 32.2±13.7. In addition, glycemic control parameters showed elevated mean HbA1c, FBG, and 2hPPBG levels at 8.4±2.8%, 148.2±62.9 mg/dL, and 200.6±88.4 mg/dL, respectively, indicating suboptimal metabolic control among the study participants.

**Table 2.** Metabolic profile of patients with DR (n = 45).

| Metabolic Profile | Mean | SD |
|---|---|---|
| TC | 227.0 | 65.3 |
| HDL | 43.3 | 12.2 |
| LDL | 150.4 | 63.8 |
| TG | 138.3 | 63.3 |
| TC/HDL | 5.6 | 2.2 |
| LDL/HDL | 3.8 | 2.0 |
| TG/HDL | 3.6 | 2.2 |
| Ur | 31.2 | 15.2 |
| Cr | 1.1 | 0.6 |
| Ur/Cr | 32.2 | 13.7 |
| HbA1c | 8.4 | 2.8 |
| FBG | 148.2 | 62.9 |
| 2hPPBG | 200.6 | 88.4 |

After that, Table 3 presents the association between participant characteristics and health protocol compliance scores among patients with DR. Female and male participants demonstrated nearly identical mean health protocol compliance scores (21.04 ± 2.49 vs 21.05±2.73), with no statistically significant difference observed (p = 0.994). Similarly, no significant association was found between age group and health protocol compliance score, although participants aged <60 years showed slightly higher health protocol compliance scores compared with those aged ≥60 years (21.34±2.61 vs 20.31±2.43; p = 0.225).

Educational level demonstrated a statistically significant association with health protocol compliance score (p = 0.008). Participants with higher educational attainment had progressively higher mean health protocol compliance scores, with the highest score observed among participants with high education levels (22.22 ± 2.73), followed by medium (21.44±2.60) and low education groups (19.67±1.71). This finding suggests that educational background was associated with differences in improving adherence to health protocols.

Although occupation was not significantly associated with health protocol compliance score (p = 0.068), participants with formal occupations tended to have higher health protocol

compliance scores compared with unemployed and informal workers. In addition, no statistically significant associations were identified between serological status or types of masks used and health protocol compliance scores ($p > 0.05$). Nevertheless, participants using medical-based masks demonstrated slightly higher mean health protocol compliance scores than those using non-medical or combined masks.

**Table 3.** Association between sociodemographic characteristics and health protocol compliance among patients with DR.

| Variables | Categories | Mean | SD | Statistical Test | df | P Value |
|---|---|---|---|---|---|---|
| Gender | Male | 21.05 | 2.73 | Independent T-Test | 43 | .994 |
| | Female | 21.04 | 2.49 | | | |
| Age | <60 | 21.34 | 2.61 | Independent T-Test | 43 | .225 |
| | ≥60 | 20.31 | 2.43 | | | |
| Education Level | Low | 19.67 | 1.71 | One-Way ANOVA | 2 | .008 |
| | Medium | 21.44 | 2.60 | | | |
| | High | 22.22 | 2.73 | | | |
| Occupation | Unemployed | 20.57 | 2.39 | One-Way ANOVA | 2 | .068 |
| | Informal Occupation | 19.83 | 1.33 | | | |
| | Formal Occupation | 22.19 | 2.86 | | | |
| Serological Status | Seropositive | 20.67 | 2.66 | Mann-Whitney | - | .449 |
| | Seronegative | 21.10 | 2.59 | | | |
| Types of Masks | Non-Medical Mask | 20.70 | 2.46 | Kruskal-Wallis | 2 | .286 |
| | Medical-Based Mask | 22.13 | 3.00 | | | |
| | Combined Mask | 21.10 | 2.56 | | | |

In addition, this study also identified associations between sociodemographic characteristics and metabolic profile parameters among patients with DR, as presented in Table 4. Gender demonstrated a statistically significant association with the TC/HDL ratio ($p = 0.048$), while no significant associations were observed between gender and other metabolic parameters. Age was significantly associated with glycemic control parameters, including HbA1c ($p = 0.006$), FBG ($p = 0.008$) and 2hPPBG ($p = 0.045$). These findings suggest that age may be associated with differences in glucose metabolism and glycemic control among patients with DR.

Occupation also demonstrated significant associations with lipid profile indicators, specifically the TC/HDL ratio ($p = 0.008$) and LDL/HDL ratio ($p = 0.019$). Participants with different occupational backgrounds may have varying lifestyle patterns, physical activity levels, and dietary behaviors that could affect lipid metabolism. In contrast, educational level, serological status, and types of masks used were not significantly associated with metabolic profile parameters ($p > 0.05$). Overall, the findings indicate that certain sociodemographic factors, particularly age and occupation, may contribute to differences in metabolic characteristics among patients with DR.

The present study demonstrated that educational level was significantly associated with health protocol compliance among patients with DR. Participants with higher educational attainment showed progressively better health protocol compliance scores compared with

those with lower educational backgrounds. This finding suggests that differences in educational attainment may be associated with variations in health literacy, awareness, and preventive health behaviors, particularly during the COVID-19 pandemic. Individuals with higher educational levels are generally more capable of understanding public health recommendations, accessing reliable health information, and adopting appropriate preventive measures consistently. Recent studies have similarly reported that health literacy and patient education are strongly associated with better adherence to diabetes-related screening and preventive healthcare behaviors [18], [19].

Although age was not significantly associated with health protocol compliance scores in this study, younger participants tended to demonstrate slightly better adherence to health protocols compared with older participants. This trend may reflect differences in access to information, adaptability to behavioral changes, and digital literacy. Elderly patients with chronic diseases often face greater barriers in obtaining healthcare information and implementing preventive recommendations consistently [20], [21]. Nevertheless, the lack of statistical significance may partly reflect the relatively small sample size of this study, which may have limited the statistical power to detect associations.

Although health protocol compliance scores differed across occupational groups, the observed association did not reach statistical significance. Participants with formal occupations demonstrated higher health protocol compliance scores than unemployed and informal workers. Formal working environments may encourage stricter implementation of health regulations and increase exposure to workplace health education programs. Occupational status has previously been linked to disparities in healthcare utilization, lifestyle behaviors, and preventive practices among individuals with chronic diseases [22], [23].

An important consideration in interpreting these findings is the conceptual relationship between COVID-19 health protocol compliance and metabolic profiles. In the present study, these two domains were examined as separate outcomes rather than assuming a direct causal pathway from health protocol compliance to metabolic regulation. The findings suggest that sociodemographic characteristics may contribute to both behavioral and metabolic differences among patients with DR.

**Table 4.** Association between sociodemographic characteristics and metabolic profile among patients DR

| Variables | Categories | TC/HDL | LDL/HDL | TG/HDL | Ur/Cr | HbA1c | FBG | 2hPPBG | Statistical Test | P Value |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gender** | Male | 6.03±2.13 | 4.08±1.85 | 4.18±2.61 | 30.05±16.75 | 8.45± 3.13 | 149.29±74.20 | 199.57±88.20 | Mann-Whitney U | .048 / .088 / .101 / .099 / .794 / .707 / .927 |
| | Female | 5.27±2.30 | 3.47±2.18 | 3.01±1.72 | 34.03±10.45 | 8.43±2.56 | 147.17±52.71 | 201.46±90.52 | | |
| **Age** | <60 years | 5.77±2.28 | 3.88±2.14 | 3.47±2.00 | 33.61±15.35 | 9.14±2.91 | 163.59±65.43 | 217.34±87.07 | Mann-Whitney U | .548 / .793 / .689 / .210 / **.006** / **.008** / **.045** |
| | ≥60 years | 5.28±2.16 | 3.45±1.77 | 3.76±2.80 | 28.63±8.01 | 6.71±1.57 | 110.15±35.13 | 159.31±80.54 | | |
| **Education Level** | Low | 4.97±1.69 | 3.27±1.45 | 2.85±1.52 | 32.70±16.93 | 8.63±2.47 | 148.83±59.54 | 203.72±85.81 | Kruskal-Wallis | .325 / .380 / .234 / .830 / .718 / .992 / .825 |
| | Medium | 6.28±2.19 | 4.34±1.97 | 4.35±2.35 | 33.24±10.23 | 8.00±2.47 | 145.78±44.05 | 213.00±89.93 | | |
| | High | 5.95±2.64 | 3.94±2.50 | 3.86±2.66 | 31.11±12.27 | 8.47±3.36 | 148.67±75.96 | 191.22±94.24 | | |
| **Occupation** | Unemployed | 4.80±1.54 | 3.02±1.21 | 3.16±2.19 | 30.11±9.10 | 7.70±2.14 | 134.39±52.05 | 186.91±91.08 | One-way ANOVA / Kruskal-Wallis | **.008** / **.019** / .079 / .072 / .069 / .234 / .515 |
| | Informal Occupation | 5.25±1.68 | 3.67±1.47 | 2.93±1.78 | 44.02±23.92 | 7.85±1.48 | 130.50±24.67 | 199.67±58.20 | | |
| | Formal Occupation | 6.95±2.68 | 4.84±2.67 | 4.37±2.33 | 30.68±13.28 | 9.73±3.59 | 174.56±79.12 | 220.56±94.47 | | |
| **Serological Status** | Seropositive | 4.96±1.95 | 3.29±1.80 | 3.33±1.26 | 30.80±11.83 | 8.28±1.95 | 126.67±50.75 | 176.50±101.70 | Mann-Whitney U | .423 / .559 / .764 / .652 / .764 / .413 / .480 |
| | Seronegative | 5.73±2.28 | 3.83±2.08 | 3.59±2.36 | 32.38±14.13 | 8.46±2.94 | 151.46±64.45 | 204.28±87.10 | | |
| **Types of Masks** | Non-Medical Mask | 5.43±1.78 | 3.52±1.47 | 3.70±2.33 | 31.64±14.95 | 8.26±2.51 | 140.85±60.32 | 198.96±91.83 | One-way ANOVA / Kruskal-Wallis | .163 / .260 / .406 / .753 / .732 / .353 / .989 |
| | Medical-Based Mask | 4.87±1.45 | 3.37±1.24 | 2.55±1.38 | 32.43±15.12 | 9.16±3.84 | 177.38±81.93 | 202.38±81.16 | | |
| | Combined Mask | 6.75±3.40 | 4.69±3.38 | 3.96±2.47 | 33.39±9.83 | 8.34±2.87 | 144.50±51.57 | 203.50±93.37 | | |

Educational level was significantly associated with health protocol compliance, whereas age, occupation, and gender were associated with selected metabolic parameters. Thus, the observed associations may reflect differences in health-related behaviors and metabolic conditions across sociodemographic groups. Because of the cross-sectional design and the absence of a direct analysis between health protocol compliance scores and metabolic parameters, this study cannot determine whether better health protocol compliance is associated with improved metabolic control. Further studies using longitudinal designs and multivariable analyses are needed to clarify whether health-related behaviors during infectious disease outbreaks have an independent relationship with metabolic regulation in patients with DR.

In addition to behavioral outcomes, this study identified several significant associations between sociodemographic characteristics and metabolic profile parameters. Age was significantly associated with HbA1c, FBG, and 2hPPBG, indicating that glycemic control may worsen with increasing age. Aging is commonly associated with decreased insulin sensitivity, progressive pancreatic β-cell dysfunction, and longer duration of diabetes, all of which contribute to impaired glucose regulation [24]. Persistent hyperglycemia has been widely recognized as a major contributor to the development and progression of DR through mechanisms involving oxidative stress, chronic inflammation, and retinal microvascular damage [25], [26].

The present study also demonstrated significant associations between occupation and lipid profile indicators, specifically TC/HDL and LDL/HDL ratios. The observed differences in lipid profiles across occupational groups may reflect variations in dietary patterns, stress exposure, socioeconomic circumstances, and physical activity levels, although these factors were not directly assessed in the present study. Dyslipidemia is considered an important risk factor in DR progression because abnormal lipid accumulation contributes to endothelial dysfunction and retinal vascular injury [27]. Elevated atherogenic lipid ratios, particularly TC/HDL and LDL/HDL, have been associated with increased cardiovascular and microvascular complications among diabetic patients [7], [28].

Gender was significantly associated with the TC/HDL ratio, although no significant associations were observed with other metabolic parameters. Biological differences in fat distribution, hormonal regulation, and lifestyle-related factors between males and females may partially explain these findings [29]–[31]. However, given that this was the only significant association observed for gender, further studies with larger sample sizes are needed to determine whether these findings are consistent across different populations of patients with DR.

Interestingly, serological status and types of masks used were not significantly associated with either health protocol compliance scores or metabolic profile parameters. Interestingly, serological status and types of masks were not significantly associated with either health protocol compliance scores or metabolic profile parameters. These findings suggest that, within this study population, COVID-19-related characteristics measured by serological status and mask type were not significantly associated with the metabolic parameters examined. However, these variables should be interpreted separately from the broader concept of health protocol compliance, as mask type and serological status do not fully capture the range of preventive behaviors or their potential relationship with metabolic regulation [11], [13]. Furthermore, the high overall health protocol compliance score observed among participants may have reduced variability between groups.

## Conclusion

This study demonstrated that educational level was significantly associated with health protocol compliance among patients with DR, while age, occupation, and gender were associated with selected metabolic profile parameters. Age was associated with HbA1c, FBG, and 2hPPBG, while occupation was associated with TC/HDL and LDL/HDL ratios, and gender with the TC/HDL ratio.

Health protocol compliance and metabolic profiles represent distinct but potentially interconnected aspects of health. In this study, both were evaluated as separate outcomes, and no direct causal or associative relationship between health protocol compliance and metabolic control was established. The findings suggest that sociodemographic characteristics may be associated with these domains in different ways. These findings support the importance of targeted education and routine metabolic monitoring in patients with DR. Further longitudinal studies with larger samples are needed to clarify the potential relationship between health-related behaviors, metabolic control, and DR outcomes.

## Limitation and Suggestions

This study has several limitations that should be considered. First, the cross-sectional design limits the ability to establish causal relationships between sociodemographic characteristics, health protocol compliance, and metabolic profile parameters. Second, the relatively small sample size and the use of total sampling from two hospitals may limit the generalizability of the findings to broader populations. Third, health protocol compliance assessment was based on self-reported data, which may be subject to recall bias and response bias. Fourth, the relatively small sample size (n = 45) precluded multivariable analysis to adequately control for potential confounding among sociodemographic characteristics. Although age, gender, education, and occupation may be interrelated, including multiple

predictors in regression models with this sample size could result in unstable estimates and overfitting. Consequently, the associations identified in this study are based on unadjusted analyses and should be interpreted cautiously as exploratory findings. Fifth, multiple statistical comparisons were performed to examine the associations between several sociodemographic factors and multiple outcomes, particularly in Tables 3 and 4, without adjustment for multiple testing, such as the Bonferroni correction. Therefore, the possibility of inflated Type I error and chance findings cannot be excluded, particularly given the relatively small sample size. The statistically significant findings should consequently be interpreted with caution and considered exploratory.

Despite these limitations, the study provides important preliminary data regarding behavioral and metabolic characteristics among patients with DR during the COVID-19 pandemic. Future studies are encouraged to involve larger multicenter populations, longitudinal follow-up, and additional variables such as duration of diabetes, severity of DR, socioeconomic status, and lifestyle-related factors to obtain a more comprehensive understanding of the determinants affecting DR outcomes. Larger studies should also incorporate appropriately powered multivariable analyses to account for potential confounding among sociodemographic characteristics and consider appropriate adjustment for multiple comparisons to reduce the risk of Type I error.

## Acknowledgment

The authors would like to express their gratitude to the Faculty of Medicine, Mulawarman University, for the support provided during this study.

## Conflict of Interest

The authors declare no conflict of interest.

## References

[1] Vision Loss Expert Group of the Global Burden of Disease Study and the GBD 2019 Blindness and Vision Impairment Collaborators, “Global Estimates on the Number of People Blind or Visually Impaired by Diabetic Retinopathy: A Meta-Analysis from 2000 to 2020,” *Eye*, vol. 38, pp. 2047–2055, 2024, doi: 10.1038/s41433-024-03101-5.

[2] NCD Risk Factor Collaboration, “Global Variation in Diabetes Diagnosis and Prevalence Based on Fasting Glucose and Hemoglobin A1c,” *Nat. Med.*, vol. 29, pp. 2885–2901, 2023, doi: 10.1038/s41591-023-02610-2.

[3] S. A. Medina-Ramirez *et al.*, “Prevalence and Incidence of Diabetic Retinopathy in Patients with Diabetes of Latin America and the Caribbean: A Systematic Review and Meta-Analysis,” *PLoS One*, vol. 19, no. 4, pp. 1–23, 2024, doi: 10.1371/journal.pone.0296998.

[4] T. G. Wondmeneh and J. A. Mohammed, “Prevalence of Diabetic Retinopathy and Its Associated Risk Factors Among Adults in Ethiopia: A Systematic Review and Meta-Analysis,” *Sci. Rep.*, vol. 14, pp. 1–17, 2024, doi: 10.1038/s41598-024-78596-9.

[5] P. K. Sharma, K. Kumar, A. Dubey, N. Kushwaha, and P. Maravi, “Clinical Study on Association of Diabetic Retinopathy Severity with HbA1c Level,” *Indian J. Clin. Exp. Ophthalmol.*, vol. 10, no. 2, pp. 248–255, 2024, doi: 10.18231/j.ijceo.2024.045.

[6] N. Alswaina, "Association Between HbA1c Levels and the Severity of Diabetic Retinopathy," *Cureus*, vol. 16, no. 12, pp. 1–8, 2024, doi: 10.7759/cureus.76395.
[7] M. A. Karimi *et al.*, "Lipid Variability and Risk of Microvascular Complications in Patients with Diabetes: A Systematic Review and Meta-Analysis," *BMC Endocr. Disord.*, vol. 24, pp. 1–16, 2024, doi: 10.1186/s12902-023-01526-9.
[8] H. Jeong, C. M. Maatouk, M. W. Russell, and R. P. Singh, "Associations Between Lipid Abnormalities and Diabetic Retinopathy Across a Large United States National Database," *Eye*, vol. 38, pp. 1870–1875, 2024, doi: 10.1038/s41433-024-03022-3.
[9] M. Rahmati *et al.*, "Factors Affecting Global Adherence for the Uptake of Diabetic Retinopathy Screening: A Systematic Review and Meta-Analysis," *Am. J. Ophthalmol.*, vol. 268, pp. 94–107, 2024, doi: 10.1016/j.ajo.2024.07.028.
[10] S. Dhandapani, K. Afshan, S. Shreya, C. L. Vincy, V. Yuvaraj, and V. Krithika, "Dietary Intake, Lifestyle Factors, and Metabolic Risk: Insights from Health Check-Ups at a Private Healthcare Facility in Coimbatore, India," *Amerta Nutr.*, vol. 8, no. 4, pp. 632–641, 2024, doi: 10.20473/amnt.v8i4.2024.632-641.
[11] A. D. Erawati, "Factors Associated with Compliance in Implementing Health Protocols to Prevent COVID-19 in Indonesia: A Cross-Sectional Study," *J. Ners*, vol. 17, no. 1, pp. 55–60, 2022, doi: 10.20473/jn.v17i1.25618.
[12] L. Wright, A. Steptoe, and D. Fancourt, "Patterns of Compliance with COVID-19 Preventive Behaviours: A Latent Class Analysis of 20,000 UK Adults," *J Epidemiol Community Heal.*, vol. 76, pp. 247–253, 2022, doi: 10.1136/jech-2021-216876.
[13] R. A. Ghamri and K. A. Ghamri, "Sociodemographic and Clinical Predictors for COVID-19 Preventive Measures Compliance Among Pregnant Women in Saudi Arabia: A Multicenter Study," *BMC Infect. Dis.*, vol. 23, pp. 1–11, 2023, doi: 10.1186/s12879-023-08364-z.
[14] World Health Organization (WHO), "Advice for the Public: Coronavirus Disease (COVID-19)," *WHO*, 2023. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public (accessed Mar. 18, 2023).
[15] World Health Organization (WHO), "Global Surveillance for COVID-19 Caused by Human Infection With COVID-19 Virus." WHO, pp. 1–4, 2020.
[16] Ministry of Health of the Republic of Indonesia, *Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07/MENKES/382/2020 tentang Protokol Kesehatan bagi Masyarakat di Tempat dan Fasilitas Umum dalam Rangka Pencegahan dan Pengendalian Corona Virus Disease 2019 (COVID-19)*. Indonesia, 2020.
[17] Ministry of Health of the Republic of Indonesia, *Pedoman Pencegahan dan Pengendalian Coronavirus Disease (COVID-19)*. Jakarta: Ministry of Health of the Republic of Indonesia, 2020.
[18] S. Pardhan, R. Raman, A. Biswas, D. Jaisankar, S. Ahluwalia, and R. Sapkota, "Knowledge, Attitude, and Practice of Diabetes in Patients with and Without Sight-Threatening Diabetic Retinopathy from Two Secondary Eye Care Centres in India," *BMC Public Health*, vol. 24, pp. 1–10, 2024, doi: 10.1186/s12889-023-17371-3.
[19] F. Nari, J. K. Jun, K. H. O. And, and W. Jeong, "The Association Between Health Literacy and Screening for Disease-Specific Complications Among Community-Dwelling Adults with Diabetes," *Front. Public Heal.*, vol. 12, pp. 1–7, 2024, doi: 10.3389/fpubh.2024.1418828.
[20] Y. Tang *et al.*, "Analysis of Health Information Needs of Elderly Patients with Chronic Diseases Based on Kano Model: A Descriptive Cross-Sectional Study," *BMC Geriatr.*, vol. 25, pp. 1–12, 2025, doi: 10.1186/s12877-025-06106-1.
[21] T. Schwarz, A. E. Schmidt, J. Bobek, and J. Ladurner, "Barriers to Accessing Health Care for People with Chronic Conditions: A Qualitative Interview Study," *BMC Health Serv. Res.*, vol. 22, pp. 1–15, 2022, doi: 10.1186/s12913-022-08426-z.
[22] B. Bhattarai *et al.*, "Structured Counselling and Regular Telephonic Follow-Up to Improve Referral Flow and Compliance in Nepal for Diabetic Retinopathy (SCREEN-D Study): A Randomized Controlled Trial," *BMC Health Serv. Res.*, vol. 24, pp. 1–9, 2024, doi: 10.1186/s12913-024-10647-3.
[23] I. S. Sadikin, Y. D. Lestari, and A. A. Victor, "The Role of Cadre in the Community on Diabetic Retinopathy Management and Its Challenges in Low-Middle Income Countries: A Scoping Review," *BMC Public Health*, vol. 24, pp. 1–16, 2024, doi: 10.1186/s12889-024-17652-5.
[24] M. Zhu, X. Liu, W. Liu, Y. Lu, J. Cheng, and Y. Chen, "β Cell Aging and Age-Related Diabetes," *Aging (Albany. NY).*, vol. 13, no. 5, pp. 7691–7706, 2021, doi: 10.18632/aging.202593.
[25] E. M. Everett, "Leveraging Continuous Glucose Monitors to Reduce the Risk of Diabetic Retinopathy," *JAMA Netw. Open*, vol. 7, no. 3, pp. 6–7, 2024, doi:

10.1001/jamanetworkopen.2024.0718.
[26] F. Salavatian, N. Hashemi-madani, Z. Emami, Z. Hosseini, K. G. Falavarjani, and M. E. Khamseh, "Improving Diabetic Retinopathy Screening at the Point of Care: Integrating Telemedicine to Overcome Current Challenges," *BMC Ophthalmol.*, vol. 24, pp. 1–7, 2024, doi: 10.1186/s12886-024-03508-4.
[27] K. Ezhilvendhan, A. Sathiyamoorthy, B. J. Prakash, B. S. Bhava, and A. Shenoy, "Association of Dyslipidemia with Diabetic Retinopathy in Type 2 Diabetes Mellitus Patients: A Hospital-Based Study," *J. Pharm. Bioallied Sci.*, vol. 13, no. 2, pp. 1062–1067, 2021, doi: 10.4103/jpbs.jpbs_164_21.
[28] A. R. Bourgonje, M. A. Connelly, H. Van Goor, P. R. Van Dijk, and R. P. F. Dullaart, "Both LDL and HDL Particle Concentrations Associate Positively with an Increased Risk of Developing Microvascular Complications in Patients with Type 2 Diabetes: Lost Protection by HDL (ZODIAC-63)," *Cardiovasc. Diabetol.*, vol. 1, pp. 1–11, 2023, doi: 10.1186/s12933-023-01909-1.
[29] M. F. Ramirez *et al.*, "Sex Differences in Protein Biomarkers and Measures of Fat Distribution," *J. Am. Heart Assoc.*, vol. 13, pp. 1–13, 2024, doi: 10.1161/JAHA.124.000223.
[30] I. T. De Jacobis *et al.*, "Sex Differences in Lipid Profile and Response to Statin Treatment in Pediatric Patients Affected by Familial Hypercholesterolemia," *Eur. J. Pediatr.*, vol. 184, pp. 1–6, 2025, doi: 10.1007/s00431-025-06397-x.
[31] B. R. Joshi, T. Yadav, A. K. Amit, and S. Rizal, "Gender Differences in Lipid Profile in Dyslipidemic Patients Visiting Hetauda Hospital," *Med-Phoenix*, vol. 9, no. 1, pp. 7–11, 2024, doi: 10.3126/medphoenix.v9i1.67178.

## Authors



**Dr. Yuliana Rahmah Retnaningrum, M.Kes, Sp.PD, FINASIM** is a faculty member at the Faculty of Medicine, Mulawarman University. She completed her academic and professional education—including her bachelor's degree, medical degree, master's degree in medicine, and specialist training in internal medicine—at the Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta. She currently serves as an internist at Abdul Wahab Syahrani Regional General Hospital (RSUD). She is presently pursuing a doctoral degree in Environmental Science at Mulawarman University. (email: yulianakaltim@gmail.com).



**Dr. Yuniati, M.Kes.** holds an undergraduate degree from the Faculty of Medicine at Andalas University and a postgraduate degree from the Faculty of Medicine at Brawijaya University; she is a faculty member at the Faculty of Medicine, Mulawarman University. She currently practices as a partner physician for BPJS Kesehatan. I contributed to the data collection process for this research article. (email: yuni10indah@gmail.com).



**Dr. Nur Khoma Fatmawati, MKes, SpM** completed her undergraduate, postgraduate, and ophthalmology specialist training at the Faculty of Medicine, Universitas Brawijaya. She currently serves as a faculty member at the Faculty of Medicine, Universitas Mulawarman, and practices at a private eye clinic. She specializes in medical retina and maintains a research interest in various retina-related topics. In the development of this monograph, she contributed to data collection and the interpretation of examination results to establish diagnoses—a crucial component of the study's analysis. (email: gusma_riqo@yahoo.com).



**Dr. Endang Sawitri, M.Kes.** holds undergraduate and medical professional degrees from the Faculty of Medicine at Sam Ratulangi University, as well as master's and doctoral degrees from the Postgraduate Program at Diponegoro University. She is currently an active faculty member at the Faculty of Medicine, Mulawarman University, in Samarinda, East Kalimantan. She possesses expertise in biomedical sciences and is an active researcher with interests spanning various topics related to the immunobiology of metabolic diseases and malignancies. In the preparation of this research article, she contributed to data collection and the editing of the manuscript—steps crucial to ensuring the paper's suitability for publication. (email: endangsawitri68@gmail.com).



**dr. Amalia Aswin** is currently pursuing her Pediatric Residency Program at the Faculty of Medicine, Universitas Indonesia (FKUI). She graduated from the Faculty of Medicine, Universitas Mulawarman, where she completed both her undergraduate medical education and medical professional training. Amalia has a strong interest and experience in pediatrics and medical research, with involvement in various research projects and scientific publications. In the preparation of this manuscript, Amalia contributed to data collection and data processing, supporting the development and analysis of the study. (email: learn.amaliaaswin@gmail.com).



**dr. Rudi Saputra** is a medical doctor, researcher, and public health professional from Indonesia. He graduated from Mulawarman University and is actively engaged in research and scientific activities in the field of public health. His academic interests focus on population health, health services, disease prevention, and the improvement of health outcomes through evidence-based approaches. (email: rudisaputra18052001@gmail.com).