

Beyond the pandemic declaration: Persistent daily health complaints in diabetic COVID-19 survivors and the protective effect of prior vaccination in Indonesian primary care

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Abstract

Background

Diabetes mellitus increases the risk of severe COVID-19 and persistent post-infection symptoms, yet evidence from low- and middle-income country (LMIC) primary care settings remains limited. We assessed the association of pre-infection COVID-19 vaccination with a reduced number of daily health complaints in COVID-19 survivors with diabetes in Indonesia.

Methods

This cross-sectional study was conducted in 45 community health centres (*Puskesmas*) in Yogyakarta Province, Indonesia, from March to August 2024. Eligible participants were adults (aged ≥ 15 years), diagnosed with diabetes mellitus and self-reported history of COVID-19 infection. Trained enumerators administered a structured 25-item checklist of daily health complaints (range 0–25) during face-to-face interviews. The checklist was grouped into three domains: sensory function/ pain, body system function, and activity participation. Vaccination status was verified by electronic records (*SatuSehat*) and physical cards. The count outcomes were modelled with negative binomial regression adjusted for sociodemographic and clinical variables. Missing data were handled using K-nearest neighbours' imputation ($k = 5$), yielding an analytic sample of 420 participants.

Results

Of 420 participants (median age 60 years, 70.2% female), 36.2% had prior vaccination before COVID-19 infection. The most prevalent complaints were joint/muscle pain (46.0%), visual impairment (43.1%), and fatigue (24.3%). In multivariable analysis, never-vaccinated individuals had a 45% higher rate of total health complaints than individuals vaccinated before infection (incidence rate ratio [IRR] = 1.45; 95% CI 1.10–1.91). Higher complaints rate was associated with female sex (IRR = 1.25; 95% CI 1.02–1.53), while secondary education (IRR = 0.66 for body system dysfunction) and absence of other comorbidities (IRR = 0.84 for sensory/pain complaints) were protective. Vaccination following infection was not significantly beneficial for the index infection (IRR = 1.06; 95% CI 0.90–1.26).

Conclusions

Pre-infection COVID-19 vaccination is associated with substantially fewer persistent daily health complaints in diabetic patients. Integrating vaccination promotions into routine chronic disease management at the primary care level in LMICs may reduce long-term morbidity. Future prospective studies with uninfected control groups are needed to confirm causality.

BACKGROUND

While most nations announced the end of the COVID-19 pandemic in early 2023, years after the start of the pandemic, the post-pandemic era has revealed an ongoing public health crisis: long COVID. The World Health Organization defines long COVID as symptoms that affect daily life that begin three months after infection and last for at least two months and that cannot be explained by other diagnoses [1]. Fatigue, musculoskeletal pain, cognitive impairment, and reduced quality of life are the most frequent persistent symptoms [2–4]. Post-acute COVID-19 is more than health complaints and impacts daily life. A German study found that 10–15% of severe cases experience life-threatening complications [5]. Chronic diseases like cardiovascular disorders, diabetes, etc. may also develop [6, 7]. The persistence of symptoms leads to reduced capacity for work and productivity of survivors [5] and post-acute COVID syndrome is strongly associated with reduced health-related quality of life [8, 9].

Risk factors for persistent health issues include older age [8, 10, 11], female sex [11–14], low economic status [12], living alone [10, 13], lower education [10, 13], high BMI, smoking [11, 12], severe acute symptoms [8, 14], depression [8], and comorbidities [8, 11, 12, 14]. Diabetes mellitus is an important predictor for persistent symptoms [15–17]. Meta-analyses show that the odds of long COVID are significantly higher in diabetic patients compared with non-diabetic populations. Hyperglycaemia predisposes to severe COVID-19 outcomes [18–20] and individuals with diabetes are prone to long-term sequelae [17]. Vaccination is effective against severe illness, but this may be reduced in those with obesity, Type 2 Diabetes Mellitus, and hypertension [21]. There is consistent evidence that poorer glycaemic control is associated with impaired immune response [22]. Timely primary care follow-up improves survival [23]. However,

the role of pre-infection vaccination in mitigating persistent daily health complaints rather than death is less studied, especially in low- and middle-income country contexts.

Despite well-documented vulnerability [15, 16, 24], evidence gaps remain for specific populations, especially for diabetic patients considering vaccination status. This gap is particularly important in Indonesia with the third highest diabetes burden in the world [20, 25] and unique health system factors. Its primary health centres (also known as *Pusat Kesehatan Masyarakat* or *Puskesmas*, in Bahasa) are the first line of care for majority of diabetic patients but often lack systematic protocols for post-COVID follow-up. Understanding risk factors for persistent symptoms in this setting is needed to inform resource allocation and clinical decision-making. Previous work, reviewed by Nalbandian et al. [26], has focused mostly on long COVID in hospitalised cohorts from high-income countries, but community-based data from LMICs, especially those quantifying the number rather than simply the presence of daily health complaints, are lacking.

Hence, this study aimed to assess the association of COVID-19 vaccination status and other risk factors with the number of daily health issues among diabetic COVID-19 survivors attending public primary care clinics in one Indonesian province. We hypothesised that pre-infection vaccination would be associated with fewer persistent complaints, after adjustment for potential confounders. Researching this metabolic cluster in primary care settings is very much in line with current global health priorities. As the acute phase of the pandemic recedes, LMIC healthcare systems are shifting from emergency mortality reduction to the management of a 'silent epidemic' of long-term functional impairments.

METHODS

Study design and study participants

This cross-sectional study was conducted from June to August 2024 in DI Yogyakarta Province, Indonesia. Eligible participants were adults (≥ 15 years) with diagnosed diabetes mellitus, self-reported history of COVID-19 infection, and willingness to provide written informed consent. Exclusion criteria were inability to complete the interview.

Study setting and data collection

The study was conducted in DI Yogyakarta Province, purposively selected due to its high diabetes prevalence (2.7%) [27] and strong COVID-19 management performance [28]. From the provincial health office registry, 45 *Puskesmas* with the highest documented caseload of diabetic patients were purposively selected. Eligible diabetic patients attending routine monthly chronic disease management sessions were recruited using convenience sampling. Trained enumerators conducted face-to-face interviews using a structured questionnaire. COVID-19 vaccination status was verified by cross-referencing self-reports with the *SatuSehat* application and vaccination cards where available.

Questionnaires and outcome measure

The structured questionnaire was developed in Indonesian and adapted from validated instruments used in previous post-COVID studies [3, 24, 29, 30]. It comprised five sections: (1) sociodemographic characteristics, (2) health behaviours (smoking, physical activity using the International Physical Activity Questionnaire [IPAQ] short form, categorized as low, moderate, or high [29]), (3) COVID-19 infection history (date of infection, symptoms, hospitalisation), (4) vaccination status (doses, dates, verified by official records where possible), and (5) a 25-item checklist of daily health complaints present at the time of interview. The 25 complaints were grouped a priori into three domains based on the WHO's International Classifications of Functioning, Disability and Health (ICF) framework: Sensory Function and Pain (9 items), Body System Function (10 items), and Activities and Participation (6 items). The total complaint score (range 0-25) was the primary outcome. Diabetes medication adherence was assessed using the 8-item Morisky Medication Adherence Scale (MMAS-8), categorized as low (<6), moderate (6-7), or high (8) adherence [30]. The questionnaire was pilot tested on 30 diabetic patients from non-participating *Puskesmas* to assess face validity and comprehensibility; no formal validation was conducted, which is acknowledged as a limitation.

Sample size

Sample size was calculated using a two-proportion formula for a cross-sectional study. Based on conservative assumption that 20% of unvaccinated diabetic patients would report persistent health issues and 10% of those vaccinated before infection would do so (odds

ratio 2.0), with 1:1 allocation ratio, $\alpha=0.05$ (two-sided), and power=80%, the required sample size was 346 participants. Anticipating 20% incomplete data or non-response, we targeted 415 participants. The final analysable sample was 420, exceeding this target.

Statistical analysis

All analyses were conducted in RStudio (version 2025.09.2+418). Descriptive statistics are presented as frequencies (percentage) for categorical variables and median (interquartile range) for continuous variables due to skewed distributions. Negative binomial regression was used to model the count outcomes because the variance-to-mean ratio exceeded 1 for all outcomes (overall: 10.1; sensory function and pain: 1.11; body system function: 2.02; activities: 1.10). A likelihood ratio test confirmed that negative binomial provided a better fit than Poisson ($p<0.05$ for all outcomes).

All variables listed in Table 1 and Table 2 were entered as predictors in the multivariable models (full model approach). Multicollinearity was assessed using variance inflation factors (VIF); all VIF values were <2.5 , indicating no significant collinearity.

Missing data were minimal ($<2\%$ overall, with no single variable exceeding 5% missingness). To maximise statistical power and reduce potential bias from listwise deletion, we performed multiple imputation using K-nearest Neighbours (KNN) imputations with $k=5$. The imputed dataset comprised all 420 participants who completed the interview. Negative binomial regression was then applied to the imputed dataset as the primary analysis. As a sensitivity analysis, we also performed complete case analysis ($n=412$, 98.1% of the sample). The results were nearly identical across both approaches (see Additional file 1), confirming the robustness of our findings.

Use of AI-assisted tools

During the preparation, the authors used QuillBot to improve grammar and sentence structure, and ChatGPT to assist in diagnosing and resolving data analysis errors. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Reporting guidelines

This study is reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies. The completed checklist is provided as Supplementary File.

Ethics approval

This study was approved by the Research and Community Engagement Ethical Committee of Faculty of Public Health Universitas Indonesia (Approval No: Ket-269/UN2.F10. D11/PPM.00.02/2024). All procedures were in accordance with the 1964 Helsinki declaration and its later amendments. Written informed consent was obtained from all participants, including permission to access their vaccination records from the SatuSehat application. All data were fully anonymized before analysis.

RESULTS

Participant characteristics

Of the 422 eligible diabetic patients identified, 420 (99.5%) completed the interview (Figure 1). Because missing data were minimal ($<2\%$ overall), we used KNN imputation to retain all 420 participants in the primary analysis. Complete case analysis ($n=412$) was conducted as a sensitivity check.

Table 1 summarizes participant characteristics. The median age was 60 years (IQR 53-65); and 70.2% were female. Most participants had primary or secondary education (80.9%), were married (77.1%), and were employed (53.6%). Nearly half (49.0%) were obese, and 41.4% reported high physical activity levels.

Figure 1. Flow diagram of participant selection. From 4,070 diabetic patients attending routine disease sessions across 45 *Puskesmas* in DI Yogyakarta Province, 422 were eligible after excluding those without confirmed COVID-19 infection or diabetes diagnosis. Two refused to complete the interview, yielding a final sample of 420 participants for the primary imputed analysis.

[Insert Figure 1 here]

Table 1. Demographic and clinical characteristics of diabetic patients after COVID-19 infection (n=420)

[Insert Table 1 here]

Regarding COVID-19, 91.2% had received at least one dose. However, at the time of infection, only 152 participants (36.2%) were vaccinated before infection; 268 (63.8%) were unvaccinated at infection (231 [55.0%] vaccinated after infection, 37 [8.8%] never vaccinated). Comorbidities other than diabetes were present in 67.6% (hypertension: 47.9%). Most infections were managed with self-care (79.8%); hospitalisation rate was 2.4%.

Health complaints

Patients reported a median of 3 post-COVID health issues (range: 0-20). By domain: sensory function and pain median 2 (0-7), body system 0 (0-8), activities impairment 1 (0-5). The most frequent complaints were joint/muscle pain (46.0%) and visual impairment (43.1%); fatigue (24.3%) and concentration problems (20.5%) were the leading functional impairments (Table 2).

Table 2. Daily health issues of diabetic patients after COVID-19 infection (n=420)

[Insert Table 2 here]

Factors associated with complaint count

Multivariable negative binomial regression (Table 3; Figure 2) showed that never-vaccinated individuals had a 45% higher rate of total complaints compared to those vaccinated before infection (IRR=1.45; 95% CI=1.10–1.91). Female sex was associated with higher rates of all health issues (IRR =1.25; 95% CI=1.02–1.53), sensory and pain-related symptoms (IRR=1.22; 95% CI=1.01–1.48), and activity limitations (IRR=1.37; 95% CI=1.02–1.86). Secondary education was associated with lower body system dysfunction (IRR=0.66; 95% CI=0.46–0.96), and absence of other comorbidities with fewer sensory/pain complaints (IRR=0.84; 95% CI=0.71–0.99). Vaccination after infection showed no significant difference from the reference group (all health issues IRR=1.06; 95% CI=0.90–1.26). Hospitalisation history was not significantly associated with complaint count (IRR=0.82; 95% CI=0.67–1.01), but the wide confidence interval and small number of hospitalised patients (n=14) preclude strong conclusions.

Table 3. Factor associated with the rate of daily post-COVID health issues in patients with diabetes

[Insert Tabel 3 here]

Figure 2. Association of vaccination status with daily post-COVID health complaints. Incidence rate ratio (IRRs) with 95% confidence intervals from multivariable negative binomial regression. Reference group: vaccinated before infection. Error bars represent 95% CI. The vertical dashed line indicates null effect (IRR=1). Never vaccinated individuals had significantly higher rates of all health issues (IRR=1.45, 95% CI 1.10–1.91), while those vaccinated after infection showed no significant difference (IRR=1.06, 95% CI 0.90–1.26).

[Insert Figure 2 here]

DISCUSSION

In this community-based study of diabetic COVID-19 survivors in Indonesia, pre-infection vaccination was the strongest modifiable factor associated with fewer persistent daily health complaints. Never-vaccinated individuals had a 45% higher rate of complaints compared to those vaccinated before infection. This finding is consistent with large-scale studies showing that pre-infection vaccination reduces severe acute outcomes

[3, 21, 31] and may lower long-term complications by mitigating initial infection severity and reinfections [3]. However, as we did not measure acute severity, this mechanism remains speculative.

The timing of vaccination mattered: those vaccinated only after infection showed no protection from that episode (IRR = 1.06). This risk gradient (never vaccinated > vaccinated after infection > vaccinated before infection) is unlikely to stem from random error and generate hypotheses for future research [32], though it does not prove causality given the cross-sectional design.

Female sex was associated with higher complaint rates across all domains, activity limitations (IRR = 1.37). This may reflect sex differences in inflammation responses and hypothalamic-pituitary-adrenal axis dysregulation, as reported in long COVID cohorts [33][34][35]. Higher education protected against body system dysfunction, possibly due to better health literacy and access to care [10]. Absence of other comorbidities reduced sensory/pain symptoms, consistent with lower baseline inflammation [11, 14, 36, 37].

Unexpectedly, hospitalisation history was not associated with more complaints due to low statistical power (only 14 hospitalized patients) and potential survival bias (the sickest patients may have died before the study).

Strength and Limitations

To our knowledge, this is the first community-based study of post-COVID health complaints in diabetic patients from an LMIC primary care setting, including populations often underrepresented in hospital-based studies.

Several limitations must be acknowledged. First, the cross-sectional design precludes causal inference; we can only report association. Second, COVID-19 infection history and health complaints were self-reported, introducing potential recall bias. We attempted to mitigate this by verifying vaccination status with electronic records, but no serological confirmation of past infection was available. Third, the absence of an uninfected diabetic control group means we cannot determine what proportion of complaints is specifically attributable to COVID-19 versus pandemic-related stress or diabetic progression. Horst et al. [38] found that only 6–9% of self-reported symptoms in a community cohort were attributable to SARS-CoV-2 infection itself; applying that fraction conservatively, our prevalence estimates would be substantially lower. Fourth, the sample predominantly comprised older adults (median 60 years), limiting generalisability to younger diabetic patients. Fifth, the low hospitalisation rate (2.4%) limited power to detect association with acute severity.

Despite these constraints, the observed risk gradient and biological plausibility support the protective association of pre-infection vaccination. Our findings complement Wei et al. [23], who showed that post-COVID primary care follow-up improved survival in multimorbid older adults, primary care's critical role. This suggests a dual strategy: promoting pre-infection vaccination and ensuring timely post-infection follow-up.

Implications for policy and practice

In LMIC primary care setting, integrating COVID-19 vaccination promotion into routine chronic disease management for diabetic patients may reduce long-term disability. *Puskesmas* can identify high-risk patients (unvaccinated, female, those with comorbidities) and offer early intervention. The 25-item checklist can be adapted into a shorter screening tool for daily clinical use. Family physicians should explore vaccination history in diabetes assessments and adopt a biopsychosocial framework to address multisystem complaints (pain, fatigue, visual disturbance, cognitive issues) that do not fit neatly into single-organ disease categories.

CONCLUSIONS

Pre-infection COVID-19 vaccination is associated with substantially fewer persistent daily health complaints in diabetic patients. Female sex is an additional risk factor. These findings highlight the public health value of integrating vaccination into chronic disease management at the primary care level in LMICs. Future prospective studies with serologically confirmed infection and uninfected control groups are needed to establish causality.

Abbreviations

BMI	Body mass index
CI	Confidence interval
COVID-19	Coronavirus disease 2019
CVI	Content validity index
DI Yogyakarta	Daerah Istimewa Yogyakarta (Special Region of Yogyakarta)
ICF	International Classification of Functioning, Disability and Health
IPAQ	International Physical Activity Questionnaire
IRR	Incidence rate ratio
KNN	K-nearest neighbours
LMIC	Low- and middle-income country
MMAS-8	8-item Morisky Medication Adherence Scale
Puskesmas	Pusat Kesehatan Masyarakat (community health centre)
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
VIF	Variance inflation factor
WHO	World Health Organization

Declarations

Ethic approval and consent to participate

This study was approved by the Research and Community Engagement Ethical Committee of Faculty of Public Health Universitas Indonesia (Approval No: Ket-269/UN2.F10.D11/PPM.00.02/2024). All procedure were in accordance with the 1964 Helsinki declaration and its later amendments. Written informed consent was obtained from all participants prior to data collection, including permission to access their vaccination records and health data from the *SatuSehat* application. All data were fully anonymised before analysis.

Consent for publication

No applicable. No individual person's data (such as images, video, or identifiable details) are presented in this manuscript.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to ethical restrictions (patients' privacy and confidentiality agreements with the participating community health centres) but are available from the corresponding authors on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Putri Bungsu Machmud: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing-original draft, Visualization Husnul Khatimah: Methodology, Investigation, Data curation, Formal analysis, Writing-review and editing. Renti Mahkota: Data verification, Writing-review and editing. Jessica Veronica: Data verification, Writing-review and editing. Arie Wahyu Wijayanto: Formal analysis, Data verification, Writing-review and editing. All authors read and approved the final manuscript.

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Tables

Table 1. Demographic and clinical characteristics of diabetic patients after COVID-19 infection (n=420)

Variable	Total n (%)
Age, median (IQR)	60 (53-65)
Sex (female)	295 (70.2)
Body Mass Index	
Normal	101 (24.0)
Overweight	97 (23.1)
Obesity	206 (49.0)
Underweight	16 (3.8)
Marital status (married)	324 (77.1)
Education, n (%)	
Primary	184 (43.8)
Secondary	156 (37.1)
Higher	80 (19.0)
Employed	225 (53.6)
Above poverty line	376 (89.5)
Physical activity, n (%)	
Low	103 (24.5)
Moderate	143 (34.0)
High	174 (41.4)
Diabetes medication, n (%)	
Metformin	359 (85.5)
Insulin	53 (12.6)
None	8 (1.9)
Medication adherence (moderate)	408 (97.1)
Other comorbidities, present*	
Hypertension	201 (47.9)
Tuberculosis	1 (0.2)
Renal failure	2 (0.5)
Heart disease	58 (13.8)
Stroke	7 (1.7)
High cholesterol/Triglyceride	55 (12.8)
Vaccination status at infection, n (%)	
Vaccinated before infection	152 (36.2)
Vaccinated after infection	231 (55.0)
Never vaccinated	37 (8.8)
COVID-19 hospitalization, yes	14 (3.3)
Health issues, median (range)	

All health issues	3 (0 – 20)
Sensory function and pain	2 (0 – 7)
Body system function	0 (0 – 8)
Activities impairment	1 (0 – 5)

*Respondent may be choosing more than one answer

Table 2. Daily health issues of diabetic patients after COVID-19 infection (n=420)

Sensory function and pain	n (%)	Body system function	n (%)	Activities impairment	n (%)
Joint/muscle pain [6]	193 (46.0)	Sweating a lot (14)	54 (12.9)	Exhaustion and weakness (1)	102 (24.3)
Visual impairment [18]	181 (43.1)	Loss of appetite/loss of weight (24)	52 (12.4)	Concentration disorder (23)	86 (20.5)
Itching [20]	128 (30.5)	Constipation (25)	49 (11.7)	Coughing (7)	51 (12.1)
Pain around the neck and backbone [8]	122 (29.0)	Night sweating (17)	44 (10.5)	Leg swelling (16)	25 (6.0)
Headache/dizziness [5]	62 (14.8)	Digestive disorders (13)	41 (9.8)	Cold (12)	25 (6.0)
Ear pain [21]	48 (11.4)	Heart palpitations (15)	36 (8.6)	Shortness of breath (with/without activity) (2)	16 (3.8)
Chest pain [22]	28 (6.7)	Wheezing (19)	16 (3.8)		
Olfactory impairment [3]	4 (1.0)	Diarrhoea (9)	16 (3.8)		
Taste disorder [4]	1 (0.2)	Fever (11)	16 (3.8)		
		Nausea with or without vomiting (10)	14 (3.3)		

Table 3. Factor associated with the rate of daily post-COVID health issues in patients with diabetes

Variables	All Health Issues		Sensory function and pain		Body system function		Activities impairment	
	IRR	95%CI	IRR	95%CI	IRR	95%CI	IRR	95%CI
(Intercept)	4.85	2.28–10.33	2.50	1.25–4.99	2.90	0.67–12.80	0.59	0.18–2.44
Age (years)	1.00	0.99–1.01	1.00	0.99–1.01	0.99	0.97–1.01	1.01	0.99–1.02
Sex (ref: male)	1.25	1.02–1.53*	1.22	1.01–1.48*	1.19	0.80–1.76	1.37	1.02–1.86*
BMI (BMI score)	1.00	0.99–1.00	1.00	0.99–1.01	1.00	0.99–1.01	0.99	0.96–1.00
Marital status (ref: with partner)	1.03	0.84–1.25	0.96	0.80–1.15	1.27	0.87–1.85	0.95	0.71–1.27
Education level (ref: primary)								
Secondary	0.86	0.71–1.03	0.82	0.69–0.97	0.66	0.46–0.96*	1.25	0.95–1.64
Higher	0.84	0.66–1.07	0.82	0.66–1.03	0.65	0.40–1.04	1.14	0.80–1.62
Occupation (ref: unemployed)	0.94	0.80–1.11	0.94	0.80–1.09	0.96	0.69–1.32	0.99	0.77–1.26
Economic (ref: below the poverty line)	0.84	0.64–1.11	0.92	0.72–1.18	0.71	0.42–1.18	0.88	0.59–1.35
Physical activity (ref: High)								
Low	1.10	0.89–1.35	1.05	0.86–1.26	1.15	0.77–1.74	1.08	0.79–1.45
Moderate	1.14	0.95–1.37	1.12	0.95–1.33	1.18	0.83–1.69	1.16	0.89–1.52
Other comorbidities (ref: present)	0.87	0.73–1.03	0.84	0.71–0.99*	0.92	0.65–1.30	0.81	0.62–1.06
Hospitalizations during COVID-19 infection (ref: hospitalised)	0.82	0.67–1.01	0.86	0.72–1.04	0.71	0.48–1.05	0.83	0.64–1.15
Vaccination status at time of infection (ref: vaccinated before infection)								
Vaccinated After infection	1.06	0.90–1.26	1.01	0.86–1.19	1.20	0.86–1.67	1.04	0.81–1.33
Never vaccinated	1.45	1.10–1.91**	1.29	1.01–1.63*	1.97	1.18–3.33**	1.39	1.01–2.02*

*P value <0.05

**P value <0.01

Figures

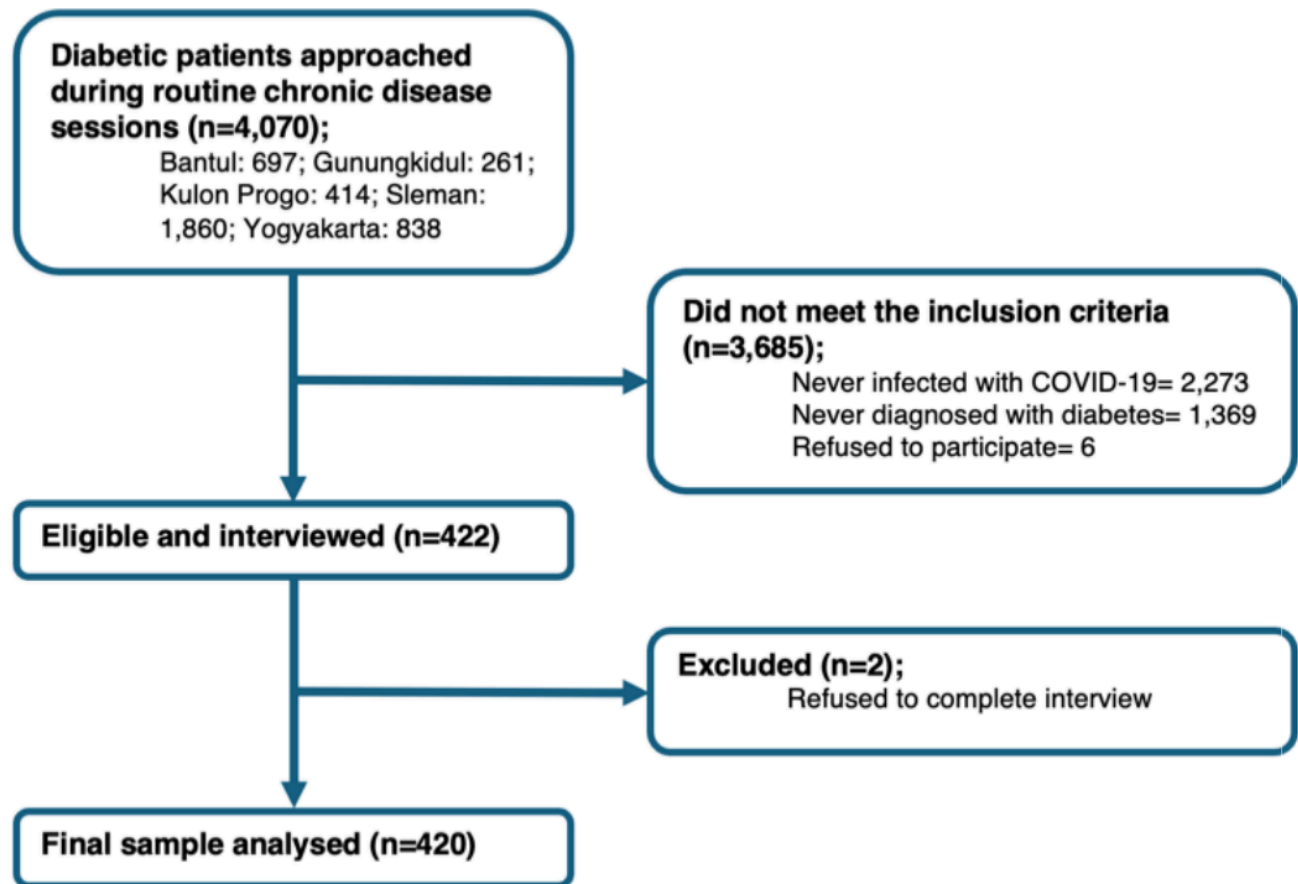


Figure 1

Flow diagram of participant selection

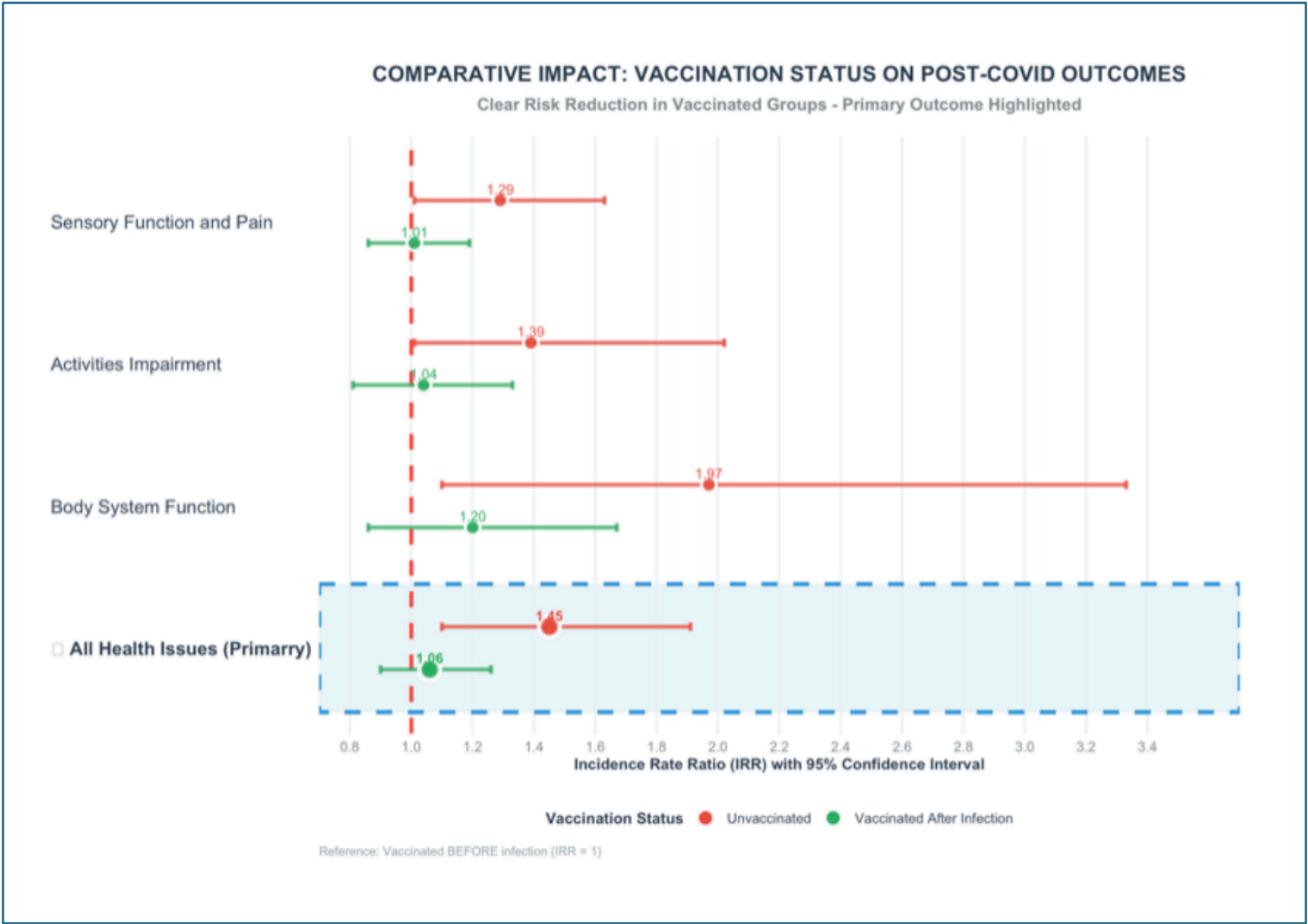


Figure 2
Association of vaccination status with daily post-COVID health complaints

Supplementary Files

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