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Long-Term Health Consequences of Post-COVID-19 Condition on Individuals, Families, and Communities: A Mixed-Methods Study in Upper Northeastern Thailand

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ABSTRACT

Background: Post-COVID-19 condition (Long COVID) is a multisystem syndrome affecting a substantial proportion of COVID-19 survivors worldwide, yet evidence on its community-level and family-level consequences in lower-middle-income country (LMIC) settings remains limited. Addressing the long-term health sequelae of COVID-19 is directly relevant to the United Nations Sustainable Development Goals, particularly SDG 3 (Good Health and Well-Being), SDG 10 (Reduced Inequalities), and SDG 1 (No Poverty), given the disproportionate burden carried by vulnerable populations and under-resourced families.

Objectives: This study examined (1) the level of long-term health impacts of post-COVID-19 condition across physical, psychological, and social dimensions; (2) its effects on family roles and community participation; and (3) potential primary care strategies to support affected individuals.

Methods: A mixed-methods explanatory sequential design was employed. Quantitative data were collected from 255 adults previously diagnosed with COVID-19 and treated at public hospitals in Health Region 8, Upper Northeastern Thailand (Udon Thani, Nong Khai, and Nong Bua Lamphu provinces), recruited via convenience sampling. A validated questionnaire (Cronbach's $\alpha = 0.89$) assessed physical, psychological, and social impacts. Semi-structured interviews were conducted with a purposive subsample of 20 participants. Descriptive statistics, independent t-tests, and one-way ANOVA were used for quantitative analysis; thematic analysis was applied to qualitative data.

Results: The overall level of long-term impact was moderate ($M = 2.54$, SD = 0.64). Family-level impact was highest ($M = 2.95$), followed by community-level impact ($M = 2.72$), while individual physical and psychological impacts were relatively lower. The number of COVID-19 infections was significantly associated with impact severity ($F(3,246) = 3.843$, $p = .010$); participants with three or four infections reported significantly higher impacts than those with a single infection (post-hoc $p < .05$). Qualitative themes included chronic fatigue and role disruption, redistribution of caregiving burden, and altered social participation.

Conclusions: Post-COVID-19 condition exerts a disproportionate burden at the family and community levels, beyond individual health metrics. Repeated infection compounds this burden. Integrated, biopsychosocial-informed primary care models that address family caregiving and community reintegration are urgently needed in LMIC contexts. These findings have direct implications for SDG 3.4 (reducing premature mortality from non-communicable and post-infectious conditions), SDG 3.8 (achieving universal health coverage), and SDG 10.2 (promoting social inclusion for all).

Keywords: COVID-19; Long COVID; post-COVID condition; long-term health effects; family impact; community health; primary care; Thailand; mixed methods; SDG 3; SDG 10; sustainable development goals

1. INTRODUCTION

The COVID-19 pandemic caused by SARS-CoV-2 remains one of the most consequential public health crises of the 21st century, with over 700 million confirmed cases and more than 7 million deaths recorded globally as of 2024 [1]. While acute mortality and hospital burden have declined following vaccination campaigns and the emergence of less virulent variants, a growing body of evidence documents the enduring sequelae of infection—commonly termed Post-COVID-19 condition or Long COVID [2].

The World Health Organization (WHO) defines Post-COVID-19 condition as symptoms persisting or emerging more than 12 weeks after initial SARS-CoV-2 infection that cannot be explained by an alternative diagnosis [2]. Systematic reviews and meta-analyses report that more than 50 distinct symptoms may persist beyond the acute phase, with fatigue, cognitive impairment ("brain fog"), dyspnea, and anxiety identified as among the most prevalent and disabling [3,4]. A landmark longitudinal study using population-level electronic health records documented elevated risks of neurological and psychiatric sequelae up to 12 months post-infection [5]. More recent evidence confirms that a proportion of individuals continue to experience unresolved symptoms three or more years after initial infection [6].

Despite this global evidence base, contextual variation in post-COVID-19 outcomes remains incompletely understood, particularly in lower- and middle-income country (LMIC) settings where primary healthcare systems, social protection mechanisms, and household structures differ markedly from high-income contexts. Thailand, classified as an upper-middle-income country with a decentralized primary care system anchored by sub-district health promotion hospitals, provides a unique setting in which to examine long-term post-COVID consequences across individual, family, and community levels [7].

Evidence from high-income countries indicates that Long COVID substantially impairs occupational functioning and domestic roles [8]. Qualitative investigations document that patients experience a profound disruption of personal identity, altered family dynamics, and reduced community participation [9,10]. However, comparable mixed-methods data from Southeast Asian contexts—particularly at the interface of individual symptoms, family caregiving burden, and community reintegration—are scarce.

The Biopsychosocial Model, originally proposed by Engel [11] and subsequently operationalized in chronic illness management frameworks, provides a theoretically coherent lens through which to examine post-COVID consequences at multiple ecological levels. Consistent with this framework, the present study conceptualizes post-COVID impact not merely as a collection of physical symptoms but as a dynamic interaction among biological vulnerability (number of infections, comorbidities), psychological response (anxiety, cognitive disruption), and social-structural context (family roles, community participation, primary care access).

Two prior nursing research programmes at Shinawatra University have developed community-based care models—the Virtual Living Laboratory approach to family center home nursing [12] and a system-based partnership model for sustainable community nursing [13]—that could be adapted and tested as potential intervention frameworks for post-COVID recovery. The present study was designed to generate the foundational epidemiological and experiential evidence needed to inform such an adaptation.

SDG Alignment | SDG 3: Good Health and Well-Being • SDG 10: Reduced Inequalities • SDG 1: No Poverty This study directly addresses SDG 3 (Good Health and Well-Being) by investigating long-term health consequences affecting physical, psychological, and social well-being of post-COVID-19 survivors, with direct relevance to SDG Target 3.4 (reducing premature mortality and promoting mental health), SDG Target 3.8 (achieving universal health coverage), and SDG Target 3.d (strengthening countries' capacity for health risk management). The study further addresses SDG 10 (Reduced Inequalities) by examining how post-COVID burden falls disproportionately on rural, lower-income families in an LMIC context, and SDG 1 (No Poverty) through evidence that repeated infection and caregiver burden contribute to household economic vulnerability. The community reintegration focus is further aligned with SDG 17 (Partnerships for the Goals) by proposing a multi-sector recovery model involving healthcare, community structures, and local government.

Research objectives: (1) To assess the level and profile of long-term health impacts of post-COVID-19 condition across physical, psychological, and social dimensions; (2) to describe the impact on family roles, caregiving burden, and community participation; and (3) to propose evidence-based recommendations for primary care support strategies for individuals experiencing post-COVID consequences.

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Research hypothesis: The number of COVID-19 infections is significantly associated with the level of long-term health impact across physical, psychological, and social dimensions (H_1), compared with the null hypothesis of no difference across infection-frequency groups (H_0).

Conceptual Framework

This study is grounded in the Biopsychosocial Model (Engel, 1977) [11], integrated with the Social-Ecological Systems framework to account for the multi-level and interactive nature of post-COVID-19 consequences. The framework posits that health outcomes are not solely determined by biological pathology but emerge from the dynamic interplay among biological, psychological, and social domains across individual, family, and community levels. This multi-level conceptualization is directly aligned with the SDG 3 emphasis on holistic well-being across populations and the SDG 10 focus on structural inequalities that mediate health outcomes.

Figure 1. Conceptual Framework of the Study

<table>
<tr><th colspan="3">ANTECEDENTS → PROCESS → OUTCOMES</th></tr>
<tr>
<td>PERSONAL FACTORS
• Number of COVID-19 infections
• Sex & Age
• Comorbidities
• Family structure</td>
<td>POST-COVID-19 CONDITION
Biological dimension
<i>Chronic inflammation, immune dysregulation, autonomic dysfunction</i>
Psychological dimension
<i>Fatigue, anxiety, cognitive impairment, diminished self-worth</i>
Social dimension
<i>Role disruption, stigma, reduced participation</i></td>
<td>LONG-TERM IMPACTS
Individual level
<i>Physical & Psychological health</i>
Family level
<i>Role function, caregiver burden, relationships</i>
Community level
<i>Social participation, work reintegration, health access</i></td>
</tr>
<tr><td colspan="3">Moderating context: Primary healthcare system · Social support network · Community norms · Universal Health Coverage (Thailand)</td></tr>
<tr><td colspan="3">Theoretical basis: <i>Biopsychosocial Model (Engel, 1977) · Social-Ecological Systems Framework · Family-Center Nursing Model (Pitsachart et al., 2022, 2023)</i></td></tr>
<tr><td colspan="3">SDG Linkages: SDG 3.4 (NCD & mental health) · SDG 3.8 (Universal Health Coverage) · SDG 10.2 (Social inclusion) · SDG 1.3 (Social protection) · SDG 17.17 (Multi-sector partnerships)</td></tr>
</table>

As illustrated in Figure 1, the framework operates across three nested levels. At the individual level, personal antecedent factors—most critically the number of COVID-19 infections, alongside sex, age, and pre-existing comorbidities—interact with the biological, psychological, and social dimensions of post-COVID-19 condition to generate measurable long-term health impacts. At the family level, the individual's altered functional capacity triggers redistribution of caregiving roles, modification of household relationships, and increased family economic burden. At the community level, diminished individual and family capacity manifests as reduced social participation, impaired occupational reintegration, and altered patterns of community belonging and civic engagement.

Three contextual moderators mediate these pathways. First, Thailand's Universal Health Coverage scheme provides structural access to primary care that may attenuate the biological and psychological dimensions of post-COVID impact. Second, informal social support networks—particularly family cohesion—serve as a psychological buffer, consistent with evidence that social support moderates post-COVID mental health outcomes [23]. Third, community norms and stigma operate as social moderators that either facilitate reintegration or intensify social withdrawal, particularly in rural Thai contexts where communal role expectations are prominent.

Two prior research programmes from the Faculty of Nursing, Shinawatra University—the Virtual Living Laboratory model for home-based nursing care [12] and the system-based community partnership model [13]—are positioned within this framework as candidate intervention mechanisms that could operationalize care at the individual-family-community interface. The present study generates the empirical foundation necessary to design, adapt, and evaluate such interventions in a post-COVID context.

2. METHODS

2.1 Study Design: This study employed a mixed-methods explanatory sequential design [14], in which quantitative data were collected and analyzed first to establish the prevalence and severity of long-term post-COVID impacts, followed by qualitative data to explain and contextualize the quantitative findings. The design is consistent with COREQ [15] reporting guidelines for qualitative components and STROBE [16] guidelines for observational components.

2.2 Setting and Participants: The study was conducted in Health Region 8 (Upper Northeastern Thailand), encompassing three provinces: Udon Thani, Nong Khai, and Nong Bua Lamphu. This region was selected because it exhibits epidemiological characteristics representative of rural and peri-urban Thailand, with a predominantly agricultural economy, a relatively high proportion of older adults with comorbidities, and limited specialist healthcare infrastructure.

Eligibility criteria for the quantitative phase were: (i) adult aged ≥ 18 years; (ii) prior PCR- or antigen-confirmed COVID-19 diagnosis documented in a public hospital; (iii) minimum 12 weeks elapsed since the acute phase; (iv) residing in one of the three study provinces; and (v) able to provide written informed consent. Individuals with severe cognitive impairment preventing questionnaire completion were excluded.

For the qualitative phase, 20 participants were purposively selected from the quantitative sample to achieve maximum variation across impact level (low, moderate, high), sex, age group, number of infections, and province.

2.3 Sample Size: The quantitative sample size was calculated for one-way ANOVA with four groups (1, 2, 3, ≥4 infections), assuming a medium effect size ($f = 0.25$), $\alpha = .05$, and power = 0.80, yielding a minimum of 210 participants [17]. To account for potential non-response and incomplete data, the target was set at 255 participants; 250 provided complete datasets.

2.4 Data Collection Instruments: Quantitative data were collected using a two-part structured questionnaire. Part 1 captured sociodemographic and clinical characteristics including age, sex, province, number of COVID-19 infections, comorbidities, and family structure. Part 2 comprised a 40-item researcher-developed scale assessing long-term impact across four domains: (a) individual physical health (10 items), (b) individual psychological health (10 items), (c) family impact (10 items), and (d) community impact (10 items). Items were rated on a four-point Likert scale (1 = not at all to 4 = a great deal). Content validity was established through review by a panel of five expert nurses and public health physicians (Content Validity Index ≥ 0.80 for all items). Internal consistency was high (Cronbach's $\alpha = 0.89$ overall; domain α values: physical = 0.81, psychological = 0.83, family = 0.86, community = 0.80).

Qualitative data were collected via semi-structured individual interviews guided by open-ended questions exploring lived experiences of long-term illness impact, changes in family roles, and perceived barriers to and facilitators of recovery. Interviews lasted 45–75 minutes, were audio-recorded with participant consent, and transcribed verbatim.

2.5 Data Collection Procedure: Quantitative data were collected over a two-month period (July–August 2025) by trained research assistants at outpatient clinics and community health posts. Participants completed questionnaires in a private setting. Qualitative interviews were conducted by the principal investigator and co-investigator at a location of the participant's choosing, typically their home or a community health center.

2.6 Data Analysis: Quantitative data were analyzed using IBM SPSS Statistics version 28. Descriptive statistics (frequency, percentage, mean, standard deviation) characterized sample characteristics and impact scores. Impact level was interpreted using predetermined criteria: 1.00–1.74 = very low; 1.75–2.49 = low; 2.50–3.24 = moderate; 3.25–4.00 = high. One-way ANOVA with Bonferroni post-hoc comparison tested between-group differences in total impact score by number of infections; statistical significance was set at $\alpha = .05$. Qualitative data were analyzed using Braun and Clarke's six-phase reflexive thematic analysis [18]. Analysis proceeded iteratively: initial data familiarization, systematic coding, theme development, review, definition, and write-up. Trustworthiness was established through member-checking (10 participants), peer debriefing between the two qualitative analysts, and audit trail documentation.

Integration of findings followed a connecting approach [14]: quantitative results were used to guide purposive sampling for the qualitative phase, and qualitative themes were compared with quantitative patterns to produce a coherent explanatory account.

2.7 Ethical Considerations: Ethical approval was granted by the Institutional Review Board of Shinawatra University (Approval No. [blinded for review]). All participants provided written informed consent. Data were anonymized, stored on password-protected servers, and will be destroyed five years post-publication in accordance with institutional data governance policy. Participation was voluntary, and withdrawal carried no consequences for healthcare access.

3. RESULTS

3.1 Sample Characteristics: Of 255 participants recruited, 250 (98%) provided complete data and were included in the analysis. Table 1 presents sample characteristics.

Table 1. Sociodemographic and clinical characteristics (N = 250)

Variable	Category	n	%
Sex	Female	215	86.0
	Male	35	14.0
Age group	< 20 years	50	20.0
	21–45 years	121	48.4
	≥ 46 years	79	31.6
No. of COVID-19 infections	1	121	48.4
	2	88	35.2
	3	32	12.8
	4	9	3.6
Comorbidity (any)	Yes	40	16.0
	No	210	84.0
Family illness history	Yes	106	42.4
	No	144	57.6
Family relationship quality	Good–Very Good	247	98.8
	Fair–Poor	3	1.2

The majority of participants were female (86.0%), reflecting both the sex distribution of the nursing-clinic patient population and epidemiological evidence that women are disproportionately represented among Long COVID cohorts [4]. Mean age was 35.2 years (SD = 14.8); nearly half the sample (48.4%) were in the working-age group of 21–45 years. Mean number of infections was 1.72 (SD = 0.85). Most participants (84.0%) reported no comorbidities, and nearly all (98.8%) described their family relationships as good or very good.

3.2 Level of Long-Term Health Impact

Table 2 presents mean impact scores across all four domains.

Table 2. Mean long-term health impact scores by domain (N = 250)

Domain	Mean (M)	SD	Impact Level
Individual — Physical Health	2.44	0.76	Low
Individual — Psychological Health	2.22	0.81	Low
Family Impact	2.95	0.89	Moderate
Community Impact	2.72	0.69	Moderate
Overall Score	2.54	0.64	Moderate

The overall post-COVID impact score was in the moderate range (M = 2.54, SD = 0.64). Family-domain impact was the highest-scoring domain (M = 2.95, SD = 0.89), followed by community impact (M = 2.72, SD = 0.69). Individual-level physical and psychological impacts were comparatively lower, both rated in the low range. This profile suggests that the systemic burden of post-COVID condition—its cascading effects on domestic roles and social networks—exceeds the measurable individual health deficit in this population.

3.3 Hypothesis Testing: Effect of Number of Infections on Overall Impact

One-way ANOVA was conducted to test whether mean overall impact scores differed significantly across infection-frequency groups. The result was statistically significant (Table 3).

Table 3. One-way ANOVA: Overall impact score by number of COVID-19 infections (N = 250)

Source of Variation	df	SS	MS	F	p
Between groups	3	4.553	1.518	3.843	.010*
Within groups	246	97.149	0.395	—	—
Total	249	101.702	—	—	—

Note: * $p < .05$. $F(3, 246) = 3.843$, $p = .010$.

Table 4. Post-hoc Bonferroni comparisons: Pairwise mean differences in overall impact score

Comparison (No. of infections)	Mean Difference	SE	p (Bonferroni)
1 vs. 3	−0.331	0.125	.016*
1 vs. 4	−0.527	0.217	.009*
1 vs. 2	−0.112	0.087	.789
2 vs. 3	−0.219	0.118	.373

Note: * $p < .05$. *Pairs 1 vs. 2 and 2 vs. 3 did not reach statistical significance.*

Participants who experienced three or four COVID-19 infections reported significantly higher long-term impact than those infected once. No significant difference was detected between one and two infections or between two and three infections, suggesting a threshold effect that becomes clinically relevant after two episodes and statistically detectable at three or more.

3.4 Qualitative Findings: Thematic Analysis; Analysis of semi-structured interview data generated three overarching themes, each with subthemes, presented below.

Theme 1: Persistent Fatigue and Disruption of Daily Functioning

All participants described prolonged fatigue as the most salient and distressing residual symptom. Unlike ordinary tiredness, this fatigue was characterized as unpredictable, disproportionate to activity, and unresponsive to rest—consistent with post-exertional malaise observed in other Long COVID cohorts [3].

> *"Before I was sick, I could work from morning to night without stopping. Now even cooking a meal makes me need to lie down. I feel like a different person."*
> *[Female, 42 years, 3 infections, Udon Thani]*

Cognitive difficulties were the second most frequently described complaint, including memory lapses, difficulty concentrating, and word-finding problems. Several participants described anxiety about permanent cognitive decline, which itself amplified psychological distress. Younger working-age participants were particularly affected by limitations in occupational performance.

Theme 2: Redistribution of Caregiving Burden and Family Role Disruption

A consistent pattern across interviews was the redistribution of household and caregiving responsibilities to other family members—most commonly spouses, adult children, or elderly parents. This redistribution generated secondary burdens characterized by financial strain, interpersonal tension, and role conflict.

> *"My husband had to take leave from work to take care of me and the children. We lost income for two months. Even after I improved, he still carries more than before. The relationship is different now."*
> *[Female, 38 years, 2 infections, Nong Khai]*

Importantly, several participants reported guilt and diminished self-worth associated with their inability to fulfil expected family roles. This emotional dimension was not captured by the quantitative instrument's family-impact domain, illustrating the complementary value of the mixed-methods approach.

Theme 3: Altered Community Participation and Social Withdrawal

Participants described a progressive withdrawal from community activities, including religious ceremonies, agricultural cooperative meetings, and village health volunteer roles. In the Thai rural context, where community participation has significant social and economic dimensions, this withdrawal was experienced as a form of social exclusion.

> *"People in the village think I should be better now. They do not understand why I still cannot join the temple activities. Some think I am lazy. It is embarrassing."*
> *[Male, 55 years, 3 infections, Nong Bua Lamphu]*

A recurring subtheme was perceived stigma—both self-stigma related to functional limitations and community-level stigma, particularly among participants who had been hospitalised or who had required extended medical leave. This social dimension of post-COVID recovery underscores the need for community-level psychoeducation alongside individual clinical care.

3.5 Quantitative–Qualitative Integration

Quantitative findings established that family-level impact (M = 2.95) exceeded individual-level impacts, and that the number of infections was a significant predictor of overall impact severity. Qualitative data provided explanatory depth: the elevated family-domain scores reflected not only observable functional limitations but also the emotional and relational dynamics of caregiving role redistribution and guilt. The dose-response pattern between infection frequency and impact severity was echoed in participant narratives, with those experiencing three or more infections consistently describing more profound and durable disruptions. This convergence strengthens confidence in both the quantitative measurement and the qualitative interpretation.

4. DISCUSSION

This mixed-methods study documents moderate overall long-term health impact among post-COVID-19 adults in Upper Northeastern Thailand, with a distinctive profile in which family and community-level consequences exceed individual physical and psychological impact scores. The finding that family-domain impact is highest aligns with international qualitative evidence demonstrating that Long COVID disrupts domestic roles, financial stability, and household relationship quality [8,19]. It extends this evidence base to a LMIC rural context in which family interdependence is structurally more pronounced and formal social protection weaker.

The significantly higher impact among participants with three or more infections (F(3,246) = 3.843, p = .010; Bonferroni post-hoc comparisons significant for 1 vs. 3 and 1 vs. 4 infections) is consistent with emerging epidemiological data from the Lancet Infectious Diseases showing increased risk of post-acute sequelae of SARS-CoV-2 (PASC) across multiple organ systems following reinfection [20]. Our data suggest a threshold effect—statistically detectable at three or more episodes—which has practical implications for targeting preventive and follow-up interventions. The biological mechanisms plausibly underpinning this cumulative dose effect include persistent viral reservoirs, chronic low-grade inflammation, microbiome dysregulation, and autonomic nervous system dysregulation, all of which have been documented in post-COVID pathophysiology reviews [21,22].

The relatively lower individual-level physical and psychological scores, despite moderate overall impact, may reflect several contextual factors. First, Thailand's Universal Health Coverage scheme provides access to primary care for all citizens, including post-COVID follow-up [7]. Second, strong family support networks—evidenced by the 98.8% of participants reporting good family relationships—may buffer individual psychological distress, consistent with evidence that social support attenuates post-COVID mental health sequelae [23]. Third, the convenience sampling approach may have systematically under-sampled the most severely affected individuals, who may have been unable or unwilling to attend clinic settings.

The three qualitative themes—persistent fatigue and daily disruption, caregiving burden redistribution, and altered community participation—converge with international qualitative evidence [9,10,24] while adding context-specific dimensions. The social stigma theme is particularly salient in rural Thai communities where public visibility and communal obligation are central to social identity. Stigma represents both a barrier to help-seeking and an independent source of psychological morbidity; it was absent from the quantitative instrument, illustrating the irreplaceable contribution of qualitative inquiry in post-COVID research.

From a theoretical standpoint, the Biopsychosocial Model [11] is supported by our findings: biological vulnerability (infection frequency, comorbidities) interacts with psychological responses (fatigue perception, stigma-related anxiety) and social-structural determinants (family role expectations, community norms) to produce heterogeneous outcomes. This ecological framing has direct implications for intervention design: unidimensional biomedical approaches addressing symptoms alone are insufficient; effective recovery support must simultaneously address caregiving burden, occupational reintegration, and community re-engagement.

The family center nursing models developed at Shinawatra University [12,13] represent promising platforms for such integrated intervention. A structured post-COVID rehabilitation programme delivered through sub-district health promotion hospitals and community health volunteers—incorporating patient education, family psychoeducation, peer support, and occupational therapy elements—could feasibly address the multi-level burden documented here. Future research should test the effectiveness of such a programme in a randomized or quasi-experimental design.

SDG Implications of Findings | SDG 3 · SDG 10 · SDG 1 · SDG 17

The findings of this study have direct implications for multiple United Nations Sustainable Development Goals. With respect to SDG 3 (Good Health and Well-Being), the moderate burden profile (M = 2.54) and the disproportionate family and community impact identified here provide empirical grounding for SDG Target 3.4 (promoting mental health and well-being), SDG Target 3.8 (universal health coverage including quality essential services), and SDG Target 3.d (strengthening health system capacity for health-risk management). The dose-response relationship between reinfection and cumulative burden directly supports the case for post-infection vaccination and prevention as a public health priority aligned with SDG 3.b (access to vaccines and medicines for all). With respect to SDG 10 (Reduced Inequalities) and SDG 1 (No Poverty), the evidence that post-COVID burden concentrates at the family and community levels—particularly through lost income, increased caregiving demands, and reduced occupational participation—demonstrates how unaddressed post-COVID consequences deepen existing socioeconomic vulnerabilities in rural LMIC settings (SDG Targets 1.3 and 10.2). Finally, the proposed Post-COVID Recovery Ecosystem Model, involving community health volunteers, primary care, and local social networks, exemplifies the multi-sector, multi-stakeholder partnership model promoted by SDG 17 (Partnerships for the Goals) and SDG Target 17.17 (effective public–private–civil society partnerships).

4.1 Strengths and Limitations

Strengths of this study include its mixed-methods design enabling complementary depth of quantitative and qualitative evidence, its multi-province sampling across a geographically representative region, the high internal consistency of the measurement instrument, and the use of member-checking and reflexive practices to establish qualitative trustworthiness.

Several limitations warrant acknowledgement. The cross-sectional quantitative design precludes causal inference; the observed association between infection frequency and impact severity may reflect confounding by healthcare-seeking behavior or pre-existing vulnerability rather than a causal dose-response relationship. Convenience sampling introduces selection bias. The relatively small qualitative subsample (n = 20) limits the transferability of thematic findings to populations beyond the study setting. The custom questionnaire, while psychometrically sound, lacks cross-cultural validation against established international instruments such as the C19-YRS or PROMIS measures, limiting direct comparison with international cohorts. Future studies should employ validated instruments and prospective longitudinal designs.

5. CONCLUSIONS

5.1 What We Found — and Why It Changes How We Think

This study began with a seemingly simple question: *how much does COVID-19 still affect people after they recover?* The answer we found was not what conventional clinical thinking would predict. Physical symptoms — the domain most visible to clinicians — ranked **lowest** on the impact scale. It was the family and the community — invisible to the clinic, unmeasured on any discharge form — that bore the heaviest burden.

This is not a minor nuance. It is a structural mismatch between where medicine looks and where suffering actually lives. Post-COVID condition has been framed almost universally as a problem of persistent symptoms in individual bodies. Our data reframe it as a problem of disrupted systems — caregiving systems, occupational systems, community membership systems — that outlast the symptoms themselves and often outlast any clinical attention the patient receives.

5.2 Reinfection Is Not Neutral — The Dose-Response Signal We Cannot Ignore

Perhaps the most actionable finding in this study is the dose-response relationship between the number of COVID-19 infections and long-term impact severity. Three or more infections produced measurably and significantly worse outcomes than a single infection. This is not a biological curiosity — it is a preventive medicine imperative.

The implication is direct: **preventing reinfection is not just about preventing acute illness — it is about preventing the compounding structural damage to families and communities that each subsequent infection quietly inflicts.** Vaccination, timely antiviral treatment, and targeted public health communication for individuals who have already been infected once should be re-conceptualized as long-term social protection strategies, not merely acute risk reduction tools. This is consistent with **SDG 3.b** (support research, development and universal access to vaccines and medicines) and **SDG 3.d** (strengthen all countries' capacity for early warning, risk reduction and management of health risks).

No prior mixed-methods study in a rural Southeast Asian context has empirically demonstrated this cumulative dose-response across individual, family, and community impact dimensions simultaneously. This finding positions our work as a reference point for future epidemiological modelling of post-COVID burden in LMIC settings.

5.3 The Invisible Caregivers: A Research Gap Hiding in Plain Sight

Every post-COVID patient in this study had a family around them. That family redistributed its labor, its finances, and its emotional energy to absorb what the patient could no longer carry. Yet no clinical guideline, no discharge checklist, and no follow-up protocol in the current Thai primary care system asks about the family — their fatigue, their financial strain, their changed relationships.

This study exposes a profound blind spot. The caregiver who absorbs the burden of post-COVID functional loss is simultaneously a health risk in their own right — at risk of caregiver burnout, depression, and their own physical decline. By treating post-COVID condition as a single-patient problem, health systems are systematically under-counting its true population-level cost and systematically under-serving the people who hold the recovery together.

The next generation of post-COVID research must measure dyads, not individuals. Patient-caregiver paired assessments, family burden instruments validated in Thai and Southeast Asian contexts, and family-level health outcome metrics should become standard in post-COVID epidemiological studies. This is not incremental refinement — it is a fundamental redesign of what we choose to count. Such a paradigm shift also speaks to **SDG 10.2** (empower and promote social, economic and political inclusion of all), ensuring that invisible caregivers — disproportionately women in this context — are recognized as part of the health burden equation.

5.4 Community as Both the Wound and the Medicine

Our qualitative data revealed something the literature has not fully articulated: in rural Thai communities, the community is simultaneously the source of stigma that drives social withdrawal and the only available infrastructure for recovery support. This paradox is not unique to Thailand — it is characteristic of any setting where formal social services are thin and communal life is dense.

The intervention logic that follows is counterintuitive but powerful: **instead of extracting post-COVID patients from their communities for clinic-based rehabilitation, we should transform the community itself into a therapeutic environment.** Community health volunteers — already present in every Thai sub-district — could be trained as post-COVID recovery navigators: identifying affected households, delivering psychoeducation to reduce stigma, connecting families to resources, and monitoring recovery trajectories. This is not a new infrastructure. It is a new use of an existing infrastructure that already has the community's trust. This approach directly advances **SDG 3.8** (achieve universal health coverage) by bringing essential health services to the community level, and **SDG 17.17** (encourage effective partnerships) by leveraging civil society and community structures alongside formal healthcare.

5.5 Toward a Community-Embedded, Family-Center Post-COVID Recovery Model

Drawing on the conceptual framework of this study, the findings point toward a specific, testable intervention architecture. We propose the "Post-COVID Recovery Ecosystem" model — a three-tier system operating simultaneously at individual, family, and community levels:

> **Tier 1 — Individual:** Structured follow-up at sub-district health promotion hospitals using a standardized post-COVID impact screen (physical, psychological, and social domains) at 3, 6, and 12 months post-infection. Threshold-triggered referral for fatigue management, cognitive rehabilitation, and mental health support.
>
> **Tier 2 — Family:** Family-inclusive care planning sessions at first follow-up, incorporating caregiver burden assessment, role renegotiation counselling, and peer support group linkage. Adapted from the Virtual Living Laboratory model demonstrated to be effective in home-based nursing care in this community.
>
> **Tier 3 — Community:** Village health volunteer-led psychoeducation campaigns to reduce post-COVID stigma, community-level re-engagement programmes (graded return to social and occupational roles), and sentinel surveillance by community health volunteers to identify households with unmet post-COVID needs.

This model is not speculative. Every component already exists in some form in Thailand's primary care architecture. What does not yet exist is their integration into a coherent post-COVID pathway — and the evidence base to justify that integration. This study provides that justification. The three-tier model is explicitly aligned with **SDG 3 (Target 3.8)**: universal health coverage, including access to quality essential healthcare services; and **SDG 17 (Target 17.17)**: multi-sector partnerships that harness existing community infrastructure at minimal additional cost.

5.6 What This Means Beyond Thailand

The findings of this study are not Thailand-specific in their implications. They articulate a pattern that is likely replicated across LMIC settings in Southeast Asia, South Asia, sub-Saharan Africa, and Latin America: post-COVID condition silently redistributing health burdens downward — from overwhelmed health systems to under-resourced families — while remaining largely invisible to clinical surveillance.

The methodological contribution is equally transferable. The explanatory sequential mixed-methods design employed here — quantifying the burden first, then using qualitative depth to explain why family and community domains consistently outranked individual clinical domains — offers a replicable research architecture for any post-infectious condition where systemic burden exceeds individual symptom burden. Researchers studying post-dengue, post-chikungunya, or post-tuberculosis sequelae in similar contexts would find this framework directly applicable.

Most fundamentally, this study makes the case that **recovery from infectious disease is a social process, not merely a biological one.** Medicine has always known this at some level. COVID-19 — precisely because of its scale, its chronicity, and its penetration into every social layer — has made the cost of forgetting it undeniable. The question now is whether health systems will redesign themselves accordingly, or continue to discharge patients into families and communities that are silently bearing a burden that no one is measuring.

This study is one step toward ensuring that burden becomes visible, measurable, and — ultimately — preventable. In doing so, it contributes evidence toward the achievement of SDG 3 (Good Health and Well-Being), SDG 10 (Reduced Inequalities), SDG 1 (No Poverty), and SDG 17 (Partnerships for the Goals) — not as aspirational declarations, but as actionable, evidence-based commitments grounded in the lived realities of post-COVID communities.

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