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Predicted but Powerless: Rethinking Clinical Predictors Against Patient-reported Recovery in Hospitalized Type 2 Diabetes

Murni Mursyid
Hasanuddin University
Yulia Yusrini
Hasanuddin University
Akhmad Ardiansyah
Universitas Sembilanbelas November Kolaka
Muhammad Rifqo
Universitas Gadjah Mada
Bustanul Arifin
b.arifin@umcg.nl

University of Groningen

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Abstract

Purpose: health-related quality of life (HRQoL) data for Indonesian patients with type 2 diabetes mellitus (T2DM) have only been collected from outpatients. This study examined HRQoL changes in hospitalized T2DM patients from admission to discharge. It also investigated whether the initial severity, rather than clinical or treatment factors, accounts for the observed improvement.

Methods: a prospective cohort of 139 T2DM inpatients (from 140 enrolled; one death excluded) was assessed using EQ-5D-5L and EQ VAS at baseline and discharge in two Indonesian hospitals using the Indonesian value set. Multivariable regression modeled change in utility (Δutility), with baseline utility, age, sex, antidiabetic regimen, length of stay, and potential drug-drug interaction (pDDI) severity, screened using the Medscape Drug Interaction Checker.

Results: the median utility increased from 0.716 (baseline) to 0.914 (discharge). Baseline utility was the only significant predictor of Δutility (β=−0.601, 95% CI −0.847 to −0.355, p<0.001), whereas the regimen, length of stay, and pDDI severity were not. Pain/discomfort remained the most persistent problem at discharge (72.7%), showing the smallest relative improvement among all the dimensions. Length of stay was independently predicted by polypharmacy, not severity; however, polypharmacy was unrelated to Δutility. Among the 49 documented pDDIs, 53.1% showed no clinical relevance.

Conclusion: apparent HRQoL recovery during hospitalization reflects a ceiling effect associated with admission severity rather than treatment characteristics. Persistent pain and unreliable pDDI outcome concordance suggest that discharge criteria centered on glycemic control may overlook patient-reported burden. This study provides the first Indonesian inpatient EQ-5D-5L utility values for pharmacoeconomic evaluation.

Highlights

- First Indonesian inpatient EQ-5D-5L utility values were generated for hospitalized patients with type 2 diabetes mellitus.

- Utility and EQ VAS scores improved from admission to discharge, although pain/discomfort persisted in nearly three-quarters of patients.

- Baseline utility, rather than clinical or treatment-related factors, explained the magnitude of HRQoL improvement, highlighting a ceiling effect in composite utility recovery.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic disease with a growing global burden. The Global Burden of Disease Study 2010 reported increasing age-standardized death rates for diabetes mellitus, while earlier World Health Organization projections estimated that diabetes would become the seventh leading cause of death by 2030 [1]. Southeast Asia has experienced some of the sharpest deterioration in this trend;

over the past three decades, the prevalence, mortality, and disability-adjusted life years (DALYs) attributable to T2DM in the region have risen steadily, with Indonesia among the countries showing the fastest increase [2]. At the primary care level alone, an estimated 10.3% of Indonesian adults live with T2DM [3], and national registry data show that 69% of patients have HbA1c levels above the recommended target [4], indicating that glycemic control remains poor for the majority of Indonesian patients. The downstream consequences are visible at the hospital level: an analysis of national health insurance (*BPJS Kesehatan*) claims among more than 610,000 inpatients found an in-hospital mortality rate of 6.6%, with older age, multiple comorbidities, and severe complications increasing the risk of death by more than tenfold [5].

This burden extends well beyond mortality. Chronic complications such as neuropathy, nephropathy, cardiovascular disease, and diabetic ulcers substantially impair patients' physical and psychological functioning, ultimately reducing their health-related quality of life (HRQoL) [6]. A systematic review and meta-analysis of South Asian populations found that patients with T2DM complications scored markedly lower on HRQoL than those without complications (utility 0.58 versus 0.816) [7], a striking gap for a single disease. Kuo and colleagues observed a similar pattern when valuing health states across a nationally representative T2DM population [8], and this finding recurs consistently across settings: studies in Bangladesh [9], Nepal [10], and Dhaka [11] all report that older age, poor glycemic control, longer disease duration, lower education, and insulin use are each independently associated with lower HRQoL.

However, most of this evidence, including a large study conducted in Ningbo, China [12], comes from outpatients. Hospitalized patients are clinically different from outpatients; they present with acute decompensation requiring immediate intervention, not routine chronic disease follow-up. This distinction is reflected in the numbers themselves; a Chinese study specifically examining patients hospitalized for T2DM-related complications reported a mean utility of only 0.562 [13], which is substantially lower than the typical outpatient figures. In Indonesia, virtually all existing T2DM HRQoL evidence is outpatient-based: a national study of 907 patients reported an EQ-5D index of 0.77, with pain/discomfort as the most frequently reported problem (61% of patients) [14]; a smaller study of 86 outpatients in West Kalimantan reported an index of 0.75 [15]. This pattern is not incidental; a systematic review of 25 Indonesian T2DM quality-of-life studies published between 2012 and 2022, spanning 17 of Indonesia's 33 provinces, found that none focused on hospitalized patients [16]. The same gap appears for other chronic conditions in Indonesia, including hypertension [17] and mixed acute/chronic outpatient conditions [18], all of which have been assessed only in outpatient settings.

The instrument most widely used to measure HRQoL in T2DM populations internationally is the EQ-5D-5L, chosen for its demonstrated validity and reliability across diverse populations [19–21] and its sensitivity in distinguishing health status by complication burden, disease severity, age, and glycemic control [10, 20]. The instrument evaluates five health dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, which are combined into a single utility index [22]. To ensure that this index reflects the preferences of the Indonesian population rather than those of another country,

Purba et al. developed and validated an Indonesia-specific EQ-5D-5L value set in 2017 [22], which has since become the standard instrument for HRQoL research in Indonesia, including the outpatient studies cited above.

Beyond this evidence gap, a conceptual gap remains. Inpatient studies on other conditions typically report that HRQoL improves from admission to discharge, a clinically predictable finding that offers limited insight. The more consequential question, rarely addressed explicitly, is what actually drives that improvement: does it genuinely reflect the effectiveness of treatment and clinical risk management, or is it simply a mathematical consequence of how the instrument is scored. Because EQ-5D-5L has a fixed upper bound (utility of 1.0), patients admitted in poor health inherently have more "room to improve" than those who were already relatively well, a measurement phenomenon known as the ceiling effect, which is well documented across EQ-5D-5L studies worldwide, with regional patterns that differ between Asian and European populations [23]. Without separating this effect from the influence of treatment and other clinical factors, claims that a given regimen or intervention "improves HRQoL" risk mistaking a measurement artifact for a genuine clinical effect. Building on this evidentiary and conceptual gap, the present study aimed to evaluate the HRQoL trajectory of hospitalized T2DM patients in Indonesia using the EQ-5D-5L at two time points, admission and discharge, comparing this trajectory at both the composite utility level and across the instrument's five individual health dimensions against outpatient-based evidence, which has, until now, constituted the only available reference for HRQoL in Indonesian T2DM patients.

METHODS

Study Design and Setting

This prospective observational cohort study measured within-patient changes in health-related quality of life (HRQoL) from hospital admission to discharge. Participants were assessed at baseline, after transfer from the Emergency Department to the inpatient ward once clinically stable, and again shortly before discharge. The study ran from November 2025 to January 2026 at two secondary-level hospitals in Palopo City, South Sulawesi, Indonesia: one privately owned Type C hospital and one government-owned Type C hospital.

Ethical Considerations

The Research Ethics Committee of Pharmacy and Health, Faculty of Pharmacy, Hasanuddin University, Makassar, approved the study (No. 4251/UN4.1.23/KP.06.05/2025; approved 2 December 2025). Participants received information on the study's purpose, procedures, benefits, risks, data confidentiality, and their right to decline or withdraw without penalty. Written informed consent was obtained prior to data collection.

Participants

Patients hospitalized with T2DM at RSU Sitti Madyang and RSUD Palemmai Tandi were consecutively recruited during the study period after clearance from the attending physician. Written informed consent was obtained from each participant or, where applicable, an authorized accompanying family member. Of the 140 patients who completed the baseline assessment, one died during hospitalization before the discharge assessment and was excluded from the paired analysis, leaving a final analytic sample of 139 patients (99.3% retention). No participant withdrew their consent or was discharged against medical advice. Consecutive enrollment over a predefined period meant that no formal a priori sample size calculation was performed.

Instruments

HRQoL was assessed using the Indonesian version of the EQ-5D-5L and the EQ Visual Analog Scale (EQ VAS), administered in a paper-and-pencil format under license from the EuroQol Research Foundation (registration no. 84379) [24]. The EQ-5D-5L descriptive system covers five dimensions — mobility, self-care, usual activities, pain/discomfort, and anxiety/depression — each rated on five levels from no problems to extreme problems. The five-digit health-state profile was converted to a single utility index using the Indonesian EQ-5D-5L value set, specifically the hybrid model reported by Purba et al. [22], which combines composite time trade-off and discrete choice experiment data. The EQ VAS is a vertical 0–100 scale ranging from the worst to the best imaginable health, reflecting the patients' overall self-rated health.

Both instruments were administered at baseline and discharge and self-administered whenever possible. For participants with limited literacy, physical weakness, or visual impairment, the items were read aloud without suggesting or influencing responses.

Antidiabetic therapy was categorized by in-hospital regimen as oral antidiabetic drug (OAD) monotherapy, insulin, or combination therapy. Potential drug–drug interactions (pDDIs) were identified using the Medscape Drug Interaction Checker [25], which classifies interactions as none, minor, moderate or serious. The highest interaction severity identified during hospitalization was used as the primary pDDI severity measure for each patient. Data verification revealed four patients whose recorded severity classification did not match the highest interaction category present in their raw interaction counts. Severity was recomputed for all patients as the highest category, and this corrected classification was used throughout the study.

Data Collection Procedure

We have already confirmed each patient's clinical suitability for participation, which required coordination with the attending physician, resident or internist, and ward nursing staff at every assessment. Sociodemographic characteristics were self-reported at baseline. Clinical information such as duration of T2DM, reason for admission, pre-admission and in-hospital antidiabetic therapy, diabetes-

related complications, comorbidities, relevant laboratory results, length of stay, and discharge status were extracted from medical records, with details confirmed by the attending physician or ward nurse when necessary. Medication adherence and herbal medicine use were recorded based on patient or caregiver reports, along with the number of non-antidiabetic medications prescribed during hospitalization to characterize the medication burden. Completed questionnaires were checked for completeness immediately after collection, and data were coded by participant identification number, with personal identifiers excluded from the analytic dataset.

Outcome Measures

The primary outcome was the change in EQ-5D-5L utility between admission and discharge (Δutility): discharge utility minus baseline utility. The secondary outcomes were the proportion of patients reporting problems (level ≥2) in each of the five EQ-5D-5L dimensions at baseline and discharge and the change in EQ VAS score between baseline and discharge.

Statistical Analysis

Participant characteristics were summarized using means with standard deviations or medians with interquartile ranges for continuous variables, and frequencies with percentages for categorical variables.

Both Δutility and ΔVAS departed substantially from normality (Shapiro-Wilk $p<0.001$ for each); therefore, baseline and discharge values were compared using the Wilcoxon signed-rank test. Changes in the proportion of patients reporting problems (level ≥2) within each EQ-5D-5L dimension were assessed using McNemar's test.

To identify factors associated with the magnitude of HRQoL change, a multivariable linear regression was fitted with Δutility as the dependent variable and baseline utility index entered as a covariate to account for the ceiling effect inherent in a bounded outcome measure. Candidate explanatory variables — age, sex, BMI, antidiabetic regimen, length of stay, herbal medicine use, DM-related complications, lifestyle risk factors (current smoking and/or absence of regular physical activity), pDDI severity, and number of non-antidiabetic medications — were chosen for clinical relevance and prespecified study objectives. A secondary multivariable model examined the length of stay as the dependent variable, given its emergence as a clinically meaningful finding during the analysis.

Model diagnostics guided the analysis at every step. The variance inflation factors remained below 2 for all predictors, ruling out meaningful collinearity. The primary model's residuals departed from normality (Shapiro-Wilk $p<0.001$) and showed heteroscedasticity (Breusch-Pagan $p<0.001$) upon initial inspection. Influence diagnostics (Cook's distance, studentized residuals) pointed to one observation with disproportionate weight, an elderly patient with severe pre-existing disability whose EQ-5D-5L profile changed little despite modest clinical improvement. A clinical review supported this as a genuine severe case rather than a data error; therefore, the observation remained in the analysis, and both regression models were reported with heteroscedasticity-robust (HC3) standard errors.

The Δ utility was compared between subgroups using the Mann-Whitney U test for two groups or the Kruskal-Wallis test for three or more groups. Effect estimates were reported with 95% confidence intervals; all statistical tests were two-sided, with $p<0.05$ considered statistically significant. Analyses were performed using Python (Pandas, SciPy, Statsmodels).

RESULTS

Cohort Characteristics and EQ-5D-5L Utility Index

A total of 140 patients with T2DM were enrolled consecutively during the study period. One patient died during hospitalization before the discharge assessment could be completed and was excluded from the paired analysis, yielding a final analytical sample of 139 patients (99.3% retention). Tables 1a and 1b summarize the sociodemographic and clinical characteristics of the cohort, alongside the EQ-5D-5L utility index at baseline and discharge, including the within-patient change in utility (Δutility) across participant subgroups. Utility indices were derived using the Indonesian EQ-5D-5L value set [22].

Table 1a. Sociodemographic characteristics with EQ-5D-5L utility index at baseline and discharge (N=139)

Characteristic	n (%)	Baseline utility Median (IQR)	Discharge utility Median (IQR)	Δutility Median (IQR)	p*
Total cohort	139 (100)	0.716 (0.525–0.835)	0.914 (0.824–0.914)	0.165 (0.079–0.305)	
Age group, years					
<45	23 (16.5)	0.716 (0.498–0.835)	0.914 (0.873–1.000)	0.169 (0.086–0.291)	0.666
45–59	66 (47.5)	0.770 (0.542–0.835)	0.914 (0.914–0.914)	0.090 (0.079–0.317)	
≥60	50 (36.0)	0.635 (0.525–0.824)	0.914 (0.795–0.914)	0.165 (0.079–0.264)	
Sex					
Men	46 (33.1)	0.626 (0.526–0.824)	0.914 (0.795–0.914)	0.178 (0.079–0.297)	0.584
Women	93 (66.9)	0.745 (0.525–0.835)	0.914 (0.910–0.914)	0.119 (0.079–0.310)	
BMI (Indonesian MoH categories)					
Underweight (<18.5)	13 (9.4)	0.525 (0.356–0.632)	0.914 (0.745–0.914)	0.264 (0.165–0.368)	0.268
Normal (18.5–22.9)	49 (35.3)	0.716 (0.595–0.824)	0.914 (0.824–0.914)	0.169 (0.079–0.319)	
Overweight (23–24.9)	39 (28.1)	0.824 (0.563–0.835)	0.914 (0.914–0.921)	0.090 (0.079–0.302)	
Obesity (≥25)	38 (27.3)	0.810 (0.525–0.894)	0.914 (0.855–0.914)	0.158 (0.081–0.203)	
Occupation					
Active employment	55 (39.6)	0.626 (0.525–0.835)	0.914 (0.795–0.914)	0.169 (0.079–0.305)	0.819

Table 1a. Sociodemographic characteristics with EQ-5D-5L utility index at baseline and discharge (N=139)

Characteristic	n (%)	Baseline utility Median (IQR)	Discharge utility Median (IQR)	Δutility Median (IQR)	p*
Housewife	79 (56.8)	0.795 (0.525–0.835)	0.914 (0.914–0.921)	0.090 (0.079–0.315)	
Retired	5 (3.6)	0.644 (0.604–0.716)	0.835 (0.705–0.921)	0.191 (0.141–0.205)	
Education level					
Up to senior high school	114 (82.0)	0.740 (0.525–0.835)	0.914 (0.832–0.914)	0.110 (0.079–0.310)	0.405
University degree	25 (18.0)	0.626 (0.525–0.835)	0.914 (0.809–0.921)	0.198 (0.086–0.293)	
Lifestyle risk factor					
No risk factor	61 (43.9)	0.824 (0.632–0.835)	0.914 (0.914–0.921)	0.090 (0.079–0.205)	0.029*
At least one risk factor	78 (56.1)	0.604 (0.478–0.824)	0.914 (0.795–0.914)	0.198 (0.086–0.384)	

Lifestyle risk factor defined as current smoking and/or absence of regular physical activity (alcohol consumption was not observed in this cohort). IQR, interquartile range. *p<0.05 (Mann-Whitney U / Kruskal-Wallis test on Δutility).

Table 1b. Clinical characteristics with EQ-5D-5L utility index at baseline and discharge (N=139)					
Characteristic	**n (%)**	**Baseline utility Median (IQR)**	**Discharge utility Median (IQR)**	**Δutility Median (IQR)**	**p***
Antidiabetic regimen					
OAD monotherapy	72 (51.8)	0.726 (0.516–0.835)	0.914 (0.834–0.921)	0.153 (0.086–0.284)	0.595
Insulin	56 (40.3)	0.638 (0.525–0.835)	0.914 (0.808–0.914)	0.165 (0.079–0.312)	
OAD + Insulin combination	11 (7.9)	0.734 (0.595–0.869)	0.914 (0.869–0.914)	0.090 (0.005–0.242)	
Medication adherence					
Non-adherent	56 (40.3)	0.644 (0.529–0.835)	0.914 (0.808–1.000)	0.165 (0.079–0.349)	0.631
Adherent	83 (59.7)	0.734 (0.525–0.835)	0.914 (0.835–0.914)	0.141 (0.079–0.272)	
Herbal medicine use					
No herbal use	112 (80.6)	0.716 (0.525–0.835)	0.914 (0.812–0.914)	0.146 (0.079–0.291)	
Uses herbal medicine	27 (19.4)	0.745 (0.525–0.835)	0.914 (0.875–0.917)	0.169 (0.086–0.327)	0.311
DM-related complication					
No complication	21 (15.1)	0.835 (0.716–0.914)	0.914 (0.914–0.914)	0.079 (0.079–0.198)	0.014*
At least one complication	118 (84.9)	0.644 (0.525–0.832)	0.914 (0.824–0.921)	0.167 (0.086–0.310)	
pDDI severity					
No interaction	26 (18.7)	0.716 (0.531–0.835)	0.914 (0.815–1.000)	0.165 (0.086–0.343)	0.533

Table 1b. Clinical characteristics with EQ-5D-5L utility index at baseline and discharge (N=139)

Characteristic	n (%)	Baseline utility Median (IQR)	Discharge utility Median (IQR)	Δutility Median (IQR)	p*
Minor	16 (11.5)	0.810 (0.497–0.914)	0.914 (0.795–0.921)	0.088 (0.079–0.260)	
Moderate	62 (44.6)	0.725 (0.555–0.835)	0.914 (0.835–0.914)	0.130 (0.079–0.307)	
Serious	35 (25.2)	0.632 (0.523–0.824)	0.914 (0.824–0.914)	0.180 (0.087–0.319)	

IQR, interquartile range; OAD, oral antidiabetic drug; pDDI, potential drug–drug interaction. pDDI severity classification corrected from source data (4 patients' recorded severity did not match their highest recorded interaction category; recomputed as the highest category present per Medscape Drug Interaction Checker output). *p<0.05 (Mann-Whitney U / Kruskal-Wallis test on Δutility).

The median EQ-5D-5L utility index rose from 0.716 (IQR 0.525–0.835) at baseline to 0.914 (IQR 0.824–0.914) at discharge, with a median Δutility of 0.165 (IQR 0.079–0.305). Every patient who changed moved in the same direction; none showed a decline in either utility or EQ VAS score between admission and discharge (Wilcoxon signed-rank test, p<0.001 for both). The EQ VAS score increased in parallel, from a median of 50 (IQR 50–55) at baseline to 85 (IQR 80–90) at discharge.

In univariate subgroup analyses, two characteristics were significantly associated with Δutility: the presence of at least one lifestyle risk factor (smoking and/or physical inactivity; p=0.029) and the presence of at least one diabetes-related complication (p=0.014). No other sociodemographic or clinical characteristics (age, sex, BMI, occupation, education, antidiabetic regimen, medication adherence, herbal medicine use, or pDDI severity) reached significance (Tables 1a and 1b). These univariate comparisons did not account for differences in baseline HRQoL, which strongly influenced the magnitude of the observed change. Therefore, multivariable linear regression was performed to test whether these associations were maintained after adjusting for baseline utility and other prespecified covariates (Table 2). A secondary multivariable model examined the length of stay as the dependent variable, given its emergence as a clinically meaningful secondary finding.

Table 2. Multivariable regression models for Δutility and length of stay (N=139)			
Variable	**B (coef.)**	**95% CI**	**p**
Panel A. Predictors of Δutility			
Baseline utility index	−0.601	−0.847, −0.355	<0.001*
Age, years	−0.004	−0.009, 0.001	0.081
Sex (Women vs. Men)	0.010	−0.054, 0.074	0.769
Body mass index	−0.004	−0.010, 0.002	0.159
Insulin (vs. OAD monotherapy)	0.005	−0.038, 0.047	0.821
OAD + Insulin combination (vs. OAD)	−0.011	−0.092, 0.071	0.799
Length of stay, days	<0.001	−0.013, 0.012	0.980
Herbal medicine use	0.036	−0.006, 0.078	0.091
DM-related complication (yes vs. no)	0.047	−0.001, 0.095	0.054
Lifestyle risk factor	−0.006	−0.044, 0.032	0.751
pDDI: No interaction (ref: Minor)	0.060	−0.023, 0.143	0.157
pDDI: Moderate (ref: Minor)	0.025	−0.041, 0.091	0.456
pDDI: Serious (ref: Minor)	0.046	−0.025, 0.117	0.205
No. of non-antidiabetic medications	0.001	−0.004, 0.006	0.785
Panel B. Predictors of length of stay, days			
Age, years	0.025	0.002, 0.047	0.033*
Baseline utility index	0.186	−0.773, 1.146	0.704
No. of non-antidiabetic medications	0.217	0.134, 0.300	<0.001*
pDDI: No interaction (ref: Minor)	−0.240	−1.231, 0.751	0.636
pDDI: Moderate (ref: Minor)	−0.752	−1.652, 0.149	0.102
pDDI: Serious (ref: Minor)	−0.590	−1.723, 0.543	0.307
Models were estimated using ordinary least squares with heteroskedasticity-robust (HC3) standard errors. *p<0.05.			

Determinants of HRQoL Recovery: The Ceiling Effect

Table 2 (Panel A) shows the baseline utility index as the single strongest predictor of Δutility (B=−0.601, 95% CI −0.847 to −0.355, p<0.001), estimated with heteroskedasticity-robust (HC3) standard errors.

None of the clinical or therapeutic covariates, including antidiabetic regimen, length of stay, herbal medicine use, DM-related complications, lifestyle risk factors, or pDDI severity, reached statistical significance once baseline utility was included. Figure 1 illustrates this relationship: patients admitted with more severely impaired HRQoL consistently showed larger absolute gains by discharge (Spearman $\rho=-0.79$, $p<0.001$), and this pattern held regardless of antidiabetic regimen (OAD, insulin, or combination therapy), indicating that the ceiling effect, rather than treatment type, drove the magnitude of Δutility in this cohort.

Table 2 (Panel B) shows the length of stay associated with age (B=0.025, 95% CI 0.002–0.047, p=0.033) and the number of non-antidiabetic medications (B=0.217, 95% CI 0.134–0.300, p<0.001), independent of baseline utility and pDDI severity.

Dimension-Specific Recovery and the Limits of Predicted Clinical Risk

Although the composite utility index improved markedly, the recovery was not uniform across the five EQ-5D-5L dimensions (Figure 2a). Pain/discomfort was reported by 96.4% of patients at baseline and remained present in 72.7% of patients at discharge, which was the highest residual burden of any dimension. All five dimensions improved significantly from baseline to discharge (McNemar's test, $p<0.001$ for each), but the proportional reduction in pain/discomfort was the smallest of the five, leaving nearly three-quarters of patients discharged with persistent pain despite meeting the clinical criteria for discharge — a gap that the composite utility score alone does not capture.

A parallel pattern of predicted but unrealized risk emerged for potential drug interactions. Despite a graded, theoretically plausible severity classification (no interaction to serious, per the Medscape Drug Interaction Checker), Δutility showed no meaningful separation across pDDI severity categories (Figure 2b; Kruskal-Wallis p=0.53), consistent with the non-significant pDDI coefficients in the adjusted model (Table 2, Panel A). The predicted pharmacological risk in this cohort did not translate into detectable differences in patient-reported recovery.

DISCUSSION

As shown in Table 2 (Panel A), the baseline utility index was the single strongest predictor of Δutility ($\beta=-0.601$, 95% CI −0.847 to −0.355, $p<0.001$), whereas none of the clinical or therapeutic covariates reached significance. To our knowledge, this study offers the first EQ-5D-5L evidence on HRQoL trajectories among hospitalized T2DM patients in Indonesia, addressing a gap noted in the existing literature, which has been consistently outpatient-based [14–16]. The median utility increased from 0.716 at the baseline to 0.914 at the discharge. The baseline value is directionally consistent with, though somewhat lower than, the outpatient benchmark of 0.77 reported among 907 Indonesian T2DM outpatients [14], reflecting the more acute state of patients upon their admission. This aligns with international data: Gu et al. reported a considerably lower mean utility (0.562) among Chinese inpatients hospitalized specifically for diabetes complications [13], a narrower and more severe case mix than our broader inpatient population. However, the discharge utility closely approximates the Indonesian general

population norm of 0.91 [26] and even exceeds outpatient benchmarks for T2DM (0.77) [14], hypertension (0.83) [17], and mixed outpatient conditions (median 1.00) [18]. This is not contradictory: discharge functions as a built-in selection filter, since patients are only discharged once acute decompensation has resolved, whereas outpatient cohorts continue to carry the cumulative burden of chronic illness between visits. Consistent with this, pain/discomfort remained the most persistent problem at discharge (72.7%), mirroring its dominance as the leading problem dimension across Indonesian outpatient studies, regardless of diagnosis [14, 17, 18]. This suggests that pain is a cross-cutting, under-addressed burden that transcends both care settings and diseases.

Beyond its clinical findings, this study contributes directly to reusable evidence for pharmacoeconomic research in the field. EQ-5D-5L utility indices are the standard input for calculating quality-adjusted life years (QALYs), which is the metric underpinning cost-utility analyses used by health technology assessment (HTA) bodies to evaluate intervention value. International guidance recommends population- and context-specific utility values rather than transferring values across settings, a concern that the Indonesian EQ-5D-5L value set was developed to address [22]. To date, Indonesian T2DM utility evidence has existed only for outpatients [14]; this study provides the first inpatient-specific values, at both admission and discharge, directly usable in future cost-utility analyses of inpatient diabetes management without relying on outpatient or internationally transferred data. As Indonesia's national insurance scheme (JKN/BPJS Kesehatan) increasingly requires local cost-effectiveness evidence for coverage decisions, such utility inputs support locally grounded HTA rather than decisions based on extrapolated data alone.

Clinically, the persistence of pain in nearly three-quarters of patients at discharge readiness, despite marked composite improvement, suggests that current inpatient care is well-oriented toward glycemic stabilization but may under-prioritize pain as a discharge criterion. A structured pain screening step in discharge checklists, with referral pathways for post-discharge management, may be a low-cost intervention that is worth testing. The strengths of this study include its prospective repeated-measures design, validated Indonesian value set [22], and multivariable modeling that explicitly accounts for the ceiling effect. Limitations include a single-city, two-hospital, non-probability sample without a priori power calculation, limiting generalizability and power for small subgroups; medication adherence could not be meaningfully assessed given nurse-supervised in-hospital administration; and complications were classified as binary presence/absence rather than by macro-/microvascular subtypes. Future research should prioritize multi-site, adequately powered inpatient studies across Indonesia's regions, alongside post-discharge follow-ups, to determine whether discharge-level gains are sustained or regress toward outpatient baselines. For the Ministry of Health and BPJS Kesehatan, these findings support (i) treating pain management as an explicit, auditable component of diabetes discharge protocols and (ii) commissioning further inpatient utility data collection to reduce reliance on outpatient-derived or foreign utility estimates in the national HTA processes.

This ceiling effect was not unique to our cohort of patients. A meta-analysis of 94 studies across 4.5 million respondents in 37 countries found a pooled full-health response of 49% for EQ-5D-5L, with

East/South-East Asian populations showing higher ceiling effects than European populations [23], consistent with our discharge distribution clustering near the Indonesian population norms [26]. The same meta-analysis found that pain/discomfort had the lowest ceiling effect of all five dimensions globally (60% versus 94% for self-care) [23], independently corroborating our finding that pain was the dimension most resistant to resolution (**Figure 2A**) as a structural property of the instrument rather than a peculiarity of this cohort sample. A second independent finding reinforces this pattern: length of stay was most strongly predicted by polypharmacy (**Table 2, Panel B**), not by baseline severity; however, this same polypharmacy burden showed no association with Δutility. Therefore, two unrelated analytic routes converge on one conclusion: factors that should plausibly predict recovery and those that predict resource use fail to predict the outcome that matters most to patients.

The finding that pDDI severity was unrelated to Δutility is reinforced by a more granular source available in this cohort: clinician-documented concordance between the MDIC-predicted interaction severity and actual clinical manifestations. Among 49 documented interactions across 36 patients with serious potential interactions, clinical corroboration was absent in 26 (53.1%). This should not be interpreted as evidence that pDDI screening is unnecessary; several non-corroborated cases likely reflect successful mitigation, as attending physicians frequently discontinued or modified the flagged combinations within days. Rather, alongside the non-significant regression coefficients, this suggests that automated severity classifiers, such as the MDIC, are best used to prompt clinical judgment and monitoring, not as standalone predictors of patient-reported outcomes. Collectively, these findings converge on one narrative: factors most confidently expected to shape recovery treatment regimen, pDDI severity, and treatment-associated length of stay proved largely powerless once baseline severity was accounted for, while persistent pain, rarely foregrounded in routine inpatient care, remained the dominant unresolved burden at discharge. Discharge-readiness criteria organized primarily around glycemic control may, therefore, overlook the dimension of suffering that patients continue to report.

This study had several notable strengths. To our knowledge, it provides the first EQ-5D-5L evidence for hospitalized T2DM patients in Indonesia, addressing a gap confirmed by a systematic review of 25 prior Indonesian studies, all of which were outpatient-based [16]. Its prospective, repeated-measures design captures genuine within-patient changes rather than the cross-sectional snapshots that characterize most existing Indonesian HRQoL studies. Utility scores were derived using a validated Indonesian value set [22] rather than weights transferred from another population. Methodologically, this study goes further than most comparable studies by explicitly modeling and quantifying the ceiling effect through baseline-adjusted regression, a safeguard often absent from studies that attribute raw pre-post HRQoL gains directly to treatment effectiveness. The null finding for potential drug-drug interactions is similarly strengthened by triangulating two independent forms of evidence, the non-significant regression coefficients and clinician-documented concordance data, rather than resting on a single analytic approach. Consecutive, non-selective enrollment further reduced the selection bias common in convenience-sampled HRQoL studies. Collectively, these features allowed the study to generate Indonesia-specific inpatient utility values with direct, practical applicability for future pharmacoeconomic evaluations, a contribution not previously available in the national literature.

However, this study has several limitations should nonetheless be acknowledged. The sample was drawn from a single city and two hospitals rather than multiple sites, limiting the generalizability of the ceiling effect pattern and other findings to Indonesia's broader and more heterogeneous T2DM inpatient population. No a priori sample size calculation was performed, and the statistical power was consequently limited for some small subgroups, such as the combination therapy (n=11) group. Because outcomes were measured only up to discharge, the study could not determine whether the observed HRQoL gains were sustained or regressed toward outpatient baseline levels after patients returned home, a question that would require post-discharge follow-up. Certain variables were necessarily simplified: medication adherence could not be meaningfully evaluated given nurse-supervised in-hospital administration, and DM-related complications were classified as a binary presence/absence rather than by granular macro-/microvascular subtypes. Finally, as an observational, non-randomized design, the associations identified here, including the apparent absence of a treatment regimen effect, cannot be interpreted causally, and residual confounding by indication cannot be fully excluded despite statistical adjustment.

CONCLUSION

This study provides the first inpatient EQ-5D-5L evidence for hospitalized T2DM patients in Indonesia, showing that composite HRQoL gains from admission to discharge are predominantly explained by baseline severity rather than antidiabetic regimens, length of stay, or pDDI severity. Pain/discomfort remained disproportionately unresolved at discharge, and predicted drug–drug interactions frequently failed to correspond with actual clinical outcomes. Together, these findings caution against interpreting composite utility improvement as evidence of comprehensive recovery and support the incorporation of pain assessment into discharge planning, alongside continued clinical vigilance for pDDIs, regardless of their predicted severity. The inpatient utility values reported here also fill a longstanding gap in Indonesia-specific evidence available for pharmacoeconomic evaluations in Indonesia.

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

All authors contributed to the study conception and design. Material preparation and data collection were performed by Murni Mursyid, Yulia Yusrini, Akhmad Ardiansyah, and Muhammad Rifqo. Data

analysis and interpretation were performed by Murni Mursyid, Yulia Yusrini, Akhmad Ardiansyah, Muhammad Rifqo, and Bustanul Arifin. The first draft of the manuscript was written by Murni Mursyid, Yulia Yusrini, and Bustanul Arifin. All authors critically reviewed and commented on previous versions of the manuscript. Bustanul Arifin and Yulia Yusrini supervised the study. All authors read and approved the final manuscript.

Human ethics and consent to participate

This study was approved by the Research Ethics Committee of Pharmacy and Health, Faculty of Pharmacy, Universitas Hasanuddin, Makassar, Indonesia (No. 4251/UN4.1.23/KP.06.05/2025; approved on 2 December 2025). All participants were informed about the study purpose, procedures, potential benefits and risks, data confidentiality, and their right to decline participation or withdraw from the study at any time without penalty. Written informed consent was obtained from each participant prior to data collection. Where applicable, consent was obtained from an authorized accompanying family member.

Consent for publication

Not applicable. This manuscript does not contain any identifiable individual data, images, or case details.

Data availability

The datasets generated and analyzed during the current study are not publicly available due to patient confidentiality and ethical restrictions. De-identified data may be made available from the corresponding author upon reasonable request and with permission from the relevant ethics committee.

Use of generative artificial intelligence tools

Claude (Anthropic), a large language model-based artificial intelligence tool, was used to support cross-checking of utility index derivation, regression outputs, exploratory data visualization, numerical table consistency, and manuscript structure. Paperpal was used to support grammar and language refinement. All AI-assisted analytical, visual, and editorial outputs were independently reviewed, verified, and edited by the authors, who take full responsibility for the accuracy, integrity, and final content of the submitted manuscript.

References

1. Lozano R, Naghavi M, Foreman K, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet* 2012; 380: 2095–2128.
2. Nugrahani ASD, Muharram FR, Novida H, et al. Trends and disability-attributable risk factors of type 2 diabetes mellitus in Southeast Asia (1990–2019): An in-depth 30-year analysis from the Global

Burden of Disease study. *Nutrition, Metabolism and Cardiovascular Diseases* 2025; 35: 103750.

3. Sari DF, Sukirto NW, Arifin Z, et al. Characteristics of type 2 diabetes mellitus patients at Puskesmas Sanden: A cross sectional study. *BIO Web Conf* 2024; 148: 01017.
4. Rosandi R, Trianto HB, Zamri A, et al. Characteristics and Care Quality of Patients with Type 2 Diabetes in Indonesia: A Study of DISCOVER CaReMe Registry Program. *Acta Med Indones* 2025; 57: 321–331.
5. Darmawan ES, Permanasari VY, Nisrina LV, et al. Behind the Hospital Ward: In-Hospital Mortality of Type 2 Diabetes Mellitus Patients in Indonesia (Analysis of National Health Insurance Claim Sample Data). *Int J Environ Res Public Health* 2024; 21: 581.
6. Gebremariam GT, Biratu S, Alemayehu M, et al. Health-related quality of life of patients with type 2 diabetes mellitus at a tertiary care hospital in Ethiopia. *PLoS One* 2022; 17: e0264199.
7. Murugadoss H, K H, K S, et al. Health-related quality of life in South Asian adults with type 2 diabetes - a systematic review and meta-analysis. *Sci Rep* 2026; 16: 9888.
8. Kuo S, Yang C-T, Chen H-Y, et al. Valuing health states of people with type 2 diabetes: Analyses of the nationwide representative linked databases. *J Diabetes Investig* 2021; 12: 1749–1758.
9. Barua L, Faruque M, Chowdhury HA, et al. Health-related quality of life and its predictors among the type 2 diabetes population of Bangladesh: A nation-wide cross-sectional study. *J Diabetes Investig* 2021; 12: 277–285.
10. Karki A, Vandelanotte C, Alley S, et al. Health-related quality of life and associated factors in people with Type 2 diabetes mellitus in Nepal: Baseline findings from a cluster-randomized controlled trial. *J Health Psychol* 2026; 31: 3114–3131.
11. Namdeo MK, Verma S, Das Gupta R, et al. Depression and health-related quality of life of patients with type 2 diabetes attending tertiary level hospitals in Dhaka, Bangladesh. *Glob Health Res Policy* 2023; 8: 43.
12. Carter N, Li J, Xu M, et al. Health-related quality of life of people with type 2 diabetes and its associated factors at a tertiary care clinic in Ningbo, China: A cross-sectional study. *Endocrinol Diabetes Metab*; 5. Epub ahead of print 3 September 2022. DOI: 10.1002/edm2.353.
13. Gu S, Wang X, Shi L, et al. Health-related quality of life of type 2 diabetes patients hospitalized for a diabetes-related complication. *Quality of Life Research* 2020; 29: 2695–2704.
14. Arifin B, Idrus LR, van Asselt ADI, et al. Health-related quality of life in Indonesian type 2 diabetes mellitus outpatients measured with the Bahasa version of EQ-5D. *Quality of Life Research* 2019; 28: 1179–1190.
15. Perwitasari DA, Urbayatun S, Faridah IN, et al. Relationship of therapeutic outcome with quality of life on type 2 diabetes mellitus patients in Abdul Azis Singkawang hospital. *IOP Conf Ser Mater Sci Eng* 2017; 259: 012023.
16. Suniyadewi NW, Sufyanti Y, Kurniawati ND, et al. Quality of life on type 2 diabetes patients in Indonesia: systematic review. *J Pak Med Assoc* 2023; 73: S140–S147.

17. Arifin B, Wahyudin E, Setiawan I, et al. Health-related quality of life in Indonesian hypertension outpatients in Western, Central, and Eastern Indonesia measured with the Bahasa Indonesia version of EQ-5D-5L. *Discover Medicine* 2024; 1: 36.
18. Arifin B, Ardiansyah A, Salamah S, et al. Health-related quality of life of outpatients living with acute and chronic diseases in 3 government hospitals in Parigi Moutong District, Central Sulawesi, Indonesia. *Discover Medicine* 2024; 1: 35.
19. Wang Y, Tan N-C, Tay E-G, et al. Cross-cultural measurement equivalence of the 5-level EQ-5D (EQ-5D-5L) in patients with type 2 diabetes mellitus in Singapore. *Health Qual Life Outcomes* 2015; 13: 103.
20. Parik P, Patel V. Health-related quality of life of patients with type 2 diabetes mellitus at a tertiary care hospital in India using Eq 5D 5L. *Indian J Endocrinol Metab* 2019; 23: 407.
21. Bilbao-González A, González-Sáenz de Tejada M, Ferrer M, et al. Psychometric properties of the EQ-5D-5L in diabetes mellitus patients in Spain. *J Patient Rep Outcomes* 2025; 9: 60.
22. Purba FD, Hunfeld JAM, Iskandarsyah A, et al. The Indonesian EQ-5D-5L Value Set. *Pharmacoeconomics* 2017; 35: 1153–1165.
23. Cheng LJ, Pan T, Chen LA, et al. The Ceiling Effects of EQ-5D-3L and 5L in General Population Health Surveys: A Systematic Review and Meta-Analysis. *Value in Health* 2024; 27: 986–997.
24. EuroQol Research Foundation. *EQ-5D-5L User Guide*. Rotterdam, The Netherlands, https://euroqol-domain.ams3.digitaloceanspaces.com/wp-content/uploads/2025/01/12124516/EQ-5D-5L-Userguide-2025-04.pdf (August 2025, accessed 31 August 2026).
25. Medscape. Medscape Drug Interaction Checker. *WebMD LLC*, https://reference.medscape.com/drug-interactionchecker (accessed 31 August 2026).
26. Purba FD, Hunfeld JAM, Iskandarsyah A, et al. Quality of life of the Indonesian general population: Test-retest reliability and population norms of the EQ-5D-5L and WHOQOL-BREF. *PLoS One* 2018; 13: e0197098.

Figures

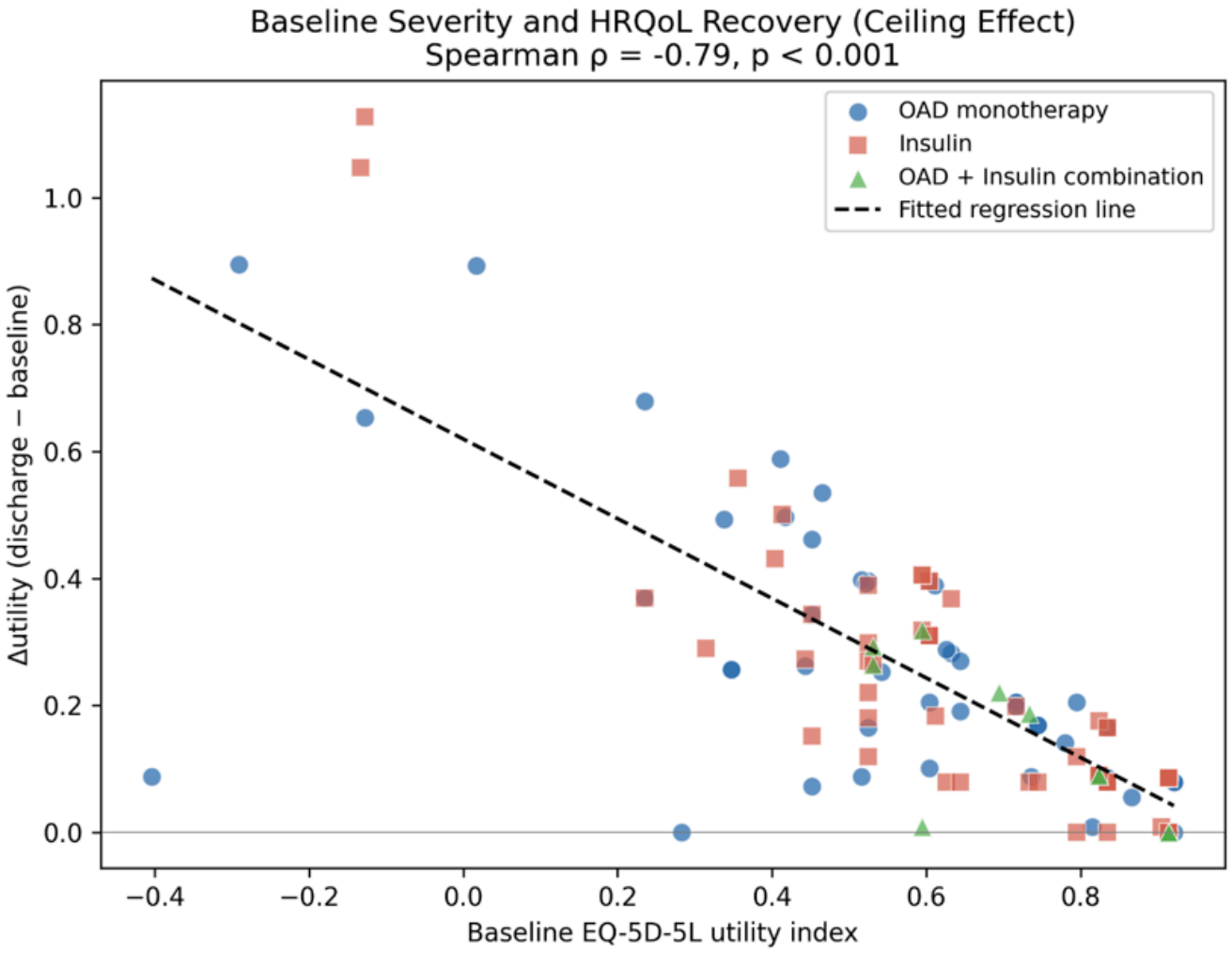


Figure 1

Baseline Severity and HRQoL Recovery (Ceiling Effect). Scatter plot of baseline EQ-5D-5L utility index against Δutility (discharge minus baseline), stratified by antidiabetic regimen (OAD monotherapy, insulin, and OAD + insulin combination). The dashed line shows the fitted regression from the univariate model (Δutility ~ baseline utility, HC3 robust standard errors). Patients with lower baseline utility showed larger gains at discharge, independent of treatment regimen (Spearman ρ=−0.79, p<0.001).

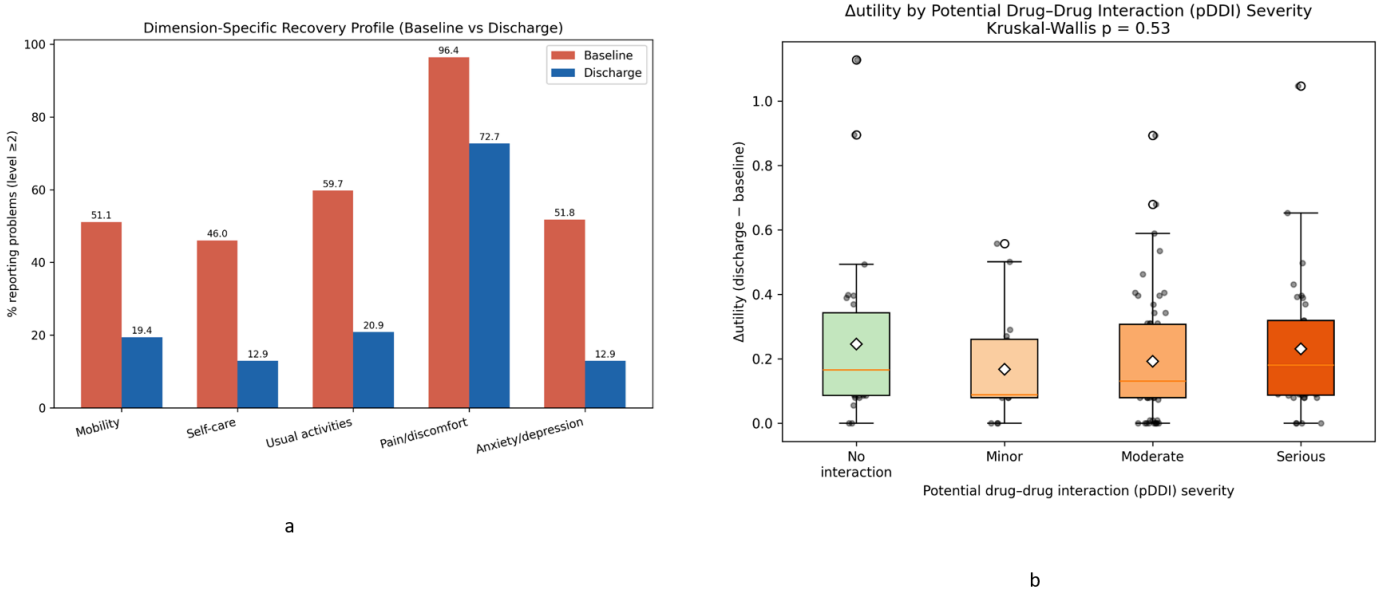


Figure 2

a. Dimension-Specific Recovery Profile (Baseline vs. Discharge). Percentage of patients reporting problems (level ≥2) on each EQ-5D-5L dimension at baseline (red) and at discharge (blue). All five dimensions showed significant improvement (McNemar's test, p<0.001 for each), although pain/discomfort remained the most prevalent problem at discharge.

b. Δutility by Potential Drug–Drug Interaction (pDDI) Severity. Boxplots of Δutility across the four pDDI severity categories (no interaction, minor, moderate, and serious), with individual patient values overlaid. No significant differences were observed across the categories (Kruskal-Wallis H=2.19, p=0.53).