Polypharmacy in Type 2 Diabetes Patients of the PROLANIS Program in Indonesia: Identification of Potential Drug-Drug Interaction

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ABSTRACT

The identification of potential drug-drug interactions (pDDIs) becomes critical in evaluating medication safety among diabetes mellitus patients. This study aimed to identify the pDDIs of polypharmacy in type 2 diabetes mellitus (T2D) patients of the Chronic Disease Management Program or Program Pengelolaan Penyakit Kronis (PROLANIS) Program. The T2D patients aged ≥18 were selected consecutively. A total sample of prescriptions containing ≥5 drugs was included. The mean age of patients was 62.70 ± 9.85 years (range 24–92 years), 62% were elderly, and 56.8% were females. Polypharmacy prescriptions were most prevalent in the Internal Medicine Department (92.8%). Of the 250 prescriptions, approximately 78.4% contained at least one pDDI. A total of 515 pDDIs were identified, with a median of 2 pDDIs per patient. Of these, 89.7% were of moderate severity. The drug pairs involved in moderate-severity pDDIs were glimepiride-metformin, glimepiride-bisoprolol, and metformin-ramipril. The number of drugs per prescription is a significant predictor of pDDIs (aOR = 7.48; 95% CI = 1.73-32.32). Subsequent analysis revealed that prescriptions containing eight or more drugs were 4.31 times more likely to have more than five pDDIs (p=0.010). Pharmacists must play a pivotal role in managing chronic disease medication to reduce drug interaction risks. This study suggests developing a digital system for healthcare professionals to improve patient medication safety.

Keywords: Drug-drug interactions; polypharmacy; prolanis; type 2 diabetes.

INTRODUCTION

World Health Organization defines polypharmacy as the concurrent administration of five or more drugs[1], regardless of whether it is appropriate (evidence-based). In addition, Guillot et al.[2] gave a comprehensive overview of polypharmacy, including factors that affect it (from 4% to 57%) and factors that influence it, such as patient, disease, and healthcare system issues. The issue of polypharmacy has become a growing public health concern in all healthcare sector.[3,4] Moreover, the risks associated with polypharmacy are drug–drug interactions, higher risk of falls, adverse drug reactions, cognitive impairment, non-adherence, and poor nutritional status.[3,5,6] A cohort research in Korea found that polypharmacy was associated with a greater risk of hospitalization and death. Those risks negatively impact health outcomes and healthcare expenditures.[1,7] Then, the most vulnerable patient groups to the risk of polypharmacy tend to be elderly patients over

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65 and people living in nursing homes.[2,3,8] In chronic disease management today, polypharmacy becomes inevitable since the patients are treated for multiple diseases that required multiple prescriptions.[9,10]

Diabetes is a chronic disease that significantly impacts the lives of the patient themselves, families, and societies worldwide.[11] Due to its widespread occurrence, detrimental impacts on the economy and society, and decreased quality of the patients, diabetes mellitus ranks among the most dangerous chronic illnesses in the world.[12] In addition, environmental, lifestyle, and genetic variables have a role in aetiology and progression of diabetes itself.[13] Among the top 10 causes of death in adults, diabetes was estimated to have caused four million deaths worldwide in 2017.[11] Among three diabetes types, type 2 diabetes (T2D) accounts for approximately 90% of the total.[11] Moreover, type 2 diabetes mellitus dominantly causes most deaths in the world.[14] It is a result of relative insulin deficiency and peripheral insulin resistance.[12] The increase in type 2 diabetes is associated with obesity, hypertension, and aging population.[15] T2D affects an estimated 463 million adults aged 20-79, which is expected to reach 578 million by 2030.[13] With a prevalence of 10.8%, Indonesia is one of the top 10 countries with the highest prevalence of T2D.[13]

Patients with type 2 diabetes mellitus are initially treated with dietary modifications, increased physical activity and exercise, and weight loss.[16] Moreover, the incidence of type 2 diabetes in the elderly is 2.28 times higher, along with higher chance of geriatric syndromes called polypharmacy, which raises the possibility of drug interactions.[17] These lifestyle modifications are supported by diabetes self-management education and consultations with certified dietitians.[18]

When patients are diagnosed with diabetes, many medications could become appropriate therapy.[5] These include medications for dyslipidemia, hypertension, antiplatelet therapy, and glycemic control.[5] As a chronic condition, diabetes is associated with an increased risk of several other diseases due to its damage to macro and microvascular structures.[14,15] Moreover, diabetes-related macrovascular and microvascular complications cause the reduced quality of life, disability, and early death related to diabetes, including peripheral vascular disease, chronic renal disease, heart failure, coronary heart disease, cerebrovascular disease, diabetic retinopathy, and cardiovascular autonomic neuropathy.[18] In addition, several organs are negatively affected by diabetes, including brain, kidneys, heart, and eyes.[14,15] Furthermore, the risk of infection is also higher among diabetic patients. In addition to the risk of complications caused by diabetes, comorbidities also contribute to the numerous prescribed drugs.[17]

Through the government's National Health Insurance System (NHIS), Indonesia establish the Indonesian Chronic Disease Management Program (*Program Pengelolaan Penyakit Kronis /*PROLANIS) in 2014.[19] PROLANIS seeks to offer people with chronic illnesses, especially those with diabetes mellitus and hypertension, and a proactive approach to healthcare services. In addition, PROLANIS provide people with chronic illnesses with the best possible quality of life by providing cost-effective and efficient healthcare services. Moreover, PROLANIS offers exercise, education, home visits, health checks, and consultations. T2D has become the main focus of PROLANIS, besides hypertension.[18,19] This integrated health service program involves the patients, healthcare professionals, healthcare facilities, and NHIS. It aims to control clinical and laboratory outcomes, prevent disease complications, and improve patients' quality of life. Furthermore, monthly regular medical consultation meetings are become the routine activities in PROLANIS program.[18,19]

Previous studies have shown pharmacists' vital role in improving PROLANIS patients' outcomes.[20,21] In addition, a research suggests that pharmacists are essential in managing chronic diseases and optimizing the use of medications, including detecting drug interactions and educating patients.[21] Since the drug interactions can cause significant morbidity and mortality, minimizing the risk of drug interactions should be an objective of drug

therapy.[5,15] Generally, a drug interaction occurs when one or more medications are co-administered, resulting in their effectiveness or toxicity alterations.[5,15] pDDIs can occur regardless of whether they result in clinically meaningful consequences and essentially occur before actual DDIs.[22] Unfortunately, the research regarding the pDDIs among T2D patients in Indonesia are limited, especially for patients enrolled in PROLANIS Program. Therefore, this research aimed to identify the pDDIs of polypharmacy in T2D patients of PROLANIS Program. The findings in this research could provide insight into the frequency, severity, and risk factors associated with pDDIs in ambulatory T2D patients enrolled in PROLANIS Program.

METHODS

Study design, setting, and participants

This research was an observational and cross-sectional research. The researchers prospectively examined the prescriptions of 250 patients diagnosed with T2D in PROLANIS Program at Muhammadiyah Hospital, Bandung, who applied to outpatient clinic between April 1 and April 29, 2023. In addition, Muhammadiyah Hospital is a public secondary care hospital located in capital of West Java province, the most populous province in Indonesia. As PROLANIS Program requires monthly visits[19], the researchers assumed the data obtained during a given month would remain the same in the following months. The T2D patients aged 18 or more were selected consecutively. Then, the polypharmacy was defined as prescribing five or more drugs, and the prescriptions without polypharmacy were excluded from this research. The sample size for this research was determined using a total sampling method.

Ethical considerations

This research was approved by Research Ethics Committee of Universitas Padjadjaran (No. No.195/UN6.KEP/EC/2023). The individuals did not provide informed consent as the researchers studied the prescriptions.

Screening of potential drug-drug interactions

The researchers screened the drug-drug interactions using drugs.com and go.drugbank.com interaction checkers.[22–24] Specifically, these programs describe all potential drug interactions and indicate that the information is available on specific drugs within a given class. As well as revealing the clinical relevance of the interaction, the literature citations are provided for the interaction. Additionally, the programs provide recommendations on monitoring and managing medications. Moreover, the DDIs were also categorized according to severity level listed.

Statistical analysis

The researchers conducted descriptive analyses to determine the frequencies and percentages of categorical and mean ± standard deviation, median, and range of continuous data. Multicollinearity was checked to test correlation among independent variables using the variance inflation factor, and none was collinear. Moreover, bivariate logistic regression analysis was assessed to determine the association of each independent variable with the presence of pDDIs. Multivariable logistic regression was assessed to identify the predictors when all variables were included simultaneously. The researchers also conducted sub-analyses to determine the significant variables that associated with the number of pDDIs. In the analyses of pDDIs predictors, some variables' categories had to be merged due to small populations within each subset. All statistical analyses were performed in IBM SPSS Statistics version 22.0 (IBM Corp., New York, USA) with a significance level of $p<0.05$.

RESULTS

Characteristics of polypharmacy prescriptions

The researchers observed 250 polypharmacy prescriptions for T2D patients of PROLANIS Program. The mean age of patients was 62.70 ± 9.85 (range 24–92 years), and 155 (62%) were aged 60 or more (elderly patients). One hundred forty-two patients (56.8%) were females. The total number of drugs per prescription ranged

from 5 to 11, with a median of 6. Then, one hundred ninety-six prescriptions (78.4%) contained five to seven drugs in a single prescription. Polypharmacy prescriptions were most prevalent in Internal Medicine Department (92.8%) and Neurology Department (5.6%). Table 1 presents the characteristics of the studied prescriptions.

Table 1. Characteristics of studied prescriptions

Characteristics	*n* (%) / mean ± SD (range) / median (range)
Age (years)	62.70 ± 9.85 (24-92)
<60 (non-elderly)	89 (35.6)
≥60 (elderly)	155 (62.0)
Missing	6 (2.4)
Sex	
Male	94 (37.6)
Female	142 (56.8)
Missing	14 (5.6)
Number of drugs per prescription	6 (5-11)
5-7	196 (78.4)
8-10	52 (20.8)
>10	2 (0,8)
Prescriptions source (Department)	
Internal Medicine	232 (92.8)
Neurology	14 (5.6)
Cardiology	3 (1.2)
Endocrinology	1 (0.4)

Abbreviation: SD = standard deviation

Frequency and severity of potential drug-drug interactions

Figure 1 illustrates the number of pDDIs per polypharmacy prescription. It was found that pDDIs were present in 78.4% of prescriptions. A total of 515 pDDIs were identified, with a median of 2 pDDIs per patient (range 1–15).

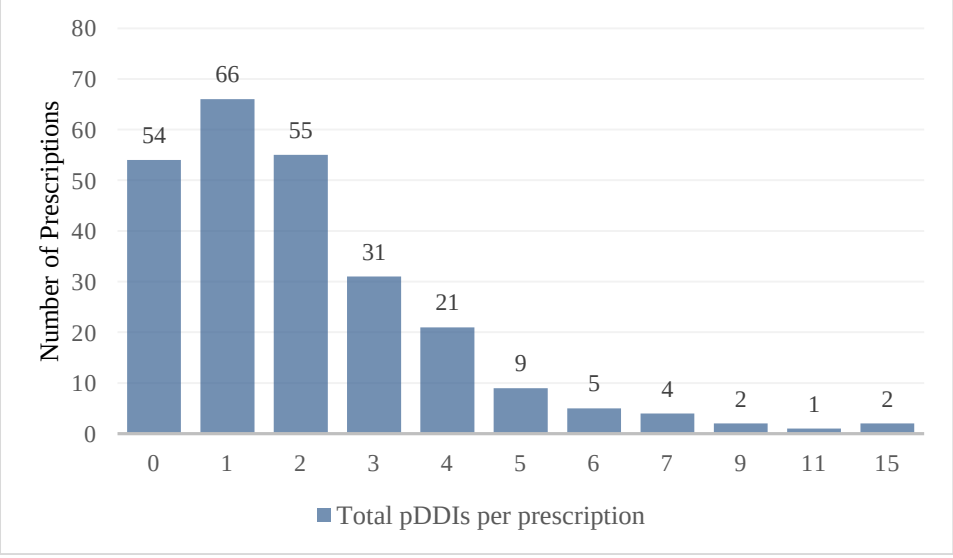

Figure 1. The number of pDDIs per polypharmacy prescription

Of the 515 pDDIs, 89.7% (*n* = 462) were of moderate severity, followed by 10.1% (*n* = 52) minor and 0.2% (*n* = 1) major pDDIs (Figure 2). In this research, it was found that 90 pairs of active substances interactions.

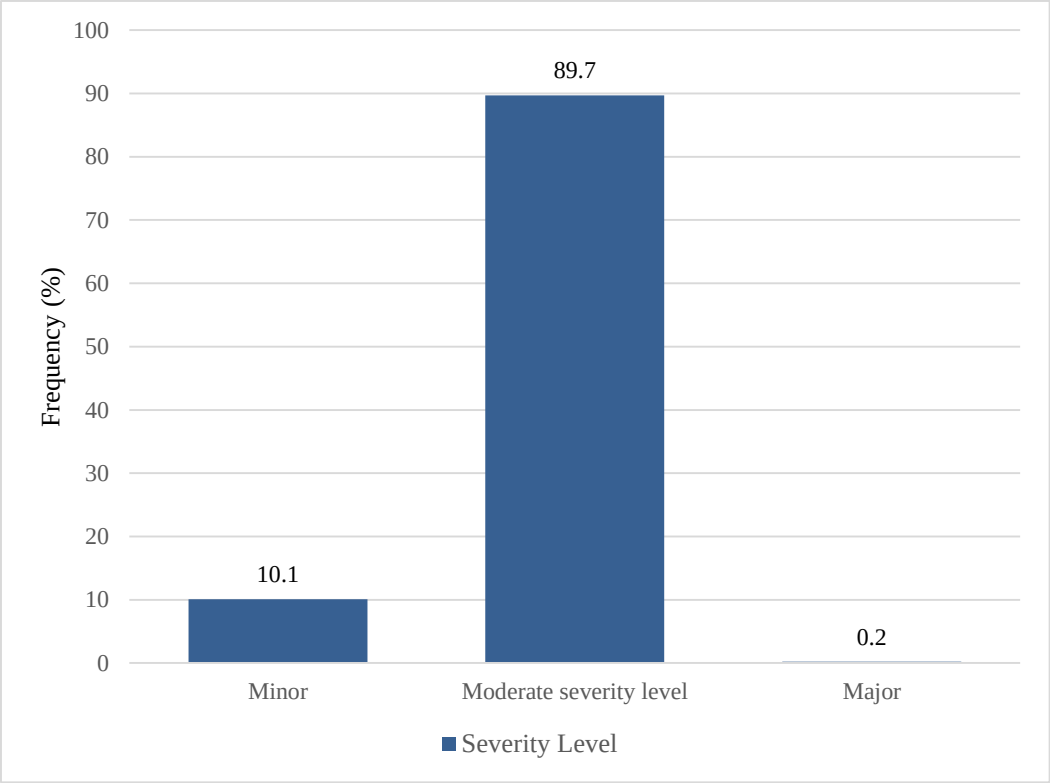

Figure 2. Severity levels of pDDIs identified

Table 2 shows the common drug pairs involved in pDDIs identified at each severity level. At the moderate severity level, most of the interactions were between glimepiride-metformin (18.6%), glimepiride-bisoprolol (8.3%), and metformin-ramipril (8.0%), whereas at the minor level, the most common interactions were between metformin-acarbose (6.6%). Then, the drug pair involved in pDDIs with major severity was pioglitazone + clopidogrel. Most drug pairs led to an increased risk of hypoglycemia (44.8%), whereas other possible consequences from the pDDIs identified were the reduced effects of antidiabetic agents (6.6%), hyperglycemia (3.3%), lactic acidosis (2.1%), and increased drug toxicity (1.7%).

Factors associated with the pDDIs

The researchers conducted a bivariate logistic regression analysis to compare the prescriptions with the presence and absence of pDDIS based on the patients' and prescriptions' characteristics. Accordingly, only prescription characteristics showed significant associations with the presence of pDDIs; *p*-values for the number of drugs per prescription and the prescription source variables were 0.004 and 0.019 respectively (Table 3).

Table 3. Bivariate and multivariable logistic regression results for predictors of the presence of pDDIs

Characteristics	Bivariate analysis			Multivariable analysis		
	SE	*p*-value	cOR (95%CI)	SE	*p*-value	aOR (95%CI)
Age (years)						
<60 (non-elderly) ≥60 (elderly)	0.33	0.453	1 0.78 (0.41-1.49)	0.36	0.278	1 0.27 (0.06-1.31)
Sex						
Male Female	0.32	0.074	1 1.78 (0.94-3.36)	0.34	0.120	1 1.69 (0.87-3.26)
Number of drugs per prescription						
5-7 ≥8	0.62	0.004*	1 5.98 (1.79-19.99)	0.75	0.007*	1 7.48 (1.73-32.32)
Prescriptions source (Department)						
Internal Medicine Others	0.50	0.019*	1 0.31 (0.12-0.83)	0.80	0.104	1 0.27 (0.06-1.31)

Abbreviation: SE = standard error; cOR = crude Odds Ratio; aOR= adjusted Odds Ratio; CI = Confidence Interval; *significant at *p*-value<0.05

However, according to multivariable analysis, only the number of drugs per prescription variable had a significant association (aOR = 7.48; 95% CI = 1.73-32.32) (Table 3). The researchers found that prescriptions containing eight or more drugs were 7.48 times more likely to have pDDIs than other polypharmacy prescriptions. In addition, table 4 presents the sub-analysis results in determining the number of drugs per prescription was associated with the number of pDDIs.

Table 4. The association between the number of drugs per prescription and the number of pDDIs

Characteristics	Binary logistic regression		
	SE	*p*-value	OR (95%CI)
Number of drugs per prescription			
5-7			1
≥8	0.57	0.010*	4.31 (1.42-13.11)

Abbreviation: SE = standard error; OR = Odds Ratio; CI = Confidence Interval;
*significant at *p*-value<0.05

The number of pDDIs was categorized into 1 = one to five interactions and 2 = more than five. Moreover, the result showed that prescriptions containing eight or more drugs were 4.31 times more likely to have more than five pDDIs (*p*=0.010).

DISCUSSION

The impact of one medication being altered (increased, decreased, or modified) by the presence of another medication when given consecutively is known as a drug-drug interaction (DDI).[25] As a subclass of adverse drug

events (ADEs), DDIs occur when two or more medications are taken at the same time and may result in a changed therapeutic effect.[26] In addition, the patients with diabetes are frequently treated with a combination of drugs due to the various comorbidities associated with the disease.[27] Identifying the frequency, severity, and risk factors associated with pDDIs among patients with T2D participating in the PROLANIS Program is essential. Besides assessing the safety of polypharmacy prescribing to these patients, it also provides suggestions for developing pharmacist services in the PROLANIS Program. An interprofessional care team made up of general practitioners, medical specialists, nurses, and pharmacists should be in charge of managing patients with chronic illnesses. In addition, pharmacists play a fundamental role in preventing, monitoring, and managing drug interactions, particularly in the case of chronic disease patients.[21,28] Pharmacists are also vital in educating patients, especially in raising awareness of the risks associated with their treatment.[21,27,29] Compared to doctors, pharmacists are able to give patients more precise advice when it comes to medication education. As a result, patients are more actively involved in achieving therapeutic goals and avoiding preventable fatal consequences, such as falls and hospitalizations.

This study found that pDDIs were present in 78.4% of the 250 polypharmacy prescriptions observed. It is higher than the frequency of pDDIs reported by other studies, either conducted in inpatient settings: Indonesia (57.7%); India (70%), or in outpatient settings: Indonesia (46.54%), Brazil (75%); Nepal (52.2%). Considering that outpatient settings are challenging to monitor compared to inpatient settings, the frequency of pDDIs identified in this setting raises some concerns. In addition, it is also needed to identify a total of 515 pDDIs, with a median of 2 pDDIs per patient. Furthermore, it is imperative that the severity of the pDDIs identified is evaluated since the presence of even one pDDI can lead to actual DDIs, thus decreasing the patient's quality of life and ultimately resulting in other harms.[22,30] These findings suggest that rational prescribing practices are of the utmost importance to chronic disease patients, especially diabetics.

Regarding severity, in the current study, approximately 89.7% (n = 462) of the pDDIs were of moderate severity, followed by 10.1% (n = 52) minor and 0.2% (n = 1) major severity. Linear with the previous studies, the most common severity of pDDIs in polypharmacy prescriptions for T2D patients was moderate level: Indonesia (89.39%)[31], Brazil (82,4%)[32], and Nepal (92.1%). The most frequent drug pairs associated with moderate-severity pDDIs were glimepiride-metformin, glimepiride-bisoprolol, and metformin-ramipril.

A combination of glimepiride and metformin is commonly used for patients with type 2 diabetes who have hypertension and dyslipidemia as main comorbidities and have micro- and macro-vascular complications.[33,34] However, a dose adjustment or blood glucose monitoring may be necessary due to the increased risk of hypoglycaemia.[35] Hypoglycemia can cause costly Emergency Room (ER) visits and hospital stays, as well as morbidity and mortality. It can also cause distress for people with diabetes and their families, medication no adherence, and disruptions to life and work.[36] Likewise, the sulfonylurea and beta-blocker combination was the most common drug-drug interaction in clinical routine.[35] According to Nurlaelah et al.[37], the drug pair interaction was also reported in their study of drug interactions in treating diabetes and hypertension in an outpatient setting in Indonesia. In addition, metformin and Angiotensin-converting enzyme (ACE) inhibitors are used together to treat hypertension in T2D patients. According to previous studies, this drug pair was also listed as a combination medication with potential drug-drug interactions. Because hyperglycemia increases platelet reactivity, clopidogrel becomes the cornerstone of ischemic secondary prevention in diabetic patients.[36] However, some observations implied that co-administering the two drugs might increase the risk of pioglitazone adverse reactions due to clopidogrel

inhibiting its metabolism.[38] A previous study in Indonesia did not find the major severity level of the pDDIs.[31] Several studies reported different drug pairs involved in major severity levels; however, clopidogrel was also present.[32,33]

Among diabetic patients, hypoglycemia is still one of the most frequent drug-related side effects and a major contributor to hospital admissions and ER visits.[39] Hypoglycemia is most common among older patients with multiple or advanced comorbidities, patients with long diabetes duration, or patients with a prior history of hypoglycemia. Moreover, insulin and sulfonylurea use, food insecurity, and fasting also increase the hypoglycemia risk.[40] In addition, most drug pairs (44.8%) increased the risk of hypoglycemia; as a result, dose adjustment, blood glucose monitoring, and improving patients' awareness of hypoglycemia symptoms were recommended.[41] In addition, patients may not recognize or receive treatment for hypoglycemia if they are unaware of its signs. Other possible consequences of the pDDIs identified, such as decreased effects of antidiabetic agents, hyperglycemia, lactic acidosis, and drug toxicity, require different management approaches. Still, in principle, the goal is to maintain normal blood glucose levels and improve patients' awareness of medication therapy risks.[6] It is essential that the patients recognize the signs and symptoms associated with possible adverse reactions, such as hypoglycemia, hyperglycemia, and lactic acidosis.[32,42] Particularly in diabetic populations worldwide, hyperglycaemic crises remain to be a significant contributor to morbidity and mortality.

In both bivariate and multivariable logistic regression analyses, the number of drugs per prescription had a significant association with the presence of pDDIs. Prescriptions containing ≥8 drugs were found to have a 7.48 times higher risk of pDDIs than those containing 5-7 drugs. Specifically, prescriptions containing ≥8 drugs were found to be 4.31 times more likely to have more than five pDDIs. It supports previous evidence of polypharmacy's role in pDDIs incidence and provides new insight into pDDIs among diabetics because it compares the risk of pDDIs among polypharmacy prescriptions.[22,32,33,43] There was no association between age, gender, or the source of prescriptions with the presence of pDDIs. Regarding the elderly and sex, the findings are consistent with those in the Brazilian study.[32] The two variables in the observed population may not affect the patients' disease-related conditions. About the prescription source variable, the significance in bivariate and insignificance in multivariable analysis indicates that the variable is only predictive due to its association with other predictors.[39]

The present study's results confirm the risk to the safety of T2D patients of the Prolanis Program subjected to polypharmacy. Nevertheless, polypharmacy prescribing is difficult to avoid due to the comorbidities of the aging population.[40] It becomes crucial to ensure rational or appropriate polypharmacy and monitor drug therapy in patients with T2D, especially in the PROLANIS Program.[40] Pharmacists play an essential role in reducing the risks of drug interactions by screening prescriptions before drug administration and providing drug information to patients to minimize these risks.[44] Due to the potential for toxicity, loss of efficacy, and adverse consequences, healthcare professionals such as prescribers, pharmacists, and nurses need to be adequately informed about drug-drug interactions.[45] A study found that patients receiving clinical pharmacy services from pharmacists were 11.6 times more likely to have controlled fasting blood glucose than those who did not receive such services.[44] Providing pharmacists with digital systems for detecting and preventing prescriptions with problems, as well as providing databases on pDDIs, interactions severity, and clinical recommendations, has become increasingly important today.[40] Moreover, mobile-enabled pharmacies are becoming more common, and digital transformation is crucial to integrating pharmacy data and providing personalized patient care.[46] It would decrease the risk of pDDIs and enhance the collaboration between health

professionals, particularly pharmacists and prescribers.

This is the first study assessing prospective prescriptions of diabetes patients enrolled in the PROLANIS Program. Additionally, the study provides information regarding the association between the number of prescribed drugs and the number of pDDIs. The study provides insight into medication safety among diabetics under the government's chronic disease management program. This study suggests developing a digital system for improving patient medication safety. Moreover, this study provides valuable data that will contribute to developing digital systems, especially for diabetics, a vulnerable group of patients due to the increased risk of complications, comorbidities, and the use of complex medications.

However, since this study was cross-sectional, the authors cannot infer a causal relationship among the factors of pDDIs. Secondly, the PDDIs in this study were determined by evaluating the medical prescriptions of ambulatory patients. Thus, the authors cannot assess their actual clinical impact, indicating that further research is needed in this area.

CONCLUSIONS

Potential drug-drug interactions (pDDIs) in patients with type 2 diabetes mellitus and cardiovascular diseases are common, with a prevalence of approximately 78.4% in polypharmacy prescriptions. The most prevalent pDDIs involve drug pairs like glimepiride - metformin, glimepiride - bisoprolol, and metformin - ramipril, which can increase the risk of hypoglycemia. Most diabetes patients were exposed to potential drug-drug interactions (pDDIs), with the number of drugs per prescription being its predictor. Most pDDIs identified were of moderate severity, involving the combination of glimepiride-metformin, glimepiride-bisoprolol, and metformin-ramipril, and most drug pairs interactions led to an increased risk of hypoglycemia. Given the complexity and risks associated with these interactions, the study suggests the development of a digital system for healthcare professionals to enhance medication safety by providing databases on interactions severity, clinical recommendations, and facilitating collaboration between healthcare providers. This digital system could assist in detecting and preventing pDDIs, ultimately improving patient outcomes and reducing the risks associated with polypharmacy prescriptions. To obtain a comprehensive understanding, further research should compare the potential and actual drug-drug interactions among the medication therapy of diabetes patients.

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تعدد الأدوية لدى مرضى السكري من النوع الثاني المشاركين في برنامج برولانيس في إندونيسيا: تحديد التفاعلات الدوائية المحتملة

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ملخص

يصبح تحديد التفاعلات الدوائية المحتملة أمرًا بالغ الأهمية في تقييم سلامة الأدوية بين مرضى السكري. هدفت هذه الدراسة إلى تحديد التفاعلات الدوائية المحتملة للتعدد الدوائي لدى مرضى السكري من النوع 2 (T2D) في برنامج إدارة الأمراض المزمنة أو برنامج إدارة مرض السكري المزمن .(PROLANIS) تم اختيار مرضى السكري من النوع 2 الذين تبلغ أعمارهم 18 عامًا أو أكثر على التوالي. تم تضمين عينة إجمالية من الوصفات الطبية التي تحتوي على 5 أدوية أو أكثر. كان متوسط عمر المرضى 62.70 ± 9.85 عامًا (المدى 24–92 عامًا)، وكان 62٪ منهم من كبار السن، و56.8٪ منهم من الإناث. كانت الوصفات الطبية للتعدد الدوائي أكثر انتشارًا في قسم الطب الباطني (92.8٪). من بين 250 وصفة طبية، احتوت حوالي 78.4٪ على تفاعل دوائي واحد على الأقل. تم تحديد ما مجموعه 515 تفاعل دوائي، بمتوسط تفاعلين دوائيين لكل مريض. ومن بين هذه الحالات، كانت 89.7% منها متوسطة الشدة. وكانت أزواج الأدوية المشاركة في pDDIs متوسطة الشدة هي جليمبيريد–ميتفورمين، جليمبيريد–بيسوبرولول، وميتفورمين–راميبريل. ويُعد عدد الأدوية لكل وصفة طبية مؤشرًا مهمًا لـ (aOR = 7.48 pDDIs؛ 95% .(CI = 1.73-32.32وكشف التحليل اللاحق أن الوصفات الطبية التي تحتوي على ثمانية أدوية أو أكثر كانت أكثر عرضة بنسبة 4.31 مرة لوجود أكثر من خمسة pDDIs (p = 0.010). يجب أن يلعب الصيادلة دورًا محوريًا في إدارة أدوية الأمراض المزمنة لتقليل مخاطر تفاعل الأدوية. تقترح هذه الدراسة تطوير نظام رقمي لمهنيي الرعاية الصحية لتحسين سلامة أدوية المرضى.

الكلمات الدالة: التفاعلات الدوائية؛ تعدد الأدوية؛ برولانيس؛ مرض السكري من النوع الثاني.

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